Asia Pacific Environmental and Occupational Health Journal (ISSN 2462 -2214), Vol 3 (2): 40 – 44, 2017

Temporal Distribution of Aedes Indices in Penang from 2011 to 2016

Mohd Hafiz Rahman[1,3], Nazri Che Dom[1,2]

[1]*Faculty of Health Sciences, Universiti Teknologi MARA, UITM Selangor, Malaysia*

[2]*Vector Control and Disease Laboratory, Faculty of Health Sciences, Universiti Teknologi MARA, Malaysia*

[3]*Penang International Entry Point Health Office, Penang, Malaysia*

Corresponding author: Nazri Che Dom; nazricd@salam.uitm.edu.my. Faculty of Health Sciences, Universiti Teknologi MARA, 42300 Puncak Alam, Selangor; Tel: +60332584447

ABSTRACT

Objective: The main objective of this study is to assess the temporal characteristics of Aedes indices from 2011 to 2016 in order to establish a reference data that can be used to predict the occurrence of dengue in Penang

Method: This study applied an integrated epidemiological study design to investigate the temporal distribution of Aedes indices. Retrospective cross-sectional study was conducted (2011 to 2016) to analyze the data with variation in terms of location and time.

Result: Based on the plot of monthly average of AI in Penang showed a consistent increasing in both zones especially in mainland area. All district had different temporal AI pattern and each year has shown a dramatic increase of this indicator.

Conclusion: Our findings have provided the profile of AI trends in Penang. This useful outcome enables for selective elimination of vector habitat thus minimizing the risk of dengue outbreak.

Keywords: *Aedes index, temporal, Malaysia*

1. Introduction

Dengue is a major public health problem in tropical countries worldwide. The main culprits or vectors are the Aedes aegypti and Aedes albopictus. The increasing number of breeding mosquitoes is the main cause of the dengue outbreak. Dengue control and prevention programme phase is very important to contain the outbreak during or before the event. While a vaccine is still under research without an immediate prospect for success, vector control remains the only way to prevent dengue transmission (Guzman et al., 2012).

Effective surveillance system and is needed in order to ensure a successful elimination of the entire possible breeding sites.The geographical expansion of vector borne diseases has been partially associated with the current changes of global warming and climate change (Laura et al., 2007). The variability of temperatures expected to take place under climate change will affected the biology of the dengue vector's development time (Costa et al., 2010; Degener et al., 2014).

One of the main problems faced in dengue epidemiology is the inadequate knowledge on the risk factors and the association among them. In Malaysia, despite having a good laboratory based surveillance system, it is basically a passive system and has little predictive capability (Gubler, 2002). Dengue control in Malaysia is primarily based on case surveillance by notification of suspected dengue cases by doctors, and vector control by space spraying of insecticides. Vector surveillance is done by regular larval surveys of Aedes mosquitoes and computing of Aedes Index (AI) and Breateau Index (BI) according to specific localities. According to the WHO 2012, the probability of transmission is directly proportional to the density of mosquitoes for local transmission to take place through man-mosquitoes contact. Therefore, the main objective of this study is to assess the temporal characteristics of Aedes indices from 2011 to 2016 in order to establish a reference data that can be used to predict the occurrence of dengue in Penang.

2. Materials and Method

This study applied an integrated epidemiological study design to investigate the temporal distribution of Aedes indices. Retrospective cross-sectional study was conducted (2011 to 2016) to analyse several information gathered from surveillance data from the Vector Control division, Ministry of Health, Malaysia. The data that was used for this research is dengue surveillance data with variation in terms of location and time. Dengue surveillance data [Aedes index (AI)] in five administrative districts in Penang was used. The data were obtained from passive surveillance system from the years 2011 to 2016, which consists of 52 weeks for each year. The collection of several types of data sets may provide a baseline that useful to develop a prediction model of future dengue outbreak. This information is collected and reviewed weekly, and over time, to allow public health epidemiologists and laboratories to understand the spread of dengue outbreak in their catchments area, providing them with the real-time information they need to detect small changes that may be important.

2.1. Study area

Penang is a state with a population of 1,902,116 and has the highest population density in Malaysia (1,490 people for every square kilometer). It is the most populated island in Malaysia and has the highest population density in the country. Geographically the Penang state is divided into two sections; (i) the Penang Island and the (ii) Province Wellesley. Figure 1 illustrates the Penang map in Malaysia. Penang has five main administrative districts, which three district, at mainland [South Seberang Perai (SPP), Central Seberang Perai (CSP) and North Seberang Perai (NSP)]. The other two districts is in island which is Northeast Penang Island (NPI) and Southwest Penang Island (SPI).

