

Dengue Review: Issues, Challenges and Public Attitudes

Ahmad Firdhaus Arham, Muhammad Rizal Razman, Latifah Amin, and Zurina Mahadi

To Link this Article: <http://dx.doi.org/10.6007/IJARBSS/v8-i4/4125>

DOI:10.6007/IJARBSS/v8-i4/4125

Received: 11 March 2018, Revised: 03 April 2018, Accepted: 05 April 2018

Published Online: 14 April 2018

In-Text Citation: (Arham, Razman, Amin, & Mahadi, 2018)

To Cite this Article: Arham, A. F., Razman, M. R., Amin, L., & Mahadi, Z. (2018). Dengue Review: Issues, Challenges and Public Attitudes. *International Journal of Academic Research in Business and Social Sciences*, 8(4), 956–972.

Copyright: © 2018 The Author(s)

Published by Human Resource Management Academic Research Society (www.hrmars.com)

This article is published under the Creative Commons Attribution (CC BY 4.0) license. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this license may be seen

at: <http://creativecommons.org/licenses/by/4.0/legalcode>

Vol. 8, No. 4, April 2018, Pg. 956 - 972

<http://hrmars.com/index.php/pages/detail/IJARBSS>

JOURNAL HOMEPAGE

Full Terms & Conditions of access and use can be found at
<http://hrmars.com/index.php/pages/detail/publication-ethics>

Dengue Review: Issues, Challenges and Public Attitudes

Ahmad Firdhaus Arham¹, Muhammad Rizal Razman¹, Latifah Amin², and Zurina Mahadi²

¹ Research Centre for Sustainability Science & Governance (SGK), Institute for Environment & Development (LESTARI), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia,

² Pusat Citra Universiti, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

Abstract

Dengue is a dangerous disease that can lead to death. This disease transmitted by Aedes mosquito that has spread throughout the world including Malaysia. Now, there is no vaccine available for the disease or no specific cure that can deal with this issue except fogging technique as the conventional way that has been used as the main strategy for controlling Aedes's mosquito population. However, the issues and challenges of dengue can be overcome by looking at public attitudes on the level of knowledge, awareness and practice of the local community to combat dengue. Therefore, this research aims to review issues, challenges and public attitudes on dengue.

Keywords: Dengue, Malaysia, Issues, Challenges, Public Attitudes

Introduction

Dengue fever is a dangerous infectious disease transmitted by Aedes mosquito that invites a public health problem in Malaysia and all over the world (Ong 2016; Rozita et al. 2006). Most of the dengue cases occur in the urban area with high population density and rapid development (Ong, 2016; Mazrura et al. 2012). In fact, the increase in population, urbanisation, globalisation, global warming, and climate change have also contributed to dengue cases (Limkittikul et al. 2014; Natasha et al. 2013; Mazrura et al. 2012; Gubler, 2011; Wilder-Smith & Gubler, 2008; Kumarasamy, 2006).

The globalisation and urbanisation factors contributed by population increase and migration from the rural to urban area or movement of foreigners from abroad into the country have resulted in the addition of human habitat. This addition caused the human to require water for domestic usage of daily need and this had allowed the Aedes mosquito to reproduce in any water reservoir created from the human activities (Mondini & Neto, 2007). The development has also demands the opening of new construction site, thus contributed to the breeding of Aedes

mosquito due to poor construction site environment. This is supported by the findings from Abu Hassan (2005) which reported that the construction site in Pulau Pinang, Malaysia has a high potential for the breeding of *Aedes* mosquito. Besides, the unsystematic structure of city planning and maintenance management of human habitat which covers the water drainage, waste, and sewage management have also contributed to dengue problem.

The factor of global warming and climate change were the major factors in the rising of dengue cases in Malaysia since it has somehow altered the life cycle of *Aedes* mosquito (Ong, 2016). Previous investigation stated that the temperature rises and extend of weather humidity have caused the survival of *Aedes* cycle to become longer, hence elevating the rate of dengue virus transmission and vector migration to other geographical areas (Mohammaed & Chadee 2011; Hii et al. 2009; Hales et al. 2002). However, the weather in Malaysia has created the most conducive environment for the dengue vector to reproduce since the rain falls throughout the year and this country receives sunlight that allow mosquitoes to live (Choy & Abdullah, 2016).

Dengue Epidemiology

In Malaysia, the first dengue fever case was reported in Pulau Pinang during the year of 1901 and the dengue fever case has become epidemic across the country (Mazrura et al. 2010; Sazaly & Norazizah, 2002; Poovaneswari, 1993) and in 1962, a dengue haemorrhagic fever was reported. The cases were not only limited in Malaysia, but the Southeast Asia region was also experiencing the virus spread which include Philippines, Thailand, Indonesia, Singapore, and Vietnam. The dengue fever cases are increasing, and this give a serious negative impact (Soodsada et al. 2009) which resulting in death. In 2015, Philippines and Malaysia had reported more than 50 % of dengue cases and the highest dengue cases in Southeast Asia whereby there was 16 % increment from the dengue cases reported in the previous year (WHO 2016). Previous studies have reported that the Asian continent is the dominant area for *Aedes* mosquitoes (Stanaway et al. 2016; Bhatt et al. 2013).

The spread of dengue virus has also involved countries of other than Asia such as Africa, America, South America, Latin America, and Pacific islands where 40 % of millions of people from this area are prone to dengue risk (Brady et al. 2012; Wandscheer et al. 2004). In 2010, Latin America reported 1.5 million dengue cases that include some countries such as Brazil, Peru, Argentina, Columbia, and Venezuela (Choy & Abdullah, 2016). The Argentina had reported dengue outbreaks in 13 out of 24 territories where the dengue fever has infected (Dryden 2001). Meanwhile, in 2015, the death rate in America had spiked up to 1,181 deaths due to dengue virus infection. Also, in the same year, Brazil had recorded 1.5 million increases in dengue cases, which three times higher than those reported in 2014 (WHO 2016). Besides, more than 19 countries of Africa continent are having the epidemiology of dengue fever with all four types of dengue serotypes (Choy & Abdullah, 2016; Srichaikul & Nimmannitya, 2000). The dengue cases were reported to increase from 2.2 million cases in 2010 to 3.2 million cases in 2015 (WHO 2016). Approximately 2.5 % deaths will happen from the 500,000 people who are infected with dengue virus and most of it can potentially infect children. To conclude, the myriad of dengue cases has brought concern to all countries, including Malaysia.

