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DENGUE INCIDENCE AND RISK FACTORS IN THE KATTANKUDY MEDICAL OFFICE OF HEALTH (MOH) DIVISION IN BATTICALOA DURING THE 2009/2010 OUTBREAK

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Abstract

The increasing dengue epidemics are one of the priority health issues in the world. Recent dengue outbreaks in Sri Lanka caused lot of deaths and hospitalization. Kattankudy is an area in Batticaloa District of Sri Lanka was identified as a "high risk" area among 48 Medical Office of Health (MOH) and declared by the Government in September 2004. This MOH area is one of the densely populated areas in the country. The highest number of dengue cases reported in year 2009/2010. No studies have been carried out on dengue outbreaks in this area before and this study describe the dengue incidence and the association between the geographical location and rainfall pattern during the period of June 2009 to April 2010 in MOH division Kattankudy. This Study was conducted using 384 cases reported to MOH during the above period and geographical area divided as four Public Health Instructor (PHI) areas, Geographic Information System (GIS) techniques were used in mapping the individual houses to describe the spatial distribution of dengue cases of the 384 dengue reported cases. People in PHI - 3 and PHI -4 area were having high risk than PHI area 1 while no differences in risk was observed between PHI area 1 and 2. No association between gender of the patients and PHI area was identified. The incidence of cases increased after a lag of three to four weeks once rainfalls start to decrease. The ability to predict potential risk area, dengue outbreaks and mapping the spatial patterns facilitates dengue surveillance; prevention and control in MOH Kattankudy. Better understanding of the above will not only feed into operational policy for dengue control, but also provide fertile terrain for vaccine application strategies in the future.

INTRODUCTION

Dengue Fever was serologically confirmed in Sri Lanka in 1962 and the first outbreak was reported in 1965. The disease which was earlier confined to urban areas has spread to peri urban and predominantly rural districts as well. At present it has become endemic in the country and epidemics have been experienced every other year since 2002. The worst ever epidemic of DF/DHF occurred in year 2004 in which there were 15463 notified cases and 88 deaths reported to the Epidemiology Unit. This could be attributed to the enhanced control efforts adopted, especially the high-risk approach in which 48 MOH areas were identified as high risk for dengue transmission in the country. The incidence rate for DF/DHF in 2008 was 3.2 per 10000 populations [5].

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Eastern province in Sri Lanka consists of three districts and Batticaloa is one of it. Dengue prevalence in Batticaloa district is gradually increase in every year since 2004 (Table 1.1) and it became major threat among communicable disease in this area as same as in the country. In first quarter of year 2010 (January to March) the dengue cases in Batticaloa District were 786 which was 6.8 percentage of total cases in the country and fourth highest Dengue prevalence district with 9 deaths (Epidemiological Bulletin in Sri Lanka, first quarter, 2010. Volume 51.) See Table 1.2.

Table: 1.1 Reported Dengue cases in Batticaloa District 2004 -2010

Year	Cases
2004	101
2005	10
2006	63
2007	79
2008	89
2009	660
2010	1248

Source: Regional Director of Health Service Office, Batticaloa

Kattankudy, an area in Batticaloa district has been identified as a 'high' risk area among 48 Medical Officer of Health (MOH) declared by the government in September 2004. The Kattankudy MOH area is one of the high or densely populated areas in the country because there is rapid urbanisation and on-going infrastructure development works. Solid waste disposal is the major problem to local government due to scarcity of bare land within the Kattankudy urban council. First dengue case in Kattankudy was reported in 1994 and with the time number of cases has increased. The highest number was cases reported in year 2010 [7].

Table: 1.2 Morbidity and mortality due to DF/DHF January to March -2010

RDHS	Cases	Percentage	Death
Colombo	1393	12.0	15
Gampaha	1435	12.4	10
Kaluthura	363	3.1	4
Kandy	469	4.0	5
Matale	289	2.5	3
Nuwaraliya	54	0.5	0
Galle	109	1.6	2
Hambandota	262	2.3	1
Matara	120	1.2	1
Jaffna	1848	15.9	16
Kilinochchi	0	0	0
Mannar	63	0.5	0
Vavuniya	467	4..0	2
Mullaithevu	0	0	0
Batticaloa	786	6.8	9
Ampara	46	0.4	0
Trincomalai	660	5.7	5
Kurunagala	433	3.7	0
Puttalam	470	4.0	3
Anurathapura	678	5.8	3
Pollanaruwa	109	0.9	0
Badulla	188	1.6	1
Monaragala	135	1.2	0
Ratnapura	461	4.0	1
Kegalle	302	2.6	0
Kalmunai	412	3.4	6
Total	11630	100%	88

Source: Epidemiological Bulletin in Sri Lanka, first quarter, 2010.volume 51.

