Dengue Hemorrhagic Fever Trend: its Association with the Rainfall Rate and *Ae.aegypti* Distribution in Jakarta, 2008-2010

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Abstract

Introduction: Dengue hemorrhagic fever (DHF) is a public health problem in Jakarta. Its outbreak seems to be highly associated with the rainfall rate (RR) and *Aedes aegypti* distribution. However, due to global climate change in dry-rainy season, the DHF trend has become irregular. The aim of this study was to determine the trend of DHF in Jakarta and its association with the RR and *Ae. aegypti* distribution represented by house index (HI) in order to establish an early warning system (EWS).

Methods: This study used secondary data of DHF cases (NC), HI, and RR measurement from each region of Jakarta in 2008-2010. One-way anova test was used to analyze the relationship between NC, HI, and RR.

Results: It showed fluctuant occurrence of DHF, with the peak number of NC has been progressively shifted from May 2008 to earlier in March 2009 and 2010. No significant difference between NC and RR ($p=0.073$) and between NC and HI ($p=0.213$) but there was significant difference between RR and HI ($p<0.001$).

Conclusion: NC was not associated with RR and HI but there was association between RR and HI. The EWS was proposed to be performed in the beginning of November before the raising in RR and HI in the later months. *J Indon Med Assoc*. 2012;62:3-9

Keywords: Dengue haemorrhagic fever, number of cases, rainfall rate, house index, early warning system
Introducsion

Dengue hemorrhagic fever (DHF) is a public health problem in Jakarta. In 2007, DHF outbreak was the most serious involving 31,836 cases with case fatality rate/CFR 0.27. In 2008, DHF cases have decreased dramatically to 23,361 cases with CFR 0.09, then to 18,735 with CFR 0.20 in 2009. Unfortunately, DHF cases have increased again up to 19,285 with CFR 0.17 as seen in 2010.1

DHF is a viral disease transmitted by *Aedes aegypti* as the principal vector and *Aedes albopictus* as the secondary vector. Dengue virus has four serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. All serotypes are found in Jakarta with DENV-3 as the highest predominance.2

The DHF transmission are associated with the rainfall rate (RR) and the total number of rainy days (RD). The RR in Indonesia is more than 200 cm every year. For comparison, in Central and South India's RR is 50-150 cm/year and in North East India, Myanmar, Thailand, and Sri Lanka are slightly more than 150 cm/year.3,4 High RR, equitable climate, and slight variation in daily temperature is suitable for the *Ae. aegypti* breeding. The distribution of *Ae. aegypti* is measured by the percentage of positive house infested with the mosquito larva indicated by house index (HI).

Currently, the global warming affect the changing between rainy and dry season.5,6 As the consequence, the old fashioned of predicting DHF peak incidence based on the annual highest RR and HI for the coming years as an epidemiological measure, has now been almost ineffective and DHF danger seems to accelerate rapidly.

Responding to this background, the objectives of this study is to determine the recent trend of DHF cases in Jakarta and its association with HI, RR, and RD, in order to establish an early warning system (EWS), the proposed preventive measure of DHF outbreak for many endemic areas.

Methods

This study used cross-sectional design and was carried out at the Department of Parasitology Faculty of Medicine Universitas Indonesia from July to September 2011. The data of number of cases (NC) and house index (HI) from 2008 to 2010 were obtained from Health Department District Jakarta (Dinas Kesehatan Provinsi DKI Jakarta).

Rainfall rate is a measure of the intensity of rainfall. It is measured by calculating the amount of rain that falls to the earth surface per unit area per unit of time. The data of RR and the RD were obtained from Indonesian Meteorological,
Climatological and Geophysical Agency (Badan Meteorologi, Klimatologi, dan Geofisika/BMKG). The data were recorded monthly in five regions of DKI Jakarta (West Jakarta, East Jakarta, Central Jakarta, North Jakarta, South Jakarta) from January 2008 to December 2010.

To find out relationship among NC, HI and RR, one-way anova hypothetical test was performed. RR was categorized into three groups, the high level (>300 mm/month), moderate level (100-300 mm/month), and low level (<100 mm/month). The HI was divided into three categories: high risk (>5%), moderate risk (2-5%), and low risk (<2%).

The ethical clearance for this research was not needed since the secondary data obtained did not display identity of the study population who suffered from DHF. We have obtained the permission from Dinas Kesehatan Jakarta and BMKG Jakarta for using and analyzing the data.

