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# Review of Dengue Trend in Kelantan using R Programming

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**Abstract**: Dengue is an illness transmitted by mosquitoes, causing sudden high fever, severe headache, rashes, muscle and joint pain, pain behind the eyes, and bleeding, in some cases. In Malaysia, dengue has become one of the major problems since it leads to serious dengue fever. This study is done in Kelantan to review the trend in dengue cases from January 2015 to October 2019. The year 2016 has the highest dengue cases compared to other years. Data were obtained from the Department of Health in Kelantan for the year 2015 until 2019. The socio-demographic analysis showed that males (51%) are prone to dengue fever compared to females (49%). Based on ethnicity, Malays (96.38%) have the highest reported dengue cases followed by Chinese, Indian, and others (2.68%, 0.2%, and 0.74%, respectively). Dengue cases were stated higher in the urban area (39.06%) than in rural areas (32.08%). R programming is used to show the trend of the dengue cases and data visualization. The result showed that at early and end of the year, more dengue cases were reported. Thus, effective and efficient strategies, as well as immediate actions for dengue prevention are needed in Kelantan.

**Keywords**: cases, dengue, Kelantan, R, trend

## 1 Introduction

Generally, dengue is an illness that is transmitted by mosquitoes that can cause a sudden high fever, severe headache, rashes, muscle and joint pain, pain behind the eyes, and bleeding, in some cases. According to the World Health Organisation (WHO) [1], dengue is a mosquito-borne viral infection that has rapidly spread in all regions in recent years. The virus that causes dengue is called dengue virus (DENV). There are four types of DENV serotypes (DENV1, DENV2, DENV3, and DENV4) which means that it is possible to be infected four times. Recovery from infection provides lifelong immunity against that particular serotype. Dengue cases have grown dramatically worldwide in recent decades. Generally, dengue is found in tropical and sub-tropical climates, mostly in urban and suburban regions. Even rural areas are beginning to be affected in certain countries. Based on a study conducted by Hwang et al [2], in the eastern and South-eastern Asia regions, dengue fever (DF) and dengue hemorrhagic fever (DHF) have affected about 500,000 people who require hospitalization each year and the majority are children.

Jain et al ( Jain, et al. 2019) have mentioned that the transmission of DENV occurs through the bite of the infected Aedes mosquitoes, predominantly, Aedes aegypti. This case has intensely risen in the last two decades due to several direct and indirect factors. These factors include the density of infected mosquitoes, the level of immunity of individuals to dengue stereotypes, climatic behaviors, and human-related factors such as housing types, population density, and cleanliness. In Malaysia, dengue fever has become a major problem as it is prone to mortality. These cases are usually at a peak during late monsoon seasons and pose an increased risk in urban and suburban areas [4]. As reported by Fong [5] in the *Star Online*, 119,198 infections were recorded with 162 deaths and it was about 359 new cases for each day.

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The highest cases were recorded in the year 2015 which stood at 120,836 cases. Various preventive measures have been taken to overcome dengue outbreaks such as fogging and removing mosquito breeding sites. Dengue studies raised awareness in Malaysia as it leads to mortality. According to Mia et al. [6], dengue cases and the number of deaths have risen with an average of 14% and 8% per year, respectively. This shows that the dengue situation has worsened with the increasing number of reported cases and deaths during the last decade (the year 2000 until 2010). The purpose of this study is to review the trend of dengue incidences in Kelantan from January 2015 to October 2019. From this study, the public health authorities can prepare, cope, and control the epidemic. This study will display which district that the dengue cases have increased dramatically. The demographic analysis will take part in obtaining important information regarding dengue victims in Kelantan so that the dengue victims' socio-demographics can be studied briefly.

## 2 Literature Reviews

In December 2014, there is a huge flood in Malaysia's east coast which put Kelantan at a dengue outbreak risk. According to Ahbirami and Zuharah [7], Kelantan has suffered a severe dengue outbreak before the area suffered a major flood. A study to review dengue fever incidence has been done by Hussin et al. [8]. The study mentioned that Kota Bharu contributed almost 70% of dengue cases due to the period of rapid industrialization and urbanization which increased the breeding sites for Aedes mosquitoes. Another study conducted in Seremban by Majid et al. [9], has observed that population frequently migrates and rapidly urbanizes which probably contributes to the rise of the dengue epidemic. Future urbanization, environment, globalization, lifestyle, and lack of vectors may lead to global distribution of dengue. Increasing dengue incidences may be due to demographic changes, huge urbanization in the city, change of agricultural land in rural, and lack of vector control programs [6], [10].