This study attempts to identify the important risk factors in order prevent and control this disease. The objectives of the study are given in section 1.2.

1.2 Objectives

1. To describe the association between dengue incidence and geographical location and rainfall pattern during the period of June 2009 to April 2010 in MOH Division, Kattankudy,

METHODOLOGY

3.1 Study Design

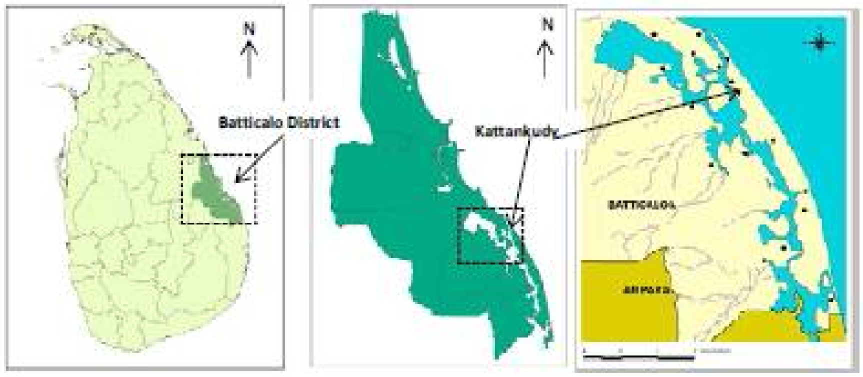
A descriptive cross sectional study was conducted at the Medical Officer of Health (MOH) Division in Kattankudy to describe the incidence of Dengue outbreak and related factors.

3.2 Study Area

The study is conducted in the MOH Division in Kattankudy which situated in Batticaloa District of the Eastern Province in Sri Lanka. The division consists of 18 Grama Niladhari (GN) divisions and has the extent of 6.5 Km2 [74]. It is one of the most densely populated towns in Sri Lanka and stands in the centre of the District as an Urban Habitat [75]. The location of the Kattankudy in Sri Lanka is shown in map 3.1.

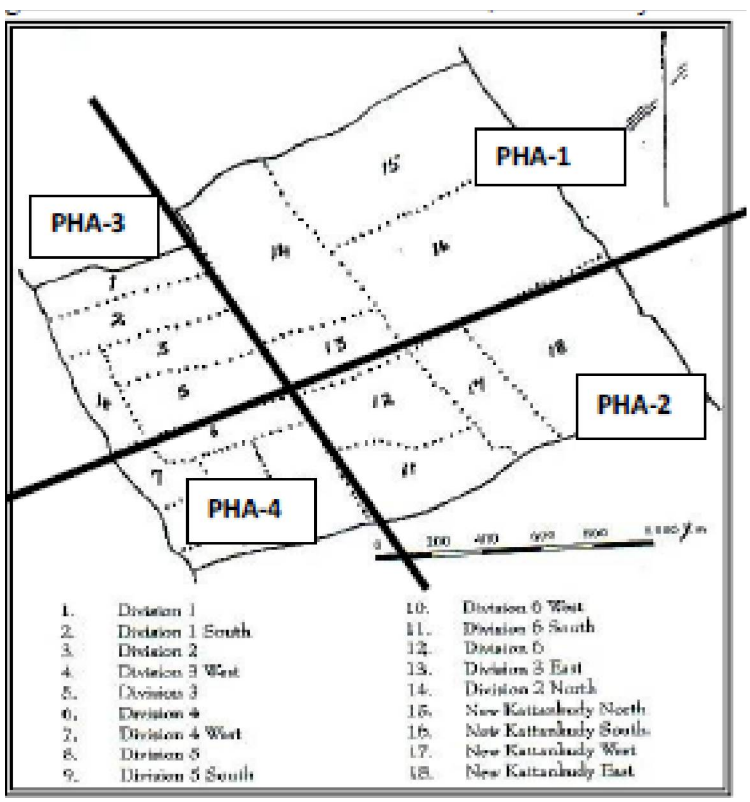
According to the census of 2010, it has the population of 48,874 and 13,344 families. It is bound by Manmunai North Divisional Secretariat on the North, Manmunai Pattu Divisional Secretariat on the South, the Bay of Bengal on the East, and the Batticaloa Lagoon on the West [74]. In the common appearance of land mass research, Kattankudy seems to be a maritime flattened land. Climate is dry Zone and it receives an average annual rainfall of 1650 mm. It receives an annual rainfall between 864 mm – 2,897 mm. The maximum rainfall is reported during September to January by North - East Monsoon. During the period from March to September, drought hits the town and as a result, more heat is felt by South – West Monsoon which is known here a “Katchaan”. The average annual temperature level is 27 °C [76][77]. The population density in Kattankudy rose in 2010 to 7519 per square kilometre while the population density of Sri Lanka prevailed to 323. In the Meantime, it was 198 in the Batticaloa District and 3300 in Colombo district [78] Total area of Kattankudy is divided in to four Public Health Inspector (PHI) Areas. In this study, these PHI areas are shown in Figure 3.1 and Map 3.2

