DEVELOPMENT AND VALIDATION OF THE MEASUREMENT TOOLS AND HEALTH EDUCATION MODULE ON KNOWLEDGE AND PRACTICES FOR DENGUE AMONG KINDERGARTEN CHILDREN IN KELANTAN

NEEVAARTHANA A/P SUBRAMANIAM

UNIVERSITI SAINS MALAYSIA

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by

NEEVAARTHANA A/P SUBRAMANIAM

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PEMBANGUNAN DAN PENGESAHAN ALAT PENGUKUR DAN MODUL PENDIDIKAN KESIHATAN BERKAITAN PENGETAHUAN DAN AMALAN MENGENAI DENGGI DALAM KALANGAN KANAK-KANAK TABIKA DI KELANTAN

ABSTRAK

Denggi telah diklasifikasikan sebagai salah satu penyakit bawaan vektor yang paling lama wujud di Malaysia. Setiap anggota masyarakat daripada semua peringkat umur adalah terdedah kepada jangkitan denggi, namun, kajian berkaitan kesedaran mengenai denggi dalam kalangan kanak-kanak tabika berusia lima hingga enam tahun tidak diteroka secara meluas. Oleh itu, kajian ini bertujuan untuk menilai tahap pengetahuan dan amalan serta menguji program intervensi pendidikan dalam kalangan kanak-kanak di kawasan bandar, sub-bandar dan luar bandar negeri Kelantan. Bagi mencapai objektif, kajian keratan rentas dan intervensi dilakukan, dengan melibatkan empat fasa yang berbeza. Dalam fasa I, borang soal selidik berasaskan temuduga yang terdiri daripada 40 item untuk mengukur tahap pengetahuan dan amalan telah dibangunkan. Kad kilat yang mewakili ilustrasi untuk item terpilih juga telah dibangunkan. Borang soal selidik berasaskan temuduga kemudiannya disahkan dan disemak semula kesahihan kandungannya. Borang soal selidik berasaskan temuduga yang disemak semula kemudiannya diteruskan dengan analisis item, faktor dan kebolehpercayaan. Setelah borang soal selidik dimuktamadkan, ianya diuji secara kajian keratan rentas dalam kalangan 200 orang kanak-kanak tabika yang dipilih secara rawak. Dalam fasa II, seramai 396 orang kanak-kanak tabika telah direkrut untuk mengetahui tahap pengetahuan dan amalan menggunakan borang soal selidik berasaskan temuduga. Seterusnya, dalam fasa III, program intervensi pendidikan

berasaskan aktiviti dan modul telah dibangunkan, disahkan oleh pakar dan disemak dengan sewajarnya. Kedua-dua program intervensi yang disemak itu kemudiannya dibawa ke fasa IV dan diteruskan dengan ujian rintis dalam kalangan 46 dan 72 orang kanak-kanak tabika. Data daripada semua fasa telah dianalisis menggunakan Pakej Statistik Sains Sosial (SPSS) mengikut ujian yang sesuai bagi mendapatkan hasil keputusan. Hasil daripada kajian ini, versi akhir borang soal selidik terdiri daripada 33 item, dengan konsistensi dalaman yang baik iaitu Cronbach Alpha sebanyak 0.788. Melalui pengukuran tahap pengetahuan dan amalan dalam kalangan responden dari ketiga-tiga kawasan tersebut telah menunjukkan bahawa tahap amalan dilihat jauh lebih tinggi di kedua-dua kawasan bandar dan sub-bandar berbanding dengan kawasan luar bandar ($p < 0.05$). Seterusnya, terdapat perbezaan yang signifikan dalam skor pengetahuan dan amalan yang diperolehi oleh kanak-kanak tersebut antara sebelum dan selepas didedahkan kepada kedua-dua program intervensi pendidikan, $p < 0.001$. Oleh itu, kajian ini menyimpulkan bahawa pendekatan menggunakan borang soal selidik berasaskan temuduga dan program intervensi pendidikan yang direka khusus adalah berkesan dan boleh dianggap sebagai instrumen kajian yang sah dan boleh dipercayai untuk pendedahan awal pengetahuan dan amalan mengenai denggi dalam kalangan kanak-kanak tabika yang berumur lima hingga enam tahun.

DEVELOPMENT AND VALIDATION OF THE MEASUREMENT TOOLS AND HEALTH EDUCATION MODULE ON KNOWLEDGE AND PRACTICES FOR DENGUE AMONG KINDERGARTEN CHILDREN IN KELANTAN

ABSTRACT

Dengue had been classified as one of the longest existing vector-borne diseases in Malaysia. Community members of all age groups had been prone to dengue infection, however, awareness related studies on dengue among kindergarten children aged five to six years had not been widely explored. Hence, this study aims to assess knowledge and practice levels and test the educational intervention programmes for young children in urban, sub-urban and rural areas of Kelantan. To achieve the objective, this study consisted of a cross-sectional and interventional study design which was conducted in four different phases. In Phase I, a guided interview-based questionnaire with 40 initial items to measure knowledge and practice levels was developed. Flashcards representing the illustration for selected items were also developed. The interview-based questionnaire was then validated and revised through content validity and face validity. The revised interview-based questionnaire was proceeded for item, factor and reliability analysis. The finalised interview-based questionnaire was then pre-tested following a cross-sectional study design among randomly selected 200 kindergarten children. In Phase II, a total of 396 kindergarten children were recruited to obtain knowledge and practice levels using the pre-validated interview-based questionnaire. Next, in Phase III, activity-based and module-based intervention programmes were developed, validated by experts and revised accordingly. In Phase IV, the revised activity and module intervention programmes

