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Environmental and Sociology Factors and its Association for Dengue Cases in Kuala Lumpur, Malaysia

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Environmental and Sociology Factors Associated with Dengue Cases in Kuala Lumpur, Malaysia

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Abstract

Background: Dengue incidence has grown dramatically around the world in recent years. It transmitted by *Aedes* mosquitoes. Many factors contributed to the vector densities such as environmental and sociological factors. **Objective**: This study is aimed at determining the environmental and sociological factors contributing to dengue cases. **Methods**: The study used questionnaire survey involving 379 respondent with dengue history. **Result**: The study showed that there is significant association between the time departs to work and mobility of respondents (95%CI = 2.779 and 5.594, $p < 0.0001$). Similarly, there is significant association between the time of arrival to work and mobility of respondents (95%CI = 1.617 and 2.155, $p < 0.0001$). Moreover, the type of housing and the surrounding vegetation were the environmental factors that showed significant values; $p = 0.023$, and $p = 0.017$. **Conclusion**: The study indicated the factors contributed are patient who lived in independent houses and the time of mobility patient.

Keyword: dengue, *Aedes* mosquitoes, environmental factor

Introduction

Dengue infection is a rapidly spreading mosquito-borne virus of global and public health importance causing high morbidity and economic loss in tropical and subtropical regions.

Globally, about 390 million dengue infections were annually reported from more than 125 countries (Bhatt *et al*., 2013). The tropical climate was considered as a suitable ground for the dengue outbreak in the Asian countries such as Malaysia, Thailand, Indonesia and Singapore. This has resulted to the outbreak of dengue fever (DF) and dengue haemorrhagic fever (DHF) The dengue virus is usually transmitted through the bite of infected mosquito (Sarfraz *et al*., 2012). In Malaysia, there are two species of dengue vectors, *Aedes aegypti* and *Aedes albopictus* are responsible for dengue transmission in Malaysia (Ruhil et.al., 2011; Che, Hassan, Razali, & Ismail, 2013).

Rapid spread of dengue in many countries are attributed to globalization, rapid unplanned urban development, poor water storage and unsatisfactory sanitary conditions (WHO, 2011). Dengue transmission elements are complex, including virus, vector and host. These parameters (virus, vector and human host) are influenced by many factors such as climatic factors (temperature, rainfall, wind and relative humidity), human movement and behavior, sociological, economic, demographic and ecological factors (Gubler DJ., 2011; Akter, Naish, Hu, & Tong, 2017 & Raphael, 2017)

Aedes mosquitoes preferred to breed in the artificial containers and natural breeding sources such as concrete tanks, drum, flower pots, discarded tires, plant, animal shells, leaves stalk, tree holes and bamboo stumps (Che et al., 2013; Paupy et.al., 2009 & Okogun et.al., 2005). These breeding habitat are close related to the human areas such as playground or parks, cemetery and residential areas. Most of the mosquitoes preferred the habitat near to the water bodies including small lakes, swamps, spring and river (Okugun et.al., 2005). The uncontrolled expansion of urban environments where the population growth rapidly have accelerated the prevalence of dengue fever (Delmelle et.al., 2016).

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Many studies also suggested that dengue associated with several sociological factors such as household crowd, poor housing areas, household density, type of housing, and human movement (Cano et al., 2017; Braga, 2010 & Krishna Prasad Bhandari, 2008). The daily routine such as working and studying during the peak biting time are contributed factors to the dengue incidence because the aedes mosquitoes found to be attracted to the human baits (Goutam Chandra, Indranil Bhattacharjee, Rita Banerjee, Srabani Talukdar, Ruby Mondal, 2015).

Since there is no available vaccine and specific drugs for dengue fever, the control measure are based on the biological *aedes* mosquitoes. In order to improve the control management, the better understanding of several factors that leads to the abundance and distribution of aedes mosquitoes are crucially need (Cano et al., 2017) .The aim of this study is to determine the sociological and environmental factors associated to dengue cases at urban setting in the capital city of Malaysia.

