DISTRIBUTION AND ABUNDANCE OF *Aedes* MOSQUITO BREEDING SITES AT CONSTRUCTION SITE WORKERS' HOSTEL IN GELANG PATAH, JOHOR, MALAYSIA

Shahril Hamidun[1,2], Farah Ayuni Shafie[1,3*]
Ahmad Razali Ishak[1,3] & Nazri Che Dom[1,3]
[1] Centre of Environmental Health and Safety,
Faculty of Health Sciences,
Universiti Teknologi MARA,
Kampus Puncak Alam,
42300 Bandar Puncak Alam, Selangor, Malaysia
[2] Pejabat Kesihatan Pelabuhan Tanjung Pelepas,
Blok B, Wisma PTP 81560
Gelang Patah, Johore, Malaysia
[3]Integrated Mosquito Research Group,
Faculty of Health Sciences,
Universiti Teknologi MARA,
Kampus Puncak Alam,
42300 Bandar Puncak Alam, Selangor, Malaysia
*Corresponding author: *farahayuni@uitm.edu.my*

ABSTRACT

In recent decades, the increase of dengue epidemic cases is likely due to the rapid and broad-ranging migration of people and urbanization. Knowing the source is a critical key component for the disease transmission. The main objective of the study was to assess the relationship between the residential area and non-residential area at the construction site workers' hostel towards the *Aedes* breeding distribution and abundance from May 2019 to September 2019. Distribution and abundance of *Aedes* mosquito was determined by using Positive Ovitrap Index (POI) and Mean Eggs per Trap (MET). From 400 ovitraps placed, residential area (Zone A) has the highest number of positive ovitraps with a total of 86 positive ovitraps out of 167 ovitraps that were successfully retrieved with the index of 51.50%. Non-residential area (Zone B) has a total of 60 positive ovitraps out of 152 ovitraps with the index of 39.47%. The number of eggs identified from Zone A was 1656 eggs with MET value of 19.35 while for Zone B, the number of eggs identified was 1025 eggs with MET value of 17.09. The *P*-value obtained for distribution and abundance was 0.05, which means that there is no significant difference in POI and MET for the two types of land use. The outcome of the distribution and abundance from this study can be used to design appropriate strategies to control the vector population and predict the disease transmission. It should also provide a base-line information that is essential for future studies in different types of land uses and towards better understanding of population dynamics of *Aedes* mosquito under local conditions.

Keywords: *Aedes,* distribution, abundance, land use, construction site, positive ovitrap index, mean eggs per trap

ABSTRAK

Dalam beberapa dekad kebelakangan ini, peningkatan kes wabak denggi adalah disebabkan oleh migrasi penduduk dan perbandaran yang pantas dan meluas. Mengenal pasti punca adalah komponen penting untuk merancang strategi yang sesuai untuk mengawal populasi vektor dan menjangkakan penularan penyakit. Objektif utama kajian ini adalah untuk menilai hubungan antara kawasan berpenduduk dengan kawasan tidak berpenduduk di asrama pekerja tapak pembinaan dengan melihat taburan dan kelimpahan pembiakan nyamuk *Aedes* dari Mei 2019 hingga September 2019. Taburan dan kelimpahan pembiakan nyamuk *Aedes* ditentukan dengan menggunakan Indeks Ovitrap Positif (POI) dan Purata Telur per Perangkap (MET). Dari 400 perangkap yang ditempatkan, kawasan perumahan (Zon A) mempunyai jumlah ovitrap positif tertinggi dengan jumlah 86 ovitrap positif daripada 167 ovitrap yang berjaya diambil dengan indeks 51.50%. Kawasan bukan kediaman (Zon B) mempunyai sejumlah 60 ovitrap positif daripada 152 ovitrap dengan indeks 39.47%. Bilangan telur yang dikenal pasti dari Zon A adalah 1656 telur dengan nilai MET 19.35 sementara untuk Zon B, jumlah telur yang dikenal pasti adalah 1025 telur dengan nilai MET 17.09. Nilai *P* yang diperoleh untuk pengagihan dan kelimpahan adalah 0.05, yang menunjukkan tidak ada perbezaan yang signifikan dalam POI dan MET untuk dua penggunaan tanah berbeza. Hasil taburan dan kelimpahan dari kajian ini dapat digunakan untuk merancang strategi yang sesuai untuk mengawal populasi vektor dan meramalkan penularan penyakit. Ia juga memberikan maklumat garis dasar yang penting untuk kajian masa depan dalam berbagai jenis penggunaan tanah dan ke arah pemahaman yang lebih baik tentang populasi tempatan nyamuk *Aedes*.

