Original Research Article

External Factors Governing Dengue Outbreaks and Practices Associated in Curbing Dengue Infections among Population in Northern Malaysia

Monica Danial[1,2] , Sivasangari Subramaniam[1,2], Yoon Chee Kin[1], Ong Loke Meng [1]

[1]Clinical Research Center (CRC), Hospital Pulau Pinang, 10990 Jalan Residensi, Pulau Pinang, Malaysia.
[2]National Clinical Research Center, Ministry of Health, Malaysia Level 3, Blok Dermatology, Hospital Kuala Lumpur, 50586 Jalan Pahang, Kuala Lumpur, Malaysia.

Corresponding Author: Monica Danial

ABSTRACT

Dengue infections have been increasingly causing deaths worldwide. In this study the awareness and practices on dengue infection and fever and its association with external factors like effects of urbanization, temperature and humidity profiles and its direct effects to the *Aedes* mosquito population growth were accessed with the demographics of the population. It is evident that although high level of awareness (94.2%) is reported there are profoundly low levels of practice to curb dengue infection such as participation in communal clean-up is less than 75%, less than 60% for participation in the communal fogging, less than 77% for examination of mosquito larvae breeding sites and lesser than 40% for the usage of Abate® for the elimination of mosquito larvae. Therefore, the awareness doesn't translate into practice in curbing the dengue infection among the participated respondents.

Keywords: *Aedes* mosquitoes; Dengue outbreak; Extrinsic factors; Urbanization, Temperature; Humidity.

INTRODUCTION

The occurrence of dengue infection has increased tremendous throughout the world in recent years. It has been reported that there are more than 2 billion people worldwide are at the risk of dengue infection. Currently, dengue is considered as the most important arthropod borne disease in terms of morbidity and mortality. [1]

Dengue is an endemic disease that is prevalent in more than 100 countries which includes Africa, America, Mediterranean, South East Asia and Western Pacific. Among these regions, South East Asia and the Western Pacific are most affected. Before the 1970, it was reported that only nine countries in the world that had experienced the dengue epidemics however there are reports on the outbreaks at new regions not knowing to have cases or epidemics before this like France, Croatia, Florida (USA) and Yunan (China) [2] The first major outbreak was reported in Malaysia in the year 1973 and have been increasing ever since. [3]

Dengue is caused by flavivirus or commonly known as dengue virus which is specific to its vector mosquito. The most common dengue vector mosquitoes are *Aedes aegypti* and *Aedes albopictus*. The four types of dengue serotypes that contracts humans are DEN-1, 2, 3 and 4. The manifestation and disease progression of dengue may even cause death. [4]

There are many effort undertaken by the related bodies for curbing the outbreaks, however limitations arises in the implementation of the programmes due to the lack of support and involvement from the community. Apart from it, there have

been several issues related to the difficulty of controlling dengue infection in some identified hotspots. This is due to the rapid weather changes in our country in [5,6]

Dengue eradication and elimination programs are better implemented if knowledge and vector control practices of the population are understood. [7-9] This study aimed to assess factors affecting awareness and practices on dengue infection and fever among population of northern Malaysia.

MATERIALS AND METHODS

Participants: A cross sectional face to face study conducted from August 2014 until August 2015 among voluntary participation of 337 respondents at the Penang General Hospital, Malaysia. which This study includes participation from the five districts in Penang, Malaysia namely North Seberang Perai (NSP), South Seberang Perai (SSP), Central Seberang Perai (CSP), South West (SW) and North East (NE).

Respondents aged 18 and above who were able to communicate in either Bahasa Malaysia or English were included in this study. Written informed consent was obtained and brief respondent explanatory note was read out to the participants before they answered the questionnaire. The study was carried out after obtaining the approval from the Malaysia Research Ethics Committee (MREC) (Approval number: NMRR-14-1496-22936(IIR).

Validity and Reliability

The questionnaire was adopted from written permission from Sami et al (2013). [5] The Cronbach alpha of different sections of the questionnaire was between 0.681 to 0.954, indicating good reliability. For the current study, the questionnaire was pilot-tested on 20 voluntary participants to test the appropriateness of the questions and their comprehension. This pilot study revealed that the questions seemed to be readily understood by those participated in the pilot.

Statistical methods

The data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) base version 21.0. The study included descriptive and bivariate analysis.

RESULTS

Data from 337 respondents were included in the analysis that agreed to participate in this study.