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Materials and Methods

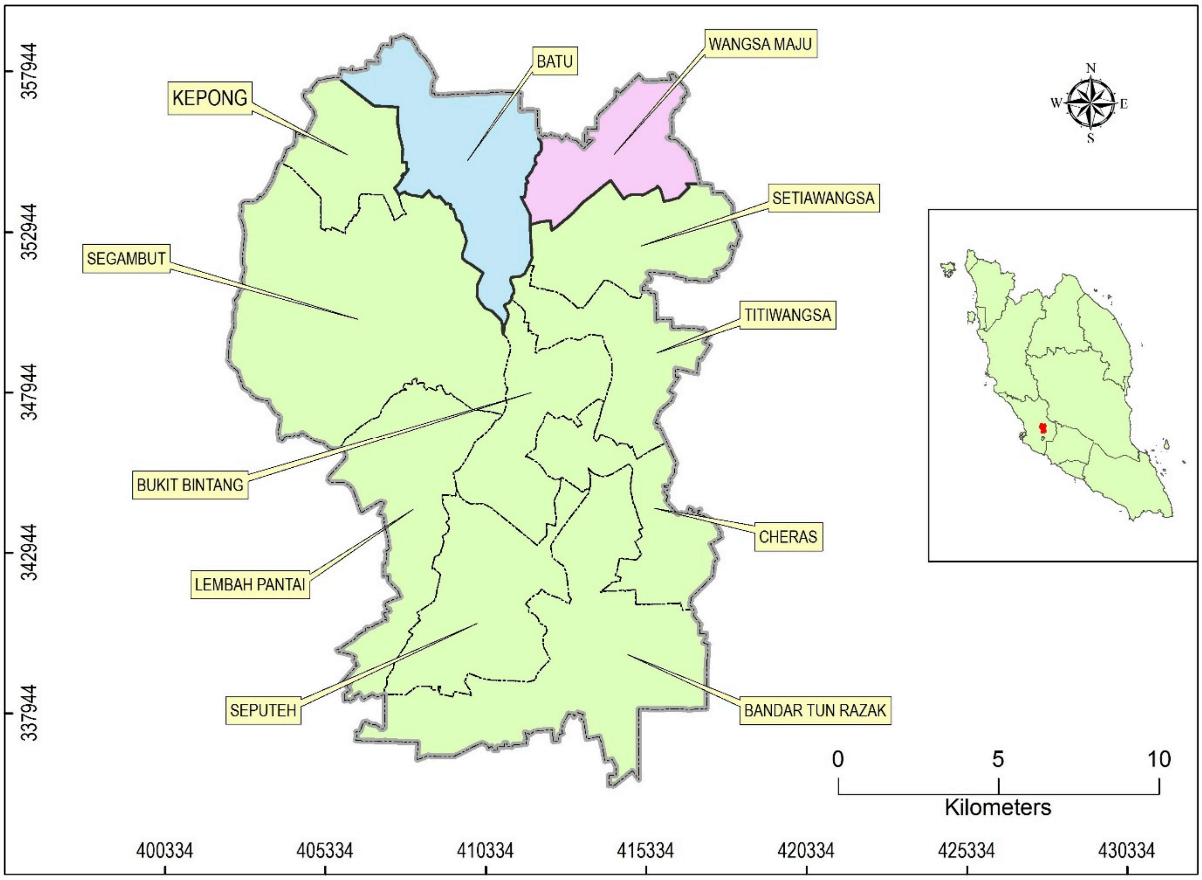

Figure 1: Map of study areas in Kuala Lumpur, Malaysia.

