ISSN: 2833-4353

Review Article

Archives of Epidemiology & Public Health Research

Tackling Dengue Issue Need Proactive Measures: A Narrative Review of Current Level of Prevention and Control of Dengue in Malaysia

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Submitted: 02 Jan 2023; **Accepted**: 10 Jan 2023: **Published**: 18 Jan 2023

Citation: Norsyahida Md Taib and Azman Atil (2023). Tackling Dengue Issue Need Proactive Measures: A Narrative Review of Current Level of Prevention and Control of Dengue in Malaysia. Arch Epidemiol Pub Health Res, 2(1), 148-153.

Abstract

Background

Dengue is a severe mosquito-borne disease that is endemic in tropical and subtropical regions, including Malaysia. Dengue appears to lack both a particular treatment and an effective tetravalent vaccination. Suppression of the two most significant vectors, Aedes Aegypti and Aedes Albopictus, is the only method for controlling dengue. The disease continues to spread despite diligent and comprehensive attempts by health organizations to contain it. This review is to determine the current level of prevention and control of dengue in Malaysia.

Method

This review derived from 35 kinds of literature obtained from PubMed, red journal I Dengue, WHO Library database (WHOLIS), WPRO, International Journal of Environmental Research in Public Health (IJERPH), ResearchGate, Springer, Vector Biology Journal and PLOS Neglected Tropic Diseases that were published in English between 1992 to 1 December 2022. Literature is relating epidemiological studies of dengue fever, dengue prevention and control, dengue forecasting, the factor of dengue occurrence and dengue surveillance.

Discussion

Dengue vector control is still considered the most efficient method for controlling and preventing dengue virus transmission. As a result of the declining efficacy of conventional ways of managing dengue transmission, it is time to re-evaluate the currently employed and other available strategies. Current dengue vector depends heavily on chemical approaches as space treatments, either thermal or ultra-low-velocity (ULV) fogging, but the technique appears to fall short of expectations. The community should be involved in mass source reduction activities as part of dengue control strategies instead of merely having health workers visit every home. New approaches, such as the mass release of Wolbachia-infected male dengue vectors and sterile insect technique to generate sterile offspring when mated with wild populations, are prompted to be tested in Malaysia. Simple, accurate, and low-cost technologies for dengue forecasting that could be utilized to improve decision-making on the timing, magnitude, and usage of limited resources.

Conclusion

The control of dengue vectors should not exclusively on a single strategy, neither genetic modification of artificially Wolbachia-infected method nor traditional insecticide treatment. It should include environmental management as the primary strategy, a well-planned integrated control program, and effective coordination among the organization's members.

Introduction

The vector-borne disease dengue fever is transmitted largely by Aedes mosquitoes infected with the dengue virus. It is possible to become infected four times with the four serotypes of Dengue virus (DENV) which are DENV 1, DENV 2, DENV 3, and DENV 4. Dengue virus is part of the Flaviviridae family and the Flavivirus genus [1]. In the late 1980s, DEN-1 and DEN-2 were present and reported as the circulating serotypes then DEN-3 caused recent outbreaks. DEN-3 has certain characteristics that make it more virulent [2]. In 2017 circulating serotype in Malaysia predominantly was serotype DEN-2 followed by DEN-1, DEN-3, and DEN-4 [3]. On other hand, DEN-3 was the predominant serotype in Sabah followed by DEN-4, DEN-1, and DEN-2 [4].

The factors that contributed to the spread of dengue fever have been broken down into two categories: those linked to the environment and those related to humans. Temperature, humidity, precipitation, and wind speed were the environmental factors that had an effect on the breeding of vectors [5]. For instance, the temperature rises not only affect mosquito reproduction and activity but also shorten the incubation period of mosquito larvae [6]. The typical incidence rates of dengue fever are doubled for every 3°C increase in temperature. On the other hand, precipitation has little effect on dengue prevalence [7]. Human-related issues, such as poor sanitation, inadequate water management, and improper waste disposal, pose a challenge to curbing the growth of dengue vectors [8].

Based on the circumstances, the Ministry of Health Malaysia has implemented the integrated strategy for dengue prevention and control program in the National Dengue Strategic Plan (NDSP) since 2011 [9]. Vector control strategies for dengue prevention and control include source reduction, larviciding, space spraying, targeted outdoor residual spraying, health promotion, and law enforcement. Current control and prevention measures are effective to reduce the morbidity and mortality of dengue cases in Malaysia. Thus, this narrative study aims to determine the level of dengue prevention and control in Malaysia.

Method

The protocol directed that only studies published in English during the survey period (1 December 2022 to 10 December 2012) were to be included in this review. Searches of published literature were conducted for epidemiological studies of dengue prevention and control, dengue forecasting, dengue contributing factor, dengue surveillance, and dengue fever between 1993 and 1 December 2022, in the following databases which is PubMed, ResearchGate, Springer, PLOS Neglected Tropical Disease and the Malaysian Ministry of Health (MoH) official bulletins. General internet searches were limited to the first 35 results.

