UNIVERSITI PUTRA MALAYSIA

DETERMINING DENGUE RISK FACTORS IN SELANGOR, MALAYSIA USING REGRESSION APPROACH

NURUL AKMAR BINTI GHANI

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By

NURUL AKMAR BINTI GHANI

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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NURUL AKMAR BINTI GHANI

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Chair : Associate Professor Shamarina binti Shohaimi, PhD
Faculty : Science

Dengue has become a burden to the world as dengue infection now occurs in more countries compared to before 1990s. In Malaysia, Selangor records the highest number of dengue cases every year. This study is done to investigate the risk factors that cause dengue outbreaks in Selangor. Data on knowledge, attitude and practice (KAP) together with environmental conditions were collected in hotspot and non-hotspot dengue area using questionnaires in 2015 and 2016. Data on weather in Selangor was obtained from the Malaysian Meteorological Department, and data on population distribution was obtained from the Department of Statistics Malaysia to compare with data on dengue incidences obtained from Selangor State Health Department. KAP data on communities living in hotspot and non-hotspot areas were investigated, and differences in knowledge and attitude marks were significant at p-value of 0.003 and <0.001 by T-Test, respectively. Environmental cleanliness on both areas was also examined and result shows hotspot areas were dirtier, with p-value of <0.001. Data on weather, relative humidity, mean 24-hour temperature, rainfall amount and number of rainy days were analyzed, and various correlation levels were found between weather and dengue incidences in all districts. The effect of population density on dengue was observed. District with highest population density, Petaling recorded the highest dengue incidences in both years. Logistic regression on all risk factors was done to produce the final model, which concludes that environmental condition, human attitude, and population density are the most probable risk factors that cause dengue transmission. The qualitative observation was done to look at the condition of both areas, and it confirmed that people in non-hotspot areas display better attitude and cooperation towards taking care of their surroundings. This shows that hygienic inspection and health education on dengue should be focused on hotspot areas to reduce the risk of dengue transmission.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

MENENTUKAN FAKTOR RISIKO DENGGI DI SELANGOR, MALAYSIA DENGAN MENGGUNAKAN PENDEKATAN REGRESI

Oleh

NURUL AKMAR BINTI GHANI

Disember 2020

Pengerusi : Professor Madya Shamarina binti Shohaimi, PhD
Fakulti : Sains

Denggi telah menjadi satu beban kepada dunia kerana sudah banyak negara mempunyai jangkitan denggi sekarang berbanding sebelum 1990an. Di Malaysia, Selangor mencatatkan kes denggi tertinggi setiap tahun. Kajian ini dijalankan untuk menyelidik apakah faktor-faktor yang menyebabkan jangkitan denggi di Selangor. Data tentang pengetahuan, sikap dan amalan (KAP) bersama-sama dengan data tentang tahap kebersihan kawasan wabak dan bukan wabak denggi telah dikumpul dengan menggunakan borang kaji selidik pada tahun 2015 dan 2016. Data cuaca telah diperolehi daripada Jabatan Meteorologi Malaysia dan data tentang jumlah penduduk telah diperolehi daripada Jabatan Perangkaan Malaysia untuk dibandingkan dengan data indisen denggi yang diperolehi daripada Jabatan Kesihatan Negeri Selangor. Data KAP antara penduduk kawasan wabak dan bukan wabak dibandingkan dengan menggunakan analisis ujian T dan keputusan menunjukkan bahawa pengetahuan dan sikap antara penduduk di dua kawasan tersebut mempunyai perbezaan ketara dengan nilai p 0.003 dan <0.001. Perbandingan tahap kebersihan antara kedua-dua kawasan juga dinilai melalui ujian T dan keputusan mendapati tahap kebersihan antara kedua-dua kawasan adalah ketara dengan nilai p <0.001. Data cuaca telah dibandingkan dengan data insiden denggi dan pelbagai nilai kolerasi antara kedua-dua data ditemui di semua daerah. Kepadatan penduduk juga dibandingkan dengan jumlah insiden denggi dan daerah Petaling yang mempunyai kepadatan penduduk tertinggi merekodkan data insiden denggi tertinggi. Semua faktor yang menyebabkan denggi dianalisa sekaligus menggunakan analisis logistik, dan model logistik yang diperolehi menunjukkan faktor utama yang menyebabkan jangkitan denggi adalah sikap manusia, tahap kebersihan kawasan penempatan dan kepadatan penduduk. Pemerhatian mendalam yang dijalankan mendapati penduduk kawasan bukan wabak lebih bertanggungjawab dan mudah bekerjasama dalam menjaga kebersihan tempat tinggal. Kajian ini menunjukkan bahawa pemeriksaan kebersihan dan pendidikan kesihatan perlu diberi perhatian dan dibuat dengan lebih kerap di kawasan wabak untuk merendahkan risiko jangkitan denggi.

