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KEY BREEDING CONTAINERS OF DENGUE VECTORS IN OUTBREAK LOCALITIES IN FEDERAL TERRITORY OF KUALA LUMPUR

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ABSTRACT

Dengue is a mosquito-borne disease that rapidly spreads throughout tropical and subtropical regions. An estimated 2.5 billion people live in dengue-endemic countries and millions of cases occurring each year. Identifying key breeding containers are important to prevent dengue epidemics. This study aims to identify key breeding containers and to evaluate the risks of dengue transmission in the dengue outbreak localities in Kepong District, Kuala Lumpur. Entomological surveillance was done between January 2016 to December 2017 in 38 different outbreak localities. Both indoors and outdoors water-holding containers were inspected for the presence of mosquito larvae. All collected larvae have identified the species, types of breeding containers were recorded, and three larval indices, House Index (HI), Container Index (CI), and Breteau Index (BI), were calculated. Of the 2,067 containers inspected, 227 (10.98%) containers were positive for *Aedes* larvae. The four main breeding container types in this study were plastic containers (31.72%), water drums (22.47%), drains (18.06%), and flowerpots (14.98%). The HI, CI, and BI varied from 0 to 52.94, from 1.72 to 32.76, and from 2.33 to 75.00, respectively. Key breeding containers of *Aedes* larvae found in this study provide guidance for health service providers to educate residents to eliminate the common indoors and outdoors *Aedes* mosquito breeding containers in the study area.

Contribution/Originality: This study contributes evidence-based data on dengue vectors' key breeding containers that useful in planning and monitoring the intervention of vector control strategies.

1. INTRODUCTION

Dengue has a high disease burden globally. It spreads throughout tropical and subtropical regions [1]. Over 100 countries affected by this mosquito-borne disease and approximately 400 million infections occur annually [2]. In Malaysia, dengue has become a major public health issue, with an increasing trend in dengue outbreaks every year. The number of reported dengue cases in 2014 was 108,698 with 215 deaths, followed by 120,836 cases with 336 deaths in 2015, and reduced to 101,357 cases and 237 deaths in 2016 [3]. In the Federal Territory of Kuala Lumpur, the number of reported dengue cases in 2016 was 8,663 with 22 deaths and reduced to 8,350 cases with 19 deaths in 2017 [4].

Aedes albopictus and *Aedes aegypti* are known as dengue vectors in Malaysia [5]. These vector species are widely distributed from inland to coastal areas. *Ae. albopictus* has adapted to a variety of environmental conditions and different larval habitats, while *Ae. aegypti* commonly found breeding indoors [6]. Their effectiveness in transmitting dengue is based on their ability to breed in artificial water-holding containers close to humans and their eggs' ability to survive for months in dry conditions [7].

Rapid development and growth activities in urban areas, have highlighted the problem of vector-borne diseases, especially dengue [8]. Human ecology has created the ideal mosquito breeding environment, although this situation occurs unintentionally [8]. The presence of containers in residential areas is a major factor determining the breeding of the dengue vector since artificial containers are the main larval habitat for *Aedes* mosquito [9]. Storing water in the uncovered container for a long time of period, with suitable conditions, may increase the potential to become *Aedes* breeding sites [10].

Surveys on dengue outbreaks localities in Malaysia found that the plastic containers are the major breeding sites for *Aedes* mosquito [11, 12]. In 2014, *Aedes* surveillance was carried out in outbreak localities in Selangor, Penang, and Federal Territory of Kuala Lumpur found that most of the outbreak localities predominant by *Ae. albopictus*. It breeds mostly outdoors, and the most common containers are plastic containers. Due to the abundance of *Ae. albopictus* and primary dengue vector, *Ae. aegypti* in dengue outbreak localities has suggested that vector control activities should be targeted at both species [13]. The Ministry of Health Malaysia (MOH) is coordinating a national dengue control program that implements an aggressive vector control program focusing on eliminating *Aedes* breeding habitats. This control strategy includes search and destroy any *Aedes* potential breeding sites within a 200-meter radius from the dengue case house and provides health education to the residents [14].