A study by Chew et al. [11], identified that the number of male dengue victims was higher than the female's with 63% and 37%, respectively. Males have a high probability to be exposed to the Aedes mosquitoes because males are doing more outdoor works compared to females. In another study by Rafique et al. [12], the majority of males (n=3276) were prone to dengue fever compared to females (n=1954) as most females tend to cover most of their body and would rather stay indoor than outdoor. The study is supported by Anker and Arima [13], who indicated that dengue victims of males aged between 5 – 14 years old exceeded that of above 15 years old. The findings suggest that the number of victims may differ between males and females probably due to the difference in exposure. Thus, a past study by Gupta et al. [14], stated that the 11-year gender-based analysis study showed that the male population was more likely to have an infection than the female population at a mean ratio of 2:1.

The majority of cases were Malays, as most people in Kelantan are generally Malays. A study by Hussin et al. [8] gave a different result where the Chinese have the highest cases at 43.0% followed by Malay (39.1%), Indians (6.3%), and others. Nevertheless, there was an increase in the number of cases of Malays and Indians resulting from the expansion of urban areas and the migration of Malays from rural to urban areas. In terms of races, most dengue victims were Malays followed by Chinese and Indians with a ratio of 4.1:1.5:1 [15]. Therefore, all gender and ethnic groups are vulnerable to dengue infection [16].

## 3 Methodology

### *A Study area*

This study focuses on Kelantan which is located in the north-eastern corner of the peninsula Malaysia with an area of approximately 15,040km$^2$ in 2017 [17]. The total population in Kelantan is estimated at 2.001 million. There are 10 districts in Kelantan which are Kota Bharu as the capital city followed by Pasir Mas, Kuala Krai, Tumpat, Tanah Merah, Machang, Pasir Puteh, Bachok, Jeli, Gua Musang.

This state has a tropical climate, with temperatures between 21 and 32°C and intermittent rain throughout the year. Recently, there is an increase in dengue cases in Kelantan as claimed by Bernama [18] that the cases rose by 315 percent with 2,266 cases recorded in a period of almost seven months in 2019. The State Health Department director, Dr. Zaini Hussin said that the cases continued to grow especially during the festive holiday as people keep ignoring the cleanliness of their surroundings. The department had carried out spraying 424,548 premises and larviciding 215,545 premises to reduce mosquito breeding sites.

### *B Data Collection*

The dengue fever data (demographic) used in this paper was obtained from the Department of Health in Kelantan. The data included the previous dengue cases in Kelantan for all districts with the parameters such as age, gender, ethnicity, locality, and race. The data was provided by the Division of Vector-Borne Disease in Kelantan, starting from the year 2015 until October 2019. The parameter of the data as listed in Table 1 below. The collected data represents the accumulated number of dengue cases reported in Kelantan.

Table 1: Description of parameters

| Variables | Data types | Description |
|---|---|---|
| **District** | Categorical | All districts in Kelantan |
| **Identification Number** | Numeric | The number that is used to identify whether the patients are the same and to identify recurring cases |
| **Notification Number** | Numeric | A unique identification, thus duplicate data can be avoided |
| **Date** | Date | Notification date for the case |
| **Locality Status** | Categorical | The locality is either rural, urban, or unknown |
| **Gender** | Categorical | Male or Female |
| **Race** | Categorical | Malay, Chinese, Indian, and Others |

### *C Analysis Methods*

This study used the secondary data obtained from the Division of Vector-Borne Diseases (DVBD) in Kelantan for the years 2015 until October 2019. Thus, the data needs to be checked whether there is something that may lead to unsuccessful outcomes, such as missing and duplicate data. The process of cleaning the data is called pre-processing. The datasets may have duplicate and missing data which will affect the analysis.