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Shamarina binti Shohaimi, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Alvin Hee Kah Wei, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Chee Hui Yee, PhD
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

ZALILAH BINTI MOHD SHARIFF, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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Signature: _____
Name of Chairman of Supervisory Committee: Assoc. Prof. Dr. Shamarina binti Shohaimi

Signature: _____
Name of Member of Supervisory Committee: Assoc. Prof. Dr. Alvin Hee Kah Wei

Signature: _____
Name of Member of Supervisory Committee: Assoc. Prof. Dr. Chee Hui Yee

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CDC	Centre for Disease Control and Prevention
CYD-TDV	Dengvaxia vaccine
DENV	Dengue virus
DHF	Dengue haemorrhagic fever
DSS	Dengue shock syndrome
DOSM	Department of Statistic, Malaysia
ELISA	Enzyme-linked immunosorbent essay
IMR	Institute of Medical Research
KAP	Knowledge, Attitude and Practice
MMD	Malaysia Meteorological Department
MMOH	Malaysia Ministry of Health
NAAT	Nucleic acid amplification test
NMRR	National Medical Research Registry
NSx	Non-structural protein
OR	Odds ratio
PCR	Polymerase chain reaction
RNA	Ribonucleic acid
ROC	Receiver Operating Characteristics
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
SSHD	Selangor State Health Department
WHO	World Health Organization
ZIKV	Zika virus

CHAPTER 1

INTRODUCTION

1.1 Background of study

Dengue has affected more than 30% of the world population, with a range of 50 and 100 million cases per year (Amaku et al., 2014). According to World Health Organization (WHO), in 2012, it is estimated that 500,000 dengue patients develop severe dengue, including acute bleeding, organ deficiency, and plasma leakage, while 2.5% of the patients died (Guo et al., 2016). Dengue initially found to occur in only nine countries, has become an endemic disease in more than 100 countries worldwide (WHO, 2020). The spread of the disease has gone across the continents. Millions of dengue cases have been reported around the Americas, South-East Asians and Western Pacific, and the possible risk of dengue fever outbreaks now exist across Europe (WHO, 2020).

Almost half of the world population lives in areas highly exposed to dengue outbreaks (Buczak et al., 2012) and over 2.5 billion people living in endemic prone areas (Bharati & Saha, 2018). Low to middle-income countries are the most affected by dengue (Gutierrez-Bugallo et al., 2017). Dengue is a type of climate-sensitive disease. Therefore more cases are reported in hot and tropical weather with adequate rainfalls (Connor & Mantilla, 2008). The distribution of dengue is expected to widen as global warming has spread the warm regions further (Degallier et al., 2010). Apart from climatic variables, the geographic distribution of dengue is also influenced by socioeconomic variables (Astrom et al., 2012). Dengue, transmitted by *Aedes* mosquitoes, is also associated with urbanization, water storage, inadequate water supply, discarded containers and population movements (Vanwambeke et al., 2006).