Map 3.1 Geographical Location of Study Area - Kattankudy



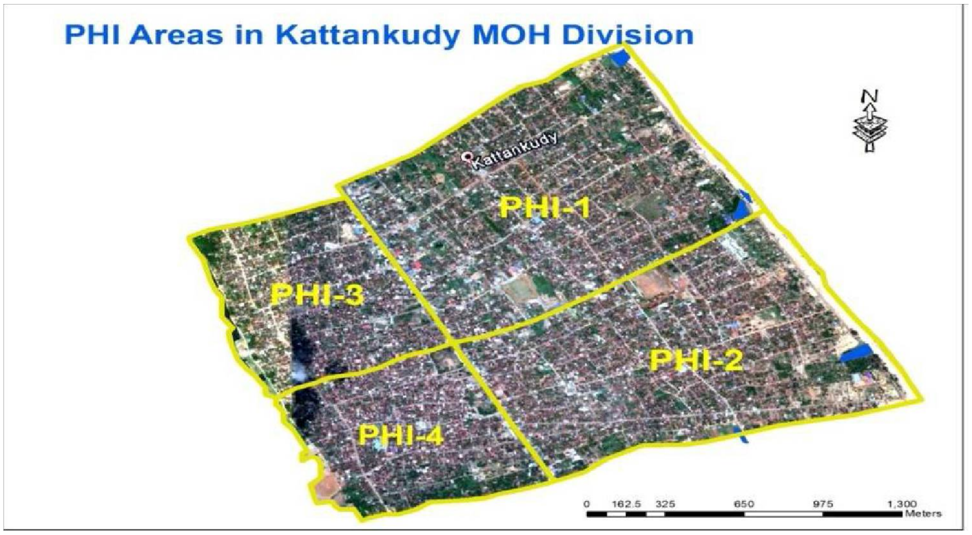
Source: Divisional Secretariat, Kattankudy

Figure 3.1: PHI Areas of MOH Division, Kattankudy



Source: MOH Office, Kattankudy

Map 3.2 Aerial View of PHI areas, Kattankudy



3.3 Study Period

This study was conducted for eleven months from 1st of June 2009 to 30th of April 2010.

3.4 Sampling and Sample Size

The minimum sample size required for this study was calculated based on an assumption the epidemic might had happened any three months period [5]. According the minimum sample size required was estimated using the following formula:

$$n = \frac{Z^2 pq}{d^2}$$

Where,

n = minimum sample size required for three months

Z = two tail critical Z value for 95% confidence which is 1.96

d = the accepted amount of absolute error which is taken 0.05

p = Probable estimate of proportion of a given characteristic. It was taken as 0.00368 that the WHO standard to be called as epidemic.

q = 1-p which is 0.99632

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Then the minimum sample size required for three months was estimated as:

$$n = \frac{1.96^2 \times 0.00368 \times 0.99632}{0.05^2} = 62$$

Therefore for one year minimum sample of 248 was required. However in this study it was able to record 384 cases during the eleven months period.

