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## PUBLIC HEALTH RESEARCH

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### Measuring Aedes & Breteau Indices in Determining Dengue Outbreak; A Study in Kota Tinggi

Norzaher Ismail<sup>1\*</sup>, Razali Maulod<sup>2</sup>, Shamsul Azhar Shah<sup>1</sup> and Nazarudin Safian<sup>1</sup>

<sup>1</sup> Department of Community Health, University Kebangsaan Malaysia Medical Centre, Jalan Yaacob Latiff, Bandar Tun Razak, 56000, Kuala Lumpur, Malaysia.

<sup>2</sup> Pejabat Kesihatan Daerah Kota Tinggi, Jalan Tun Habab, 81900, Kota Tinggi, Johor, Malaysia.

\*For reprint and all correspondence: Norzaher Ismail, Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaacob Latiff, 56000 Cheras, Kuala Lumpur, Malaysia. Email: norzaherismail21@gmail.com

#### ABSTRACT

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**Introduction** Dengue fever, the most known vector-borne disease in the tropical and subtropical regions has become major public health concern worldwide. Rapid urbanization, increased population movement and poor public hygienic lifestyle contributed to the proliferated of high incidence of dengue fever in urban and semi urban areas. With the increasing trend of dengue cases and deaths, methods of dengue surveillance should be reevaluated in predicting dengue outbreak.

**Methods** This study aimed to determine association between Aedes Index and Breteau Index with dengue outbreak in the district of Kota Tinggi, Johor.

**Results** Total of 593 dengue cases in 2015 collected from Kota Tinggi Health Office. The study found that there were significant association between Aedes Index and Breteau Index with localities ( $p < 0.01$ ) significant association between dengue outbreak incidence and low transmission of aedes indices ( $p < 0.01$ ). However these indices reported low sensitivity and specificity in predicting dengue outbreak in this area.

**Conclusions** As dengue disease remains a major endemic in Malaysia, better surveillance index should be reconsider as the main surveillance for dengue disease.

**Keywords** Dengue Outbreak - Aedes Index - Breteau Index.

### INTRODUCTION

Dengue fever is a arthropod-borne viral disease that become known pandemic to the most tropical countries. Globally, there are estimated that almost 400 million cases of dengue infection per year affecting almost 2.5 billion people in 100 countries.<sup>1,2</sup> The suitable temperate climate environment of tropical and subtropical regions become major advantage for vector of *Aedes* mosquitos to breed and lead dengue fever as among leading cause of illness and deaths in many countries.<sup>3</sup> In 2014, Malaysia reported 108 698 cases of dengue fever with 215 deaths which increased tremendously compare to 49 335 cases with 112 deaths in 2008 and 30 110 cases with 69 deaths in 2009. While in the 2013, Malaysia had registered 98% increment of dengue case from 21 900 cases in 2012 to 43 346 in 2013. Worst, the total death in 2013 reported 163% increment from 35 cases in 2012 to 92 cases in 2013.<sup>2</sup> Further analysis showed that 61% of the dengue cases occurred in highly populated urban area state of Selangor and Federation of Kuala Lumpur and Putrajaya.<sup>3</sup> Lying along the line of tropical climate, dengue fever really gave a lot of burden to the health authority. Other factors such as improper management of domestic wastage, poor sanitation and poor public concern also exacerbate the rising of the dengue incidence in Malaysia.<sup>3,9</sup>

Urban and semi urban areas that involved in rapid urbanization, increased population movement and poor public hygienic lifestyle contributed to the proliferated of high incidence of dengue fever. Area like parks, cemeteries, vacant lands, public infrastructure areas, construction sites and rubbish dumping sites are identified as favorable areas for mosquito breeding in Malaysia.<sup>4-6</sup>

In Malaysia, National Dengue Control Program was planned to control the rising dengue fever. Among the strategies planned was disease surveillance for early detection and disease control. These strategic planning programs included detection of cases, notification of cases, case and outbreak investigation, vector surveillance and also vector control. In the program, indices were used to monitor the presence of *Aedes* larvae which are Aedes Index, Breteau Index, Ovitrap Index, Container Index and Premises Index. Sensitive level of each indices were set as Aedes Index < 1%, Breteau Index < 5, Container Index < 10% and Premises Index < 5%.<sup>2</sup> By having sensitive level of each indices, health authority believed that dengue outbreak may be prevented by reduce potential breeding and transmission of disease. Besides, these indices may also use to measure and determine the effectiveness of the dengue control and prevention.<sup>2-5</sup> In 2013 reported that 95.8% of dengue outbreak cases occurred in Selangor and Kuala Lumpur were from locality with high Aedes