Aedes aegypti and *Aedes albopictus* are two main mosquitoes that spread dengue from one person to another by carrying the dengue virus. Its unique structure facilitates the spread of the virus, host response, presence of various serotypes and advantageous condition of mosquitoes breeding environment (Gurugama et al., 2018). The symptoms of dengue vary from minimal to mild such as flu-like and fever to severe ones like joint pain, headache, nausea and vomiting (Buczak et al., 2012). Some patients develop the more severe syndrome, which is known as dengue haemorrhagic fever (DHF) or dengue shock syndrome (DSS), which can be detected by coagulopathy, increased vascular fragility and loss of fluid, which can subsequently lead to hypovolemic shock (Guzman et al., 2013). There are reports on dengue complications that cause multi-organ failure and complex dengue infection on the stomach, liver, lung, kidney and brain (Gurugama et al., 2018). DHF causes a death rate as high as 50%, where more than 60% of the fatality cases occur in children, as improperly treated children easily capitulate (Ismail, 2014).

An estimation of 3 billion people lives in regions easily exposed to dengue outbreaks and 600 million come from Southeast Asia itself. Indonesia recorded the highest dengue cases compared to other South-East Asian countries (WHO, 2020). Dengue fever has been one of the most lethal vector-borne diseases in Malaysia, and the fatality rate due to dengue has almost tripled in numbers for 2014 compared to the same period the previous year, which were 215 versus 922 deaths (Ismail, 2014). The fatality rate continued to increase in 2015 with 335 deaths before the number decreased gradually to 237, 177 and 147 in 2016, 2017 and 2018, respectively. However, in 2019 deaths due to dengue in Malaysia recorded an increase again, at 182 (MMOH, 2020). In 2013, 43,000 cases were reported in Malaysia, higher than before (Australian Network News, 2014). Dengue cases continued to rise to 120,836 in 2015 before it lowered steadily to 101,357, 83,849 and 80,615 in 2016 to 2018, respectively. In 2019, dengue cases rose again to 130,101 (MMOH, 2020).

Malaysian Health Minister S. Subramaniam stated there were peaks of the cycle every three to four years (AFP, 2014). Localities of dengue were detected in 13 states which account for 594 in number, and 115 hotspot areas were reported in Selangor, Kuala Lumpur and Putrajaya (Bernama, 2014). More than one thousand premises inspected showed that they had optimal atmosphere for the *Aedes* breeding process and among all states, Sarawak, Penang, and Selangor ranked the three highest states with *Aedes* index between 2.0% to 5.1% (Bernama, 2014). By 2019, among all states in Malaysia, Selangor recorded the highest dengue incidence rate per population with the value of 1096.8 per 10,000 population, while Terengganu reported the highest death rate with a value of more than 0.5 in 2019 (MMOH, 2020).

Most dengue cases occur in urban areas, favourable for their high-density population and rapid development, which help mosquitoes breeding and dengue spread faster (MMOH, 2020). Socioeconomic factors also affect dengue transmission, where older age groups showed poor knowledge of dengue compared to younger people (Naing et al., 2011). The condition of surrounding areas influences dengue transmission too. Spots like institutional, workshops and agriculture areas presented more dengue vector habitat, especially after rainy seasons, while areas with systematic and cleaner surroundings showed fewer habitats suitable for *Aedes* (Sarfraz et al., 2012).

Public awareness, disease surveillance, and control programs might help monitor dengue cases to keep track of the outbreaks that might happen at any time throughout the year (Atkinson, 2010). In foreign countries, treatment of dengue patients acquired them to be ready financially to pay for the care and medication. Hospitals in countries with high dengue incidence annually must also prepare enough resources for treatment and medicine during predicted peak periods. Shepard & Suaya (2010) study showed that giving dengue vaccination can contribute to cost-effectiveness not only to the infected persons but also to the countries, with the condition that vaccines become accessible and available.