Dengue Aetiology

The dengue virus spread through the bite of infected female *Aedes* mosquitoes. The infected mosquito will transfer the dengue virus directly through the bite while sucking blood from the victim. Once the victim was bitten by the infected mosquito, the dengue virus will enter and circulate in the victim's blood circulation system. The dengue virus transmission can also occur when the non-infected *Aedes* mosquitoes suck in blood from the infected victim, and transfer the dengue virus to other victim through its bite during bloodsucking. All *Aedes* mosquitoes are the dengue virus vector once they got infected, before transferring it to other victim. However, the dengue virus transmission can also be transferred by female *Aedes* mosquito to its own eggs and this is known as trans-ovary, hence the infected eggs will become adults and free into the environment as well as infecting the next victim (Zul-Izzat Ikhwan, 2013). The dengue-infected individuals are the main carrier and virus multiplier, and these individuals are the virus source for the non-infected mosquitoes (Choy & Abdullah 2016).

Aedes mosquitoes can be easily recognised because of their colour of body structure and legs are white and black stripes. The *Aedes* mosquitoes actively bite their victims during early morning and late evening (Chan, 2007; Whelan & Hurk, 2003; Lee, 2000). They are also can easily reproduce in any water reservoir, either outdoors or inside the house because these mosquitoes are easily found in the human habitat (Lam, 1993; Lee & Cheong, 1987). The *Aedes* mosquitoes usually found to breed in stagnant clear water reservoir such as the saucer of plant pot, bucket, plastic container, water tank, old tyre, water container, coconut shell, ants trap, clogging drain, and others for them to lay eggs (Abu Hassan, 2014; Nyamah et al. 2010; Lee, 2000; Lam, 1993; Lee & Cheong, 1987; Cheong, 1967). Yap et al. (1994) stated that the *Aedes* mosquitoes can also reproduce in natural habitat such as leaf petals, branches' hole, and others. Meanwhile, previous investigation reported that the common container used by *Aedes* mosquitoes to reproduce was the container of polystyrene and plastic types (Mazrura et al. 2010, 2012). On the other hand, a study by Leishnam et al. (2005) found the manmade container was the most common site for adult *Aedes* mosquitoes to lay eggs in the New Zealand town.

In Malaysia, there are two types of *Aedes* mosquitoes vector that spread the virus dengue which are the *Aedes aegypti* and *Aedes albopictus* mosquitoes (Ong, 2016; Lee et al. 2015; Mazrura et al. 2012; Rozhan et al. 2006; Lee, 2000; Lam, 1993). The *Aedes aegypti* mosquitoes are the main vector for this dengue problem (Shuaib et al. 2010; Mousson et al. 2005; Coleman & McLean, 1973), and also can cause the yellow fever (Aitken et al. 1977), chikungunya (Chua, 2010), and the latest, zika. *Aedes aegypti* mosquitoes live around the house and dark spots inside the house (Zul-Izzat Ikhwan 2013). Mosquitoes of this type lay eggs and reproduce in water reservoir of either outdoors or inside the house. However, the *Aedes aegypti* mosquitoes usually will not suck the blood of the host where they live (McCall & Kittayapong, 2007) since they only fly around 100 metres from the living area (Harrington, 2005; Honorio et al. 2003; Muir & Kay, 1998).

Meanwhile, the *Aedes albopictus* mosquitoes are the second type of vector that responsible for transmitting the dengue virus, especially in Asia, which later spread to America, West Africa, and Mediterranean countries (McCall & Kittayapong, 2007). *Aedes albopictus* mosquitoes are usually outdoors (Mazrura et al. 2012). They reside and reproduce in the holes of tree branches, plants

that hold water, and manmade container that available outdoors. This type of mosquito normally bites their victim outdoors and rarely indoors. A study by Rozilawati et al. (2007) which investigated the ovitrap found that the *Aedes albopictus* mosquitoes were mostly found at the open space outside the house and building premise. The mosquitoes are actively biting the victim the most within 7 to 9 in the morning and 5 to 7 in the evening (Mazrura et al. 2012; Chan, 2007).

The dengue virus-infected female Aedes mosquitoes will attack the middle part of the mosquito's body whereby the virus will replicate and then moves to the salivary channel in 12 days for incubation. Later, the virus is transmitted to the human through a bite while sucking the victim's blood. The Aedes mosquitoes can live up to 30 days and throughout this period, they can lay eggs for more than 10 times hence producing dozens or hundreds of eggs. These eggs will be active in nature and reproduce in water reservoir. With enough water and foods, the eggs will be able to hatch into larvae in only one day. The larvae will then change into pupae in 96 hours, and during this phase, the pupae will not eat and in a resting phase. In two days, the pupae will turn into the adult mosquitoes with a perfect structure. Once it become an adult Aedes mosquito, its body parts will harden, and its wings began to open for flying. Thus, the Aedes mosquitoes' life cycle takes approximately seven days (Ikhwan, 2013).

There are four types of virus carried by Aedes mosquitoes that able to cause dengue fever and result in dengue epidemic in Malaysia which are the flavivirus of DENV 1, DENV 2, DENV 3, and DENV 4 (Ong, 2016; Lee et al. 2015; Chinnakali et al. 2012; Rozita et al. 2006). All these dengue viruses are having 60 – 80 % of homology with each other (Choy & Abdullah 2016). The surface proteins for all dengue viruses differ from each individual (Gubler, 2015). According to a report by Ministry of Health, Malaysia, in Peninsular Malaysia, the DENV 1 virus serotype is more than 50 % as compared to other serotypes. Unlike in Sabah and Sarawak, the DENV 2 virus serotype is abundantly found there. However, according to investigation by Normile (2013), the fifth virus serotype was found and announced in 2013, but the virus is yet to be spread in Malaysia.

The dengue virus-infected individuals will experience bad health condition after the third day and following. Initially, the victim might be having sudden fever and followed with various non-specific sign and symptom such as severe headache, red rashes throughout the body, pain at the back corner of the eyes, and sore muscles and joints (Lee, 2000). The condition is more dramatic when there is inflammation in the blood vessels which causes the classical dengue fever turns into a haemorrhagic dengue fever or dengue shock syndrome (Azami et al. 2011). The haemorrhagic dengue fever happens when there is blood vessels leakage inside the body that causes the reduction in the blood volume. The patient may experience shock or shock syndrome because of the blood vessels leakage that causes internal bleeding that lead to coma and can eventually lead to death. However, for the individuals that been infected with this virus and live in the dengue epidemic area, they can be infected more than once throughout their lifetime due to infection with either one virus serotype will give the immunity towards the virus. Hence, it is not recommended to reside in the area of high dengue rate since it might welcome the infection. Now, there is no specific treatment and drug to treat the dengue fever (Ong, 2016; Lee et al. 2015; Simmons et al. 2012; Kumarasamy, 2006; WHO, 2000; Yap et al. 1994). The dengue fever can only be treated with the help of therapy support (Shuaib et al. 2010).

Dengue Control and Prevention Techniques

Various techniques of control and prevention are introduced, either by chemical, biological, genetical and environmental controls through the cooperation from the community. Regardless of that, the dengue vector control is the most effective technique to control the spread of dengue virus (Ong, 2016). The control of dengue vector is also aims to control the breeding and density level of *Aedes* mosquitoes (Idahan, 2014).