Index area more than 1%. Hence, the Ministry of Health had decided that new target and planning to control dengue fever by empowering source reduction by eliminating potential source of breeding.<sup>2,6</sup>

Comparing to other studies done in various countries had showed that Aedes Index was used to determine the association with dengue outbreak. Study in Singapore and Cuba showed that the dengue outbreak still occurred in less sensitive level of Aedes index less than 1% while in Brazil there was no outbreak occurred in area with Aedes index less than 1%.<sup>7,8</sup> Hence it is believed that there is importance of study the effectiveness of Aedes Index and Breteau Index in predicting dengue outbreak occurrence in the area. The objective of this study was to measure the association between Aedes indices and dengue cases at the different area in Kota Tinggi and to evaluate the sensitivity and specificity of aedes indices in predicting dengue outbreak in the area.

### METHODS

#### *Study Area*

Kota Tinggi is one of the ten districts located in Johore with area of 3,484 km<sup>2</sup> that consist of urban, semi urban and rural area with total population of 250 000 people. Kota Tinggi is administered by four main local authorities which are Kota Tinggi City Council (MDKT), which mainly covering urban area, Johore South East Development (KEJORA), agent of development under Ministry of Rural Development at the semi-urban, Federal Land Development Authority (FELDA), a Malaysian government agency that was founded to handle the resettlement of rural poor into newly developed areas and to organize smallholder farms growing palm oil plants and others includes traditional village, estate and farms that managed by respective plantation companies.

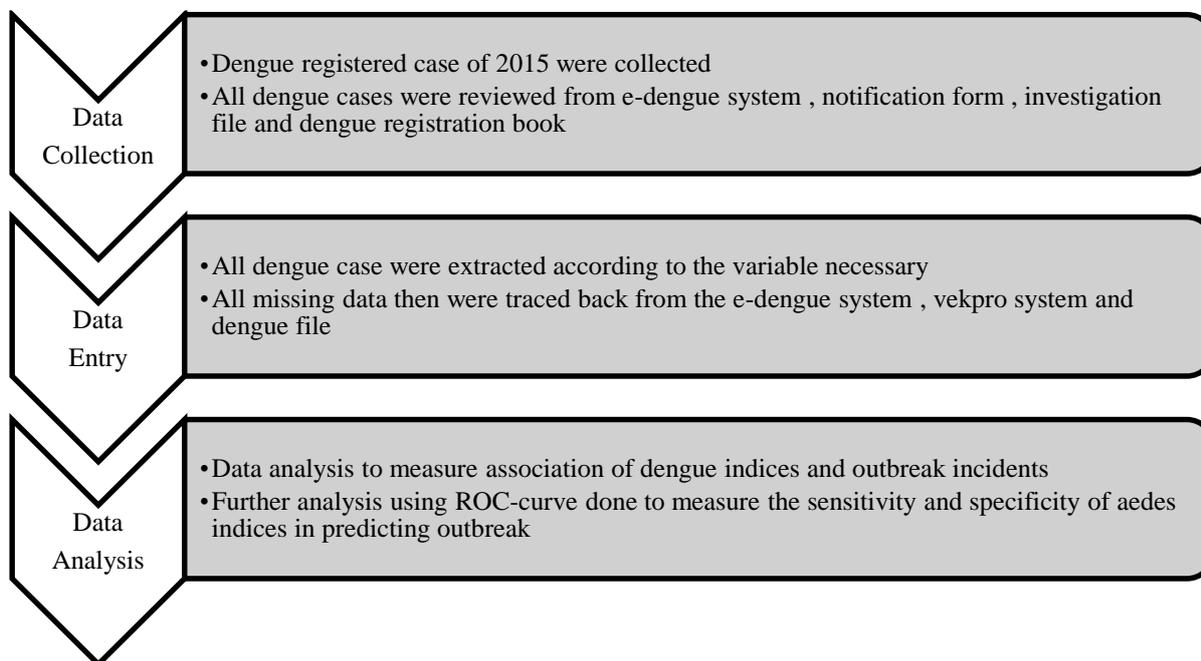
Retrospectively dengue cases in Kota Tinggi reported less than ten percent of state dengue cases which 80 cases in 2011, 140 cases in 2012, 143 cases in 2013, 230 cases in 2014. Data from state health department stated almost 75% of dengue cases were reported in Johor Bahru district and another 25% were distributed among nine other districts. Thus this district purposely chosen due to geographical and population distribution that consist of urban, semi-urban, rural and also the ability of aedes indices been used in low dengue incidence area.