Study Location

Kuala Lumpur is the capital of Malaysia, making up an area of 243 km2 with an average elevation of 21.95 m (Figure 1). Kuala Lumpur has a population of l.8 million as of 2018 which is 5.5% of the total national population. The average annual population growth rate from 2017-2018 was 0.1 % (Department of Statistics Malaysia, 2018). The city experiences a hot and humid climate all year-round with seasonal variation in the temperature and rainfall. The maximum temperature float between 31ºC and 33ºC and have never exceeded 37.2ºC (average is 32.4ºC), while minimums hover between 22 and 23ºC (average is 23.3ºC) and had never fallen below 17ºC. Kuala Lumpur typically receives 2,266 mm of rain annually with

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June and July being relatively dry (Malaysia Meteorological Department, 2018). Since 1972, Kuala Lumpur has been governed by Kuala Lumpur City Hall (KLCH). The Kuala Lumpur City Hall Health Department was established to monitor the health status of Kuala Lumpur residents as well as improving the population's quality of health. This study was conducted at the high risk areas of Parliment Batu and Wangsa Maju recommended by Kuala Lumpur City Hall Health Department. The recommendation based on the hot spot areas of dengue fever in Kuala Lumpur.

Study Population

The target population for this study was respondent who lived in Parlimen Batu or Wangsa Maju which had positive dengue between January 2016 until May 2016. The respondent must be fullfilled the inclusive and exclusive criterias. The inclusive criteria is the respondent who had experienced with dengue fever and are living in Parliment Batu or Wangsa Maju however the exclusive criteria is the patient who live outside the study area. Of 730 respondents were listed as positive dengue provided by Kuala Lumpur City Health Department ,only 379 of them agreed and gave us full cooperation to participate in this study. This study designed and estimate the sample of the respondents from the high risk areas considering the sociological, and environmental determinants that contributes to dengue incidence within 5% of true prevalence with 95% confidence (Koyadun, Butraporn, & Kittayapong, 2012) The calculation formula of sample size was applied using OpenEpi Software (Soghaier et al., 2015). Based on the calculation, the statistical required sample is 384 respodent derived from dengue data cases January 2016 to May 2016. The respondents were interviewed via phone call to obtain the answers designed in the questionnaire since January to May in order to avoid recall bias if the longer period were chosen (Pérez-Guerra, Seda, García-Rivera, & Clark, 2005 & Vazquez-prokopec, Kitron, Montgomery, Horne, & Ritchie, 2010).

Questionnaire on sociological and environmental factors

The structured questionnaire consists of the information on sociological and environmental factors. The sociological section consists of information related to working or study, mobility time for working/study, history of dengue infection (Vazquez-prokopec et al., 2010), and households (Alpana Bohra and Dr. Haja Andrianasolo, 2001; Penna, 2004; Spiegel et al., 2007 & Soghaier et al., 2015) however the environmental section consists of information regarding type of housing, the distance of housing to water bodies, playground, cemetery, vegetation and construction site (Walker, Joy, Ellers-Kirk, & Ramberg, 2011; Khormi & Kumar, 2011 & Sarfraz et al., 2012). Information gathered through phone interview and questionnaire was documented.

Data Analysis

The dengue determinants were chosen as the outcomes of dengue transmission includes those who had history of dengue more than once and also other householders who ever had experienced dengue fever (Koyadun *et.al.*, 2012). Data were entered and analyzed by using Statistical Packages for Social Sciences (SPSS) version 22.0. Analysis was done by using this software at different levels. Chi-square tests followed by binary regression were used in order to investigate the association between variables. The level of significance in this study was set up at $P < 0.05$.

Result

Association between sociological factors with mobility among respondents.

A total 379 (52%) respondent with history of dengue answered questionaires provided. The study showed that majority of the mobile respondents had only once get infected by dengue (76.1%), time depart to work from 6.30am to 8.00am (94.6%), time arrival from work from 6.00pm to 8.00pm (97.0%) and those used public transport (83.3%) (Table 1).

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This study found that there is significant association between time depart to work and mobility of respondents (95%CI = 2.779 and 5.594, p < 0.0001). Besides, there is also significant association between time arrival from work and mobility of respondents (95%CI = 1.617 and 2.155, p < 0.0001) (Table 1**)**.

Table 1: Association between sociological factors with mobility among respondents.