In Malaysia, the chemical control of fog spray is the main method used to control the dengue vector by reducing the population of adult mosquitoes. There are two types of fogging techniques which are the thermal spray or ultra-low volume (ULV) spray that will be sprayed to the area with reported dengue fever cases (Ong, 2016). This fogging technique is used to control the density of adult *Aedes* mosquitoes. This spray can interfere the cycle of viral transmission and stop the cycle by killing the main vector within 24 hours. The technique will be applied once an area is reported with dengue fever case. The spray only involves the indoor and outdoor environment with the potential area for *Aedes* mosquitoes to hide (Lee et al., 2015). The fog spray can only kill the adult *Aedes* mosquitoes, and not killing the larvae. For the area with high repetitive dengue fever cases, the area will be given ULV spray using thermal fogger machine which is mixed with poison such as temephos or Bti placed on the health inspector's vehicle for spraying the area. The number of ULV spray is in large scale, where the spray can extend across a wider area. The ULV spray also can only kill the adult mosquitoes and its effect remains longer.

The environment control through the larvae poison such as sprinkling the abate powder in water reservoir can also reduce the breeding of *Aedes* mosquitoes. This chemical powder is believed to not bring any harm or negative effect on human, otherwise it affects the *Aedes* mosquitoes' life cycle at early stage. It is safe, effective, readily available, and easy to use. It is effective for three months. The larvaciding activity is also one of the chemical environment controls which can be sprayed onto the water reservoir. This spray can control the *Aedes* mosquitoes reproduction and kill the larvae that reside in the water. The example of larvicide is temephos which is available in powder or spray forms which can be put into water reservoir. The environment control and use of larvicide are the traditional dengue control techniques which are still being used until today. This dengue vector control can reduce the number of *Aedes* mosquitoes' population in an area. However, the increasing and unpredictable number of dengue cases have shown that there is a need of alternative technique for eradicating the *Aedes* mosquitoes.

The use of *Bacillus thuringiensis israelensis* (Bti) pesticide which produced from soil bacteria is one of the alternatives used to kill the larvae by destroying and damaging the epithelium cells of larvae's intestine (Pandy et al. 2012). The Bti poison can caused the larvae to paralyse and die within 24 hours. It is a biology control method that can be utilised by spraying it on the water reservoir to treat the water. It is also used as additional mixture in the ULV spray. Next, the investigation of biology control on *Wolbachia* bacteria has been actively done since the bacteria have successfully reduced the Chikungunya virus as the *Wolbachia* bacteria injection resulted in the virus resistance to breed inside the *Aedes* mosquitoes (Afizah et al., 2015). In the case of dengue, the laboratory research produced the *Wolbachia* on male *Aedes* mosquitoes by producing male *Aedes* mosquitoes with genetic defect. The *Aedes* mosquitoes that infected with

the bacteria are released into the environment for continuing their life cycle by mating with the wild female *Aedes* mosquitoes. However, once a fertilisation occurs, the wild *Aedes* mosquitoes will lay eggs and the offspring produced will not survive long. This method can also kill the male mosquitoes with these bacteria faster and it also increased the spread of *Wolbachia* bacteria to other wild female *Aedes* mosquitoes, hence shorten the life span of the female *Aedes* mosquitoes itself. The Institute of Medical Research, Malaysia (IMR) did the research on *Wolbachia* bacteria by releasing the *Aedes* mosquitoes with these bacteria in a research site. Later, the research was continued by catching and collecting the *Aedes* mosquitoes from the research site to identify whether there is presence of bacteria or not. The bacteria were identified through polymerase chain reaction (PCR) and DNA sequencing. The results found 100 % homology of *Aedes* mosquitoes from those that taken from various research site with *Wolbachia* bacteria (Lee et al., 2015). This showed that the *Wolbachia* bacteria were successfully bred in the mosquito's population of that area.

Among the latest innovations in the environment control or pesticide suggested by Ministry of Health, Malaysia are the outdoor residual spraying (ORS) and autocidal which are the easy and efficient methods for solving the dengue problem. The ORS activity is the complimentary activity to control dengue in the outdoors. It is done to reduce the vector population of *Aedes* mosquitoes. The pesticide is durable, effective for three months, and its nature of rain-resistant that allow it to be able to trap the resting mosquitoes in the sprayed area. However, the ORS effectiveness also depends on the wall surface, geographical area, rainfall, humidity level, and temperature of that area.

Besides, the use of autocidal trap is also one of the techniques used to trap the larvae and female *Aedes* mosquitoes. This trap is cheap, environment-friendly, durable, and safe to be used with minimal maintenance. The important component of this trap is the sticky plastic strip that floats on the water surface. Then, the sticky surface is able to trap the female mosquitoes that about to lay eggs, since they are attracted to approach the floating water inside the trap to lay eggs. This technique was experimented and marked using ovitrap index and the reduction in dengue cases was observed to 13 cases in 2014, as compared to 53 cases reported in 2013 (Nazni et al., 2015).

The other method being developed in the genetically modified *Aedes* mosquitoes (GM *Aedes* mosquitoes). The GM *Aedes* mosquitoes was developed by a company known as Oxitec, a United Kingdom based biotechnology firm, established for fighting the dengue virus. The GM male *Aedes* mosquitoes produced will be released into the environment for mating process with the wild female mosquitoes, however the process results in offspring that is died during the larvae or pupae stages unless there are enough additional food (tetracycline) in their breeding medium (Lee et al. 2015). Tetracycline suppresses the death gene by allowing the larvae to develop into adult mosquitoes in the laboratory environment, but the larvae produced from GM *Aedes* mosquitoes will die in the environment due to the absence of tetracycline (Lee et al. 2015; Phuc et al. 2007). If the female *Aedes* mosquitoes only mate with the GM male *Aedes* mosquitoes, the population of dengue vector will be reduced.

In the Asia's first field test, 6,000 GM *Aedes aegypti* mosquitoes were released into a forest near Bentong, Pahang on 21st December 2010 in the effort to combat dengue in Malaysia. The GM *Aedes* mosquitoes obtained a widespread coverage from the media and resulted in no support from Malaysians. Few news has beforehand reported that the study was postponed after objections made by the NGO and public. The Consumers Association of Pulau Pinang (CAP) and Friends of the Earth, Malaysia (SAM) wrote a memorandum to the National Biosafety Board (NBB) to cancel the approval of this research (Memorandum to NBB by CAP and SAM, 20 December 2010). More than 20 NGOs of public health and environment unions had wrote open letters to the government requesting to abolish the spread of GM *Aedes* mosquitoes and asking them to invest in a safer approach to deal with dengue. Even though this open release for the first experiment have found that it is successful and safe (Lacroix et al. 2012), the release of GM mosquitoes brings in controversy and protest from Malaysians. This trial brings major concern among NGO, environment activist, scientist, and public. They argue on the transparency of the research, absence of public participation in making decision, the process of releasing GM *Aedes* mosquitoes is meanwhile done in hurry (Koh et al. 2011, Teh et al. 2012), incomplete risk assessment (Wallace 2013), as well as concern on the issues of ethics, laws, and human's right (Memorandum to NBB by CAP and SAM, 2010). Despite of that, the Malaysia government had granted the permission for this trial of GM *Aedes* mosquitoes research in order to control dengue in Malaysia. If the trial shows success, the GM *Aedes* mosquitoes will be released into the Malaysia's environment. However, if the public's consent issues are not well-managed, the potential benefit of GM *Aedes* mosquitoes may not be realised. Hence, the involvement of public's consent is very important in continuing the effectiveness of this new technology.