were proceeded to be tested among 46 and 72 kindergarten children, respectively. Data from all the phases were analysed using the Statistical Package of the Social Sciences (SPSS) according to the respective tests needed to produce the results. For the outcome of this study, the final version of questionnaire consisted of 33 items, with a good internal consistency of Cronbach Alpha of 0.788. Through the measurement of knowledge and practice, practice levels were seen to be significantly higher in both urban and sub-urban areas compared to the rural area ($p < 0.05$). Significant differences ($p < 0.001$) were observed in both knowledge and practice scores among participants after implementation of educational intervention programmes. Therefore, this study concludes that the approach using the interview-based questionnaire and the specifically designed educational intervention programmes are effective. They can be considered valid and reliable study instruments for early exposure of dengue knowledge and practices among kindergarten children aged five to six years old.

CHAPTER 1

INTRODUCTION

1.1 Study Background

From the past few decades, dengue had appeared to be prominently vulnerable to the health of the public in many regions of the world. Dengue is known to affect more than 100 countries on a global scale, where, up to 400 million people are infected with dengue every year (CDC, 2019a). In Malaysia, the first outbreak of dengue took place in 1962 (MOH, 2017a). In the year 2021, records updated until December indicated a total of 26,365 dengue cases and 20 deaths in Malaysia (Outbreak News Today, 2022). The breeding of *Aedes* mosquitoes is characterised to be prolific and widespread among residential areas of human population due to escalating development and urbanisation factors, locally varying rainfall and seasonal temperatures in the tropics (WHO, 2018a, Neiderud, 2015, Vanek *et al*., 2006).

The dengue, or in a more serious case, known as the dengue haemorrhagic fever (DHF), was first detected in the 1950s in areas of the Philippines and Thailand (WHO, 2011). Dengue is transmitted to humans by *Aedes* mosquito bites (WHO, 2018a). Dengue infection is usually symptomatic and is classified as a febrile illness (CDC, 2019b). The most abrupt effect of the transmission of dengue among human communities is the death rate. There is no particular treatment available to overcome dengue, however early detection methods of rapid diagnosis which can be used in laboratory for serology testing is on – going (Kabir *et al*., 2021, Teoh *et al*., 2015; Parida *et al*., 2005). Thus, underdeveloped vaccines, unavailability of treatment and the increasing vector - insecticide resistance towards dengue had victimised most

Malaysian communities, including kindergarten children aged five to six years in Malaysia (Rezza, 2016, WHO, 2018c).

As such, an increasing trend had been recorded in dengue cases among children aged below 11 years in Malaysia in the year 2016 (ASEAN, 2017). This is a worrying condition as compared to the hand, foot and mouth disease among children because dengue has higher mortality rate if not detected and treated properly, proving that it is much more dangerous for children (Vinmec Healthcare System, 2019). Baseline awareness based on knowledge, attitude and practice (KAP) analysis had been conducted among most communities in Malaysia (Ghani *et al*., 2019, Arief *et al*., 2017, MOH, 2017b, Rahman *et al*., 2015, Lugova *et al*., 2016, Shafie *et al*., 2016, Al-Zurfi *et al*., 2015; Chandren *et al*., 2015). A local study concluded that the lack of awareness among Malaysian communities encompassing young children can be the main factor for the expansion of dengue in Malaysia (Wong *et al*., 2014). Proportionately, vector control and disease prevention interventions focusing community participation have been proved to provide positive results in decreasing the spread of diseases (Alvarado-Castro *et al*., 2017, Khun *et al*., 2007). However, most intervention programmes only target adults and are rarely suitable for children. Studies have shown that children are especially best to be targeted with innovative and creative interventions to deliver information (Huthmaker, 2015). As such, strategies that include the development of study tool and interventions should be created to access and improve awareness among kindergarten children.

1.2 Significance of Study

Children aged five to six years old had been selected as the target group for this study as the prevalence of dengue in Malaysia had been one of the highest among children aged five to eleven years old (21,570 cases) after prevalence in reproductive age groups (108,531 cases). As such, one of the reasons in the increase of dengue cases among kindergarten children in Malaysia had been the lack of awareness among children. Hence, this study gives an opportunity to spread awareness that is levelled to the understanding of children aged five to six years old, rather than using an approach that requires the involvement of parents or guardians. Study tool and intervention programmes developed will enable further research and assist studies to widely assess knowledge and practice levels among kindergarten children within Malaysia. Knowledge and practice data obtained can be utilised to determine effective early preventive methods for personal protection and vector control especially made for younger children in Malaysia. This study is also important for children as this approach is potentially capable of helping researchers, law or policy makers, health authorities and parents to understand the amount of information and habits possessed and needed by the children regarding dengue.