Table 1: Socio-demographic characteristics of respondents (n=337)

Characteristics	Number (n)	Percentage (%)
Gender		
Male	79	23.4
Female	258	76.6
Age group (years)		
18-30	185	54.9
31-40	86	25.5
≥41	66	19.6
Ethnicity		
Malay	186	55.2
Indian	53	15.7
Chinese	88	26.1
Others	10	3.0
Marital Status		
Single	162	48.1
Married	175	51.9
Employment status		
Employed	214	63.5
Unemployed	123	36.5
Education		
Non tertiary	196	58.2
Tertiary level	141	41.9
People per household		
≤3	126	37.4
4 to 6	162	48.1
≥6	49	14.5

The majority of the respondents were female which constitutes about 76.6%. There were only about 79 male respondents in this study. This is due to the more number of females consented to participate in this study compared to males and other reason given were majority of females plays a major role in maintaining their household cleanliness. Respondents from the age group of 18-30 years responded mostly in this study which constitutes about 54.9% of the total of whom participated. There were about 25.5% participation from the age group of 31-40 years and about 19.6% participation from the age group 41 years and above.

In terms of ethnicity, the Malays participation is the highest which is about

55.2%, followed by Chinese 26.1%, Indian 15.7% and finally others about 3.0%. In addition, mostly married people (51.9%) participated in this study. There were about 48.1% participants whom are single who constituted of the not married and divorced respectively.

Almost sixty four percent of the respondents are employed. Most of the respondents (58.2%) received non tertiary level education which consist primary school, secondary school, diploma and pre-university education. Those whom received tertiary level education about 41.9% consist of the respondents with University degree, Masters and PhD. In terms of people per household, majority there were 4 to 6 people in a household which constitutes about 48.1%, followed by three or less which makes about 37.4% and six or more about 14.5%. The important characteristics of the study respondents are given in Table1.

Based on the data collected, majority of the survey participants reside in the North East (NE) district, which is about 49.0%. The second largest number of the survey participant resides in the South West (SW) district (19.6%). The participation of the respondents from the districts of North Seberang Perai (NSP), South Seberang Perai (SSP) and Central Seberang Perai (CSP) were 15.4%, 9.2% and 6.8% of the total 337 respondents respectively.

Majority of the respondents reside in high rise building like the Apartment (Apt) (27.9%) and Flats (Flat) (22.3%) respectively. The third largest majority of the respondents reside in double storey terrace (Dst) which is about 16.3%, followed by respondents residing in single storey terrace (Sst) (12.5). The participation of the residence from other type of residence such as Kampung or village houses (Kpg), Semi-detached (Sd), Bungalow (Bg) and Hostel (Hos) were about 9.5%, 6.5%, 2.7% and 2.4% respectively.

Table 2: Association between awareness and Socio-demographic characteristics of respondents (n=337)

	Aware n (%)	Unaware n (%)	Adjusted OR	(95% CI)	p-value
Gender					0.950
Male	75(94.9%)	4(5.1%)	1.00(ref.)		
Female	246(95.3%)	12(4.7%)	0.96	(0.28,3.25)	
Age group (years)					0.215
18-30	178(96.2%)	7(3.8%)	1.00(ref.)		
31-40	83(96.5%)	3(3.5%)	0.91	(0.19,4.36)	
	60(90.9%)	6(9.1%)	0.29	(0.06,1.31)	
Ethnicity					0.896
Malay	179(96.2%)	7(3.8%)	1.00(ref.)		
Indian	50(94.3%)	3(5.7%)	0.92	(0.20,4.31)	
Chinese	83(94.3%)	5(5.7%)	0.81	(0.20, 3.18)	
Others	9(90.0%)	1(10.0%)	0.40	(0.04, 4.25)	
Marital Status					0.669
Single	151(95.6%)	7(4.4%)	1.00(ref.)		
Married	136(93.8%)	9(6.2%)	1.33	(0.36,4.99)	
People per household					0.504
≤3	120(95.2%)	6(4.8%)	1.00(ref.)		
4 to 6	153(94.4%)	9(5.6%)	0.90	(0.29,2.79)	
≥6	48(98.0%)	1(2.0%)	3.31	(0.33,33.05)	
Locality					0.469
North Seberang Perai (NSP)	50(96.2%)	2(3.8%)	1.00(ref.)		
South Seberang Perai (SSP)	28(90.3%)	3(9.7%)	0.37	(0.05,2.63)	
Central Seberang Perai(CSP)	22(95.7%)	1(4.3%)	1.29	(0.10,16.30)	
North East (NE)	159(96.4%)	6(3.6%)	1.65	(0.30,9.25)	
South West (SW)	62(93.9%)	4(6.1%)	0.92	(0.15,5.81)	
Residential area affected	165(49.0%)	172(51.0%)			0.493
Yes			0.68	(0.22,2.07)	
No			1.00(ref.)		
Employment Status					0.530
Employed	203(94.9%)	11(5.1%)	1.00(ref.)		
Unemployed	118(95.9%)	5(4.1%)	1.45	(0.46,4.56)	