Currently, there is no effective vaccine for all four dengue virus serotypes that are able to cure dengue fever in Malaysia. Through the scientific investigation on dengue-infected individuals that are injected with vaccine, the body produced antibody that are able to increase the immunity from dengue virus infection. The scientists are now actively producing the suitable vaccine, but the research continues to be intensified since there are concern on ensuring the safety of the vaccine use against four dengue virus serotypes (Lee et al. 2015; Amin & Hashim, 2014; WHO, 2000).

Review of Previous Studies Related to Public Attitude on Dengue Control and Prevention

The environment is invaluable treasure that should be preserved, appreciated, and best kept by human (Rizal et al. 2009). Therefore, its sustainability should be ensured so that is protected for the next generation (Hueting, 2009). The environment sustainability is aimed to maintain the environment stability so that it won't be any damage that results in negative impact. Recently, Malaysia and the world are facing the poor public attitude since it was assumed that the environmental protection isn't their responsibility to the extend where the dengue fever cases are worsening. Thus, the public are demanded to change their attitude by strengthening their knowledge, awareness, and understanding so that a safer and healthier lifestyle are ensured, which away from any syndrome of vector-borne disease, especially dengue.

The attitude is correlated with the extend of knowledge and public practice in their acceptance on any issue. This attitude is expressed through their knowledge in deciding action which leads

to the practice. There were many studies worldwide that study on the extend of public knowledge, attitude, and practice (KAP) on dengue issues. Literature review revealed there was a previous study which showed positive or negative correlation between the knowledge and dengue prevention practice. A study by Farizah et al. (2003) in Kuala Kangsar found that 68.5 % of respondents have information regarding the dengue fever and Aedes mosquitoes, while 91.5 % were having good attitude towards the dengue control, but only 51.5 % respondents were willing to practice the dengue control and prevention. This study was supported by Claro et al. (2004) which stated that there was no correlation between the extend of knowledge variable with the positive attitude on the extend of dengue prevention practice. The level of knowledge and positive attitude on dengue issue did not drive the extend of practice in controlling dengue. An investigation in Brazil found that the public knowledge and attitude on dengue problem were stemming from the gap between level of knowledge and practice of dengue vector prevention (Neto et al. 2006). Other than that, Khamis et al. (2009) explained that the public attitude towards dengue is still lacking, as showed by the epidemiology factor and ecology of Aedes mosquitoes is still expands. This study showed that the level of knowledge, attitude, and practice towards dengue differ according to the population, especially among students with insufficient information related to this issue. This study suggested the more active educational campaign in order to change the Jeddah community perception to practice the dengue prevention.

The investigation by Soodsada et al. (2009) among the community of Pakse, Laos found that the majority of the respondents were aware and acknowledged the symptoms of dengue through the health education messages by mass media. Most of the respondents knew about the dengue virus transmission and potential area for dengue vector breeding. They also knew about the biological control technique, closure of water reservoir, use of mosquito net, and frequent change of water reservoir. However, their knowledge on this control and prevention techniques did not determine their attitude and practice on the dengue control and prevention. Meanwhile, study by Gunasekara et al. (2012) in Colombo town, Sri Lanka found that 58 % of the locals were aware about the symptom, management, and transmission sign of dengue virus, while only 37 % were aware on the control and prevention of dengue. This study revealed that there was a gap between the knowledge level and the poor attitude affected the practice. Gunasekara et al. (2012) has also found that the continuous information education and communication program related to dengue are required in order to change the public attitude and practice towards the control and prevention of dengue in Sri Lanka. Investigation by Shuaib et al. (2010) showed that 54 % of the parents in Westmoreland, Jamaica knew about the signs, symptoms, and dengue virus transmission. Meanwhile, 47 % regard the dengue is serious, but the disease is preventable, and the majority 77 % did not practice the effective method to avoid the breeding of Aedes vector at the house. This percentage showed there was a poor level of awareness to practice the control and prevention of dengue. This study recommended the plan of health program to enhance the practice of dengue control which was found poor among the Westmoreland residents even though they were knowledgeable about dengue. This was supported by Koendraadt et al. (2006) which stated that the knowledge on dengue did not driven or influence the positive attitude towards the dengue control and prevention.

A study by Phuanukoonnon et al. (2006) reported low level of knowledge in dengue control practice and ineffective control agent have caused few challenges in controlling and preventing dengue in Northeast Thailand area. Study by Syed et al. (2010) in Karachi, Pakistan was meanwhile showed 35 % out of 400 respondents knew about dengue and its vector. This study found the inadequate knowledge was due to low level of education and socioeconomic status which results in the problem of public attitude towards the dengue control and prevention practice in Pakistan. It was found that the prevention practice of dengue vector was high among the group with high socioeconomic status. Meanwhile, the study by Faisal Hafeez et al. (2012) has stated that the level of knowledge significantly affected the attitude and practice of dengue prevention among Punjabi community in Pakistan. This study has explained the extend of knowledge on dengue was higher among urban community as compared to rural community and men were more knowledgeable compared to women. The knowledge on dengue was obtained from mass media such as radio, television, or printed material. When the attitude question was asked, 67.3 % respondents from urban community worry about the dengue effect and only 39.2 % respondents from rural area concern on the effect of dengue. This showed that the level of knowledge can increase the perception and improve the Punjabi community attitude on dengue. Most of the respondents with sufficient knowledge will support the spraying practices to control the Aedes mosquitoes breeding.