Discussion

Dengue Trend

According to World Health Organization (WHO) reports on dengue fever, 3,9 billion individuals are at risk of developing dengue fever in the 129 dengue-endemic countries worldwide. The Western Pacific region accounts for 75% of the worldwide illness load. From 0.20 million in 2011 to more than 0.45 million in 2015 and 0.68 million in 2019, the number of dengue cases in the Western Pacific Region has gradually risen. As a result of enhanced case management, the number of dengue-related fatalities in the Western Pacific Region declined from 0.32 percent in 2008 to 0.16 percent in 2014, a decrease of fifty percent [10].

In Malaysia, the total of dengue cases was reduced by 70.8 % from 90,304 in 2020 to 2635 in 2021 [11]. During epidemiological week 40 of 2022, 1,474 dengue cases were reported. This is an increase compared to 1,460 cases in the previous week. From epidemiological weeks 1 until 40 of 2022, a total of 45,018 cases were cumulatively reported. This is an increase of 24,642 cases (121%) compared to 20,376 cases reported during the same period (epidemiological weeks 1 until 40) in 2021. Up until epidemiological week 40, a total of 28 deaths due to dengue had been reported (Case Fatality Rate 0.06%) in 2022, compared to 14 deaths during the same period in 2021 (Case Fatality Rate 0.07%) [12].

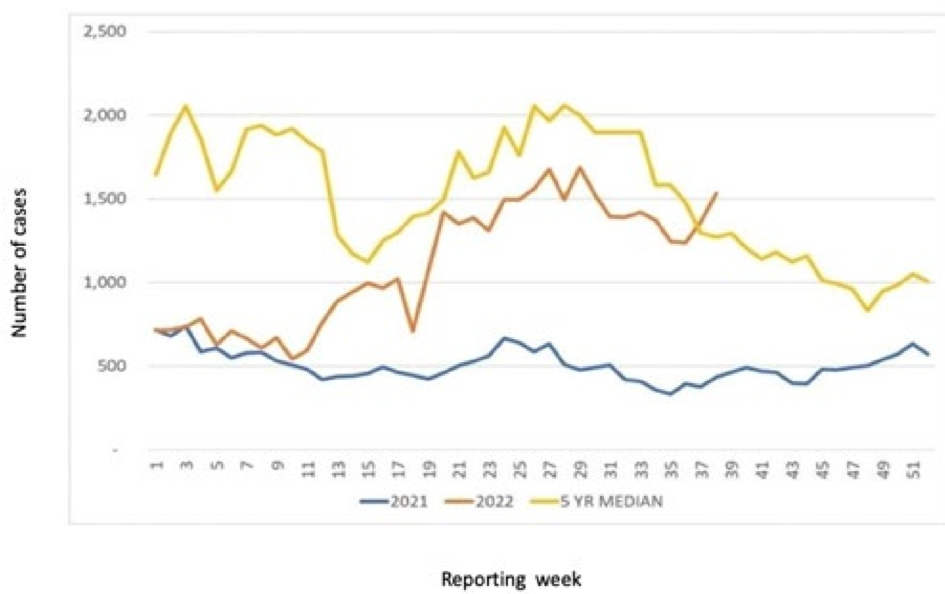

Figure 1: Dengue cases reported weekly from 2021, 2022 and median 2017-2021 in Malaysia

Source : iDengue and World Health Organization (WHO)

Current Approaches in Dengue Control

There are several conventional approaches for dengue control in Malaysia that all the district health office implements. The objective of vector control is to reduce the abundance of vector density to a level that not might permissive the transmission. The larval and adult stages of the Aedes mosquito are targeted by vector control measures [13]. Actions taken for larval management include source reduction strategies, the use of Abate larvicide, routine home inspections, and the enforcement of the Destruction of Disease Bearing Insects Act, of 1975 [14].

Source reduction of Aedes larvae activity including search and destruction of Aedes breeding places should be done within 24 hours after the case is notified in the eDengue. The premise coverage in the affected locality must be 100% within three days in 200 meters for a single case and 400 meters for an outbreak. The purpose of source reduction is to eliminate Aedes mosquito breeding grounds in and near homes, state properties, public parks, construction sites, factories, schools, and government buildings. This is accomplished through the participation of the community, the different agencies involved, and the local government. Illegal dumping of domestic waste on the side of the road is one of the problems encountered in source reduction activities. This provides Aedes mosquitoes with favorable breeding grounds. To address this issue, local authorities must increase waste collection services and provide waste bins in designated places [15].