3.5 Inclusion Criteria and Exclusion Criteria

All the confirmed Dengue cases registered in the notification register during the study period and the residence inside the Kattankudy MOH Division were included in the study. Cases reported during this study period in the Kattankudy MOH Division but has the residence outside this MOH Division were excluded in the study. Also cases from Private Hospitals not included.

4.7 Collection of Data and Analysis

The demographic and clinical information of cases were recorded in the standard form. This form is given in Appendix – I and II. The other secondary data such as rainfall were collected from the reliable sources with references and these were cross checked. This collected information was transformed to Excel software and statistical analyses were carried out using Minitab 16 version. Basic descriptive analysis was carried out for describing the fact and inferences were made based on ‘t’ tests and ANOVA for quantitative data. Categorical data analyses were performed to tests the association between the qualitative variables.

The residential address of each participant was manually geocoded into the available digital map of the MOH division Kattankudy using Arc Info version 10packages (ESRI, Redlands, CA, USA) GIS software, which generated a point pattern layer. Arc Info version 10 (ESRI, Redlands, CA, USA) was used to digitize the map on which the Public Health Inspector (PHI) area was demarcated. Geo-referenced aerial photographs were used to improve the identification and the location. Individual house locations of Dengue cases were plotted on the map (reported cases of Dengue incidence attributes were then linked to the PHI areas, age sex and weekly reported cases) for each PHI Area, the Dengue cases were shown on the map as a solid circle. Kernel Density calculates the density of point features around each output raster cell. Ethical clearance was obtained from the ethical committee of Post Graduate Institute of Science University of Peradeniya (Appendix –II). The procedure involved submission of the proposal approved by the board of study of the Zoological Sciences, PGIS. Permission letter from study institution and consent forms.

Permission was obtained from the provincial director of health department of Eastern Province to use the MOH Kattankudy database. Although this is a study that uses secondary data, the confidentiality of the identification data of the individuals was guaranteed. Data were collected directly from official records to improve the quality of data. Source of data were determined prior to the study and this were followed. Cross checking the records were included to get accurate data. The principal investigator himself participated in data collection. If any defect was found in the recording it was referred back to the relevant PHI for clarification. The locations of the cases were confirmed with the visit of the PHI.

RESULTS

A total of 384 people with dengue (DF/DHF) reported to the Medical Officer of Health, Kattankudy were included in this study.

4.1 Incidence of Dengue within the Public Health instructor Area

Table 4.8 shows the incidence of dengue among the four PHI areas. The risk for dengue was compared using linear logistic models. In this model, the risk were compared with PHI area I. The relative risk for dengue in the PHI area II was 3.15 time greater compare to PHI area I (95 % CI, 2.7, and 3.6). The relative risk for dengue in the PHI area IV was 3.05 times greater comparing to PHI area I (95 % CI, 2.6, 3.5). No difference in risk was observed between PHI areas I and II (p = 0.491). People in PHI area III and PHI area IV are having high risk than PHI area I. This is shown by the GIS map in Figure 4.2 by gender.

4.1 Geographical distribution of reported Dengue cases to MOH Division Kattankudy from June 2009 to April 2010

Figure: 4.1 Dengue cases in Kattankudi June 2009 to April 2010.