Kata kunci: *Aedes,* taburan, kelimpahan, guna tanah, tapak pembinaan, indeks ovitrap positif, purata telur per perangkap

INTRODUCTION

Dengue fever is a serious public health problem in tropical and subtropical regions of the world. Malaysia is an endemic country of dengue fever and the most affected regions include Johor, Selangor and Kuala Lumpur (Cheong et al. 2014). Populated areas may be an indicator as the larval habitat has increased rapidly in the urban and peri-urban areas (Nazri et al. 2013a; Mohd Ngesom et al. 2020). The rapid changes in forest to become construction areas may have also influenced the pattern of dengue virus distribution (Faiz et al. 2016; Wan Norafikah et al. 2020).

The Dengue virus is transmitted through the bite of female *Aedes* mosquitoes. The main vectors in the transmission of dengue fever infection are *Aedes albopictus* and *Aedes aegypti*. *Aedes* vectors are container breeders. *Aedes aegypti* prefers indoor artificial containers meanwhile *Ae. albopictus* prefers natural water receptacles found outdoors such as tree holes, rock pools and other natural sites (Ishak et al. 2015; Nazri et al. 2013b; Rao et al. 2011; Wan Norafikah et al. 2010). However, deforestation activities, climate change and rapid growth of human population may have altered the way these two species live and survive in the environment (Shafie et al. 2012; Wan Najdah et al. 2020).

The study area was a newly developed area located inside a village in Gelang Patah, Johor Bahru. The village is located 30 km from the main city and fishery is the main source of income for the villagers. A workers' hostel was erected in the village for the construction workers. Before the hostel was built, there was no reported dengue cases in that village. On 31st July 2018, Johor Bahru Health District Office has declared the hostel area as a Dengue Uncontrolled Outbreak area with 21 cases reported. Until October 2018, 334 dengue cases were reported at various location within the construction sites including the study area. As of end of year 2020, many of the construction work has been completed. This study aimed to investigate the relationship between different types of land use towards the *Aedes* mosquito breeding distribution and abundance in a worker's hostel setting by using Positive Ovitrap Index (POI) and Mean Eggs per Trap (MET).

MATERIALS AND METHODS

Study Area

The study area was a newly developed area for an integrated residential development located in Gelang Patah, Johor Bahru, Malaysia. The hostel for the construction workers was built in the village nearby the construction area. The construction workers were all foreigners and majority of them were from Bangladesh, Nepal, China and Vietnam. The hostel areas were studied for having different types of land use namely the residential area (Zone A) and the non-residential area (Zone B). The description of the study area is detailed out in Table 1. Basically, Zone A consists of the high population area, where the workers live while Zone B consists of the non-residential area, where the landscaping and the plant nursery were located.

Table 1. Description of the study area

Sampling area	Description
Zone A	Residential area. Highly populated with hostel buildings (46 blocks). The distance between each block is small (less than 5 meter). Less vegetation.
Zone B	Landscaping nursery area. Less populated with abundant vegetation and nursery plants for landscaping at the construction site.

Sampling Methods

The ovitraps used to provide suitable resting and breeding site for mosquitoes consisted of 300 ml plastic container with straight and with slightly tapered sides following the method by Lee (1992). The opening measurement is 7.8 cm in diameter with base diameter of 6.5 cm and with 9.0 cm in height. In order to collect and hold the eggs, a paddle made of wooden hardboard (8 cm x 2 cm) has been placed diagonally in each ovitrap. Each ovitrap was filled with dechlorinated water according to Anis et al. 2016 method. Following Ho et al. 2005 and Rozilawati et al. (2015) methods, the ovitraps were deployed every week for two months from shaded locations to avoid direct sunlight exposure and over-flowing of water after rainfalls. The study was conducted for five months starting from May 2019 until September 2019. The traps were remained exposed for four consecutive days. Each trap was positioned at 150 to 200 m from each other. Within the two zones, 10 mini-zones were created within the construction site workers' hostel to facilitate the placement of the ovitraps (Figure 1). There were 10 ovitraps per mini-zone, with a total of total 50 ovitraps in both zones. In total, at the end of the study, 400 ovitraps had been placed in both zones with 200 ovitraps in each zone.