In Malaysia, house-to-house larval surveys were first implemented in the 1970s to combat mosquitoes that breed in containers, primarily Aedes Aegypti and Aedes Albopictus. The health authority conducts daily house inspections for Aedes breeding. The objective is to educate the people on strategies to prevent Aedes breeding, including the use of Abate larvicide and the search for Aedes breeding in individual homes. A second objective of house visits is to assure that people adopt source reduction strategies. The results of Aedes larval surveys can be used to regularly assess the Aedes situation and density in terms of time and geography and to identify high-risk regions so that they can be prioritized for mosquito control. The district dengue control team does house inspections, and a single team can often evaluate 200 homes per day [16]. Aedes house index, breteau index, and container index can be derived from these surveys. Using these indices as a surveillance tool, health professionals were able to give health education to the populace during surveys [17].

Larviciding usually uses temephos or Bacillus Thuringiensis Israelensis (BTI). This pesticide can use at any site that has a potential breeding container for example back lane or empty lot, bushes, or building structure. The development of pesticide resistance continues to provide the greatest challenge to the mosquito control program. According to the local government, sand granule temephos was the only larvicide utilized in the area and provided to people for use on their properties. Temephos is the insecticide of choice for Aedes larval control since it is inexpensive and has long residual activity [18]. Consideration was given to the likelihood that long-term temephos use in mosquito control could contribute to chemical resistance. To maximize the effectiveness of dengue control programs, it is crucial to alternate temephos with other larvicides, such as Bacillus thuringiensis israelensis [19].

Space spray for adult Aedes needs to be done within 24 hours after registering to confirm a dengue case in the eDengue system. Premise coverage in the affected locality must be 80% within 200 meters radius of the index case and 400 meters radius for uncontrolled outbreaks and hotspots. Space spraying should be done indoors and outdoors during peak biting hours which is during dawn (5 am until 7 am) and dusk (5 pm until 7 pm). Thermal fogging should be complemented with Ultra Low Volume (ULV) space spraying in an outbreak situation [20]. In the event of an epidemic, however, ULV is utilized to cover a broader area. ULV is ineffective for killing adult mosquitoes because the droplets are only carried as far as the sitting room and if the mosquitoes are hiding in closets or underneath beds, they will not be killed [35]. Malathion was shown that it was more effective than pyrethroids in terms of ULV's efficacy. Malathion was more effective, which led to higher fatality rates than Resign. Outdoors, adult Aedes Aegypti had a greater fatality rate than in the living room and kitchen. Both pesticides have not shown promising larvicidal activity [17].

Targeted outdoor residual spray (ORS) is the new approach initiated by the Institute of Medical Research (IMR) Malaysia with applying of low dose pyrethroid onto the outer surfaces where mosquitoes are suspected to hide or rest. The residual activity of the insecticide lasts between two to 3 months. This is a preventive method in dengue hotspot localities or areas with recurring dengue and is done with at least two cycles of spray every three months. Health promotion is depending on the type of dengue cases reported either a single case or an outbreak [21]. The type of health promotion for example announcements, media mass, banners, posters, flyers, health education, and community behavior [22]. Vector control should be complemented by Destruction with Bearing Insect Act 1975. An inspector or a public officer authorized in writing on that behalf by the Director General may compound any offense committed by any person under this act or any regulations made under this act [23].

The World Health Organization recommends vector control programs be strengthened in accordance with the Global Vector Control Response (GVCR) plan, and numerous vector control initiatives are migrating to this new approach. The Dengue Task Force Committee in Malaysia was established in 2013 to monitor and provide guidance for the plan's implementation. An Inter-Agency Dengue Taskforce conducts intersectoral initiatives and meets regularly and monthly during dengue epidemics. In the event of a serious dengue outbreak, the membership of the Taskforce is elevated to the level of Minister. In addition to regular meetings, Taskforce members regularly communicate opinions and information by email and telephone. Integration of technologies and procedures, effective surveillance, and community engagement are essential factors [24].

New Innovative Approaches in Dengue Control

The new innovative approaches in dengue control are Wolbachia mosquito release. These bacteria cannot live in the environment as they can only live inside the host cell. Wolbachia naturally infects insects including flies, grasshoppers, butterflies, spiders, and others but cannot infect mosquitoes. It cannot be transmitted between insects. Since it cannot survive outside cells, it is injected into the Aedes eggs using a technique called microinjected since it cannot survive outside cells. These bacteria will grow in the Aedes mosquito's abdomen to make the dengue virus harder to grow by boosting the natural immune system of the mosquito and consuming cholesterol inside the mosquito. The criteria for the locality selection are high burden dengue cases, type of premises is high rise building, natural boundaries (river, highways, open space, or fields), no industrial sites, area of at least 0.6 kilometers, number of households, and good public co-operation and support. The important outcome that is measured is epidemiological endpoints (weekly confirmed dengue cases reported in the area) and entomological endpoints (Wolbachia frequency in the environment) [25].