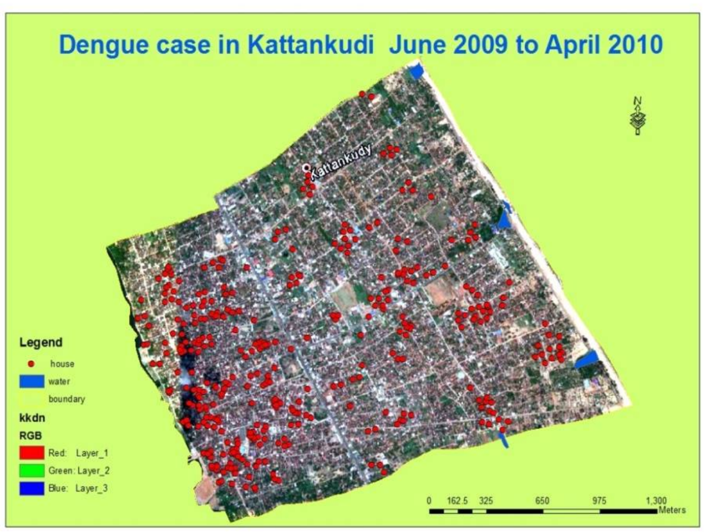
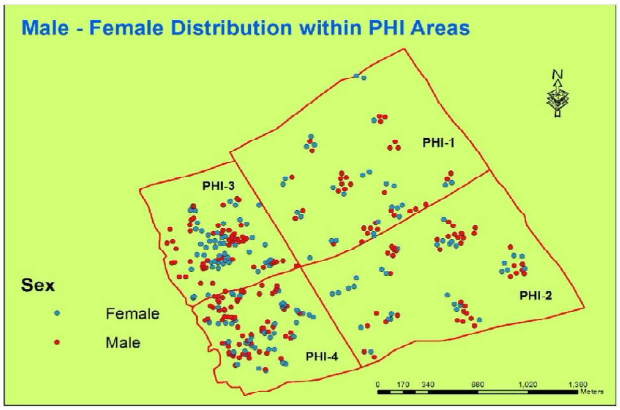


Table 4.3 Incidence of Dengue within the Public Health instructor Area

PHI Area	Incidence %
PHI I	0.50
PHI II	0.45
PHI III	1.35
PHI IV	1.31

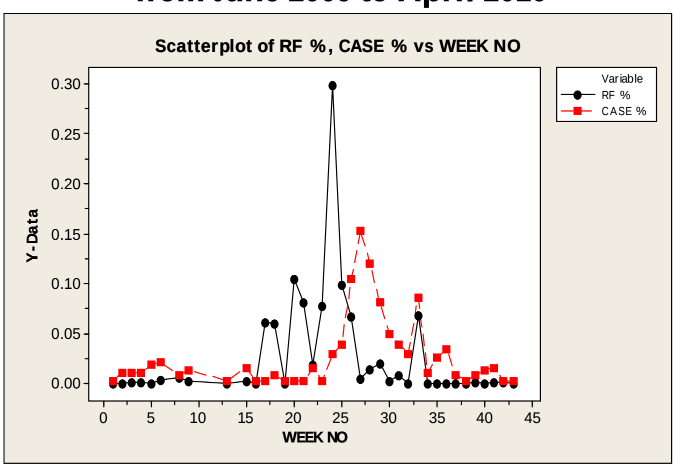
Figure 4.3. GIS map to show the Male Female distribution within PHI Areas



4.6 Rainfall and dengue distribution

Figure 4.4 shows weekly rainfall and weekly reported dengue cases during the study period plotted. The incidence was lower during the period of heavy rainfall and increased after a lag of three to four weeks once the rainfall started to decrease. The week number is the first week of June 2009 and it continues up to 43 weeks which last week of April 2010.

Figure 4.4 Rainfall and dengue distribution of MOH Kattankudy from June 2009 to April 2010



Kattankudy was an area in Batticaloa district had been identified as a 'high risk" area for dengue among 48 Medical Officer of Health (MOH) declared by the government of Sri Lanka in September 2004 [79]. During the period from June 2009 to April 2010, 384 dengue cases were reported in this MOH area, and this area was taken for studied in this research.

MOH division Kattankudy divided into 4 PHI areas to find the high risk area within the MOH division Kattnkudy to take necessary preventive and control measures most appropriately. PHI areas III and IV were the most risk area compare to the PHI areas I and II. Population density, housing type, intra urban mobility or flow of travellers, nearest solid waste dumping area, water lodging area, poor garbage collection system and on-going infrastructure development work could be the reason for the higher risk for these two areas.

Northeast - Monsoon Season last from December to February brings heavy rainfall to this study area. Study period fall within this monsoon season. The first week of June 2009 was the 1st week of reported cases to this study area. From week 24 (December 1st week) to week 33 (February 1st week) cases were in increasing trend where the cases increased exponentially in the 26th, 27th, 28th and 29th weeks.