A unique identification, known as Notification Number, is a parameter in the dataset that is used to identify any duplication in the dataset. The method of eliminating the duplication in the cleaning process, work on the source of computing the degree of similarity between closed records in an organized database [19]. The Identification Number (IC) cannot be used as a unique identification, since the patient may have dengue fever several times.

The study by Angelov [20] clarifies that the messiness in real-world data is represented by the missing value. However, removing missing data may lessen the amount of data and will lead to problems in machine learning. Treating the missing value can be manually inspected as 'NaN', 'NA', 'None', ' ', '?', and so on. The missing value may not harm knowledge discovery in Databases if the rate is between 1% to 5% as it is still manageable. However, sophisticated methods are needed if the rate is greater than 5% as it will cause a severe impact in interpretation as the findings may be biased [21], [22].

R programming is used in this study for better analysis and several related packages have to be installed. R language is an open source which is usually used for visualization in statistical computing. It is an open-source software and it is easy to use. The software can be downloaded for free from the Comprehensive R Archive Network (CRAN) [23]. The beginning of analysis in R should start with importing data into RStudio using package `readxl`, so it will be able to read data

from Microsoft Excel file. Some other packages are needed to extract the variables and handle the missing values as shown below.

```
library(readxl)
library(tidyverse)
#read the data and extract the variables needed
data2 <- read_excel("Dengue.xlsx")
myvars<- c("District", "Age", "IC", "Date", "NotificationNum",
     "Kewarganegaraan","Race","Gender", "LocalityStatus",
     "Outcome")
data2<- data2[myvars]

#handle the missing values
library(knitr)
library(kableExtra)
colSums(is.na(data2))%>%
  kable()%>%
  kable_styling()
data2$LocalityStatus[is.na(data2$LocalityStatus)]<- 'None'
data2$Outcome[is.na(data2$Outcome)]<- 'Unknown'
data2<- na.omit(data2)
```

## 4 Results and Discussion

Since the data has undergone pre-processing, the number of reported dengue cases is different every year. Table 2 shows that Kelantan has reported the highest dengue cases in the year 2016 with 6,132 cases and in the year 2018, 1,954 dengue cases were reported. The dengue cases can increase and decrease dramatically. A total of 18,266 cases of dengue fever were reported in Kelantan during the five years, from January 2015 until October 2019.

Table 2: Number of Dengue cases in Kelantan

| Year | Total Cases |
|---|---|
| 2015 | 2,726 |
| 2016 | 6,132 |
| 2017 | 2,493 |
| 2018 | 1,954 |
| 2019 | 4,961 |

The study continued to see the trend of dengue cases annually by month. Figure 1 shows that there is a different trend for each year. However, in the months of January, September, and October, dengue incidence is at its peak. Early and at the end of the year, dengue cases were the highest in Kelantan since it is the rainy season. This is possibly caused by the increase in breeding sites due to the accumulation of water in containers and construction sites [8]. In the year 2018, dengue cases were the highest in the month of June compared to other months. This showed that dengue cases can increase or decrease depending on climates, environment, and human behavior. The study by Ramadona [24] mentioned that the primary vector of dengue (Aedes aegypti) can adapt well to human environments and the vectors are delicate towards climate change especially in the rainy season as rainfall may contribute to building vector-breeding spots.