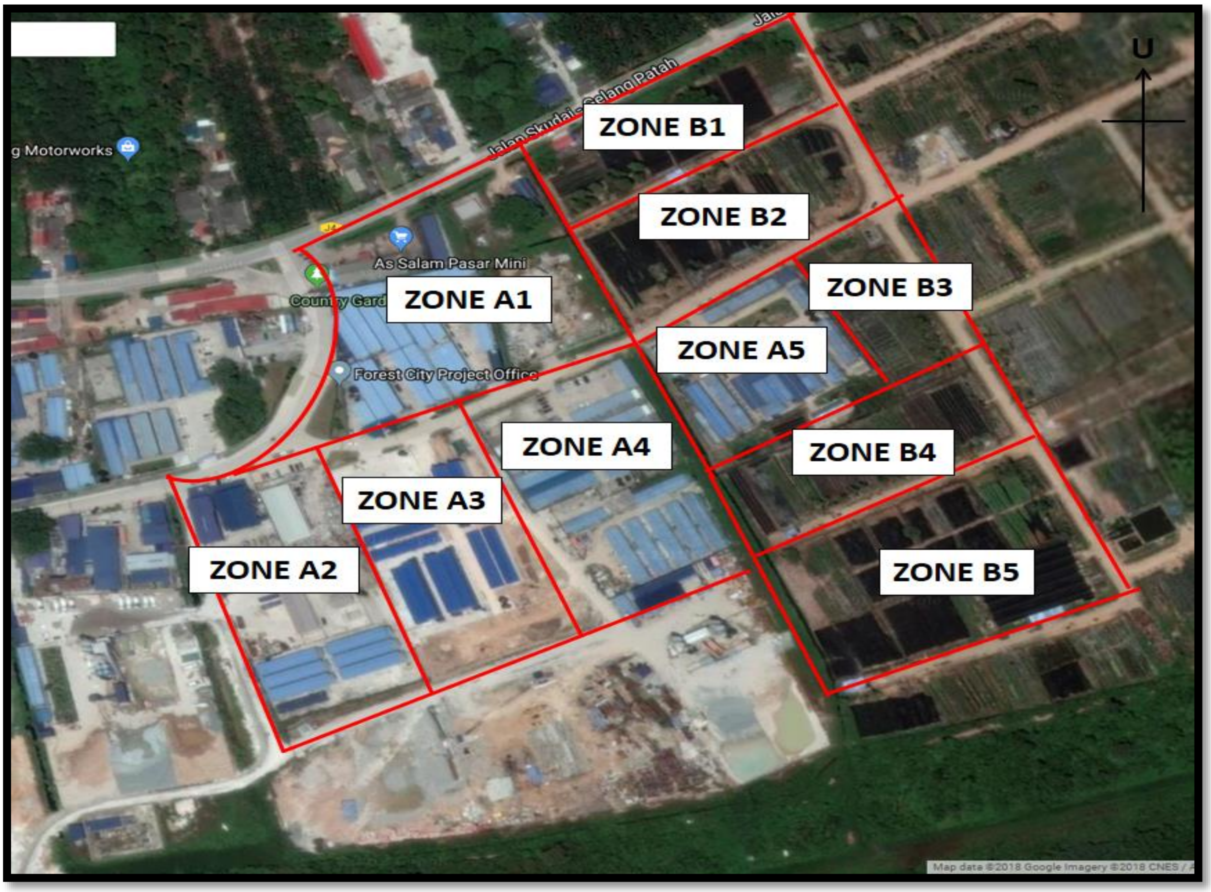


Figure 1. Mini-zones A and B mapped within the construction site

Source: Google Maps (2020)

Data Collection

Upon collection of the ovitraps, the paddles were transferred into airtight plastic bag (13 cm x 6 cm). The ovitraps were tightly covered with its container cap. This exercise was carried out with caution to avoid water spills and loss of the eggs. The paddles were dried to facilitate the process of egg identification and count. The number of eggs in the water were counted and considered as the number of eggs in the ovitraps. For the egg identification, the water in the ovitraps were filtered and dried off.