The Sterile Insect Technique (SIT) was the first biological insect control method that is familiar in agricultural pest management for suppression of insects using radiation and is now a part of integrated vector management. The technique is using ionizing radiation to sterile the male mosquito using a gamma ray from the radioisotope of cobalt-60 and cesium-137 or Xray [26]. The sterile male mosquito is released over towns and cities where they compete with wild males to mate with females. Then, this female mosquito will lay eggs that are infertile and bear no offspring and will be reducing the insect population. This technique should involve community engagement [27]. In Malaysia sterile insect technique was done in Kota Laksamana Melaka on 21 February 2019. There is a 96.74% suppression of Aedes Aegypti larvae in the release site (Kota Laksamana Melaka) compared to the control site (Taman Tasik Utama) after 16th release [26].

The forecasting model to predict the dengue outbreak gives sufficient time to allow for effective interventions to be implemented using the disease surveillance data and meteorological parameters. Utilize the weather predictors which are maximum temperature, mean relative humidity, and mean rainfall with dengue incidence in Tawau by using a multivariate Poisson regression model, a Seasonal Autoregressive Integrated Moving Average model (SARIMA), and SARIMA with external regressors for selection. This study demonstrates an ability to forecast potential dengue outbreaks 1 to 4 months in advance [14]. There is a significant non-linear effect between warmer temperature, intermittent rainfall, and slow wind speed in Kelantan using Generalized Addictive Model (GAM), and become a reliable variable to be included in an early dengue warning system [28]. Dengue Model Forecasting Satellite-based System (D-MOSS) is a system that forecasts dengue outbreaks 6 months in advance by using 20 years of historical earth observation data from satellites and 10 years of dengue data. This dengue forecasting is a pilot project since 2021 funded by UK Space Agency International Partnership Program (IPP) [29].

Limitation of Dengue Prevention and Control in Malaysia

As the case fatality and complication rates among dengue cases are higher than in neighboring nations, clinical research on dengue management should also be accelerated.

Therefore, an early warning system is required so that action can be performed before cases are reported. Dengue vaccine research is also an ongoing endeavour worldwide. The vaccine may lower dengue-related death and morbidity. Due to the complexity of the four serotypes of the dengue virus, its development had been gradual. Currently, the French business Sanofi-Pasteur is undergoing Phase III clinical trials to determine its efficacy [30].

Cases of dengue occur one week after infected mosquitoes are caught. Health officials cannot conduct daily larval surveys from house to house within 200 meters. Epidemics of dengue may not be under control because personnel is insufficient to cover all households during larval surveys, many of the houses are locked during the surveys conducted during working hours, and many cryptic breeding sites are not discovered during larval surveys [31]. In larger cities, the Local Council is responsible for vector-borne diseases, but it lacks the expertise to undertake effective vector control measures [32]. When compared to larval surveys, setting up GOS traps to catch mosquitoes allows the health team to cover a greater number of locations [33].

Detecting the dengue virus in mosquitoes and implementing control measures prior to the reporting of cases is one such proactive measure. In Thailand, it has been demonstrated that a positive Aedes mosquito was collected prior to a dengue case being recorded [34]. They employed RT-PCR to detect the dengue virus in mosquitoes; nevertheless, it is challenging for public health professionals to adopt these approaches for routine surveillance. Recent research has shown that the NS1 antigen test kit (used to detect dengue virus antigen in patients) may also be used to detect dengue virus antigen in mosquitoes [33]. This is a way that public health professionals can use to monitor dengue vectors.

The Destruction of Disease-Bearing Insects Act of 1975 is an effective technique, especially against uncooperative and ignorant individuals who resist or refuse to follow instructions and cooperate in the control program and are found to have Aedes larvae breeding in and around their homes. The public's unwillingness to heed warnings and settle fines given to them is a source of difficulty for law enforcement. To address this issue, offenders are typically charged in court and could face fines of up to RM1,000. Several flaws exist in the act's implementation. To combat this, feedback from the various states and municipal governments is being gathered with the intention of revising the legislation to increase its efficacy [23].

Conclusion

Vector control will remain an important method for the prevention and control of dengue until a breakthrough in the development of a dengue vaccine or a viable medication is achieved. Problems have been identified in the vector control program's source reduction actions, house inspections, law enforcement, and fogging operations. Consist of environmental management as the foundational method, a well-planned integrated control program, effective inter-organizational interaction, and community empowerment. Numerous novel methods are intended for specialized monitoring systems or are still in the experimental or development stages, and are therefore not utilized in real practical surveillance. This review has determined, based on previous research, that there is a need for improvement and evaluation of dengue prevention and control strategies. Several suggestions and recommendations were highlighted to ensure effectiveness in the future control and management programs of dengue mosquito vector in Malaysia.

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