Categorical Variables	Mobility of respondents		p-value	Prevalence ratio	95% CI	
	Mobile (%)	Immobile (%)			Lower	Upper
Frequency of respondents get infected by Dengue						
More than once	37 (75.5)	12 (24.5)	0.933	0.993	0.837	1.177
Once	251 (76.1)	79 (23.9)				
Time depart to work						
6.30am-8.30am	264 (94.6)	15 (5.4)	< **0.001*** *	3.943	2.779	5.594
>8.30 am/Home	24 (24.0)	76 (76.0)				
Time arrival from work						
6.00pm-8.00pm	196 (97.0)	6 (3.0)	< **0.001*** *	1.867	1.617	2.155
>8.00 pm/Home	92 (52.0)	85 (48.0)				
Transport						
Personal	218 (73.9)	77 (26.1)	0.074	0.887	0.789	0.997
Public	70 (83.3)	14 (16.7)				

*Significant at p<0.05

**Significant at p<0.01

Predictor influencing mobility among respondents

Regression analysis was conducted to predict the mobility among respondents. Independent variables were time depart to work, time arrival from work and transportation used daily by respondents. The study's result indicated a medium strong relationship (R= 0.769) between prediction and grouping. It was found that 76.9% of total variation of mobility is explained by respondent's time depart to work, time arrival from work and transportation used daily (Table 2).

The study shows that respondents who depart to work from 6.30am to 8.30am to work have ninety one more likely in mobility compared to those who depart from above 8.30am or stayed at home. Respondents who have time arrival from work at 6.30pm to 8.00pm have seventy four times prone in mobility compared to those in 8.00pm or stayed at home. Besides it was found that those who used personal transport have nearly four times more likely in mobility compared to those who used public transport (**Table 2).**

Table 2: Predictor influencing mobility among respondents

Variable	Logistic Coefficient (B)	SE	Adjusted Odd Ratio	95% CI		p-value
				Lower	Upper	
Time depart to work						
6.30am-8.30am	4.511	0.540	90.991	31.601	261.997	< 0.001**
>8.30 am/Home			1			
Time arrival from work						
6.00pm-8.00pm	4.306	0.647	74.142	20.863	263.488	< 0.001**
>8.00pm/home			1			
Transportation used daily						
Public Transport			1			
Personal Transport	1.295	0.567	3.650	1.202	11.090	0.022*
Constant	- 3.107	0.512	0.045			< 0.001**
X^2	46.682					
df	1					

*Significant at p < 0.05
**Significant at p < 0.01
Method = Backward LR
R = 0.769, Overall Percentage = 95.8%

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Association between environmental factors with household members gets infected by dengue among respondents.

Majority of the respondents had household members get infected by dengue are those who lived in independent houses (47.5%). The study also found that majority of the respondents had household members get infected by dengue are from houses with present of cemetery (35.1%), construction area (36.0%), playground area (36.0%) and water bodies (35.1%). Furthermore, majority of the respondents who had household members get infected by dengue are from houses without present of vegetation (60.0%) (**Table 3)**.

This study showed that there is a significant association between types of housing and household members that gets infected by dengue (95%CI = 1.079 and 1.997, p = 0.023) as shown in **Table 3**.

Table 3: Association between environmental factors with household gets infected by dengue among respondents.

Categorical Variables	Household members get infected by dengue (%)		p-value	Prevalence ratio	95% CI	
	Yes (%)	No (%)			Lower	Upper
Types of housing						
Independent	29 (47.5)	32 (52.5)	**0.023***	1.468	1.079	1.997
Mixed/Interdependent	103 (32.4)	215 (67.6)				
Present of cemetery						
Yes	33 (35.1)	61 (64.9)	0.948	1.011	0.736	1.388
No	99 (34.7)	186 (65.3)				
Present of construction area						
Yes	124 (36.0)	220 (64.0)	0.119	1.577	0.844	2.945
No	8 (22.9)	27 (77.1)				

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Present of playground/ recreation areas						
Yes	99 (36.0)	176 (64.0)	0.436	1.135	0.821	1.567
No	33 (31.7)	71 (68.3)				
Present of water body						
Yes	33 (35.1)	61 (64.9)	0.948	1.011	0.736	1.388
No	99 (34.7)	186 (65.3)				
Present of vegetation area						
Yes	129 (34.5)	245 (65.5)	0.347	0.575	0.277	1.192
No	3 (60.0)	2 (40.0)				

*Significant at $p < 0.05$
**Significant at $p < 0.01$

Association between ecological and environmental factors with frequency of dengue infection among respondents.