Data Analyses

To determine the abundance and distribution of *Aedes* data of Positive Ovitrap Index (POI) and Mean Eggs per Trap (MET) were calculated. The *Aedes,* POI value represents the mosquitoes' distribution while MET value indicates the vector's population abundance. For this study, the mean number of eggs per traps and positive ovitraps index were analyzed using descriptive analysis. After normality testing was conducted, the distribution and abundance of dengue vector were analyzed either by using t-test or Mann Whitney test to determine the significant difference between the two different types of land use.

RESULTS AND DISCUSSION

A total of 400 ovitraps were deployed during the eight weeks of study in the residential and non-residential area of the construction workers' hostel area. Out of 400 ovitraps deployed, 319 ovitraps were successfully retrieved from both zones and 146 ovitraps were positive with the presence of *Aedes* mosquitos breeding. A total of 2681 eggs were enumerated from the 146 positive ovitraps from both zones.

Distribution and Abundance of *Aedes* Mosquito Breeding in Residential Area (Zone A)
During the eight weeks of study, 200 ovitraps were placed in zone A, in which 167 ovitraps were recovered from the residential area. The remaining number of ovitraps were either missing, damaged or being interfered. A number of 86 ovitraps (51.50%) were tested positive with the presence of *Aedes* mosquito eggs. The findings have showed the distribution of *Aedes* population in the residential area, ranged from 35% to 65%. Figure 2 shows the POI and MET of the residential area for eight consecutive weeks.