Children can gain basic information on their own when taught or emphasised to them. As this study applies quantitative measurement, questionnaire - based data collection will be able to provide standard, measurable, and quantify-able data that can help reduce the prevalence of dengue among young children. This will further help teachers and parents to be more effective in educating the younger generation towards the importance of having proper knowledge and practices to prevent dengue. In fact, this study will enable children to learn preventive actions that can be taken individually against dengue in the absence of parents. On the long run, children aged five to six

years will be a part of community participation in any intervention programmes conducted by government or non – governmental organisations. Quoting Tun Dr Mahathir Mohamad, good moral values should be nurtured from kindergarten levels up to university (BERNAMA, 2018), hence the importance of this study can be highlighted to promote good knowledge leading to good attitude and practices in terms of their health and safety in line with the national education focus.

The intervention programmes conducted in this study also provided advantages and benefits that had not been discussed in any of the studies coordinated on dengue till date. In fact, these intervention programmes enabled existing knowledge and practice levels to be assessed again after intervention is introduced. Since children of young ages were not included in any of the previous studies conducted, this study provides the opportunity to test the impact of intervention programmes and further identify the gap present between young children and dengue interventions. Following that, kindergarten children, who are at the very start of developing cognitive thinking and physical abilities will be benefitted and data obtained from this study can be used to evaluate knowledge and practice levels of a community in a more effective and inclusive manner.

1.3 Conceptual Framework

Figure 1.1 below shows the conceptual framework of this study. The study population in this study consists of kindergarten children aged five to six years old. In this conceptual framework, gender and geographical areas may influence practice levels among young children. Biological factors (gender), socio-demographic factors and geographical areas are confounders can have significant effects on dengue awareness in terms of knowledge and practices (Koyadun *et al*., 2012).

When strategies such as suitable health education or intervention programmes (independent variables) are introduced, knowledge and practice levels (dependant variables) can significantly increase among study populations (Gupta *et al*., 2015, Suwanbamrung *et al*., 2015). As for children, interventions based on active interaction can demonstrate a high degree of participation and good understanding on dengue and its prevention. This leads to better understanding of dengue and its prevention measures, providing a comprehensive protection for themselves and surrounding environments. This will also directly help improve parents' contribution in preventing dengue in their households.