*Adjusted OR = adjusted by age, gender and ethnicity

The table 2 summarises the association between awareness on the dengue incidence and socio demographics of the study participants. The association was performed using the logistic regression and chi square test. There were no significant association between awareness on dengue infection and the socio demographic variables.

In terms of locality and awareness, most of the respondents responded that they are aware of the incidence of dengue. Of the majority of the study respondents from North East area (96.4%) indicated that they are aware compared to the 3.6% whom have indicated that they are unaware of the dengue incidence. Respondents from the NE area have more awareness on the dengue incidence in their locality (OR: 1.65; 95% CI 0.30-9.25) compared to respondents from other localities such as CSP, NSP, SW and SSP.

As demonstrated in Table 2, 49.0% respondents are aware of the dengue incidence in their residential area. On contrary, 51.0% of respondents do not know if their residential area has been reported for dengue incidence. However, it is insignificant between the two groups.

Table 3: Association between Practices and Socio-demographic characteristics of respondents (n=337)

	Respondents Participate in communal effort to clean up housing area				Respondents Participate in communal fogging				Respondents examine for mosquito larvae indoor and outdoor			
	Yes (n %)	Adjusted OR	(95%CI)	p-value	Yes (n %)	Adjusted OR	(95%CI)	p-value	Yes (n%)	Adjusted OR	(95%CI)	p-value
Locality				0.263				0.555				0.849
North Seberang Perai (NSP)	38 (73.1%)	1.00 (ref.)			23 (44.2%)	1.00 (ref.)			37 (71.2%)	1.00 (ref.)		
South Seberang Perai (SSP)	19 (61.3%)	0.83	(0.29,2.35)		13 (41.9%)	1.24	(0.48,3.22)		21 (67.7%)	0.89	(0.32,2.44)	
Central Seberang Perai (CSP)	15 (65.2%)	0.73	(0.23,2.32)		14 (60.9%)	2.53	(0.87,7.32)		17 (73.9%)	1.15	(0.37,3.61)	
North East (NE)	97 (58.8%)	0.64	(0.30,1.37)		73 (44.2%)	1.32	(0.68,2.57)		103 (62.4%)	0.74	(0.36,1.51)	
South West (SW)	32 (48.5%)	0.39	(0.16,0.94)		27 (40.9%)	1.21	(0.55,2.67)		42 (63.6%)	0.47	(0.33,1.72)	
Residence type				0.279				0.240				0.431
Single storey terrace	28 (66.7%)	1.00 (ref.)			18 (42.9%)	1.00 (ref.)			32 (76.2%)	1.00 (ref.)		
Double storey terrace	27 (49.1%)	0.67	(0.27,1.69)		19 (34.5%)	0.98	(0.40,2.39)		38 (69.1%)	0.73	(0.29,1.85)	
Bungalow	6 (66.7%)	1.29	(0.25,6.80)		3 (33.3%)	0.71	(0.15,3.45)		4 (44.4%)	0.27	(0.06,1.23)	
Semi-detached	14 (63.6%)	0.89	(0.27,2.96)		13 (59.1%)	2.20	(0.72,6.74)		15 (68.2%)	0.61	(0.19,1.98)	
Apartment	45 (47.9%)	0.52	(0.23,1.20)		35 (37.2%)	0.93	(0.42,2.04)		62 (66.0%)	0.66	(0.28,1.55)	
Flat	52 (69.3%)	1.20	(0.50,2.89)		43 (57.3%)	2.01	(0.90,4.51)		46 (61.3%)	0.48	(0.20,1.15)	
Kampung	22 (68.8%)	0.98	(0.33,2.94)		14 (43.8%)	0.98	(0.36,2.65)		19 (59.4%)	0.40	(0.14,1.11)	
Hostel	7 (87.5%)	3.49	(0.31,38.84)		5 (62.5%)	1.88	(0.36,9.76)		4 (50.0%)	0.25	(0.05,1.26)	
Dengue outbreak in residential area				0.544				0.382				0.903
Yes	96 (58.2%)	1.00 (ref.)			78 (47.3%)	1.00 (ref.)			109 (66.1%)	1.00 (ref.)		
No	105 (61.0%)	0.70	(0.22,2.22)		72 (41.9%)	0.62	(0.22,1.83)		111 (64.5%)	1.07	(0.36,3.18)	