#### *Study Design & Data collection*

This is a cross sectional study. All confirmed registered dengue cases notified to Vector Unit Kota Tinggi Health Office in 2015 were taken as a study sample. Data include details of cases, socio-demographics, locality, Aedes Index, Breteau Index and dengue outbreak locality. All these data

then were arranged and extracted into Microsoft Excel program. The dengue cases then were categorized into dengue cases and dengue outbreak cases. Outbreak cases were defined as second or more confirmed dengue case to occur in the same locality within 200 meters of radius from the index case within two weeks. Aedes index (AI) was defined as the percentage of premises positive for

Aedes larval breeding in a locality with <1% (low transmission) and  $\geq 1\%$  (high transmission). Breteau Index (BI) was defined as the number of containers positive for Aedes larval breeding over 100 premises inspected with < 5 (low transmission) and  $\geq 5$  (high transmission) in reference to the objectives of the National Dengue Control Program (NDCP).

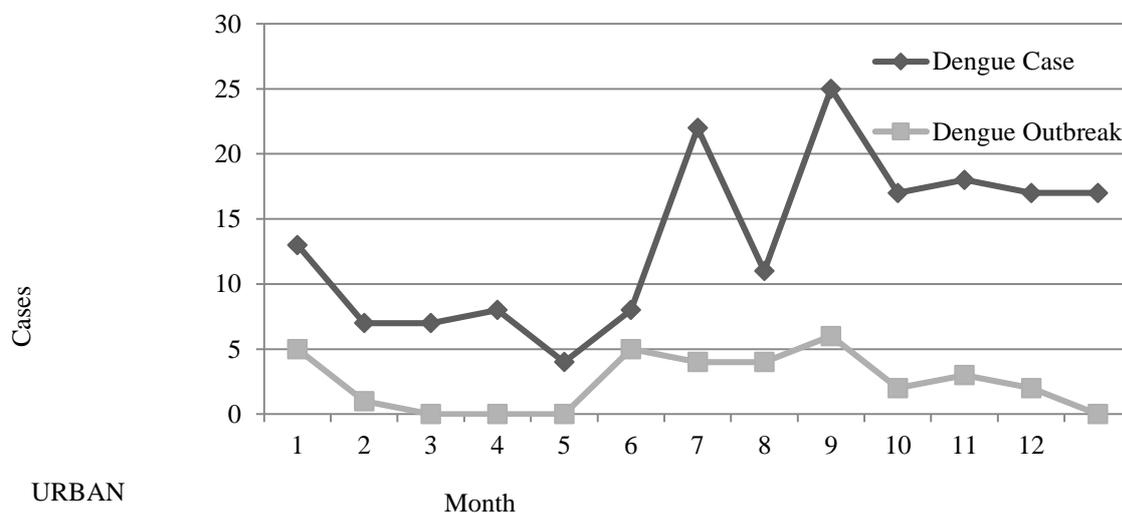


*Data Analysis*

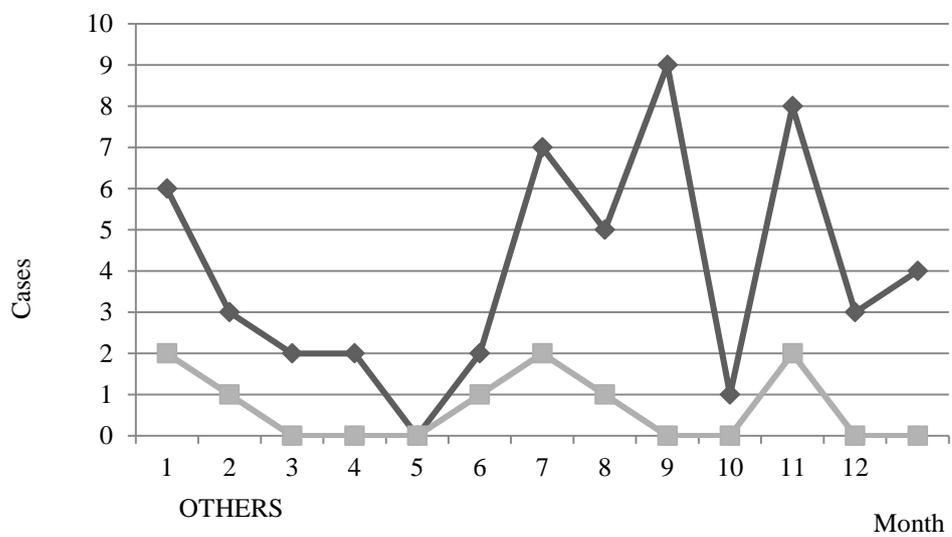
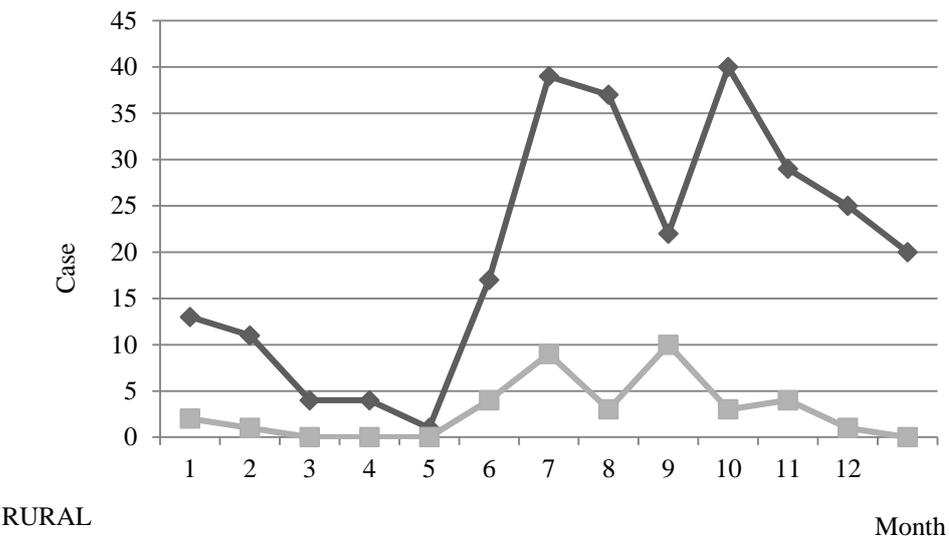
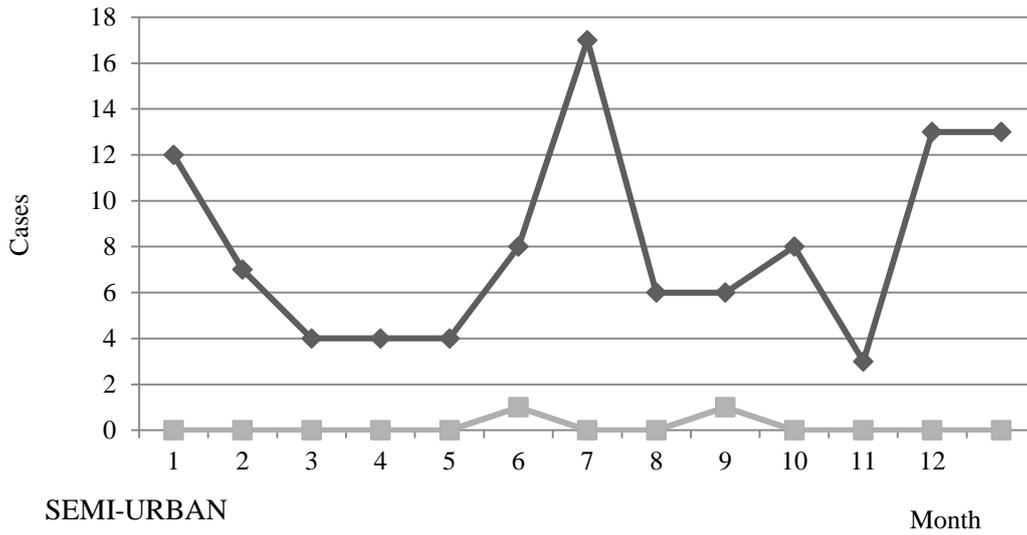
Data analysis was divided into two phases. The first phase of the analysis was focused on descriptive distribution of the dengue cases, dengue outbreak, Aedes Index, Breteau Index into sociodemographic and locality. Second phase of the analysis was to find association or relationship between dengue outbreak with Aedes Index and Breteau Index by using Pearson Chi Square analysis from SPSS program. Receiver operating