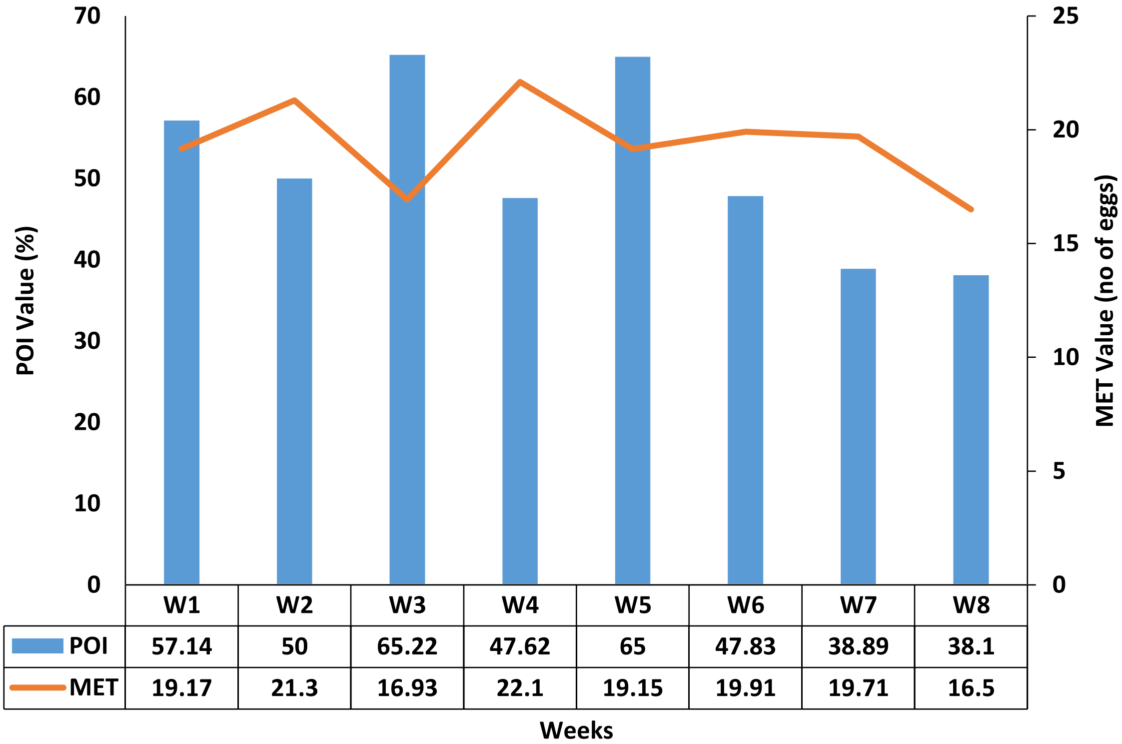


Figure 2. POI and MET against weeks in residential area

The highest percentage of POI in residential area was recorded in week 3 with 15 positive ovitraps (65.22%). Presence of *Aedes* mosquito eggs were in more than half of the ovitraps placed in the zone. The second highest POI was observed in week 5 with 13 positive ovitraps (65%), which was followed by week 1 with 12 positive ovitraps (57.14%). The lowest distribution of *Aedes* mosquito was identified in week 8 with eight positive ovitraps (38.1%). By the end of the study, the average for positive ovitraps was 10.75, whereas for the index for eight weeks, the POI value for residential area was 51.50%. Table 2 describes the mean egg per trap (MET) by weeks.

Table 2. Mean Egg per Trap (MET) by weeks in residential area

Zone	Week	No of Ovitraps Placed	No of Ovitraps Recovered	No of Positive Ovitrap	No of Eggs	Mean Eggs per Trap (MET)
Residential Area (Zone A)	W1	25	21	12	230	19.17
	W2	25	20	10	213	21.3
	W3	25	23	15	254	16.93
	W4	25	21	10	221	22.1
	W5	25	20	13	249	19.15
	W6	25	23	11	219	19.91
	W7	25	18	7	138	19.71
	W8	25	21	8	132	16.5

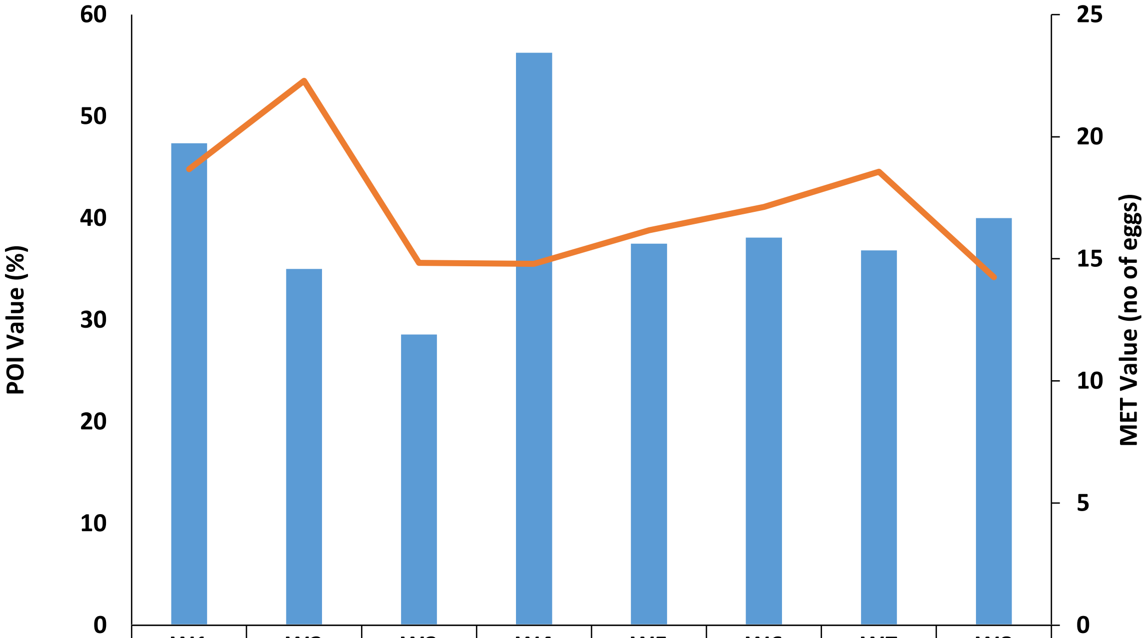
A total of 1656 eggs were collected in the residential area during the eight weeks of study. The number of eggs collected were ranging between 130 and 260 eggs per week. This finding shows that there has been an abundance of *Aedes* mosquitoes breeding in the area. All eggs were collected from 87 positively identified ovitraps. The highest number of eggs recorded was in Week 3 (254 eggs) followed by Week 5 (249 eggs) and the third highest was in Week 1 (230 eggs). The lowest eggs count was in Week 7 with 132 eggs. According to the formula provided by Wan Norafikah et al. (2010), the MET can be obtained after the number of eggs are divided with number of positive ovitraps each week. The three highest MET recorded was in Week 4 [22.1 (221 eggs)], Week 2 [21.3 (213 eggs)] and followed by Week 6 [19.91(219 eggs)]. The lowest MET recorded was in Week 7 [11.73 (138 eggs)]. The average of MET recorded for the eight weeks was 19.35.