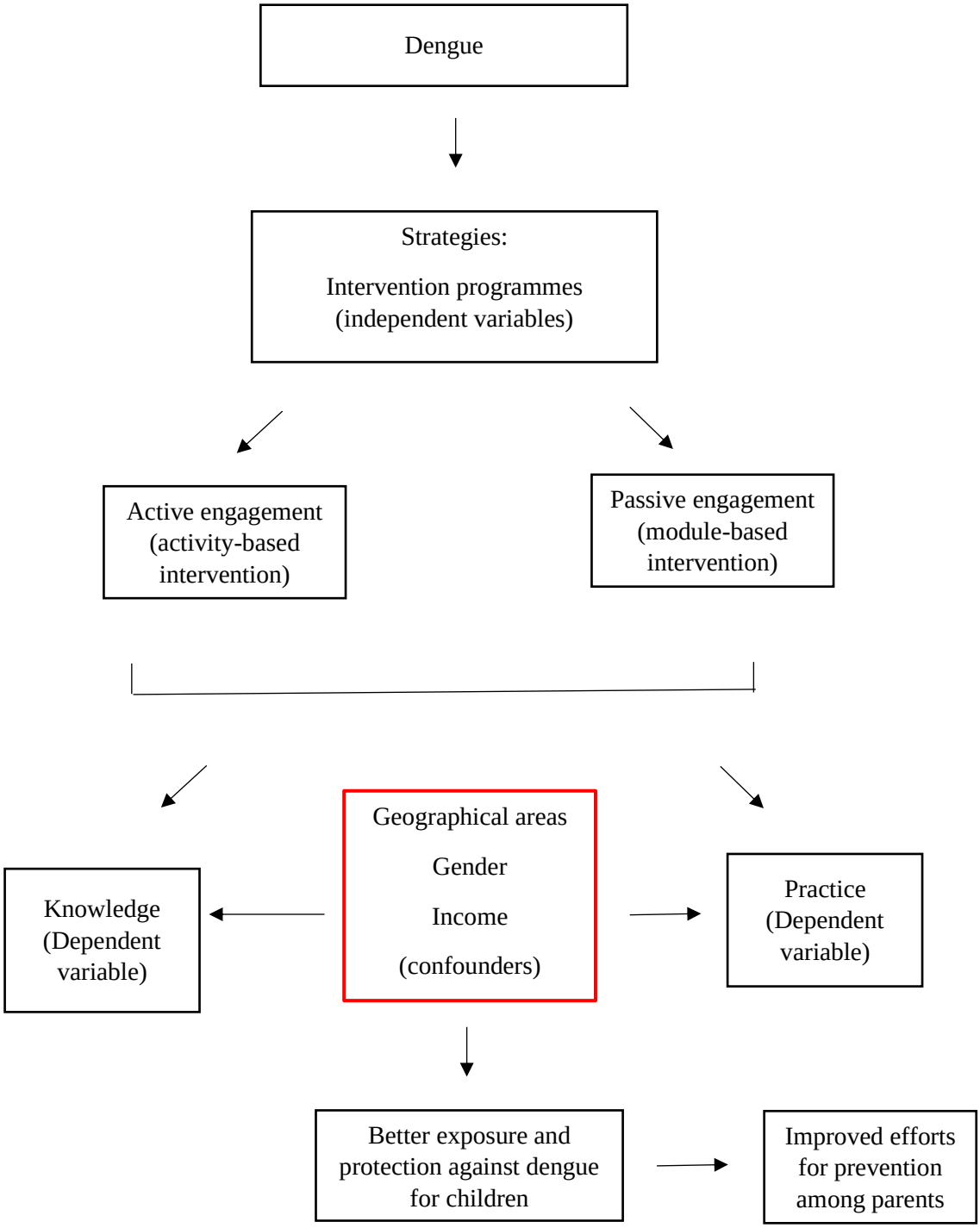

Figure 1.1 Conceptual framework of research

1.4 Problem Statement

The occurrence of dengue in Malaysia takes place across all age groups including young kindergarten children aged five to six years old. The number of children ranged five to 10 years (approximately 10% for 7,454 cases and approximately 6% for 13 deaths) affected with dengue had been recorded to be lesser than reproductive age groups (68% that is for about 58,834 cases and 73% that is for 171 deaths) in Malaysia but remained high compared to older non – productive age groups in 2016 (ASEAN, 2017). This is because adults in reproductive age groups stay outdoors and socialize more, increasing the susceptibility to *Aedes* mosquito bites (Awasthi, 2019). Young children, however, have been categorised as high-risk group due to their low immune system and the inability to resist the dengue virus (MOH, 2021a). This contributed to the overall cases and deaths of dengue in Malaysia. In this case, no further studies were conducted to compliment the condition and awareness levels of kindergarten children as reported in 2016 (ASEAN, 2017).

Besides, all studies on the awareness of public on occurrences of dengue had been observed to be limiting participation to only school children and adults in Malaysia (Arief *et al*., 2017; Rahman *et al*., 2015, Lugova *et al*., 2016, Shafie *et al*., 2016, Al-Zurfi *et al*., 2015, Chandren *et al*., 2015). The 'Program Bebas Denggi' conducted in schools was also curated in a content that is not suitable for young children due to the kind of interventions designed to inform students about dengue (MOH, 2022a). The absence of study tools designated for the understanding of young children have constrained researchers from focusing on kindergarten children. Therefore, the baseline data, extent and intensity of awareness on dengue among kindergarten children is unknown in Malaysia.

Insufficient information and knowledge on the signs and symptoms, transmission of the diseases and preventive practices may leave children uninformed regarding their individual health conditions. Knowledge and awareness on dengue among the teenage and adult population had been thoroughly researched and discussed, however, kindergarten going children were not added as study subjects, disregarding the significant impact of dengue on these children. A great deal of health education on dengue prevention activities took place in almost all community targets; however, no effort was reported to be taken in promoting preventative activities on dengue in kindergartens (MOH, 2017c). The interventions designed are usually built on adult-friendly methods (e.g. posters with unknown terms and words for children) and seminars or talks conducted by field experts to a group of known adults. However, interacting dengue with children needs to be catchy, children-friendly and understandable which enables information or knowledge of dengue to be transferred well among them. Hence, young children are neglected along the way. There is a gap between the ways of education on dengue between adults and young children, which, in return leads to the lack of extensive exposure on awareness of dengue in kindergarten children. It is also challenging to bring changes to an individual's perspective and existing knowledge unless started young.

As the dengue virus has potential of developing and occurring in different strain types, young children without awareness on dengue may grow into vulnerable and unguarded adults to this viral disease in future if they are not exposed to adequate knowledge and practices, increasing the burden of the health department and government. Therefore, kindergartens should be made a medium to study and disseminate awareness using appropriate study tools for kindergarten children from

young and help them learn and develop their knowledge, perception and preventive methods against dengue.

1.5 Purpose of Study

Most interventions and data on prevalence regarding dengue had been conducted to educate public on the prevention of dengue. However, no proper intervention programmes nor baseline studies was introduced for kindergartens. Being the first learning institution attended by every individual, kindergartens play an important role in introducing dengue and their prevention practices just like exposed to the effects of smoking and 3R practices. The purpose of this study is therefore, to describe the baseline knowledge and practice levels among kindergarten children and effects of health intervention programmes on their existing knowledge and practice levels. Most importantly, pioneering this study will help safeguard the children against dengue from a young age and produce knowledgeable adults in future.

1.6 Research Objectives

The general aim of this study was to assess the effect of activity and module - based programmes on the knowledge and practice on dengue among kindergarten children in rural, sub – urban and urban settings of Kelantan and improve them through educational intervention programmes. In order to achieve the aim, several objectives were specified as follows:

1. To develop and validate a knowledge and practices interview-based questionnaire on dengue among kindergarten children in the rural, sub – urban and urban settings in Kelantan.
2. To describe the socio-demographic data and basic information collected as on dengue knowledge and practices among kindergarten children in the rural, sub – urban and urban settings in Kelantan.
3. To describe and compare the knowledge and practices levels on dengue among kindergarten children in three different settings, rural, sub – urban and urban before intervention programmes in Kelantan.
4. To evaluate the effect of activity-based intervention programme on knowledge and practices levels on dengue among kindergarten children in Kelantan.
5. To evaluate the effect of module-based intervention programme on knowledge and practices levels on dengue among kindergarten children in Kelantan.