curve (ROC) analysis been done to evaluate the ability of the Aedes Index and Breteau Index to discriminate between the dengue cases and dengue outbreak area. There were no issue with missing data as all variable in this study were mandatory in the e-dengue system and dengue case management.

**RESULTS**



## Indices and Dengue Outbreak



**Figure 1** Distribution of Dengue case and Dengue outbreak with locality.

Total of 593 cases of the dengue cases were registered in 2015 by Kota Tinggi Health Office (Figure 1). A majority of the cases were occurred in the rural area with 263 cases, (44.3%), followed by urban with 177 cases, (29.8%), others with 109 cases (18.4%) and semi-urban with 44

cases (7.4%). A total of 75 dengue outbreak localities were registered with most of the outbreak occurred in rural area (37 outbreaks, 49.3%) followed by urban area (27 outbreaks, 36.0%), others (9 outbreaks, 12.0 %) and semi-urban (2 outbreaks, 2.7%).

**Table 1** Descriptive table of Dengue cases, Dengue outbreak, Dengue demographic and source of dengue notification in Kota Tinggi in 2015

Variable		Frequency (n)	Percentage (%)
Dengue Fever	Rural	263	44.3
	Semi-Urban	44	7.4
	City	177	29.8
	Others	109	18.4
Dengue Outbreak	Rural	37	49.3
	Semi-Urban	2	2.7
	City	27	36.0
	Others	9	12.0
Age	≤ 19	227	38.2
	20-29	149	25.2
	30-39	101	17.0
	40-49	51	8.6
	50-59	32	5.4
	≥ 60	33	5.6
Sex	Male	370	62.4
	Female	223	37.6
Race	Malay	474	79.9
	Chinese	46	7.8
	Indian	19	3.2
	Others	54	9.1
Notification Source	Government Hospital	323	54.5
	Private Hospital	32	5.4
	Government Health Clinic	236	39.8
	General Practitioner Clinic	2	0.3

Comparing gender difference had showed that 62.4% of dengue case infected male. Difference in race had showed that majority of cases were among Malays (79.9%). People age less than 30 years old contributed to the majority of cases (63.4 %). Most of the cases were notified from government hospital which contributed to 54.5% followed by government health clinics (39.8%), private hospital (5.4%) and private general practitioners (0.3%) (Table1).

Data on distribution of dengue cases and dengue outbreak with the months showed that there were increment of dengue case and outbreak occurred in the second half of the year between July and December (Figure 1). Rural localities had showed high number of dengue cases which showed 39 cases in July, 37 cases in August and highest cases of 40 in October. Rural area also had showed high occurrence of dengue outbreak which 9 outbreaks in July and 10 outbreaks in September. (Figure 1).

Table 2 and Table 3 showed that association between Aedes Index, Breteau Index,

localities and dengue outbreak occurrence. Analysis of Aedes Index and Breteau Index for dengue cases in Kota Tinggi noted there was significant association between the Aedes index ( $p < 0.01$ ) and Breteau index ( $p < 0.01$ ) with localities of the dengue cases. Rural area documented 55.1% of Aedes Index  $> 1\%$ , Semi-Urban showed 62.8% Aedes Index more than 1% and others localities showed 63.6% Aedes Index more than 1% while Urban showed only 39.0% Aedes Index more than 1% in the dengue cases area. While in Breteau Index, the significant association showed in the all localities with dengue cases with total of 82.3% of all dengue cases showed Breteau Index  $< 5\%$  (Table 2). This explained that dengue cases may still be occurred in the area with low breeding site. In the analysis between aedes index with dengue outbreak incidence also showed that there was significant association between dengue outbreak and low transmission level of aedes indices that indicate the dengue outbreak may occurred in the area with low transmission of aedes index (Table 3).