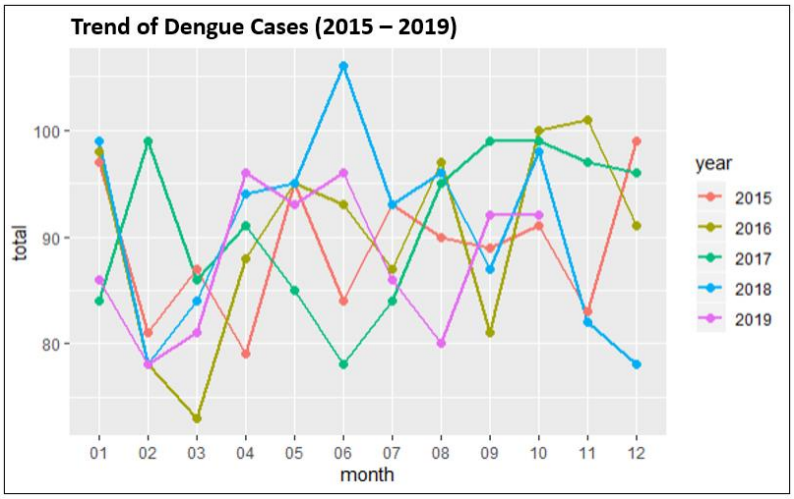


Figure 1: Trend of Dengue Cases from the year 2015 until 2019

As in Figure 1, the differences in the number of cases for both months and years were statistically significant. Dengue cases are high in certain months may be caused by seasonal change or human behaviors. Annual seasonal variation patterns in the incidence of dengue indicate that infections appear suddenly in the month of July, just after the beginning of the rainy season, and cases peak in the months of August and September, which are considered to be the months with the most favorable environment for mosquito breeding [14]. To generate the graph shown in Figure 1, the following R codes were used using `ggplot` package.

```
ggplot(ndate,aes(x = month, y = total, group=year, color=year))
          + geom_line(size=1)+ geom_point(size=2)+
           ggtitle("Trend of Dengue Cases (2015 -2019)")
```

Table 3 shows the socio-demographic analysis for dengue fever. The most race that reported dengue fever cases were Malays (17,609 or 96.38%) and more than half (9313 or 51.0%) were males. Males have a high probability to be exposed to dengue fever as they tend to travel and do more outside work than females [11]. Regarding the classification of cases, it shows that 39.06% of reported dengue cases (n=7,135) came from urban areas and 32.08% (n=5,860) were from rural areas. 28.86% (5,271) data was unknown which means the data was not available for locality status.

Table 3: Socio-demographic characteristics of Dengue Fever

| Variables | Frequency | % |
|---|---|---|
| **Race** | | |
| **Malay** | 17605 | 96.38 |
| **Chinese** | 489 | 2.68 |
| **Indian** | 36 | 0.20 |
| **Others** | 136 | 0.74 |
| **Sex** | | |
| **Male** | 9313 | 51.0 |
| **Female** | 8953 | 49.0 |
| **Locality Status** | | |
| **Urban** | 7135 | 39.06 |
| **Rural** | 5860 | 32.08 |
| **Unknown** | 5271 | 28.86 |

Table 4 shows the pattern of dengue cases in 10 districts in Kelantan yearly from 2015 to 2019. The year 2016 recorded the highest dengue cases, and Kota Bharu has the highest number of cases (n=4117). Kota Bharu has recorded peak number of cases every year, which is more than a thousand cases reported, since it is the capital city of Kelantan, and urbanization may be the cause of dengue

increase. Hsu et al. [25] state that in Taiwan, urban areas located in the southern region have the highest prevalence rate, probably due to high population density, tropical climate, and the presence of Aedes aegypti mosquitoes.

Table 4: Dengue cases in Kelantan by district for the years 2015 until 2019

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **Bachok** | 163 | 639 | 249 | 165 | 462 |
| **Gua Musang** | 33 | 38 | 75 | 56 | 59 |
| **Jeli** | 26 | 21 | 15 | 36 | 140 |
| **Kota Bharu** | 1383 | 4117 | 1287 | 951 | 2723 |
| **Kuala Krai** | 87 | 73 | 72 | 48 | 166 |
| **Machang** | 138 | 92 | 87 | 34 | 136 |
| **Pasir Mas** | 334 | 197 | 157 | 155 | 331 |
| **Pasir Puteh** | 65 | 135 | 75 | 131 | 158 |
| **Tanah Merah** | 231 | 260 | 211 | 141 | 363 |
| **Tumpat** | 266 | 560 | 265 | 237 | 423 |

## 5 Conclusion

The results of this study review the trend of dengue cases as well as determine the socio-demographic profile for dengue fever in Kelantan between the years 2015 until 2019. The increasing dengue trend in the number of reported cases needs to be taken seriously. Preventive measures should be taken immediately to cope with the increase in dengue cases. The current analysis was unable to determine the factors why the number of dengue cases among males were greater than females, Malays were the highest, and the majority of cases were reported in urban areas. Factors that may indirectly contribute to dengue are unhygienic surroundings, natural disasters, climatic change, and population. Future work is required to identify the factors and causes that contribute to dengue cases so that specific strategies can be taken to control dengue outbreak.

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