1.7 Research Hypothesis

1. There is a significant difference in the level of knowledge and practice levels on dengue among kindergarten children in all three rural, sub – urban, and urban settings before intervention.
2. There is a significant increase in the level of knowledge and practice on dengue among kindergarten children after activity-based intervention programme.
3. There is a significant increase in the level of knowledge and practice on dengue among kindergarten children after module-based intervention programme.

1.8 Operational Definition

a) Knowledge refers to the understanding on information regarding dengue among kindergarten children aged five to six years.

b) Practice refers to the ways or habits kindergarten children aged five to six years demonstrate their knowledge through actions.

c) Activity - based intervention programme is a combination of theater and games designed to produce changes in behavior or the health status of kindergarten children aged five to six years through active participation at a selected venue.

d) Module-based intervention programme is an educational programme based on a Japanese story-telling method (kamishibai) designed to produce changes in behavior or the health status of kindergarten children aged five to six years through passive participation in classrooms.

CHAPTER 2

LITERATURE REVIEW

2.1 Dengue

Dengue is a mosquito borne flavivirus that occurs predominantly in the tropics and has become a global burden to the public health. Severe cases of dengue fever (DF) are recognised as dengue haemorrhagic fever (DHF) (WHO, 2011). DHF can be differentiated from DF by a positive tourniquet test, bleeding or haematemesis signs (WHO, 1999). The initial occurrence of DHF was observed in Manila, Philippines (Gubler, 1998) and Thailand (WHO, 2011). DHF had then become widespread among the Southeast Asian countries in a span of 20 years (Gubler, 1997). Annually, an estimated of 500 000 people are infected with severe cases of dengue while death is recorded to be at 2.5% (WHO, 2018a).

The dengue virus is categorised to be hyperendemic as the virus appears to have multiple serotypes (Gubler, 1997). The virus consists of a single stranded RNA (Back *et al*., 2013) that is usually divided into four different serotypes based on the antigens on the surface: known as dengue virus 1 (DENV-1), dengue virus 2 (DENV-2), dengue virus 3 (DENV-3) and dengue virus 4 (DENV-4) (WHO, 2018a). Recently, the discovery of the fifth serotype of dengue virus, known as dengue virus 5 (DENV-5) had been reported to be existing as well (Normile, 2013). Infection by one dengue serotype does not provide immunity towards a different dengue serotype (Halstead, 1970). DENV-2 was the most prevalent serootype for almost two decades now (You *et al*., 2001) where the prevalence of a serotype changed from DENV-1 to DENV-3 in the recent years (MOH, 2014).

2.2 Vectors of Dengue

Aedes aegypti (A. aegypti) and *Aedes albopictus (A. albopictus)* are two mosquito species that are associated with dengue. Both species are characterised with specific morphological characteristics and preferences that differentiate one species from another. *A. aegypti* is identified as the primary causative agent while *A. albopictus* are mainly secondary in most places (Guerbois *et al.*, 2015, Wong *et al*., 2013). Although the characteristics of both the species are perpetual, it is still important to gain better insights on the important attributes of these mosquitoes as they can develop self-sustaining abilities for continuous endurance. It is also easier to screen for effective control methods against *Aedes* mosquitoes when the biological components are known. Studies show that the analysis of constituent parts of this mosquito species and ecological preferences such as breeding sites and temperature can help reduce the abundant population of *Aedes* mosquitoes in a habitat (Haarlem *et al.*, 2018, Reinhold *et al.*, 2018).

2.2.1 Taxonomy of *Aedes aegypti* and *Aedes albopictus*

Dividing living organisms in a taxonomic hierarchy is important to reflect a particular evolution history of the organism. *Aedes* was discovered by Meigen in 1818, without any description about the species, classified under the subfamily of Culicinae and the tribe Aedini (Mosquito Taxonomic Inventory, 2015). As such, both *A. aegypti* and *A. albopictus* are vectors commonly perceived to cause important health issues such as the occurrence of dengue and many other *Aedes* mosquitoes borne diseases in the world (Tyagi *et al*., 2015). The taxonomical classification below shows that both

the mosquitoes share the same taxonomical classification and are only distinct as species as in Table 2.1.

Table 2.1 Taxonomical classification of *A. aegypti* and *A. albopictus*

Classification levels	***A. aegypti***	***A. albopictus***
Kingdom	Animalia	Animalia
Phylum	Arthropoda	Arthropoda
Class	Insecta	Insecta
Order	Diptera	Diptera
Family	Culicidae	Culicidae
Genus	*Aedes*	*Aedes*
Species	*aegypti*	*albopictus*
Common name	Yellow fever mosquito	Asian Tiger mosquito

*Source: (ITIS, 2018)