*Adjusted OR = adjusted by age, gender and ethnicity

	Respondents uses Abate® (Temephos) for elimination of mosquito larvae				Respondents examines discarded materials that potentially serves as mosquito breeding site			
	Yes (n%)	Adjusted OR	(95%CI)	(p-value)	Yes (n%)	Adjusted OR	(95%CI)	(p-value)
Locality				0.619				0.890
North Seberang Perai (NSP)	9(17.3%)	1.00(ref.)			37(71.2%)	1.00(ref.)		
South Seberang Perai (SSP)	3(9.7%)	0.53	(0.13,2.22)		21(67.7%)	0.88	(0.34,2.27)	
Central Seberang Perai(CSP)	6(26.1%)	1.60	(0.48,5.33)		17(73.9%)	0.67	(0.24,1.86)	
North East (NE)	32(19.4%)	1.27	(5.48,2.96)		103(62.4%)	0.94	(0.48,1.84)	
South West (SW)	11(16.7%)	0.96	(0.22,1.04)		42(63.6%)	1.11	(0.50,2.47)	
Residence type				0.332				0.047
Single storey terrace	7(16.7%)	1.00(ref.)			32(76.2%)	1.00(ref.)		
Double storey terrace	10(18.2%)	1.24	(0.42,3.68)		38(69.1%)	0.67	(0.29,1.55)	
Bungalow	2(22.2%)	1.79	(0.29,10.87)		4(44.4%)	0.72	(0.17,3.14)	
Semi-detached	8(36.4%)	2.79	(0.83,9.38)		15(68.2%)	2.02	(0.62,6.60)	
Apartment	12(12.8%)	0.83	(0.30,2.33)		62(66.0%)	1.40	(0.65,3.05)	
Flat	15(20.0%)	1.24	(0.46,3.40)		46(61.3%)	0.53	(0.24,1.16)	
Kampung	4(12.5%)	0.65	(0.17,2.50)		19(59.4%)	0.92	(0.35,2.43)	
Hostel	3(37.5%)	2.98	(0.55,16.24)		4(50.0%)	3.36	(0.37,30.46)	
Dengue outbreak in residential area				0.513				0.607
Yes	29(17.6%)	1.00(ref.)			109(66.1%)	1.00(ref.)		
No	32(18.6%)	0.66	(0.19,2.28)		111(64.5%)	0.76	(0.26,2.19)	

*Adjusted OR = adjusted by age, gender and ethnicity

In terms of data collected on the respondents or anyone in their household affected by dengue infection, 80.7% or 272 respondents answered that they were not infected. On the other hand, 19.3% or 65 of them responded that they were affected by dengue infection.

The awareness level is observed to be higher among those who are 18-30 years old compared to other age groups. In addition, it was observed that married (OR: 1.33; 95% CI 0.36-4.99) and individuals with household number 6 or more are more aware of the dengue incidence in their residential area (OR: 3.31; 95% CI 0.33-33.05) respectively.

Table 3 illustrates the association between practices and socio demographic characteristics of respondents. Practices associated with communal efforts to clean up housing area or 'gotong-royong', participation in communal fogging, examination of mosquito larvae and breeding sites of mosquitoes from the discarded materials plus the usage of Abate® among the respondents was accessed. There is no significant difference between the locality, residence type and the dengue outbreak reported in the residential area for all these practices except residence type and examination of discarded materials that potentially serves as mosquitoes breeding sites (p=0.047).

In terms of percentage, there are low levels of practice for all the areas indicated. Participation in 'gotong-royong' is less than 75% for the locality, residence type and the dengue outbreak in residential area. In addition, less than 60% of the respondents participate in the communal fogging for all the areas accessed. Less than 77% of the respondents examines for the mosquito larvae indoor plus outdoor and lesser than 40% of the respondents actually uses Abate® for the elimination of mosquito larvae.

There are more participation in the communal effort to clean up housing area or 'gotong-royong' from NSP compared to SSP, CSP, NE and SW. Based on the residence type, there were practice from those residing in hostel (OR: 3.49; 95% CI 0.31-38.84). This may due to the implementation of the policies of participating in 'gotong-royong' if the person resides in the hostel. In addition, there is more practice of 'gotong-royong' from the residential area with dengue outbreak.