Majority of the respondents had more than once of dengue infection are those who lived in mixed or interdependent houses (13.5%). The current study also found that majority of the respondents had more than once of dengue are from houses without present of cemetery (13.7%), playground area (18.3%), water bodies (13.3%) and vegetation (60.0%). Furthermore, majority of the respondents who had more than once of dengue infection are from houses with present of construction area (13.1%) as shown in **Table 4**.

This study showed that there is a significant association between vegetation area and frequency of infection by dengue (95%CI = 0.905 and 0.441, p = 0.017) (**Table 4)**.

Table 4: Association between environmental factors with frequency of infection by dengue among respondents.

Categorical Variables	Frequency of infection (%)		p-value	Prevalence ratio	95% CI	
	More than once (%)	Once (%)			Lower	Upper
Types of housing						
Independent	6 (9.8)	55 (90.2)	0.432	0.727	0.324	1.634
Mixed/Interdependent	43 (13.5)	275 (86.5)				
Present of cemetery						
Yes	10 (10.6)	84 (89.4)	0.445	0.777	0.404	1.496
No	39 (13.7)	246 (86.3)				
Present of construction area						
Yes	45 (13.1)	299 (86.9)	1.000	1.145	0.438	2.994
No	4 (11.4)	31 (88.6)				
Present of playground/recreation areas						
Yes	30 (10.9)	245 (89.1)	0.057	0.597	0.352	1.013
No	19 (18.3)	85 (81.7)				
Present of water body						
Yes	11 (11.7)	83 (88.3)	0.683	0.878	0.468	1.647
No	38 (13.3)	247 (86.7)				
Present of vegetation area						
Yes	46 (12.3)	328 (87.7)	**0.017***	0.205	0.905	0.441
No	3 (60.0)	2 (40.0)				

*Significant at $p < 0.05$
**Significant at $p < 0.01$

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Predictor influencing household members gets infected by dengue among respondents (environmental factors)

Regression analysis was conducted to predict the household infected among respondents. Independent variables was type of housing. The study's result indicated a very weak relationship (R^2 = 0.018) between prediction and grouping. It was found that 1.8% of total variation of household infected is explained by respondent's type of housing (**Table 5**).

The study showed that independent houses have two times more likely to have household members infected by dengue compared to mix or interdependent houses (**Table 5).**

Table 5: Predictor influencing household members gets infected by dengue among respondents (environmental factors)

Variable	Logistic Coefficient (B)	SE	Adjusted Odd Ratio	95% CI		p-value
				Lower	Upper	
Type of housing						
Mixed/Interdependent			1			
Independent	0.637	0.283	1.892	1.086	3.294	0.024
Constant	0.098	0.256	1.103			0.701
X^2	5.002					
df	1					

*Significant at $p < 0.05$

**Significant at $p < 0.01$

Method = Backward LR

R^2 = 0.018, Overall Percentage = 65.2%

Predictor influencing frequency of dengue infection among respondents (environmental factors)

Regression analysis was conducted to predict the household infected among respondents. Independent variables was a present of vegetation. The study's result indicated a very weak relationship (R^2 = 0.030) between prediction and grouping. It was found that 3.0% of total variation of frequency of dengue infection is explained by present of vegetation (**Table 6)**.