2.2.2 Origin, Morphology and Characteristics of *A. aegypti* and *A. albopictus*

A. aegypti is non – indigenous to Malaysia, originating from the Tropical Africa while *A. albopictus,* on the other hand, had been locally found in East Asia including Malaysia (Bonizzoni *et al*., 2013, Smith, 1956). *A. aegypti and A. albopictus* appear as common insects with three pairs of legs, large compound eyes, a pair of well - developed wings and an elongated snout with a mouthpiece (JAICO, 2015). However, *A. aegypti* and *A. albopictus* can be generally identified by their smaller body size, presence of white – lyre shaped markings and white dorsal stripes on their black pigmented body parts and banded legs (ECDC, 2016). The eggs of *A. aegypti*

are also able to withstand desiccations, enabling survival without water (CDC, 2016). Although similar, *A. aegypti* can be differentiated from *A. albopictus* by the presence of a median silver – scale line on the dorsal part of the thorax, known as scutum. The male of *Aedes* mosquitoes can be distinguished from the female *Aedes* mosquitoes by their feather-like antennae and altered mouthpart used to suck nectar (Wahid *et al*., 2002). The female *Aedes* mosquitoes generally feed on human blood for nutrients such as proteins and iron for the development of eggs while male *Aedes* mosquitoes feed on water and nectar (Gonzales *et al*., 2016). These mosquito species have been recognised to have medical importance as they are the causative vectors transmitting diseases such as dengue, chikungunya and Zika (CDC, 2012).

2.3 Prevalence of dengue

There are about 100 to 400 million infections each year in numerous numbers of countries for the past three decades (WHO, 2021a). Although a vast number of infections are reported each year, these numbers seem to be under-reported most times. This is because most cases are usually asymptomatic or extremely mild, self – managed or mistaken as other febrile illness (WHO, 2021a, Waggoner *et al*., 2016). Global monitoring had seen new outbreaks and changes in the pattern of distribution and infection categories of dengue in Africa and Australia (WHO, 2011). However, the global risk assessment for dengue have not seen rapid changes where diseases spread geographically to regions where competent vectors exist. Stressing on vectors, the prevalence of dengue fluctuates due to several factors such as climatic changes, urbanisation and globalisation that happen in an expeditious mode (Gubler, 2011). Apart of that, level of knowledge and awareness in communities also plays a major

role in increasing dengue (Kumar *et al*., 2020). All these factors subsequently increase breeding sites of *Aedes* mosquitoes that is derived from various situations, moving the disease at a fast pace (Gubler, 2011).

2.3.1 Prevalence of Dengue Across the Globe

The incidence of dengue occurred as early as 1789 to 1790 around the continents of Asia, Africa and North America and has since grown drastically across the globe (Gubler *et al*., 1995). These days, more than 100 countries are affected due to dengue and the most affected regions include the regions of America, Southeast Asia and the Western Pacific (WHO, 2021a). Throughout the past two decades, the number of dengue cases reported to WHO increased eight times more than a total of 505, 430 cases initially reported in the year 2000 (WHO, 2021a). In 2017, a significant decrease was reported at a rate of 53% especially in countries such as Aruba, Panama and Peru (WHO, 2021a). However, in 2019, there was an increase in the number of dengue cases reported globally and had been the highest number recorded so far; dengue transmission was detected in Afghanistan for the very first time in history (WHO, 2021a). In 2020, dengue cases are still a threat with an increasing number of cases in countries such as Bangladesh, Brazil, Cook Islands, Ecuador, India, Indonesia, Maldives, Mauritania, Mayotte (Fr), Nepal, Singapore, Sri Lanka, Sudan, Thailand, Timor-Leste and Yemen (WHO, 2021a).

Currently, it is reported that nearly half of the world's population are at risk of infecting dengue where an estimated of 100 to 400 million infections have been recorded so far (WHO, 2021a). A total of more than 1.5 million suspected and confirmed cases were reported in America and Caribbean while a remaining of

150,000 cases were reported from Asian countries (ECDC, 2020). The number of deaths per year were estimated to be approximately 20,000 (Gubler *et al*., 1999). This is because most countries are known to be in areas that are suitable for the breeding of *Aedes* mosquitoes (Bhatt *et al*., 2013). A study predicted that, in future, there will be an increase in the percentage of population of risk to dengue, globally, from the year 2020 towards 2080, with Africa showing the most drastic increase (Messina *et al*., 2019). It is believed that the predictions from the study will enable effective decisions to be made by the responsible authorities to prepare and respond to the changes in dengue outbreaks in future.

2.3.2 Prevalence of Dengue in Malaysia

In Malaysia, the first outbreak of dengue was recorded in 1962, in Penang (MOH, 2017a). Since then, the numbers have increased tremendously without control. Dengue cases occur in most states of Malaysia especially in urban and peri-urban areas; peak seasons knowing to increase dengue cases usually occur in the late monsoon seasons in both East and West Malaysia (IAMAT, 2020). Despite occurring for many decades now, dengue cases had been recorded the highest in 2014 since its consequent occurrence after the year 2000 due to the severe flooding that took place in 2014 (Hii *et al*., 2016). The trend of dengue cases and deaths had been fluctuating from the year 2000 until 2013 where dengue cases increased dramatically in 2014, peaking in 2015 and gradually decreased again until 2017 (Mudin, 2015).