1.2 Problem statement

Dengue is considered one of the most lethal vector-borne disease in the world. It is responsible for the most morbidities and mortalities compared to other arboviral diseases (Alobuia et al., 2015). In 2018, an estimation of 390 million people was affected by dengue, leading to mild to chronic health threat in the human population (Asad et al., 2018). Fifty percent of the world population is at risk of dengue infection, and 70% live in Southeast Asia and Western Pacific parts (Harapan et al., 2016). In Malaysia, the number of dengue cases fluctuates from year to year, and the highest number of dengue cases recorded every year is in the Selangor state (MMOH, 2019). The fluctuation of the number of dengue cases shows a lack of knowledge, attitude and practice among Selangor citizens and contributing factors such as environmental conditions, weather, and population density, which necessitates this study.

1.3 Significance of the study

Most dengue studies done worldwide and in Malaysia reported many cases, risk factors, vector factors, and the best available treatment to dengue patients. However, few published research data on risk factors take into account all possible aspects of dengue linked to its epidemiology triad. Selangor, the state that recorded the highest dengue in Malaysia, showed fluctuation of dengue incidences over the years, for example, 62,867 incidences in 2015, 51,652 in 2016 and the number increased after 2016. There is a need to do a study in Selangor to investigate the reasons. There are also few published researches on KAP related to dengue in Selangor, but none of them combines it with other factors to see how the combination affects the number of dengue cases. This study does not investigate dengue cases and death by one factor per se but aimed to determine the risk factors of dengue in Malaysia from available data using statistical approaches to confirm the main risk factors, elucidate what caused the main factors to influence dengue outbreak for years and suggest a probable solution that helps Malaysians combat dengue in the right approach. The result established in this study will take vectors and humans into consideration and seasonal forecast, socioeconomic factors, urbanization areas, knowledge, and much more to predict dengue outbreaks. This will help authorities and physicians be fully prepared in all aspects the next time a dengue outbreak occurs. It will also help in planning and making decisions to help lower dengue cases and death caused by dengue.

1.4 Research questions

i) What are the differences in KAP levels of communities living in hotspot and non-hotspot dengue areas in Selangor?

ii) What is the difference in environmental conditions between hotspot and non-hotspot areas of dengue outbreak in Selangor?

iii) How weather affects dengue outbreak in Selangor?

iv) What is the relationship between population density and dengue cases in Selangor?

v) What are the main risk factors of dengue outbreak in Selangor?

1.5 Hypothesis

i) The level of KAP among communities living in non-hotspot areas are higher than communities living in hotspot areas of dengue outbreak

ii) The cleanliness of non-hotspot areas of dengue is more hygienic than hotspot areas

iii) Weather factors such as rainfall distribution, temperature and humidity affect the fluctuation of dengue cases in Selangor

iv) Areas with higher population density show higher cases of dengue

v) KAP, weather, population distribution and environmental conditions influence dengue outbreak

1.6 Objectives of study

1.6.1 General objective

To investigate risk factors of dengue fever outbreaks and transmission in Selangor, Malaysia, using a regression approach

1.6.2 Specific objectives

i) To examine the difference of level of KAP between communities living in hotspot and non-hotspot areas of dengue outbreak in Selangor

ii) To illustrate the difference of environmental condition between hotspot and non-hotspot areas of dengue outbreak in Selangor

iii) To observe the influence of weather factors towards dengue outbreak in Selangor

iv) To demonstrate the effect of population density of dengue spread

v) To present a regression model that encapsulates all important variables related to dengue outbreak

1.7 Scope of study

This study is done in Selangor, and communities living in hotspot and non-hotspot areas were involved in this study. Apart from investigating human and socioeconomic factors, this study also inspects other factors related to dengue: environmental conditions of hotspot and non-hotspot areas of dengue, monthly-yearly weather, and population density compared to dengue date obtained from Selangor State Department of Health, as illustrated in Figure 1.1. The focus of this study is to examine thoroughly which factors contribute the most to dengue outbreak and transmission in Selangor, Malaysia, thus suggesting the best probable solution to combat the outbreak. This study is relevant to be applied to other states in Malaysia and other areas in the world with similar population density and climate type.