Investigation by Yboa dan Leodoro (2013) in Philippines showed that 61.45 % respondents were having enough knowledge on the dengue causes, symptoms, and prevention practices. Findings from this study suggested that the sufficient knowledge did not necessarily results in good prevention practice, hence educational campaign on dengue transmission and affordable effective method are required to be considered in order to reduce the growth of Aedes vector in eliminating dengue issue. The information, expertise, and support are needed to be supplied by the government to enhance the public awareness (Yboa & Leodoro, 2013). This study had found no correlation between the knowledge on dengue and prevention practice. Therefore, this study explained that a good level of knowledge did not determine good practice since the people will stop practising the prevention step if there was no continuous monitoring. The findings were further supported by studies done by Shuaib et al. (2010) and Koenraadt et al. (2006) which stated that the knowledge level was not in line with the dengue control and prevention. In contrast with Dhimal et al. (2014), the study found a very low knowledge about dengue in Nepal, but the public attitude on it was very good and the prevention practice was in moderate level. This study predicted that the education will increase the public awareness on health aspect and the findings was positively correlated between the knowledge, attitude, and practice (Dhimal et al. 2014). An investigation done in Indonesia by Hadisoemarto and Castro (2013) was meanwhile observed the community acceptance and willingness in Bandung, Indonesia to accept the dengue prevention practice through vaccination. Through this study, more than 90 % of the Bandung community supported the vaccination to control the dengue and willing to spent on the vaccination cost. Besides, a study done by Amin and Hashim (2014) studied the factors that influence the stakeholders' attitude on GM Aedes. It was found that the acceptance attitude towards dengue control technique of GM Aedes was influenced by the factors of confidence in stakeholders, attitudes towards technology and nature, acceptance of benefits and risks, and moral concerns that contribute to public acceptance of this control technique. Makornkan et al.

(2015) in a study found that 50.5 % respondents were having knowledge on dengue, 55.6 % were understand on the causes of dengue, 47.5 % were able to relate the Aedes mosquitoes' life cycle, and 68.2 % knew about the risk of dengue virus transmission. Generally, this study reported the moderate level of knowledge on dengue prevention and the attitude was very good with 82.8 %. The knowledge level and positive attitude significantly affect the respondents to practice the good dengue control and prevention.

Al-Zurfi et al. (2015) in a study had found no meaningful relationship between the knowledge status and socio-demographic factor among the students of Sekolah Sains Alam Shah. The respondents of this school were having good knowledge (63.2 %), attitude (79.9 %), and practice to prevent dengue (74 %). However, the students' knowledge increased once they attended the health education program through campaign and dengue prevention promotion by mass media. This study recommended active health education is needed to enhance the positive attitude and cultivate the prevention practice among public to eradicate dengue fever in this country. Study done by Al-Zufri et al. (2015) was further supported by Jeelani et al. (2015) that studied on the knowledge, awareness, and practice of residents of Puducherry, India which showed that most of them were having lack of knowledge especially related to the vector's breeding habitat. Hence, the effort to increase their understanding on dengue should be intensified by the government. The study by Jeelani et al. (2015) was done due to dengue epidemic problem in India in 2012. The findings stated that most of the respondents were unaware about dengue which 80 % of them had ever heard about dengue and 68 % regard that the drainage system and landfill are the source of dengue vector breeding, as well as 59 % felt that the dengue symptoms were the common one (Jeelani et al. 2015).

In contrast with study done by Al-Hazmi et al. (2016) among high school students in Makkah, Saudi Arabia, it was found that the knowledge on dengue fever was low, as reflected by poor practice of dengue prevention. Other than that, investigation done by Handel et al. (2016) among physician of Machala, Ecuador has found high level of knowledge on dengue signs and its treatment, but the aspect of prevention practice, exercise, and prevention diagnosis needed to be enhanced. Study by Elyas et al. (2016) done in rural area of Jazan in June 2015 until March 2016, where the knowledge, attitude, and practice (KAP) of housekeeper on dengue was investigated. Three hundred and eighty-four of housekeeper respondents were asked using a structured pre-coded questionnaire. The result found that 74 % had a good knowledge on dengue and 35 % assumed medium such as radio and newspaper were the source of information. Regardless of that, there were not many of them did knew about Aedes mosquitoes' aetiology since it was reported that 28 % were aware on the Aedes mosquitoes' active bitten period. This study had also found a close correlation between the housekeeper's knowledge towards the attitude and practice of dengue prevention. This study suggested the continuous KAP assessment and enhancement of awareness on dengue prevention (Elyas et al. 2016). According to literature review, it was clearly stated that the level of knowledge, attitude, and practice were closely related in determining the public attitude on the dengue control and prevention. However, according to the researcher, the attitude is required to be emphasised since a good attitude will allow them to reflect their knowledge through the practice. Hence, the study of public attitude on the techniques of controlling and preventing dengue was the right thing to do as the public

attitude towards the knowledge that they have with their practice and belief in dengue control and prevention techniques can be identified.

Conclusion

In conclusion, this study has extensively reviewed the literature on the issues, challenges, and public attitude towards the dengue issue which include the dengue background in terms of epidemiology and aetiology. This study has also explained few techniques of controlling and preventing dengue that can be implemented to control and prevent dengue. Future studies are recommended to study on the knowledge, attitude, and understanding of the public which able to encourage public participation in the techniques of controlling and preventing dengue. Additionally, future studies can also add more literature related to the factors that influence the public attitude on those techniques. Besides, the study of structural equation modelling on public attitudes towards these techniques may also be established so that it can be a measurement model in determining the attitude of the public to the control and prevention techniques of dengue.

Corresponding Author

Ahmad Firdhaus Bin Arham, Research Centre for Sustainability Science & Governance (SGK), Institute for Environment & Development (LESTARI), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia. Email: firdhaikal@gmail.com

References

- Abu Hassan, A., Che Salman, M. R., Ngumbang, J., Ramli, A., & El-Badri, A. M. (2005). Mosquitoes of urban areas of Penang abundance and control in *Proceeding of the 5th International Conference on Urban Pests*.
- Afizah, A. N., Roziah, A., Nazni, W. A., & Lee, H. L. (2015). Detection of Wolbachia from field collected *Aedes albopictus* Skuse in Malaysia. *Indian Journal of Medical Research*, 142(2), 205-210. [http://doi: 10.4103/0971-5916.164259](http://doi:10.4103/0971-5916.164259)
- Aitken, T. H. G., Downs, W. G., & Shope, R. E. (1977). *Aedes Aegypti* Strain Fitness for Yellow Fever Virus Transmission. *The American Journal of Tropical Medicine and Hygiene*, 26(5), 985–989.
- Al-Hazmi, S. A., Khamis, N., Abalkhail, B., Muafaa, S., Alturkstani, A., Turkistani, A. M., & Almahmoudi, S. (2016). Knowledge, attitudes, and practices relating to dengue fever among high school students in Makkah, Saudi Arabia. *International Journal of Preventive Medicine Research*, 5(5), 930-937.
- Al-Zurfi, B. M. N., Fuad, M. D. F., Abdelqader, M. A., Baobaid, M. F., Elnajeh, M., Ghazi, H. F., Ibrahim, M. H., & Abdullah, M. R. (2015). Knowledge, attitude and practice of dengue fever and health education programme among students of Alam Shah science school, Cheras, Malaysia. *Malaysian Journal of Public Health Medicine*, 15(2), 69-74. [http://doi: 10.5455/ijmsph.2016.15012016330](http://doi:10.5455/ijmsph.2016.15012016330)
- Amin, L., & Hashim, H. (2014). Factors influencing stakeholder's attitudes toward genetically modified aedes mosquito. *Science and Engineering Ethics*, 21(3), 655–681.
- Bhatt, S., Gething, P. W., Brady, O. J., Messina, J. P., Farlow, A. W., Moyes, C. L., Drake, J. M., Brownstein, J. S., Hoen, A. G., Sankoh, O., Myers, M. F., George, D. B., Jaenisch, T., Wint,