Dengue cases distribution throughout past years till year 2020 showed that the most affected areas were mostly central Peninsular regions, followed by northern and southern regions and finally the east coast regions (MOH, 2021a). In the period of a

few years, while 90% of the deaths due to dengue reported in the country were from the west coast while the rest of the 10% were from the east coast of Malaysia (AbuBakar *et al*, 2022). Nationwide, among young children and teenagers aged two to 16 years old, dengue haemorrhagic fever is mostly prevalent among children five to eight years with an incidence rate of 347.2 per 100,000 person-years (AbuBakar *et al*, 2022). In fact, over the years, half a million dengue cases were reported to take place among children aged five to 15 years old (AbuBakar *et al*, 2022). Gender wise, in Malaysia, males are at higher risk, that is almost 4.17 times higher than females (Khamis *et al*., 2022). Kelantan had been identified as one of the states with active dengue hotspots (MOH, 2021a). As of first week of March this year, a total of 305 cases have been recorded in Kelantan (MOH, 2022). Recent cases in Kota Bharu, Pasir Mas and Tumpat have been recorded to have 122 cases, 31 cases and 28 cases, respectively (MOH, 2023). Total deaths in Kelantan have been recorded to be at only 2 deaths last year and none this year (MOH, 2022). A total of 25 children aged five to six years have been identified as to be victims of dengue (MOH, 2023).

Cumulative records last year recorded a total number of 26,365 cases and 20 deaths (The Sun Daily, 2022). As of now (March 2022), a total of 9,021 cases have already been recorded with Selangor recording the highest number of cases (MOH, 2022b). At a global level, Malaysia is listed as one of the countries with the highest number of cases alongside Brazil, Paraguay, Mexico and Vietnam (ECDC, 2020). Hotspot localities of dengue infection prolonged over 30 days in 2021 include states such as Selangor, Negeri Sembilan, Wilayah Persekutuan Kuala Lumpur and Melaka, totalling up to 96 hotspot localities where Selangor covers the largest portion of hotspot areas while Negeri Sembilan the smallest portion (MOH, 2021a). More control strategies and educational programmes that involve both rural and urban areas as well

as the development of a local vaccine have been encouraged to reduce the prevalence of dengue in Malaysia (Murphy *et al*., 2021, Pang *et al*., 2016).

2.4 Factors Causing Dengue

The main reason behind the emergence of *Aedes* mosquitoes borne diseases is the uncontrollable existence of *Aedes* mosquitoes in the surrounding. Nevertheless, the risk of infectious diseases possessed by these mosquitoes are influenced by several human and nature - based factors across the globe. The vectors, *A. aegypti* and *A. albopictus* have been present in the environment since many decades ago. However, in the past, no incidences on dengue were detected like in the current years. This is because, throughout these years, many changes for the benefit of the human population and future generation had taken place. When changes are made to the environment, humans expose themselves to risks that are least expected during the process of environment altering. One of it is the rise of the *Aedes* mosquitoes' population, increasing the prevalence of dengue and threatening the health of the public in many countries.

One of the factors that gave rise to the *Aedes* mosquitoes' population is the process of development and urbanisation. To date, dengue is rated to be one of the most highly prevailing Arboviruses due to urbanisation (Hotez, 2017). Rapid development and urbanisation take place to provide quality living to mankind. However, such developments degrade the environment through poor sewage and garbage collection systems, inconsistent schedules of water supply and piping systems, extensive amounts of waste productions and crowding (Rudolph *et al.*, 2018). A degraded environment together with unorganised management facilitate the

breeding and survival of *Aedes* mosquitoes. Apart of that, through urbanisation, the natural habitat of *Aedes* mosquitoes is tremendously reduced. Previously, *Aedes* mosquitoes usually feed on blood meal that is obtained from various sources of wild animals within the thick forests (OECD, 2018). Ever since habitat destruction occurred, *Aedes* mosquitoes get their supply of feed only from the developing human populations, exposing humans to the risk of virus infection brought by these mosquitoes.

In Malaysia, poor hygiene practices such as haphazard waste management and irresponsible littering of non-biodegradable items had been key factors underlined by the Ministry of Health leading to the occurrence of dengue. Example of these items that have topped the list as the most common breeding sites are polystyrene food containers, plastic items and unused tyres (MOH, 2017a). Despite of waste materials, several other areas such as flowerpots, basins, flushing tank, water collecting tanks, roofs in a particular building around residential areas were pinpointed to be breeding sites of *Aedes* mosquitoes (Abu Hassan, 2014). Apart of that, many potential breeding sites have also been detected in construction areas leading to the survival of larvae due to the accumulation of water collected through rainfall (Abu Hassan, 2005).

Besides that, travel and mitigation through the expansion of transportation modes had also enabled the transmission of dengue to many parts of the world. Cross geographical movement and distribution of humans allowed the introduction of pathogens to new areas, increasing the risk of vector-borne diseases (Paixao *et al*., 2018). One such risk refers to the introduction of the DEN-3 virus in Malaysia that was transmitted from Thailand between 1993 to 1994 (Kobayashi *et al*., 1999). Apart of that, busy lifestyles are also one of the reasons that cause a substantial increase in the level of dengue prevalence. Studies suggest that people with hectic lifestyles, paid

skill work and high workload possessed poor prevention practices against dengue (Wong *et al.*, 2015). In addition, traditional health beliefs among Malaysians also negatively influence their perception on the occurrence of dengue, commonly found among Orang Asli communities in Malaysia (Chandren *et al.*, 2015).