There are more participation in the communal fogging from CSP (OR: 2.53; 95% CI 0.87-7.32), residing in the semi-detached house (OR: 2.20; 95% CI 0.72-6.74) and in residential area with dengue outbreak. In addition, examination for mosquito larvae indoor and outdoor, most participation are from CSP (OR: 1.15; 95%

CI 0.37-3.61), single storey terrace and with no dengue outbreak in their residential area. Apart from that, utilization of Abate® (Temephos) for elimination of mosquito larvae are more in CSP (OR: 1.60; 95% CI 0.48-5.33), residing in hostel (OR: 2.98; 95% CI 0.55-16.24) and residing in area with dengue outbreak. More participation from SW (OR: 1.11; 95% CI 0.50-2.47), residing in hostel (OR: 3.36; 95% CI 0.37-30.46) and semi-detached (OR: 2.02; 95% CI 0.62-6.60) plus from dengue outbreak area actually examines discarded materials that potentially serves as mosquito breeding sites.

DISCUSSION

In this study, we found out that most of the study participants are from the North East (NE) and secondly from the South West (SW) locality. These respondents are appropriate as the highest number of dengue cases are reported from these areas. Thus this is important as this study explores that awareness and the practices of the people from these areas.

Hot spots are areas with high incidence of dengue that have reported. The high incidences are reported in terms of number of cases and also the number of death associated of dengue. In the state of Penang high number of dengue hot spots are reported in North East (NE) and South West (SW) followed by Central Seberang Perai (CSP). Low numbers of hot spots were recorded from North Seberang Perai (NSP) and South Seberang Perai (SSP). The hots spots in CSP mainly concentrated at the Bukit Mertajam and Butterworth district. [10]

The awareness of the respondents in dengue infection is high which about 94.2%. There is a trend of increment in the awareness based on the previous studies done in the same area. Similar study was done by Sami et al (2013). In their study found that the awareness of dengue fever was relatively high (89.7%). [5] This results have been supported by previously done studies at several other locations in Malaysia with the awareness rates of 90.0%

and 98.5%. [11,12] In contrary, there have also reports on the low level of dengue awareness about 67.0% and 78.0%. [8,13]

In addition, in this study we discovered that majority of the respondents resides in the high rise building like the apartment and flats which contributes about 50.2% of the total residence type. The high rise building would be a potential as mosquito breeding site. In addition, current reports indicate that *Aedes aegypti* is capable of flying in heights that was not reported before. It is reported that, *Aedes aegypti* also prefers to live inside buildings rather than outside. Economic expansion and rapid urbanization in the Southeast Asia which led to conditions of cramped living quarters, low quality housing and poor management of water, sewage and waste systems favoured the dengue epidemics. [14]

The Penang Structure Plan (PSP) 2020, forecasts a population growth from 1.6 million in 2010 to 2 million by 2020 in the Penang state. 40% of these populations are anticipated to reside on the island. There is a concentrated distribution of housing stock in the North East district on the island which consists of 41% of the state's housing. About 12% of the residence is located in South West. The island alone accounts for 53% of residence with only 28% of the land mass. On the mainland, Central Seberang Perai (where Butterworth and Bukit Mertajam are located) contains 22% of all housing stock, while north Seberang Perai (14%) and South Seberang Perai (11%). [15]

Exploring distribution by housing type, there is a clear distinction between high rise property on the island and low rise and landed property on the mainland. Flats constitute the largest property type, with 83% of these on the island, and 74% in North East. Terraced property is the largest residence type on the mainland, 47% of property is single storey and 2/3 storey terraced properties; the majority of the residence type is located in Central Seberang Perai. [15] Thus, this data reveals that the residence type and the residence

concentration in the corresponds directly in the North East, South West and Central Seberang Perai.