2.1. Data processing

This research relied on the dengue surveillance data (DSD), which were collected from Vector control division, Penang State Health Department. The original DSD was a daily-based dataset between 2011 to 2016 with four attributes (year, month, types of premise, mean AI). Details of dataset are presented in Table 1.

Data processing involved two tasks; to convert weekly-based DSD into monthly-based data and to granulate continuous data into discretized ones for the mining mechanism to perform the classification task. The task used to conduct data discretization is unsupervised equal width interval (Wu et al., 2013). Penang district are being divided into several zone based on their administrative boundaries. In this study, the changes and secular trends of AI had been monitored temporally. Therefore, annual average AI for each zones were performed using Time-Series analysis to understand the epidemiological trends by monthly basis (Nagao et al., 2008). In order to examine the temporal trends, AI was plotted (12 months) for each zones (5 zones). Information from the electronic records was extracted and coded for health outcomes. Monthly AI was calculated and uses as response variable. All the calculation was done in Microsoft Excel 2010 spread sheet. Then, in order to evaluate the relationship, the detailed of types of premise was done in order to obtain the demographic distribution of AI and BI.

Figure 1. Geographical representation of Penang district boundaries layout which is highlighted by different color code; (Blue: Southwest Penang Island); (Green: Northeast Penang Island); (Red: South Seberang Perai); (Yellow: Central Seberang Perai) and (Orange: North Seberang Perai).

Table 1. Dataset and their attributes

Dataset	Attributes	Value	Being preprocessed
Dengue surveillance data	Data period	2011 - 2016	-
	Size	-	-
	Week	1-53	Monthly
	District	-	5 district
	Types of premise	-	9 types

3. Results

The present study was undertaken in five-district area of Penang over a period of six years. Each district was classified into two main zones; (i) Penang Island and (ii) Mainland of Penang.

3.1. Temporal distribution of Aedes index in Penang

In an effort to understand about the distribution of Aedes indices, this study have come out with a graph for a continuous six years in order to study the trend of Aedes indices in Penang. Figure 4.1 show the graph of temporal distribution of Aedes indices for a continuous period from 2011 to 2016. The graph analysis has been divided into five fractions namely A, B, C, D, E and F in which representing 2011, 2012, 2013, 2014, 2015 and 2016 respectively for a better view of the results.

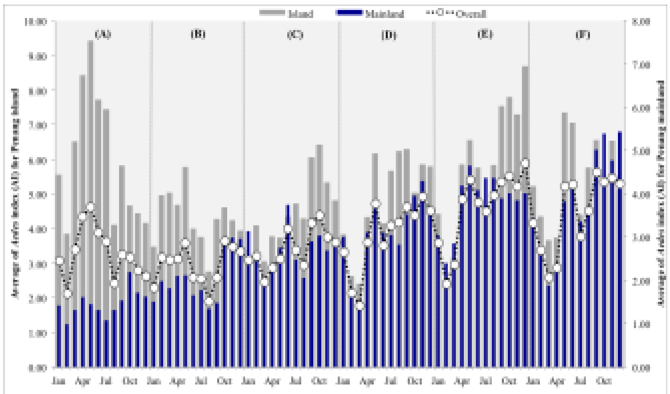

Figure 1. Temporal distribution of Aedes index (AI) in Penang

From the temporal distribution of Aedes indices (AI) in Penang, several dissemination patterns of AI maybe explained. In general, this study found an increase in AI over the years in Penang. The plot of monthly AI for the study period showed increasing trends in both zones. By comparing the zones, Penang Island recorded high AI as compared to Mainland. A clear difference and a gradient among the average of AI were observed. The worst AI was recorded in May 2011 in Penang Island with AI more than 9 in average. However there is a tremendous increment in AI pattern for mainland zones over the past six years observations. By referring to the fraction distribution trends for each fractions (A, B, C, D, E and F), the distribution trends for AI for each years is quite similar in both zones, but didn't reveal consistently distinctive seasonal pattern of AI throughout the year of 2011 to 2016.

3.2. Comparison on the profile of Aedes indices

In order to identify and analyse different temporal pattern, the values of AI and DF cases were calculated for each months and its descriptive statistics across the study area. To pinpoint the difference in this distribution, the comparison on the profile of AI with DF density was performed which subsequently classified based on districts.