The study further showed that houses without vegetation have ten times more likely to have dengue infection compared to houses with vegetation (**Table 6).**

Table 6: Predictor influencing frequency of dengue infection among respondents (environmental factors)

Variable	Logistic Coefficient (B)	SE	Adjusted Odd Ratio	95% CI		p-value
				Lower	Upper	
Present of vegetation area						
Yes			1			
No	2.370	0.926	10.696	1.741	65.723	0.011
Constant	-0.405	0.913	0.667			0.657
X^2	6.231					
df	1					

*Significant at $p < 0.05$

**Significant at $p < 0.01$

Method = Backward LR

R^2 = 0.030, Overall Percentage = 87.3%

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Discussion

The investigation into sociological and environmental perspectives can provide foresight into appropriate and effective vector control responses in combating dengue. Human movements contribute to the transmission of dengue on spatial scales that exceed the limits of mosquito dispersal (Wesolowski et al., 2013 & Padmanabha, Correa, Rubio, Baeza, & Osorio, 2015). This study had investigated the respondent mobilize during the exposure period prone to get virus infection. The study has demonstrated that peak human activity hours were in the early and the late evening with significant result more than 90%. There was a study in Kolkata, India showed that both of mosquitoes *aedes aegypti* and *aedes albopictus* attracted to human throughout the day, however the peak hours were in the morning (Goutam Chandra, Indranil Bhattacharjee, Rita Banerjee, Srabani Talukdar, Ruby Mondal, 2015). The *aedes* mosquitoes preferred to rest outside in the dark areas. Thus, the human activities begin early morning will trigger to the biting habit *aedes* mosquitoes. The successful dengue transmission depend the time human remains at the certain areas and the number of human visited the viremic areas (Vazquez-prokopec et al., 2010 & Sumayyah et.al., 2016) . In this study, the most common areas for most dengue patient area residential areas, working areas and school. Thus, several preventive and control measure can be used by publics during the peak biting hours such as the application insecticide, wearing the long-sleeves shirt, and use mosquitoes repellant (Mazrura et al., 2010; Wong & Abu Bakar, 2013 & Sumayyah, Fadzly, & Zuharah, 2016).

Urban area with high density population, will increase the mosquito population since the source mosquito's food are easily to get. Human's blood is the essential food for *aedes* mosquitoes (WHO, 2009) . The higher numbers of mosquito also will lead to increasing of the dengue cases because human-mosquitoes contact increased (Churcher, 2015). This study presented the significant result for the households members got experienced with dengue lived in independent houses. Most of the independent houses is bungalow. Usually, the ornamental plants are surrounding the houses. The plant/vegetation serve as natural habitat as well as food for the *aedes* mosquitoes as the *aedes* mosquito feed on nectar of the plant (Yuval, 1992 & Rothman & Cooper, 2010). Considering the optimum flight range approximate 200 meter will make the growth of *aedes* population uncontrollable if there is any breeding site near to human (WHO, 2011).

The study also proved that, 83.9% the patient in this study area lived in interconnection houses such as apartment and terrace houses. These type of housing could lead the rapid transmission of the dengue virus in crowded and urban area (Koyadun et al., 2012 & Cano et al., 2017). The short flight range of *aedes* mosquitoes (less than 200m) especially *aedes albopictus* from the sources of food and the breeding site during the outbreak will expose to the spread of dengue (Bohra & Andrianasolo, 2001 & Odoi et al., 2005). The understanding of the ecological and biological characteristic of *aedes* mosquitoes will help local health authority to improve the control measures by targeting the breeding areas (Troyo *et al*, 2009 & Che *et al*., 2013). As example, the space spraying should be carried out within 200 m from the breeding sites. Furthermore, the present study proved the flower vases, lid of paint bucket from the interconnected as the source of breeding sites which were worsened since the residents not manage the plants areas properly (Saleeza, Norma-Rashid, & Sofian-Azirun, 2011). Public who lived in the apartment and terrace houses used to plant their trees and flower in vase due to lack of ground areas and most of the floor was cement (Mangudo et.al., 2011; Saifur et al., 2013 & Fareed, Ghaffar, & Malik, 2016).