Determination of the larval indices, namely the House Index (HI), Container Index (CI), and Breteau Index (BI) is used in *Aedes* surveillance to evaluate the abundance of *Aedes* mosquito, spatial distribution, and provide information about the period or areas of *Aedes* mosquito population growth [15]. The larval indices have been used in most studies on *Aedes* mosquito, and it supports a significant association between the larval indices and the risk of dengue transmission [16-18]. Therefore, the application of vector control measures and strategies can be performed in a timely manner with knowledge of the larval indices [19].

Identifying *Aedes* key breeding containers are an important key to prevent dengue epidemics. In this context, we aimed to identify the key breeding container of *Aedes* mosquito and to evaluate the actual risk of dengue transmission in the dengue outbreak localities in Kepong District, Federal Territory of Kuala Lumpur based on the larval indices.

2. MATERIALS AND METHODS

2.1. Study Site

Kepong District in the Federal Territory of Kuala Lumpur was selected as the study site. It is located at 3°12′51.2″N and 101°38′20.1″E. A house-to-house container survey was conducted at the 38 outbreak localities from January 2016 to December 2017.

2.2. Larvae Collection and Examination

All water-holding containers both indoors and outdoors were inspected from different randomly selected houses around 50 to 100-meter radius from the case index to determine the existence of mosquito larvae [12]. Each container found was recorded their specific characteristics such as, type of containers, location, exposure to the sun, container's lid status, type of water, and water status. All containers that have the potential to be the mosquito breeding sites were counted and recorded. Pipette or dipper was used to collect the mosquito larvae from the containers depends on the container type. The mosquito larvae found in large opening containers will be slowly scooped by a dipper. While mosquito larvae found in containers with narrow openings will be sucked up using a pipette. To facilitate the larval identification process, only third stage and fourth stage of mosquito larvae were collected.

All mosquito larvae were transported to the Entomology and Pest Unit, Health Department of Federal Territory Kuala Lumpur & Putrajaya's Laboratory, for species identification. Mosquito larvae were killed in hot water (60°C) and transferred to a 70% ethanol solution. After two hours, all mosquito larvae were carefully identified for its species under a microscope, using identification keys [11]. The species of mosquito larvae from each container were recorded and compared. The consent to conduct this study was obtained from the health department and selected households. However, we excluded the households that were not present or disagreed to be involved in this study [20].

2.3. Data Analysis

Data were compiled into a Microsoft Excel sheet to create a database. Larval indices used in the investigation are HI, CI and BI as per guidelines issued by the MOH Malaysia [21]. The threshold for larval indices value for HI is < 1%, CI is < 10% and BI is < 5 [22]. Larval indices were calculated and analyzed using the following equations:

House Index (HI)

$$= \frac{\text{Number of positive houses}}{\text{Total number of houses inspected}} \text{ X } 100\%,$$

Container Index (CI)

$$= \frac{\text{Number of positive containers}}{\text{Total number of containers inspected}} \text{ X } 100\%,$$

Breteau Index (BI)

$$= \frac{\text{Number of positive containers}}{\text{Total number of houses inspected}} \text{ X } 100$$

3. RESULT

Overall, 959 houses were surveyed both indoors and outdoors in the 38 outbreak localities in Kepong District, and of these, 116 (12.10%) houses were found positive for *Aedes* mosquito larvae. A total of 2,067 water-holding containers were inspected, of which 227 (10.98%) containers were infested with *Aedes* mosquito larvae. From these positive containers, 72 (31.72%) plastic containers, 51 (22.47%) water drums, 41 (18.06%) drains, 34 (14.98%) flowerpots, 14 (6.17%) toilet flush tanks, 10 (4.41%) tires, and 5 (2.20%) gully traps. Water-holding containers were found slightly higher outdoors (59.94%), were unlidded or partially lidded (81.57%), and were totally of partially exposed by the sun (50.46%) Table 1.

A total of 2,118 mosquito larvae were collected and identified from 227 positive containers, and of these 1,176 were *Ae. aegypti* and 942 were *Ae. albopictus* Table 2. *Ae. aegypti* bred in all types of water-holding containers were found in the study areas. The majority of the *Aedes* mosquito larvae were collected from containers containing rain water and when they were mixed with tap water (86.78%).