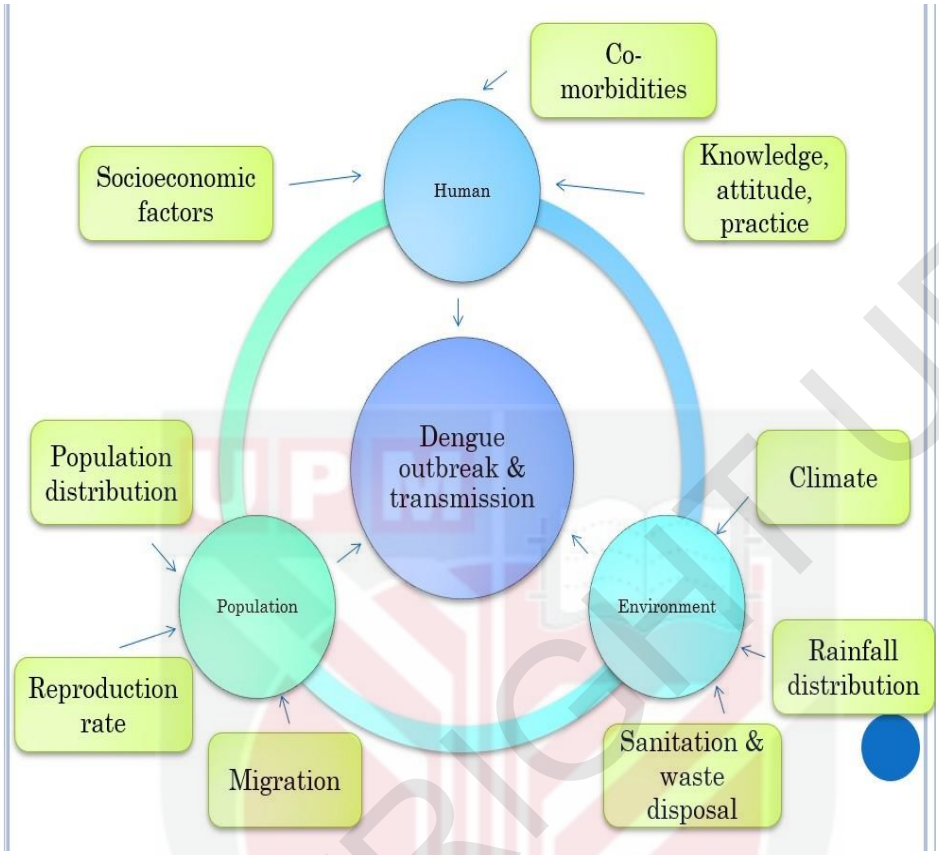

Figure 1.1: The relationship between dengue outbreak and transmission with human, environmental, and population factor

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BIODATA OF STUDENT

Nurul Akmar binti Ghani was born on 1st November 1985. She got her primary and secondary education in Terengganu and Kelantan. She obtained her Bachelor of Science (Genetics & Biotechnology) from University of Melbourne, Australia and graduated her Master of Medical Statistic from Universiti Sains Malaysia. She worked temporarily as Research Officer in Clinical Research Centre, Hospital Sultanah Nur Zahirah, Terengganu before pursuing her PhD in Universiti Putra Malaysia, Selangor to complete her academic education.

LIST OF PUBLICATIONS

Nurul Akmar, G., Shamarina, S., Kah-Wei, A. H., Hui-Yee, C., Emmanuel, O. & Lamidi Sarumoh, A. A. (2019). Comparison of Knowledge, Attitude, and Practice among Communities Living in Hotspot and Non-Hotspot Areas of Dengue in Selangor, Malaysia. *Tropical Medicine and Infectious Disease, Dis.* 2019, 4, 37. https://doi:10.3390/tropicalmed4010037

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