The incidence was lower during the period of heavy rainfall (23rd week) and increased after a lag of three to four weeks (26th and 27th week) once the rainfall started to decrease. This finding is supported by the previous study found that temporal distribution of dengue cases was closely associated with the post rainfall period. The relationship was statistically supported by the power regression model established in this study indicating that there is a strong statistical association between dengue and rainfall. Dengue incidences were relatively low during the heavy rainfall and increase when the rainfall started to decrease, showing that about three to four weeks lag time between the rainfall and dengue outbreaks. The outbreaks predicted by the model were clearly related to the actual outbreaks indicating its ability to predict potential outbreaks [66]. Another study shows the total weekly rainfall slightly influenced dengue incidence in Colombo and Anuradhapura [89].

CONCLUSION AND SUGGESTIONS

The Kattankudy MOH Division has a combination of urban and peri-urban setup and is densely populated. The outbreak of dengue studied showed that it could develop to a severe degree. My study identified and mapped spatial distribution of dengue incidence during the period concerned.I also developed a model to predict dengue outbreaks analysing the association between rainfall and outbreaks. The methodology used in this study with GIS applications, improved the understanding of disease outbreak patterns and its association with different PHI areas within MOH division of Kattankudy. It can also be safely mentioned that GIS may contribute towards improving the surveillance, control and study on transmission of disease.

From this study, PHI areas III and IV were identified as high risk areas with compared to the other two areas. In future, the MOH Kattankudy must pay special attention to these two areas and strategic plans to control dengue with the special concern on proper awareness such as use of mosquito nets or repellent at house level must be implemented. The solid waste dumping area of Kattankudi situated close to these two areas must be relocated or proper measures should be taken to dispose of it by the local authority

Higher incident rate in Kattankudy MOH Division may also be due to high population density. Therefore, the local authority should carefully and strictly follow the guidelines when giving approval for new houses, buildings and other constructions in order to maintain the population density in the area. The Base Hospital and MOH Kattankudy should be well equipped with sufficient human resources to reduce incidence rate of the dengue.

Association between rainfall and dengue outbreaks in this study clearly indicated that, 3 to 4 weeks after heavy rains, the dengue cases increased. This model can be used by the MOH to predict the future situations and gather maximum resources to manage the future potential dengue outbreaks.

The spatial clusters study in here provided valuable insights into Dengue transmission in the area though the factors determining the spatial and temporal clustering were not specifically investigated. This study area would certainly need more detailed work and different methods of data collection. Such clustering have several origins such as host pathogen dynamic, national scale radiating pattern of cases, mosquito-vector ecology, or individual or house hold level risk determinant. This study showed that by integrating spatial analysis using GIS, that it is possible to improve the understanding of dengue cases distribution within areas. This study has shown that implementation of spatial analysis with metereological factors (i.e. rainfall) could enhance the understanding of vector born diseases such as like dengue and could possibly assist in identifying areas that are in need of immediate attention from health agencies in order to plan and implement efficient deterrent programmes for future.

This study focused the first ever dengue outbreak in MOH Kattankudy during the period from June 2009 to April 2010 but the present situation of dengue in MOH Kattankudy is slightly different to this. Another major epidemic occurred in 2017 in which a total of 1180 cases were reported. This was the highest number of cases reported in the Batticaloa district during the recent past. The previous outbreaks were reported during the monsoon period while the subsequent outbreak was not possibly associated with monsoon. However, it could be related to the observed climatic change in the area which lead to change in the rainfall of the particular year subsequent to my study. Furthermore, some other factors such as change in host - pathogen or vectors may also have contributed to this observed change in the pattern. However, the high risk age group (4-12 years), even in the subsequent outbreak had not changed though the national statistics indicate that the high risk age group is above 15 years. This certainly needs further investigation. In addition during the subsequent outbreak (not during my study period), the high risk PHI area changed when compared to my study period. This warrants a further study as to why and how the pattern and geography changed.

MOH Kattankudy expected that the number of cases might increase in 2018 though only 98 cases (up to June 2018) has been reported and still, such an increase has not been noted. However, the Batticaloa is currently experiencing an increase in total number of dengue cases which needs further immediate action.

Both local and national health authorities such as Ministry of Health, Regional Director of Health service (RDHS), Batticaloa and Dengue Control Epidemiology Division, MOH division Kattankudy would benefit from these study findings and would and prioritize their efforts in effective dengue control activities. Better understanding of the above will not only feed into operational policy for dengue control, but also provide fertile terrain for vaccine application strategies in the future.

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