- W. G. R., Simmons, C. P., Scott, T. W., Farrar, J. J., & Hay, S. I. (2013). The global distribution and burden of dengue. *Nature*, 496(7446), 504–507. <http://doi: 10.1038/nature12060>
- Brady, O. J., Gething, P. W., Bhatt, S., Messina, J. P., Brownstein, J. S., Hoen, A. G., Moyes, C. L., Farlow, A. W., Scott, T. W., & Hay, S. I. (2012). Refining the global spatial limits of dengue virus transmission by evidence-based consensus. *PLoS Neglected Tropical Diseases*, 6(8), e1760. <http://doi: 10.1371/journal.pntd.0001760>
- Chan, C. K. (2007). *The study of biting behavior and the detection of resistance status by using biochemical methods on Culex quinquefasciatus, Aedes albopictus and Armigeres subalbatus in Kuala Lumpur* (Degree Thesis). Universiti Sains Malaysia.
- Cheong, W. H. (1967). Preferred Aedes aegypti larval habitats in urban areas. *Bulletin of the World Health Organization*, 36, 586-589.
- Chinnakali, P., Gurnani, N., Prakash, R. U., Parmar, K., Suri, T. M., & Yadav, K. (2012). High level of awareness but poor practices regarding dengue fever control: a cross sectional study from North India. *North American Journal of Medical Sciences*, 4(6), 278-282.
- Choy, E. A., & Abdullah, W. (2016). Menangani wabak Denggi di Malaysia: Satu tinjauan kaedah rawatan dan pencegahan. *GEOGRAFIA Online™ Malaysian Journal of Society and Space*, 12(9), 56-68.
- Chua, K. B. (2010). Epidemiology of chikungunya in Malaysia: 2006-2009. *Medical Journal of Malaysia*, 65(4), 277-282.
- Claro, L. B., Tomassini, H. C., & Rosa, M. L. (2004). Dengue prevention and control: a review of studies on knowledge, beliefs, and practices. *Cadernos de Saúde Pública*, 20(6), 1447-1457.
- Coleman, J. C., & Mclean, D. M. (1973). Dengue virus transmission by aedes aegypti mosquitoes following intrathoracic inoculation. *The American Journal of Tropical Medicine and Hygiene*, 22(1), 124-129.
- Dhimal, M., Aryal, K. K., Dhimal, M. L., Gautam, I., Singh, S. P., Bhusal, C. L. & Kuch, U. (2014). Knowledge, Attitude and Practice Regarding Dengue Fever among the Healthy Population of Highland and Lowland Communities in Central Nepal. *PLoS ONE*, 9(7), e102028. <http://doi.org/10.1371/journal.pone.0102028>
- Dryden, C. (2001). Dengue and Dengue Hemorrhagic Fever. *Wilderness & Environmental Medicine*, 12(2), 147.
- Al-Hazmi, S. A., Khamis, N., Abalkhail, B., Muafaa, S., Alturkstani, A., Turkistani, A. M., & Almahmoudi, S. (2016). Knowledge, attitudes, and practices relating to dengue fever among high school students in Makkah, Saudi Arabia. *International Journal of Preventive Medicine Research*, 5(5), 930-937.
- Elyas, T. B., Elsidig, E. M., Aseri, A., Break, A., Salim, H., Adil, R., & Hamoud, R. (2016). Knowledge, Attitudes and Preventive Practices of House Hold Regarding Dengue Fever in the Rural Areas of Jazan Region, Saudi Arabia. *International Journal of Preventive Medicine Research*, 2(2), 8-12.
- Hafeez, F., Akram, W., Suhail, A., & Arshad, M. (2012). Knowledge and Attitude of the Public towards Dengue Control in Urban and Rural areas of Punjab. *Pakistan Journal of Zoology*, 44(1), 15-21.
- Gubler, D. J. (2011). Dengue, urbanization and globalization: The unholy trinity of the 21st century. *Tropical Medicine and Health* 39(4): 3-11.

- Gunasekaran, T. D. C. P., Velathantiri, V. G. N. S., Weerasekara, M. M., Fernando, S. S. N., Peelawattage, M., Guruge, D., & Fernando, S. (2012). Knowledge, attitudes and practices regarding dengue fever in a suburban community in Sri Lanka. *Galle Medical Journal*, 17(1).
- Neto, G. V. S., Monteiro, S. G., Goncalves, A. G., & Rebelo, J. M. (2006). Public knowledge and attitudes concerning dengue in the Municipality of Sao Luis, Maranhao Brasil, 2004. *Cadernos de Saude Publica*, 22(10), 2191-2200.
- Hadisoemarto, P. F., & Castro, M. C. (2013). Public acceptance and willingness-to-pay for a future dengue vaccine: A community-based survey in Bandung, Indonesia. *PLoS Neglected Tropical Diseases*, 7(9), e2427. <http://doi.org/10.1371/journal.pntd.0002427>
- Handel, A. S., Ayala, E. B., Borbor-Cordova, M. J., Fessler, A. G., Finkelstein, J. L., Espinoza, R. X. R., Ryan, S. J., & Stewart-Ibarra, A. M. (2016). Knowledge, attitudes, and practices regarding dengue infection among public sector healthcare providers in Machala, Ecuador. *Tropical Diseases, Travel Medicine and Vaccines*, 2:8. <http://doi: 10.1186/s40794-016-0024-y>
- Hales, S., de Wet, N., Maindonald, J., & Woodward, A. (2002). Potential effect of population and climate changes on global distribution of dengue fever: an empirical model. *Lancet*, 360(9336), 830-834.
- Harrington, L. C., Scott, T. W., Lerdthusnee, K., Coleman, R. C., Costero, A., Clark, G. G., Jones, J. J., Kitthawee, S., Kittayapong, P., Sithiprasasna, R., & Edman, J. D. (2005). Dispersal of the dengue vector *Aedes aegypti* within and between rural communities. *The American Journal of Tropical Medicine and Hygiene*, 72(2), 209-220.
- Hii, Y. L., Rocklöv, J., Ng, N., Tang, C. S., Pang, F. Y., & Sauerborn, R. (2009). Climate variability and increase in intensity and magnitude of dengue incidence in Singapore. *Global Health Action*, 2. <http://doi: 10.3402/gha.v2i0.2036>
- Honorio, N. A., Silva, W. C., Leite, P. J., Gonçalves, J. M., Lounibos, L. P., & Lourenço-de-Oliveira, R. (2003). Dispersal of *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) in an urban endemic dengue area in the State of Rio de Janeiro, *Memórias do Instituto Oswaldo Cruz*, 98(2), 191-198.
- Hueting, R. (2010). Why environmental sustainability can most probably not be attained with growing production. *Journals of Cleaner Production*, 18, 525-530.
- Jeelani, S., Sabesan, S., & Subramanian, S. (2015). Community knowledge, awareness and preventive practices regarding dengue fever in Puducherry - South India. *Public Health*, 129(6), 790-796. <http://doi: 10.1016/j.puhe.2015.02.026>
- Koh, H. L., Teh, S. Y., DeAngelis, D. L., & Jiang, J. (2011). Infectious diseases: surveillance, genetic modification and simulation. In: Disaster management and human health risk proceedings of the disaster management 2011.
- Koenraadt, C., Tuiten, W., Sithiprasasna, R., Kijchalao, U., Jones, J., & Scott, T. (2006). Dengue knowledge and practices and their impact on *Aedes aegypti* populations in Kamphaeng Phet, Thailand. *American Journal of Tropical Medicine and Hygiene*, 74(4), 692-700.
- Kumarasamy, V. (2006). Dengue fever in Malaysia: time for review? *Medical Journal of Malaysia* 61(10): 1-3.
- Lacroix, R., McKemey, A. R., Raduan, N., Kwee Wee, L., Hong Ming, W., Guat Ney, T., Rahidah, A., A. S., Salman, S., Subramaniam, S., Nordin, O., Hanum, A. T. N., Angamuthu, C., Mansor, M. S., Lees, R. S., Naish, N., Scaife, S., Gray, P., Labbe, G., Beech, C., Nimmo, D., Alphey, L., Vasan, S. S., Lim, H. L., Wasi, A. N., & Murad, S. (2012). Open field release of genetically engineered