Another factor that could contribute to the high incidence of dengue is the local temperature profile. According to the Malaysian Metrological Department, the average temperature recorded for Pulau Pinang is about 28°C and with the average rainfall of 340mm of rain. [16] It has been reported that climate variable may increase dengue transmission potential [17] and that *Aedes aegypti* eggs are capable to thrive across a wide range of humidity and temperature combinations. [18] Temperature further interacts with rainfall as the chief regulator of evaporation, thereby also affecting the availability of water habitats. In addition, rainfall, temperature, and humidity influences land cover and land use, which can promote or impede the growth of vector populations such as *Aedes aegypti.* [19,20]

In addition, Wu et al. (2007) found temperature to be a significant predictor of dengue fever incidence. This is because dengue virus (DENV) replication within the mosquito is regulated by temperature and the length of the extrinsic incubation period (EIP) of the virus. [21]

Various studies have estimated the average EIP based on number of days and/or temperature such as 5-9 days, 15 days (25°C) and 6.5 days (30°C). In addition, EIP have been classified as either the time when the virus was detected in the mosquito or the end of the time when the mosquito transmitted the virus. [21-23]

On the other hand, Rohani et al. (2009) demonstrated that for both DENV-1 and DENV-4 virus the time between feeding and virus detection in the salivary glands of *Aedes aegypti* mosquitoes decreased from 9 days at 26°C and 28°C to 5 days at 30°C. [22] Thus, this supports the tremendous blooming of the mosquito population in Penang due to the temperature and humidity ambiance. In addition, survival of *Aedes aegypti* through all developmental phases peaked at approximately 90% (27°C). [24]

This study further been supported by Tun et al (2000) where they concluded that ideal range for survival of the *Aedes* mosquitoes through all phases of development (88-93%) occurs between the temperatures of 20-30°C. [25] Apart from it, the *Aedes* mosquitoes have been reported to have accelerated development rates in warmer water. [17] This further accelerates the *Aedes* mosquito growth population in Penang.

On the other hand, study conducted by Wilder-Smith et al., 2010 on the association of dengue activity with haze concluded that haze is not associated with the reduction of the dengue activity. [26]

Association between practices and socio demographic characteristics of respondents were evaluated in this study. Practices associated with communal efforts to clean up housing area or 'gotong-royong', participation in communal fogging, examination of mosquito larvae and breeding sites plus the usage of Abate® among the respondents recorded less than 65% of level of participation of the study respondents. Among the reasons informed by the participants of not adequately involving in these practices are lack of time to join the 'gotong-royong' and the communal fogging programmes, it is adequate to keep only the only the internal part of the residence clean compared to the external area of their residence. Apart from that, the majority of the respondents answered that it is the sole responsibility of the local municipality to ensure that their residential area to be kept clean and free from the mosquitoes breeding sites.

It is important to keep our surrounding clean and the waste are properly manage and discarded. Containers which are very commonly used in urban environments are often an important habitat for the growth of the mosquito population and deemed the most important pupae habitat for producing adult mosquitoes. [27,28] In addition, Tun-Lin et al. (2000) discovered that containers with more organic matter resulted in larger mosquitoes, quicker development, and higher survival rates. [25]

Realizing the importance of having good practice in terms of retaining clean environment community effort importance was implemented through the Communication for Behavioral Impact (COMBI) programme. Community-wide efforts is the key to eradicate dengue, commitment and participation at individual level such as emptying flower pots and practice of regular removing of water collecting containers and rubbish plays a critical role in dengue eradication. [29] However, the study done by Azmawati et al (2013), reported through their study that qualitative results, epidemiological and entomological evaluation showed that the programme failed to give the desired behavioural impact of the COMBI programme. [30] The results in this study were discussed with the acknowledgement of certain study limitations. One major study limitation would be the method of the sampling. The method of sampling in this study may be imprecise, thus may cause the selection bias and could not be representing the overall Penang population.

CONCLUSION / RECOMMENDATION

As to conclude, there are high levels of awareness on dengue infection among the study participants. However, there were no significant association between awareness on dengue infection and the socio demographic variables. Thus, this indicates the success in creating awareness among the public. However, in terms of practices associated in curbing dengue, there are low levels of practice for all the areas evaluated in this study which indicates the awareness does not translate into practice.

More efforts in engaging the community participation especially those residing in the high rise buildings in communal activity is needed to curb the *Aedes* mosquitoes breeding sites and indirectly to bring down the dengue incidence. More punitive action like fine imposition for the building and property management may be appropriate in terms of impregnating the practices to keeping the neighbourhood clean.

In addition, the electronic signboards that are placed extensively along the major roads and expressways may play a vital role in dissemination of information in regards to dengue hotspots and residential area with high incidence of dengue cases. The public should not solely depend on the municipalities in terms of keeping their areas cleans, instead should work together to ensure that their residential area is clean. Following the example of 'No car day' in the state, few hours a week can be allocated for 'Community day' for cleaning up own residential areas. In addition, social media could be engaged to enforce practice effectiveness.

Although this study was a step forward in evaluating the awareness and practice, further studies are needed to bridge the gap between awareness and behaviour.

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