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**Table 2** Association between localities with Aedes Index and Breteau Index

Variables	Aedes Index		$\chi^2$ (df)	p value
	< 1% n (%)	≥1% n (%)		
Locality				
Rural	118 (44.9)	145 (55.1)	20.993 (3)	<0.01
Semi-Urban	16 (37.2)	27 (62.8)		
Urban	108 (61.0)	69 (39.0)		
Others	40 (36.4)	70 (63.6)		
Overall	282 (47.6)	311 (52.4)		

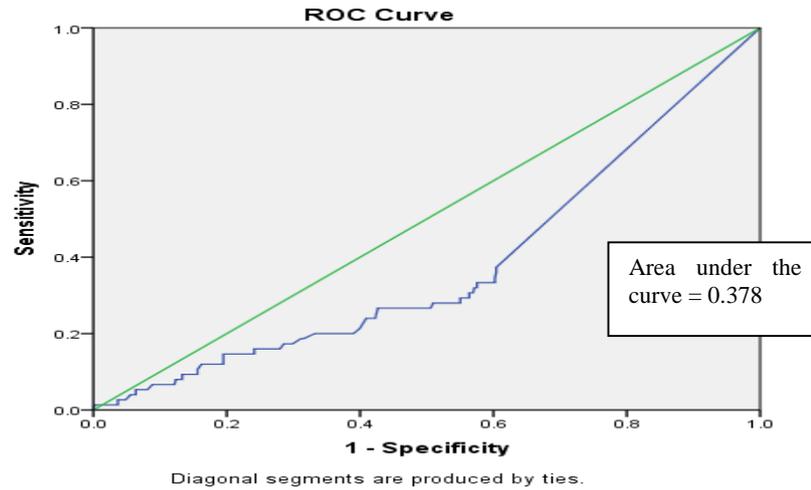
Variables	Breteau Index		$\chi^2$ (df)	p value
	< 5% n (%)	≥ 5% n (%)		
Locality				
Rural	209 (79.5)	54 (20.5)	37.652 (3)	<0.01
Semi-Urban	32 (74.4)	11 (25.6)		
Urban	170 (96.0)	7 (4.0)		
Others	77 (70.0)	33 (30.0)		
Overall	488 (82.3)	105 (17.7)		

**Table 3** Association between Localities, Aedes Index and Breteau Index with Dengue Outbreak.

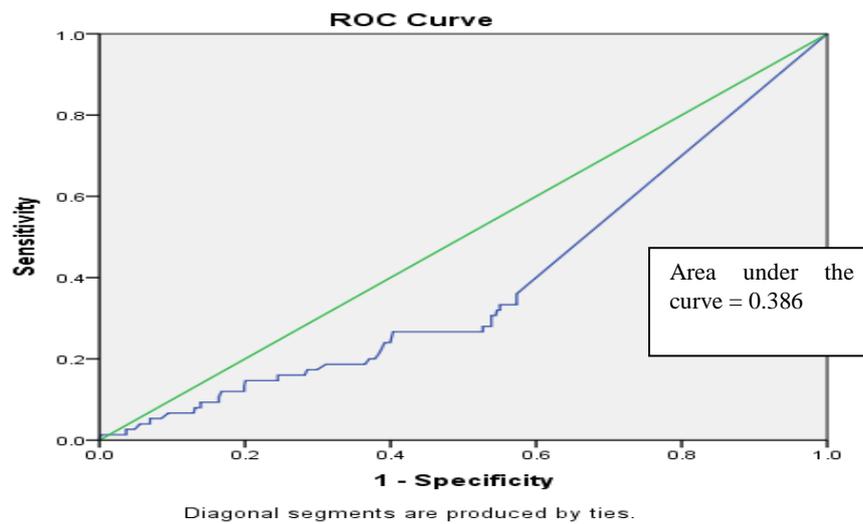
Variables	Dengue Outbreak		$\chi^2$ (df)	p value
	Yes n (%)	No n (%)		
Locality				
Rural	37 (14.1)	226 (85.9)	6.044 (3)	0.110
Semi-Urban	2 (4.7)	41 (95.3)		
Urban	27 (15.3)	150 (84.7)		
Others	9 (8.2)	101 (91.8)		
Overall	75 (12.6)	518 (87.4)		
Aedes Index				
Low Transmission	53 (18.8)	229 (81.2)	18.389 (1)	<0.01
High Transmission	22 (7.1)	289 (92.9)		
Overall	75 (12.6)	518 (87.4)		
Breteau Index				
Low Transmission	66 (13.5)	422 (86.5)	1.919 (1)	0.166
High Transmission	9 (8.6)	96 (91.4)		
Overall	75 (12.6)	518 (87.4)		

The figure 2 and figure 3 showed that aedes index receiver operating characteristics (ROC) curve documented only 0.38 (95% CI:0.31-0.45) and Breteau Index ROC had showed 0.39

(95% CI : 0.30-0.43) which showed that aedes indices reported low sensitivity and specificity in this area.