Table 2 presented the distribution of AI according to district and the value of DF density. A clear difference and a gradient among the averages were observed. By comparing the area for the AI, all district had different temporal AI pattern. Each year has shown a dramatic increase of this indicator. The result for the year 2011 showed the highest AI was recorded in NPI (AI_{max}: 9.90; AI_{min}: 4.63; $AI_{Average}$: 6.69) and SPI (AI_{max}: 9.55; AI_{min}: 3.05; $AI_{average}$: 5.55) with the DF density of 72 and 156 cases respectively. In contrast for the year 2016, SPI (AI_{max}: 11.78; AI_{min}: 4.79; $AI_{average}$: 8.16) and NSP (AI_{max}: 9.81; AI_{min}: 2.74; $AI_{average}$: 6.11) recorded highest AI as compared with others district with a total of 119 and 94 cases recorded respectively.

Table 1. Comparison on the profile of Aedes indices with DF density based on administrative district areas in Penang for 2011 to 2016

Year	District	Profile of *Aedes* indices			Evaluation indices		
		AI_{max}	AI_{min}	$AI_{average}$	DF cases	Population*	DF density
2011	NSP	2.78	0.70	1.64	90	312,900.00	28.76
	SPP	2.57	0.99	1.71	67	162,200.00	41.31
	CSP	1.30	0.58	1.05	231	393,400.00	58.72
	NPI	9.90	4.63	6.69	363	500,900.00	72.47
	SPI	9.55	3.05	5.55	343	220,400.00	155.63
2012	NSP	2.60	0.75	1.54	57	305,403.00	18.66
	SPP	2.80	1.30	1.93	60	176,491.00	34.00
	CSP	5.41	0.85	2.79	178	383,819.00	46.38
	NPI	6.81	3.68	5.12	87	536,808.00	16.21
	SPI	5.85	1.60	3.52	229	208,579.00	109.79
2013	NSP	4.25	1.14	2.40	63	305,600.00	20.62
	SPP	2.53	1.09	1.68	64	191,800.00	33.37
	CSP	6.49	3.17	4.23	247	387,700.00	63.71
	NPI	6.60	2.52	3.93	171	531,400.00	32.18
	SPI	7.49	2.49	5.10	251	211,900.00	118.45
2014	NSP	5.34	1.43	3.77	389	308,100.00	126.26
	SPP	2.95	0.88	1.65	152	198,100.00	76.73
	CSP	5.37	1.59	3.86	864	391,400.00	220.75
	NPI	5.58	2.68	4.53	286	533,300.00	53.63
	SPI	7.51	2.03	5.09	623	214,700.00	290.17
2015	NSP	6.51	2.67	5.10	341	310,700.00	109.75
	SPP	2.80	1.49	2.18	255	204,400.00	124.76
	CSP	2.78	2.78	4.10	1541	395,100.00	390.03
	NPI	5.11	2.57	3.91	470	535,200.00	87.82
	SPI	13.78	2.27	7.79	1008	217,600.00	463.24
2016	NSP	9.81	2.74	6.11	346	369,340.00	93.68
	SPP	2.55	1.07	1.64	233	209,020.00	111.47
	CSP	5.89	1.48	3.78	938	437,640.00	214.33
	NPI	3.95	2.19	2.75	276	540,200.00	51.09
	SPI	11.78	4.79	8.16	267	223,640.00	119.39

3.3. Infestation profile of Aedes in different spot

In order to identify and analyse different temporal pattern, the values of AI and DF cases were calculated for each months and its descriptive statistics across the study area. To pinpoint the difference in this distribution, the comparison on the profile of AI with DF density was performed which subsequently classified based on districts.

The analysis of the AI trends according to the different spot area from 2011 to 2016 in the whole Penang district was significantly increased. The high AI was reported in construction area and open area (AI: 40). In summary, AI was significantly higher in all spot areas and the densities of AI was in order from greatest to least were open area (H) > cemetery area (F) > construction area (B) > recreational area (I) > industrial area (E) > religious area (C) > school area (D) > open dumping area (G) > residential area (A) (AI: 25.53, 21.16, 17.49, 13.39, 12.63, 10.31, 7.22, 5.69 and 1.2 respectively).

4. Discussion

The findings from this evaluation have an important implication for surveillance and control of DF outbreak in Malaysia. Based on the epidemiological analysis, AI pattern in Penang either in mainland or island showed a consistent increased for every year. This will lead to increase in mosquito population densities with the emergence of unknown status of new mosquito populations and potentially increase the spread of mosquito-borne diseases among the disaster-affected areas. Increase in mosquito density can be further exacerbated with environmental variables such as temperature and humidity, vegetation and land use patterns (Costa et al., 2010; Chang et al., 2014).