The infestation levels of dengue vector on Week 1 until Week 6 were high, reaching approximately 40% of the value of POI. The construction workers' residential area is a highly populated area. The high infestation of dengue vector in the area could be due to the unhygienic conditions of the hostels where litters and discarded receptacles were left lying around inside and outside of the area. Neglecting the surrounding natural and man-made environment may cause the abundance of *Aedes* mosquitoes breeding in human's environment (Anis et al. 2016; Tauxe et al. 2013).

Urbanization activities have provided the ideal environment for *Aedes* mosquitoes as a carrier vector of dengue to breed in urban settlement area such as construction workers' hostels (Conroy et al. 2015). The high infestation and abundance of dengue vector is related to the human activities in the residential area. The habit and nature of *Aedes* mosquitoes are to live within the vicinity of humans or animals so they can have blood meals during active time which is during dusk and dawn (Lu et al. 2009). The physical and outdoor activities of the residents are limited as they spent most time at their workplace every day. Furthermore, unplanned development of hostel area can also be the cause of the infestation and abundance of *Aedes* in the study area. The residents renovated the building structure to accommodate convenience shop and food stalls causing water accumulation and improper drainage in the illegal building structure. Poor waste management from the shop and stalls harbor potential breeding sites.

Distribution and Abundance of *Aedes* Mosquito Breeding in Non-Residential Area

During the eight weeks of data collection, 200 ovitraps have been placed at non-residential area of the workers' hostel. Each week, 25 ovitraps were placed in the five mini zones. Out of 200 ovitraps deployed, only 152 ovitraps were successfully retrieved. The others were either missing, damaged or disturbed. From the 152 ovitraps retrieved, a total of 60 (39.47%) were positive ovitraps in which they were identified with the presence *Aedes* mosquitoes. The POI from the non-residential area ranged was 25% to 60%. Figure 3 shows the trend of POI and MET in non-residential area.



	W1	W2	W3	W4	W5	W6	W7	W8
POI	47.36	35	28.57	56.25	37.5	38.09	36.84	40
MET	18.67	22.29	14.83	14.8	16.17	17.13	18.57	14.25

Weeks

Figure 3: POI and MET against weeks in non-residential area

The highest percentage of POI in non-residential area was in Week 4 with nine positive ovitraps (56.25%) out of 16 ovitraps recovered. The second highest POI was identified in Week 1 with nine positive ovitraps (47.36%) out of 19 ovitraps recovered, followed by Week 8 with eight positive ovitraps (40.00%) out of 20 ovitraps recovered. The lowest distribution of *Aedes* mosquito was observed in Week 3 with six positive ovitraps (28.57%) out of 21 ovitraps recovered. By the end of the study, the average for positive ovitraps was 7.50, whereas the POI value for non-residential area was 39.95%.

In the non-residential area, a total of 1025 eggs were collected during the study period. The number of eggs was used to determine the abundance of *Aedes* breeding. The number of eggs collected ranged between 80 to 170 eggs each week. The highest number of eggs was collected in Week 1 (168 eggs), followed by Week 2 (156 eggs) and Week 6 (137 eggs). The lowest egg count throughout the weeks was observed in Week 3 (89 eggs).