As shown in Table 3 the results of larval indices, HI, CI, and BI at different outbreak localities in Kepong District were ranged between 0% and 52.94%, between 1.72% and 32.76%, and between 2.33 and 75.00, respectively. There were 11 localities didn't have positive mosquito indoor breeding (HI value = 0%), but the mosquito was found breeding outdoor (CI value = >0%) in that localities. The average of larval indices at the study sites found higher than the threshold index (HI < 1%, CI < 10% and BI < 5) with HI, CI, and BI were 12.10%, 10.98%, and 23.67, respectively.

Table-1. Characteristic of *Aedes* mosquito larvae breeding sites in Kepong District.

Container type	Number of inspected containers	Number of containers with *Aedes* larvae	Location found		Sun exposure			Container's lid status			Water type			Water status	
			Outdoor	Indoor	Low	Partial	High	Lidded	Partial	Unlidded	Tap	Rain	Mix	Clean	Polluted
Plastic container	653	72	556	97	131	424	98	53	127	473	97	529	27	607	46
Water drum	425	51	128	297	378	39	8	—	64	361	334	81	10	403	22
Drain	367	41	323	44	121	192	54	—	55	312	103	156	108	334	33
Flower pot	192	34	163	29	29	92	71	—	—	192	33	102	57	177	15
Toilet flush tank	269	14	—	269	269	—	—	242	22	5	269	—	—	263	6
Tire	57	10	57	—	—	9	48	—	6	51	2	53	2	45	12
Gully trap	104	5	12	92	96	8	—	86	15	3	64	16	24	78	26
Total	2067	227	1239	828	1024	764	279	381	289	1397	902	937	228	1907	160

Table-2. *Aedes* mosquito larvae identification from positive containers in Kepong District.

Container type	Number of inspected containers	Number of containers with *Aedes* larvae (%)	*Aedes* species	
			Ae. aegypti (%)	*Ae. albopictus* (%)
Plastic container	653	72 (31.72)	317 (26.96)	483 (51.27)
Water drum	425	51 (22.47)	539 (45.83)	284 (30.15)
Drain	367	41 (18.06)	174 (14.80)	63 (6.69)
Flower pot	192	34 (14.98)	59 (5.02)	75 (7.96)
Toilet flush tank	269	14 (6.17)	42 (3.57)	—
Tire	57	10 (4.41)	9 (0.77)	37 (3.93)
Gully trap	104	5 (2.20)	36 (3.06)	—
Total	2067	227	1176	942

Table-3. Larval indices at outbreak localities in Kepong district.

Study site	Houses Inspected	Positive houses	Containers Inspected	Positive containers	HI (%)	CI (%)	BI
Anjung Villa Condominium	23	3	30	3	13.04	10.00	13.04
Apartment Melur	25	6	29	6	24.00	20.69	24.00
Asrama SMK Segambut Jaya	6	1	17	3	16.67	17.65	50.00
Berek Polis TTDI	24	2	54	2	8.33	3.70	8.33
Flat Negeri Sembilan	43	1	58	1	2.33	1.72	2.33
Flat Sentul Utama	22	0	31	3	0.00	9.68	13.64
Flat Seri Pangkor	29	8	57	10	27.59	17.54	34.48
Flat Seri Perak	108	14	125	18	12.96	14.40	16.67