- sterile male *Aedes aegypti* in Malaysia. *PLoS ONE*, 7(8), e42771. <http://doi:10.1371/journal.pone.0042771>
- Lam, S. K. (1993). Strategies for dengue control in Malaysia. *Tropical Medicine*, 35(4), 303-307.
- Lee, H. L. (2000). *Aedes: Mosquitoes That Spread Dengue Fever*. Mosquitoes & Mosquitoes-borne Disease: Biology, Surveillance, Control, Personal & Public Protection Measures. Kuala Lumpur, 29-30 June 1999.
- Lee, H. L., & Cheong, W. H. (1987). Field evaluation of the efficacy of *Bacillus Thuringiensis* H-14 for the control of *Aedes (Stegomyia) albopictus* (Skuse). *Mosquito-Borne Disease Bulletin*, 3, 57-63.
- Leishnam, P. T., Salney, D. P., Lester, P. J., & Weinstein, P. (2005). Increased larval mosquito densities from modified landuses in the Kopti Region, New Zealand: Vegetation, water quality and predators as associated environmental factors. *Journal of Ecology and Health*, 2, 1-10.
- Limkittikul, K., Brett, J., & L'Azou, M. (2014). Epidemiological trends of dengue disease in Thailand (2000–2011): a systematic literature review. *PLoS Neglected Tropical Diseases*, 8(11), e3241. <http://doi:10.1371/journal.pntd.0003241>
- Makornkan, S., Toomsan, A., Intachai, P., Saminpanya, P., Saengproa, P., & Marerngsit, D. (2015). Knowledge, Attitude and Practice of Dengue Fever Prevention Among the Villagers of Moo 1 Baan Klongsai, Nhongyansuea Subdistrict, Muaklek District, Saraburi Province, Thailand. *Catalyst*, 12(2), 56-62.
- Mazrura, S., Hidayatulfathi, O., Atiqah, N. M. N., Rozita, H., Zainuddin, M. A., Naim, M. R., & Choy, E. A. (2012). Kajian ekologi nyamuk *Aedes* di Senawang Negeri Sembilan, Malaysia. *Sains Malaysiana*, 41(2), 261-269.
- Mazrura, S., Rozita, H., Hidayatulfathi, O., Zainudin, M. A., Naim, M. R., Atiqah, N. M. N., Rafeah, M. N., Er, A. C., Norela, S., Ashikin, N. Z., & Joy, J. P. (2010). Community vulnerability on dengue and its association with climate variability in Malaysia: a public health approach. *Malaysian Journal of Public Health*, 2, 25-34.
- McCall, P. J., & Kittayapong, K. (2007). Control of dengue vectors: tools and strategies. Report of the Scientific Working Group meeting on Dengue, Geneva, 1-5 October 2006, 110-119.
- Memorandum on Malaysia's GM *Aedes* mosquito planned release: ethical, legal and human rights concerns by Consumers' Association of Penang & Sahabat Alam Malaysia, 20 December 2010. Retrieved June 23, 2016, from <https://www.consumer.org.my/index.php/focus/gm-mosquito/401>
- Mohammed, A., & Chadee, D. D. (2011). Effects of different temperature regimens on the development of *Aedes aegypti* (L.) (Diptera: Culicidae) mosquitoes. *Acta Tropica*, 119, 38-43.
- Idahan, M. A. (2014). *Semangat kepunyaan dalam memperkasakan pendekatan COMBI bagi mengawal kadar kes demam denggi di Kampung Soronsob Kudat Sabah* (Master Thesis). Fakulti Sains Kesihatan, Universiti Kebangsaan Malaysia.
- Mondini, A., & Neto F. C. (2007). Socioeconomic variables and dengue transmission. *Revista de Saude Publica*, 41, 923-993.
- Mousson, L., Dauga, C., Garrigues, T., Schaffner, F., Vazeille, M., & Failloux, A. (2005). Phylogeography of *Aedes (Stegomyia) aegypti* (L.) and *Aedes (Stegomyia) albopictus* (Skuse) (Diptera: Culicidae) based on mitochondrial DNA variations. *Genetics Research*, 86(1), 1-11. <http://doi:10.1017/S0016672305007627>