The mean number of eggs per trap was obtained by dividing the number of eggs collected with the number of positive traps (Wan Norafikah et al. 2010). The highest MET value was calculated in Week 2 [22.29 (156 eggs)]. The second highest MET value was identified in Week 1 [18.67 (168 eggs)], followed by Week 7 [18.57 (130 eggs)]. The lowest

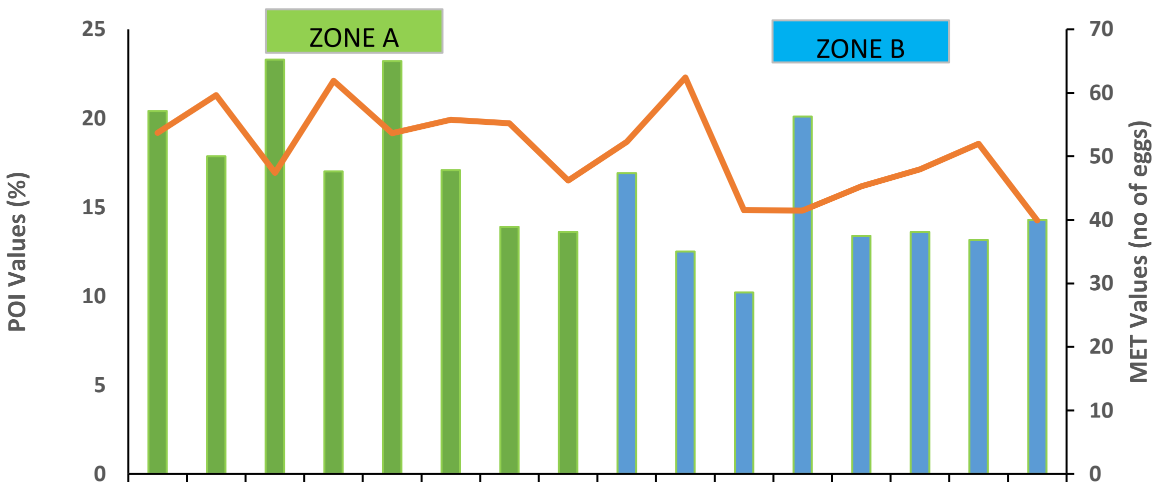
MET value was calculated in Week 8 [14.25 (114 eggs)]. The average of MET calculated for eight weeks was 17.09.

The average of POI value (39.95%) shows medium infestation in the non-residential area. Although there is no residential unit, human activities such as plant maintenance still took place. The distribution of dengue vectors has been associated with the presence of the vegetation in urban and rural areas, and its abundance relies on spaces modified by human activity (Anis et al. 2016). According to Izabel et al. (2009), although non-residential area has more potential breeding sites, it is still not significantly more infested than residential area.

In the non-residential area of study area, there were various types of discarded containers that can hold water. There was also a concrete water storage tank installed by the nursery management for the workers to water the plants. The water storage tank was not covered and not administered with any larvicide. Most of the discarded containers that hold rainwater may be infested with *Aedes* larvae, which could be from female *Aedes albopictus* that prefers to oviposit in a natural and outdoor manmade container that contains high amount of organic debris (Faiz et al. 2016; Nazri et al. 2013b). *Aedes albopictus* is frequently found in sylvatic areas, where there is high vegetation coverage and low human density (Lima-Camara 2016). However, the changes in container preference by both of the dengue vectors have been observed through time and in Malaysia, both species have been found indoors and outdoors regardless the preference (Nazri et al. 2013b; Saifur et al. 2012).

Comparison on the Distribution and Abundance of *Aedes* Breeding in the Different Types of Land Use

For descriptive analysis, the data of both land uses were put together to see the trend of POI and MET. The trends for POI and MET against weeks are shown in Figure 4.



	W1	W2	W3	W4	W5	W6	W7	W8	W1	W2	W3	W4	W5	W6	W7	W8
POI	57.14	50	65.22	47.62	65	47.83	38.89	38.1	47.36	35	28.57	56.25	37.5	38.09	36.84	40
MET	19.17	21.3	16.93	22.1	19.15	19.91	19.71	16.5	18.67	22.29	14.83	14.8	16.17	17.13	18.57	14.25

Weeks

Figure 4. POI and MET against weeks in different types of land use

The highest POI value was in Week 3 (65.22%), which was in Zone A. The second and third highest POI also comes from Zone A, which was in Week 5 (65.00%). The highest MET value was from Zone B in Week 2 (22.29). It was followed by Week 4 in Zone A with MET value of 22.1. Then, the third highest MET value was in Week 2 (21.30) and from Zone A. The lowest MET value was from Zone B in Week 8 (14.25). The highest number of eggs collected throughout this study was in Week 3 in the Zone A with a total of 254 eggs collected within a week.