The environmental control was permanently used to control dengue fever outbreak by improving the environmental condition (WHO, 2009). The elimination of immature stages or disruption of the mosquito immature life cycle were the principle technique of decreasing the vector population. The reducing of larval and pupae stages will lead to the decreasing of adult mosquitoes. Consequently, the density of vector population will decline, and dengue incident will remain reducing. Public participation has been shown to be the most effective control measure for the eradication of this man-made disease because combating dengue was community-based program (Rosa-freitas et al., 2006 ; Suwannapong, N., Tipayamongkholgul, M., Bhumiratana, A., Boonshuyar, C., Howteerakul & and Poolthin, 2014).

Vegetation served as the resting areas for *aedes* mosquitoes. However, the prevalence result of our study shows contrast finding from several previous study even majority of the houses surrounding by vegetation (Arunachalam et al., 2010 & Koyadun et al., 2012). Based on this study, the vegetation may not give the high impact to dengue infection however the combination with multifactorial would arise the dengue cases in study areas (Vieira et al., 2014 & Wong, Abu Bakar, & Chinna, 2014). Several study also reported the vegetation not significantly associated with *aedes* mosquitoes due to the biological of *aedes* mosquitoes preferred less vegetation areas (Chen et.al., 2005 & Vezzani et. Al., 2008). Even the areas with less vegetation such as high rise building also indicated the dengue incidence was high (Wong et.al, 2014). It has been reported the water stagnant in the houses from the small pot of indoor ornamental plants are the common breeding site (Wan, et.al., 2010 & Dieng, et. Al., 2010).

Malaysia Ministry of Health has identified the parks (including playground and recreation areas), cemeteries, vacant land, public infrastructure areas and construction sites as the favorable breeding sites of the trouble insect (Wan-Norafikah et al., 2009 & Shafie, 2011). These areas are overcrowding areas where the artificial containers are easily can be found (Scott & Morrison, 2010 & Khormi & Kumar, 2011). This study revealed that about 275 out of 379 patient lived near to playground and recreation parks. Moreover, these parks were also used as the discarding ground of garbage by public, and this points trapped water after rainfall incidence, it is thus a perfect points for mosquito oviposition areas (Viennet, Ritchie, Williams, Faddy, & Harley, 2016). The recreation parks and playground are surrounded with trees, ornamental plants and shrub. Thus, without elimination of the rubbish, man-made container and other breeding sources, the female *aedes* mosquitoes will oviposit, complete the life cycle and adult mosquitoes will increase since the areas already serve as natural habitat for them (Che et al., 2013 & Fareed et al., 2016). Crowd-gathering places such as recreation parks, playground, school and market played an important roles in dengue transmission if there were abundance of infected *aedes* mosquitoes (Wen et.al., 2012 & Fareed et al., 2016).

Land cover changes also facilitates the human health problems connected to the dengue transmission by modified the mosquito's habitat. Based on the result, 91% patient who are infected with dengue lived close to the construction areas. The previous study also proved that land cover types are significant to the dengue spread (Sarfraz et al., 2012; Ling, Leitão, & Lakes, 2014 & Akter et al., 2017). For instance, in 2012, the Singapore Health Authorities found 900 *aedes* mosquitoes breeding on construction sites (Viennet et al., 2016). In Malaysia, the construction areas not only significantly influence to the dengue spread but also to the Malaria cases as well (Hafiz & H, 2012). Generally, the certain areas in construction site leave unnoticed by the workers when it already trap with the water (Ling et al., 2014). Thus it become the breeding areas for dengue vector. The situation become worse when there is dengue cases notification in this area.

Conclusion

The factors contribute to dengue transmission found in this study are the respondent who lived in independent houses and the time of mobility respondent especially during the morning (peak biting time). Although, others factor found to be not significantly associated with dengue incidence however the combination multifactorial are also crucial. Other determinants may give indirectly contribution to the abundance of *aedes* mosquitoes. Since the factors affecting dengue incidence and transmission are diverse, the implementation of dengue control are challenging. As the suggestion, the integrated control program, participation of community and health authorities will encounter dengue problem and reduce the mosquito population.

Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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