- Azami, M. N. A., Salleh, S. A., Neoh, H. -M., Zakaria, S. Z., & Jamal, R. (2011). Dengue epidemic in Malaysia: Not a predominantly urban disease anymore. *BioMed Central Research Notes*, 4, 216.
- Muir, L. E., & Kay, B. H. (1998). *Aedes aegypti* survival and dispersal estimated by mark-release-recapture in northern Australia. *The American Journal of Tropical Medicine and Hygiene*, 58(3), 277-82.
- Khamis, N. R. I., Al-Bar, A., Kordey, M., & Al-Fakeeh, A. (2009). Knowledge, attitudes and practices relating to dengue fever among females in Jeddah high schools. *Journal of Infection and Public Health*, 2(1), 30-40.
- Natasha, E. A. M., Mikkil, B. Q., & Annelies, W. S. (2013). Epidemiology of dengue: past, present and future prospects. *Clinical Epidemiology*, 5, 299-309.
- Normile, D. (2013). Tropical medicine. Surprising new dengue virus throws a spanner in disease control efforts. *Science*, 342(6157), 415.
- Nyamah, M. A., Sulaiman S., & Omar, B. (2010). Categorization of potential breeding sites of dengue vectors in Johor Malaysia. *Tropical Biomedicine*, 27(1), 33-40.
- Ong S. Q. (2016). Dengue Vector Control in Malaysia: A Review for Current and Alternative Strategies. *Sains Malaysiana*, 45(5), 777-785.
- Pandy, D. S., Purnama, S. G., & Sudiana, I. G. (2012). Pemanfaatan limbah cair industri pengolahan tahu untuk memproduksi spora *Bacillus Thuringiensis Serovar Israelensis* dan aplikasinya sebagai biokontrol larva nyamuk. *Indonesian Journal of Public Health*. 1(1), 1-9.
- Phuanukoonnon, S., Brough, M., & Bryan, J. H. (2006). Folk knowledge about dengue mosquitoes and contributions of health belief model in dengue control promotion in Northeast Thailand. *Acta Tropica*, 99, 6-14.
- Phuc, H. K., Andreasen, M. H., Burton, R. S., Vass, C., Epton, M. J., Pape, G., Fu, G., Condon, K. C., Scaife, S., Donnelly, C. A., Coleman, P. G., White-Cooper, H., & Alphey, L. (2007). Late-acting dominant lethal genetic systems and mosquito control. *BMC Biology*, 5, 11.
- Poovaneswari, S. (1993). Dengue situation in Malaysia. *Malaysian Journal of Pathology*, 15(1), 3-7.
- Razman, M. R., Matsah, M., Md. Jahi, J., Arifin, K., Aiyub, K., & Awang, A. (2009). Pemakaian Undang-Undang Kecuaian dalam Pengurusan Ekologi dan Habitat Manusia di Melaka, Malaysia. *Malaysian Journal of Environmental Management*, 10(2), 135-155.
- Rozhan, S., Jamsiah, M., Rahimah, A., & Ang, K. T. (2006). The COMBI program in the prevention and control of dengue-the Hulu Langat experience. *Jurnal Kesihatan Masyarakat Malaysia*, 12, 1-13.
- Rozilawati, H., Zairi, J., & Adanan, C. R. (2007). Seasonal abundance of *Aedes albopictus* in selected urban and suburban areas in Penang, Malaysia. *Tropical Biomedicine*, 24(1), 83-94.
- Sazaly, A. B., & Norazizah, S. (2002). Outlook of dengue in Malaysia: a century later. *Malaysian Journal of Pathology*, 59(2), 23-27.
- Shuaib, F., Todd, D., Campbell-Stennett, D., Ehiri, J., & Jolly, P. E. (2010). Knowledge, attitudes and practices regarding infection in Westmoreland, Jamaica. *West Indian Medical Journal*, 59(2), 140-146.
- Simmons, C. P., Farrar, J. J., Nguyen, V., & Wills, B. (2012). Dengue. *The New England Journal of Medicine*, 366(15), 1423-1432.

- Srichaikul, T., & Nimmannitya, S. (2000). Haematology in dengue and dengue haemorrhagic fever. *Best Practice & Research Clinical Haematology*, 13(2), 261-276. <http://doi:10.1053/beha.2000.0073>
- Stanaway, J. D., Shepard, D. S., Undurraga, E. A., Halasa, Y. A., Coffeng, L. E., Brady, O. J., Hay, S. I., Bedi, N., Bensenor, I. M., Castañeda-Orjuela, C. A., Chuang, T. W., Gibney, K. B., Memish, Z. A., Rafay, A., Ukwaja, K. N., Yonemoto, N., & Murray, C. J. (2016). The global burden of dengue: an analysis from the Global Burden of Disease Study 2013. *Lancet Infect Dis*, 16(6), 712–723. [http://doi:10.1016/S1473-3099\(16\)00026-8](http://doi:10.1016/S1473-3099(16)00026-8)
- Soodsada, N., Yoshitoku, Y., Satoshi, M., Keo, S., & Junichi, S. (2009). Knowledge, attitude and practice regarding dengue among people in Pakse, Laos. *Nagoya Journal Medical Science*, 71 (1-2): 29-37.
- Syed, M., Saleem, T., Syeda, U., Habib, M., Zahid, R., Bashir, A., Rabbani, M., Khalid, M., Iqbal, A., Rao, E., Shujja-ur-Rehman., & Saleem, S. (2010). Knowledge, attitudes and practices regarding dengue fever among adults of high and low socioeconomic groups. *Journal of the Pakistan Medical Association*, 60(3), 243-247.
- Teh, S. Y., Koh, H. L., & Yeap, K. L. (2012). Genetically modified mosquito: Myth and reality. *Journal of Science and Technology*, 4(2), 13-21.
- Rozita, W. M., Tap, B. W., Veronica, S., Muhammad, A. K., Lim, K. H., & Sumarni, M. G. (2006). Knowledge, attitude and practice (KAP) survey on dengue fever in an urban malay residential area in Kuala Lumpur. *Malaysia Journal of Public Health Medicine*, 6(2), 62-67.
- Wandscheer, C. B., Duque, J. E., da Silva, M. A. N., Fukuyama, Y., Wohlke, J. L., Adelman, J., & Fontana, J. D. (2004). Larvicidal action of ethanolic extracts from fruit endocarps of *Melia azedarach* and *Azadirachta indica* against the dengue mosquito *Aedes aegypti*. *Toxicon*, 44, 829-835.
- Whelan, P., & Van Den Hurk, A. (2003). Medically important insects in the Northern Territory and how disasters may affect them. *The Northern Territory Disease Control Bulletin*, 10 (No. i), 27-38.
- World Health Organization. (2016). Dengue and severe dengue. Retrieved January 26, 2017, from <http://www.who.int/mediacentre/factsheets/fs117/en/>
- World Health Organization. (2000). Scientific working group on dengue. Meeting Report 3-5 April 2000. Retrieved May 15, 2016, from <http://www.who.int/tdr/publications/documents/dengue-swg.pdf>
- Wilder-Smith, A., & Gubler, D. J. (2008). Geographic expansion of dengue: the impact of international travel. *The Medical clinics of North America*, 92(6), 1377-1390. <http://doi:10.1016/j.mcna.2008.07.002>
- Yap, H. H., Chong, N. L., Foo, E. S., & Lee, C. Y. (1994). Dengue vector control: Present status and future prospects. *The Kaohsiung Journal of Medical Sciences*, 10, 102-108.
- Yboa, B. C., & Leodoro, J. L. (2013). Dengue Knowledge and Preventive Practices among Rural Residents in Samar Province, Philippines. *American Journal of Public Health Research*, 1(2), 47-52.
- Zul-‘Izzat Ikhwan, Z. (2013). *Perspektif komuniti Taman Peruna, Melaka: Toleransi terhadap denggi* (Master Thesis). Fakulti Sains Kesihatan, Universiti Kebangsaan Malaysia.