In comparison, Zone A has a higher number of positive ovitraps compared to Zone B. A total of 86 positive ovitraps out of 167 ovitraps were successfully retrieved with the index of 51.50%. The total number of eggs was also higher in Zone A compared to Zone B with a total of 1656 eggs. Zone A also has higher mean eggs per trap (MET), which was 19.35. Therefore, it can be concluded that Zone A has higher distribution and abundance of dengue vectors than Zone B. The contributing factor could be due to more human activities occurring in Zone A compared to Zone B. Mosquitoes are known to be attracted to the carbon dioxide and pheromone odor emitted by humans which could originate from the skin odor, smelly socks, worn clothes and bedding (Raji et. al 2019).

Another explanation to Zone A having higher distribution and abundance of dengue vector than Zone B could be due to the presence of human at the location during the active time of the vector. According to Lu et al. (2009), the active time of *Aedes* mosquitoes is during dusk and dawn. It is the time where the workers are going and coming back to the construction site. It is also possible that when the workers are walking or cycling back from the construction site to their hostels, they might attract the mosquitoes to follow them with to their body odour, heat and moisture after long working hours and causing the mosquitoes to establish in the residential area.

Furthermore, the residential area Zone A is also not well-maintained. The surrounding was occupied with littered rubbish, which can be potential breeding site for the dengue vector. Although the surrounding condition in Zone B cannot be considered clean, but it was in better condition than Zone A. Neglecting cleanliness of the living and surrounding environment, can cause the abundance of *Aedes* mosquitoes breeding (Anis et al. 2016). Irresponsibility of the people in managing their surrounding may also contribute to the favorable condition of the mosquito breeding sites (Md Shahin et al. 2013).

Distribution and Abundance of *Aedes* Breeding in Different Types of Land Use

Table 3 shows the parametric test, which was the independent sample t-test performed on the Positive Ovitrap Index data for both zones as the data was normally distributed. The significance value for the POI is equal to the alpha value (P<0.05) which is 0.05. Therefore, there is no significant difference in Positive Ovitrap Index between different types of land use. The fact that the number of positive ovitraps found in both zones was relatively high thus, both zones can be declared as highly infested with dengue vector. Both of the zones also have many potential breeding sites for *Aedes* mosquito and were not well maintained in terms of cleanliness and waste management.

Table 3. Independent sample t-test of Positive Ovitrap Index

	t-value	***df***	***P***	**Mean Difference**
Positive Ovitrap Index (POI)	2.15	14	0.05	10.62

Abundance of Aedes Breeding in Different Types of Land Use

Table 4 shows the independent sample t-test performed for Mean Eggs per Trap (MET) for the different types of land use as the data were normally distributed. The significance value is equal to the alpha value (P<0.05) which is 0.05 for Mean Eggs per Trap. Therefore, there is no significant difference in Mean Eggs per Trap between different types of land use. This result is supported by the relatively high total number of eggs found in areas of both zones. Therefore, both zones can be declared as zone of high infestation of dengue vectors.

Table 4. Independent sample t-test of Mean Eggs per Trap

	t-value	***df***	***P***	**Mean Difference**
Positive Ovitrap Index (POI)	2.18	14	0.05	2.49

CONCLUSION

The findings of this study showed that both residential and non-residential areas have the tendencies to become the breeding sites of *Aedes*. Planning and control measures need to be conducted in both areas as environmental management is still the best practice to be adopted to create a safe and healthy environment. After the study completed, the findings were shared with the Johor Bahru District Health Office. The construction developer was instructed to hire a private pest control to conduct activities to reduce abundance of the mosquitoes including fogging, larvaciding and 'search and destroy' activities to destroy potential breeding containers. In 2019, dengue cases were still reported and few locals nearby the village area were also infected but the area was no longer an outbreak area. As of end of 2020, no more new cases were reported as most of the construction works were completed.

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