Surveillance is an important component of any prevention and control programme (Dom et al., 2013). Unfortunately, most dengue endemic countries have neither an effective surveillance system nor an effective mosquito control program. Basically passive surveillance systems are insensitive and rarely detect an epidemic much before peak transmission said Rigau-Perez, (2001). By then it is too late and a lot of money is wasted controlling an epidemic that is already waning. Gubler, (1991) stated that management of dengue outbreak is costly to effectively prevent the outbreak. There are several limitations of the dengue control programs that should be considered in dengue surveillance in order to ensure their effectiveness. Traditional entomological surveillance techniques such as premise/house index (HI); Container Index (CI); and Breteau index (BI) are normally used to measure exposure of non-immune individuals to the vector based on the presence or absence of Aedes larvae and/or pupae at home. Many studies have revealed only weak correlation between Aedes density and Dengue incidence at the household level (Gubler 2002). The primary reason for this weak correlation is believed to be due to spatial and temporal mismatch between the entomological and epidemiological survey.

Integrated data source is very useful in this study because all the information in which representing parameters to be measured and analysed need to be put together to obtained desired results. Data used varies from climatic factor to urbanization as well as demographic data. The complex process of particular data generation is most vital part of this study. The need for previous statement and finding on the other hand become a baseline data for the current situation. Achieved by highlights all the previous study carried out, and by comparing all those findings and current situation, the more detailed association as well as correlation of parameters considered can be obtained accurately. Nevertheless, up to date sources of available information also need to be deliberately add up for validity as well as representing recent issues. Wrapping up, each component of data is particularly interconnected and need to be viewed vividly from all angles.

5. Conclusion

As a conclusion, the key to effectively control the DF outbreak is to identify the potential transmission area, which is generally area with high vector population. These areas would normally coincide with areas of high endemicity of the disease. Our findings have a significant implication that could strengthen public health intervention and offers priorities in designing the optimum and sustainable vector control program to combat dengue in Malaysia.

Acknowledgement

The authors sincerely thank to all the organizations involved in this project especially those that had provided the invaluable data. Special thank to the Faculty of Health Sciences, Universiti Teknologi

MARA for the technical assistance rendered. The research herein was funded by the Ministry of Higher Education (600-RMI/FRGS 5/3 (77/2015).

References

Costa, E. A. P. D. A., Santos, E. M. D. M., Correia, J. C., & Albuquerque, C. M. R. D. (2010). Impact of small variations in temperature and humidity on the reproductive activity and survival of Aedes aegypti (Diptera, Culicidae). Revista Brasileira de Entomologia, 54(3), 488-493.

Dom, N. C., Hassan, A. A., Latif, Z. A., & Ismail, R. (2013). Generating temporal model using climate variables for the prediction of dengue cases in Subang Jaya, Malaysia. Asian Pacific journal of tropical disease, 3(5), 352-361.

Degener, C. M., Ázara, T. M. F. D., Roque, R. A., Codeço, C. T., Nobre, A. A., Ohly, J. J., & Eiras, Á. E. (2014). Temporal abundance of Aedes aegypti in Manaus, Brazil, measured by two trap types for adult mosquitoes. Memórias do Instituto Oswaldo Cruz, 109(8), 1030-1040.

Gulber, D. (2002). How effectively is epidemiological surveillance used for dengue programme planning and epidemic response.Dengue Bulletin, 26(2002), 96-106

Guzman, M. G., Alvarez, A., Vazquez, S., Alvarez, M., Rosario, D., Pelaez, O., & Morier, L. (2012). Epidemiological studies on dengue virus type 3 in Playa municipality, Havana, Cuba, 2001–2002. International Journal of Infectious Diseases, 16(3), e198-e203.

Nagao, Y., & Koelle, K. (2008). Decreases in dengue transmission may act to increase the incidence of dengue hemorrhagic fever. Proceedings of the National Academy of Sciences, 105(6), 2238-2243.

Wu, H. H., Wang, C. Y., Teng, H. J., Lin, C., Lu, L. C., Jian, S. W., & Lin, L. J. (2013). Dengue vector surveillance by human population-stratified ovitrap survey for Aedes (Diptera: Culicidae) adult and egg collections in high dengue-risk areas of Taiwan. Journal of medical entomology, 50(2), 261-269.