**Figure 2** Receiver operating characteristics (ROC) curve for Aedes Index in Kota Tinggi with Dengue Outbreak 2015



**Figure 3** Receiver operating characteristics (ROC) curve for Aedes Index in Kota Tinggi with Dengue Outbreak 2015

**DISCUSSION**

The study based on distribution of age showed that majority of dengue infection affected younger age group. Analysis cases in 2015 showed that majority of dengue cases are among people aged less than 39 years while old group people age more than 60 years contributed 5.6% only. This type of trend was seen similar with other nearby country study such in Singapore where majority of the dengue cases affected people aged 16 to 25 years old that stated the success in controlling mosquitoes might have contributed to the low immunity of young adults for dengue infection; hence they became the group most infected.<sup>8-10</sup> On the gender difference comparison that there were higher rate dengue cases in male (62.4%) compare to female (37.6%). This study was similar with study findings in Sri Lanka and Singapore where the majority of dengue cases affecting male.<sup>8,10</sup> This is due to longer duration of male outdoor either working or

recreational activities comparing with female gender.

Rural area had showed majority dengue cases and dengue outbreak occurrence. This because of the geographical location of the most houses nearby palm oil plantations. Besides that, the rural area location usually face improper management of domestic wastage and poor maintenance of public area such as park and cemeteries may contribute to the high potential site for mosquito's breeding.<sup>3-5</sup> Other factor such as migration of young generation from rural to urban city area may also cause their premises or houses left empty without proper maintenance that lead to potential breeding places for Aedes mosquitos.

The study also showed increment of dengue cases in July in the semi-urban localities; the place where proper domestic waste management and good housing system been implemented.<sup>10</sup> Hence we believed that climate

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factor may also contribute to the increasing cases in the well planned housing area.

There were no evidence that dengue outbreak only occurred in the localities with high level of Aedes Index ( $\geq 1\%$ ) and Breteau Index ( $\geq 5$ ). This is most probably due to certain reasons that aedes larvae were not related to the aedes adult population.<sup>1</sup> The adult mosquitoes may fly away from breeding site and cause outbreak in the low aedes index. Although larvae mortality were high during elimination of breeding site, the survived adult mosquitoes still able to transmit the disease.<sup>1</sup> Hence, the study showed that the aedex index and breteau index are inadequate and not effective enough to measure the risk of transmission.<sup>1,11</sup> Another possible reason of high dengue cases and outbreak in the low aedes index and breteau index is the improper technique of larval survey. It is included the less background experience, improper methods of surveys or error in recording the actual aedes index compare to actual level of indices.

The study also showed that there was possibility that the aedes index and breteau index may not be effective as dengue surveillance method in this area as not all larvae may survive to become adult mosquito. Suggestion of using and practicing pupae index as the dengue surveillance in determining dengue outbreak should be reconsidered. However, using pupae index may need a lot of skills and expertise training.

### *Limitations and strengths of the study*

This study of the dengue cases and outbreak in Kota Tinggi in 2015 demonstrated the consistency of the data collected and registration system of dengue. However, there were limitations to this study such as the short study period of one year data may not project the real situation and the reliability of the aedes index and breteau index data entered into the system during registration of dengue cases or outbreak. Other technical issue during the study is the limitation of the personnel who went for the dengue survey to cover the requirement radius area needed for aedes survey. Requirement of more man power should be fulfilled for proper aedes survey activities in the area.

## CONCLUSION

The study of dengue cases and outbreak in Kota Tinggi, Johor in 2015 showed that aedes index and breteau index were not consistent and had low sensitivity and specificity in determining dengue outbreaks occurrence in Kota Tinggi. As dengue disease remains a major endemic in Malaysia, better surveillance index should be reconsider as the main surveillance for dengue disease.

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