Additionally, climate changes and seasonal fluctuations such as global warming had also effectively increased the growth and population of *Aedes* mosquitoes (Mohammed *et al*., 2011). This situation had been observed in Singapore during serious outbreaks of dengue cases in the years between 2000 – 2007 (Hii *et al*., 2009). This is because *Aedes* mosquitoes are known to be able to migrate and survive in non-endemic regions that suffer global warming (Hales *et al*., 2002). Since Malaysia is naturally hot, humid and has rain expectancy in average of 20 days in a month – approximately 70% rainfall in a year, the climate conditions are suitable for the breeding of *Aedes* mosquitoes (MetMalaysia, 2015). Studies in Malaysia have also shown elevated dengue outbreaks during the rainy season as infectious activities can increase after monsoon seasons (Chew *et al*., 2012, Gupta *et al*., 2006). Thus, efforts to reduce density of *Aedes* mosquitoes has to be consistent all year round as the nation is exposed to such weather.

Next, agent factors are also one among other reasons that played a major role in the increase of dengue cases. Dengue usually occurs through infection with any 4 related positive-sense, single stranded RNA Flaviviruses, I, II, III and IV (CDC, 2019b). This virus stays in the human blood for almost seven days (CDC, 2019b). As such, over time, *Aedes* mosquitoes carry different virus stereotypes, resulting in cross infections that causes victims to go into serious dengue symptoms such as the dengue haemorrhagic fever (Gubler, 1998). These mosquitoes become extremely resistant to

their surroundings and prevention, making it difficult to destroy *Aedes* mosquitoes population.

Recently, the emergence of the new COVID 19 viral disease have also caused a sudden spike in the number of dengue cases in the year 2020 compared to the previous years (Arumugam, 2020). As such, the attention and effort from the health authorities in curbing dengue has shifted to controlling the spread COVID 19. Community members, health authorities and policy makers are now only focussed on the prevention of COVID 19 that is much more infectious and fatal than dengue (Olive *et al*., 2020). In a common household where dengue prevention is given less attention, the emergence of the new viral disease had possibly reduced the prevention practices taken against dengue (Brady *et al*., 2021). Hence, the prevalence of dengue in Malaysia and across the globe remains high due to the more challenging health situation faced in the recent times.

2.5 Transmission of Dengue

Transmission of dengue normally occurs through female *Aedes* mosquito bites, that spread from one infected person to another, either symptomatic or asymptomatic (Carrington *et al*., 2014). In some rare cases, transmission can take place through organ transplantations, blood transfusions from infected donors or even through a needle stick injury (CDC, 2020, Pozzetto *et al*., 2015). Transmission through an infected pregnant mother to her foetus have also been recorded before (Ribeiro *et al*., 2017).

2.6 Symptoms of Dengue

Humans infected with dengue can be identified by having fever at 40°C, followed by the occurrences of nausea, vomiting, rashes, joint and muscle pain and severe headache in the period of four to 10 days after being bitten, lasting for two to seven days (WHO, 2018a). Other serious symptoms of dengue include bleeding, nausea, abdominal pain and skin rashes, measured from a meta - analysis, promoting possibility to trigger dengue shock syndrome which can cause excessive bleeding to death (Zhang *et al*., 2014). In other rare situations, some individuals may also develop a more serious dengue illness known as the dengue haemorrhagic fever. This rare form of dengue can be identified through worsened symptoms such as damages in the lymphatic system and blood vessels, bleeding of nose and gums, liver enlargement and failed blood circulation (Normandin, 2017).

2.7 Treatment for Dengue

To date, there is no specific treatment designed to directly eliminate dengue, where available medication can only treat symptoms caused by the virus (Khetarpal *et al*., 2016). Pain killers and antipyretics will usually be prescribed to control muscle aches, pains and fever (WHO, 2021a). Other supportive treatments include the intake of large amounts of water to reduce dehydration and the usage of antipyretic drugs to the condition from further deterioration (Rajapakse *et al*., 2012). In countries such as Brazil, Malaysia and the Philippines, traditional medication are being practiced; yet these treatments have not proved their effectiveness in preventing the viral properties of dengue to react in the human body (Dengue Virus Net, 2018).

2.8 Prevention and Control Strategies against Dengue

The nation's public health is continuously exposed to the threat of *Aedes* mosquitoes and dengue due to the absence of effective treatment methods and standard vaccine development, as they are time consuming, expensive and would have to undergo several trials before implemented for the use of public health. However, it must be understood that the availability of treatment and vaccine alone will not put an end to the spread of dengue. The viral strain of dengue often changes, influencing the virulence of the strain and its impact towards the human immune system. As such, suitable prevention strategies and control procedures are needed in Malaysia as an effort to manage and curb the prevalence of dengue among Malaysians. In fact, human factors such as awareness and their responsibilities as well as causative agent factors that include the resistance developed in each growing year are important factors that need to be considered for dengue prevention. Existing control measures need to be extensively implemented to prevent the spread of dengue in Malaysia.

2.8.1 Vaccination

The ultimate goal of prevention is to establish a broad-spectrum antiviral drug and vaccine that can be used to treat and prevent *Aedes*-borne diseases as well as a universal Arbovirus insecticide to limit the spread of *Aedes* mosquitoes (National Institute of Allergy and Infectious Diseases, 2017). The only vaccine available is the vaccine for yellow fever, which is required before travelling to South American and African countries (VDCI, 2013). However, to date, most of the vaccines developed are still in trial phases and have been attempted only on a certain range of people, making it not suitable for general use. One example of a vaccine in the trial stage for