Kg. Batu Muda A	23	3	32	10	13.04	31.25	43.48
Kg. Batu Muda B	22	2	29	2	9.09	6.90	9.09
Kg. Lembah Melewar	55	8	189	21	14.55	11.11	38.18
Kg. Melayu Kepong	12	2	47	8	16.67	17.02	66.67
Kg. Padang Balang	21	2	43	4	9.52	9.30	19.05
Menara Duta Condominium	13	2	72	7	15.38	9.72	53.85
Menara Megah Condo	5	0	13	3	0.00	23.08	60.00
Menara Orkid	35	0	89	2	0.00	2.25	5.71
Mont Kiara	2	0	27	1	0.00	3.70	50.00
Pangsapuri Sri Batu	17	4	30	6	23.53	20.00	35.29
Pelangi Indah Condominium	17	1	25	1	5.88	4.00	5.88
PPR Batu Muda (Blok A-D)	34	18	58	19	52.94	32.76	55.88
PPR Batu Muda (Blok E-H)	32	2	46	6	6.25	13.04	18.75
PPR Beringin	36	0	52	2	0.00	3.85	5.56
PPR Intan Baiduri	43	5	65	8	11.63	12.31	18.60
PPR Taman Wahyu 2	44	5	66	8	11.36	12.12	18.18
RKAT Ampat Tin	19	4	31	6	21.05	19.35	31.58
Rumah Panjang Jinjang Utara	30	1	59	2	3.33	3.39	6.67
Sri Intan Kondo 2	11	1	35	1	9.09	2.86	9.09
Taman Batu Muda	21	0	32	1	0.00	3.13	4.76
Taman Bukit Maluri	15	4	28	4	26.67	14.29	26.67
Taman Dato Senu A	22	0	101	13	0.00	12.87	59.09
Taman Dato Senu B	25	6	76	7	24.00	9.21	28.00
Taman Intan Baiduri	12	0	27	1	0.00	3.70	8.33
Taman Kepong	17	0	82	3	0.00	3.66	17.65
Taman Koperasi Polis Fasa 2	26	0	61	7	0.00	11.48	26.92
Taman Pelangi	15	3	65	10	20.00	15.38	66.67
Taman Pelangi Jaya	12	3	85	9	25.00	10.59	75.00
Taman Sri Sinar	26	0	33	1	0.00	3.03	3.85
Taman Tun Dr Ismail	17	5	68	8	29.41	11.76	47.06
Total	959	116	2067	227	12.10	10.98	23.67

4. DISCUSSION

In this study, *Aedes* mosquito larvae were found in all the identified containers; however, it is preferred to breed in plastic containers, water drums, drains, and flowerpots as compared to the others. The similar findings were reported from a study in Thailand [23]. *Aedes* mosquito greatly breed in water holding plastic containers in the houses and surrounding areas of the study sites, which corroborates previous studies [24-26]. Most of these plastic containers are located outside their house and are also uncovered or partially covered. *Aedes* mosquito was preferred to breed in containers and able to thrive in both clean and polluted water [27]. Mosquito breeding is associated with several factors such as the types of containers, water quality, and the condition of the containers [24]. The substance dissolved in water may also affect the development of mosquito larvae [24, 28].

Due to often water supply problems in the surveyed localities, most of the residents stored tap water and rainwater in water drums for daily use as their common practice. Water drums that are not properly covered, and the lid of water drums that holds water when exposed to rainwater, contributes to the breeding sites of *Aedes* mosquito [29]. The uncovered water-holding containers for a long period of time will be high potential for mosquitoes breeding habitats [30, 31]. The existence of water-holding containers has been a main factor to determine the breeding of *Aedes* mosquitoes. Therefore, the vector control strategies should be more focused on this issue. There were various of methods can be applied to prevent containers to become mosquito breeding habitats, such as removing unused water-holding containers [30] covering water-holding containers [32, 33] using appropriate biological control agents [32] organized waste management system for residential areas [30] providing knowledge and awareness on mosquito-borne diseases [34] and public health education to the residents [30, 34].

The larval indices found in this survey were relatively high, especially in some outbreak localities. This indicates that the high risk of dengue transmission is still occurring. HI, CI, and BI values were exceeded the threshold value in 27 localities, 20 localities, and 35 localities, respectively. Thus, dengue vector control implementation should be conducted effectively and efficiently in that localities [25]. All the positive water-holding containers for *Aedes* mosquito were found both inside and outside houses, and near to the residential areas, which was less than 100 meters radius. The presence of numerous exposed containers and their ability to hold water for long time, has created a suitable habitat for *Aedes* mosquito larvae [25]. Lack of knowledge and indifference of residents about containers that are at risk of becoming mosquito breeding sites will increase the breeding sites of *Aedes* mosquito around their house [34].

Inter-agency collaboration in eliminating *Aedes* mosquito breeding sites is essential. The evidence-based findings from this study were useful in providing health education to local communities on the importance of search and destroy the water-holding containers surrounding their houses, and these preventive activities should be carried out weekly. The systematic planning by the health department focusing on eliminating high-potential breeding containers in the outbreak localities, will make the vector control activities implemented effectively, efficiently, and cost effective [35].

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