Results

DHF Trend and its association with RR, RD, and HI in West Jakarta 2008-2010

Figure 1 shows the trend of DHF cases in West Jakarta 2008-2010. The peak NC in 2008 was in May (742 cases) then it declined progressively to November, with a slight increase in October (209 cases) and December (248 cases). Similar pattern was observed in 2009, in which the peak NC (448 cases) was lower compared to 2008 but decreased in May till December. The peak of NC seen in April 2010 (479 cases), lied between the peak NC of 2008 and 2009.

The RR and HI were kept in pace when the NC was in its peak (742 cases) in May 2008. The same pattern also happened in April 2009, however, when the NC (479 cases) and HI reached the peak in April 2011, there was a little decrease of RR compared to the previous month.
DHF Trend and its Association with RR, RD, and HI in East Jakarta 2008-2010

Figure 2 describes the trend of DHF in East Jakarta between 2008-2010. This region has the highest peak of NC compared to other regions of Jakarta. The graph shows NC peaking up to 1909 cases in May 2008, but dramatically fell down thereafter. DHF trend in 2009 had a common similar pattern with 2008. Distinct characteristic was observed in 2010, which each year had more stable NC compared to the other two year but still higher when in comparison with the remaining four regions, indicated by 698 cases in 2010.

The peak NC shifted from year to year (May 2008, April 2009, March 2010) followed by shift in rainfall peak especially in February 2008 and January 2009. In May 2008, peak of HI (1.3%) was followed by peak of NC (1909 cases) as well. In 2009, peak of HI (1%) simultaneously occurred with the peak of RR (327.1 mm) in January. HI decline in October 2010, but RR reached its peak (376 mm).

DHF Trend and its Association with RR, RD, and HI in Central Jakarta 2008-2010

Figures 3 shows a different pattern from West Jakarta, in which Central Jakarta possessed the highest NC in May 2008 (566 cases). The peak NC then decreased within the following years, with the lowest was in March 2010 (289 cases), and then in March 2009 (359 cases). Once the peak was reached, it gradually declined in the following months, while some moderate increase was found in December 2008 (232 cases), known as the second peak of the year, and also minor increase in December 2009 (61 cases). There are also secondary and tertiary peak found in August 2010 (168 cases) and November 2010 (176 cases).

In February 2008, the RR (792.9 mm) reached the peak followed by increased HI (4.7%), although the NC was not so high. When NC was peaking up with (566 cases), the HI and RR declined. In 2009, the peak RR (228.9 mm) was followed by increased HI, but the NC was stable enough. In
2010, when the NC was about to reach the peak (289 cases), the RF and HI also increased.

**DHF Trend and its Association with RR, RD and HI in North Jakarta in 2008-2010**

Figure 4 revealed DHF trend in North Jakarta in 2008-2010. Peak number of DHF cases was still observed in March 2009 (789 cases), yet different pattern was seen in May 2008 showing lower NC peak (620 cases). Both in 2008 and 2009, the graph showed progressive reduction of NC in the following months and increased again slightly in December. Instead of being at the end of the year, pattern of DHF in 2010 showed variable increase in September (304 cases) and November (247 cases).

In 2008, the peak of RR was in February (677.7 mm) and it was followed by peak of NC in May (620 cases). The peaks of RR in 2009 (455.9 mm) and 2010 (576.1 mm) were both in January and followed by peak NC two months later. In 2010, trend of HI was almost similar to trend of DHF cases in 2009.

**DHF Trend and its Association with RR, RD, and HI in South Jakarta 2008-2010**

Figure 5 demonstrated the trend of DHF in South Jakarta in 2008-2010. The data showed a more variable change in each observed year. Unlike the previous distribution, the peak NC of 2008, was seen in January (944 cases) and the second peak with a slight difference was found in May (934 cases), then it decreased until September and grew up again until December (628 cases). Similar trend found in 2009 with peak NC was in May (755 cases) then appeared to have a similar pattern like 2008. In 2010, different trend was noted by unstable variation with the maximum peak seen in March (587 cases); the second and third peaks were in August (417 cases) and November (392 cases), respectively.

Though the peak NC in 2008 was in January (944 cases), there was secondary peak in May (934 cases) which was interrupted by RR peak in February (698 mm). Trend of HI from 2008 until the beginning of 2010 appeared to be on the scent of rainfall pattern, except in November 2009. In late 2010, trend of HI was almost stable and it did not show any response for high RR in October 2010 (564 mm).

**Statistical Analysis**

There were no significant difference between NC and RR (one-way anova, p=0.073) as well as between NC and HI (Kruskal-Wallis test, p=0.213), however there was significant difference between RR and HI (p<0.001). Thus, it was concluded that there was no association between the NC and RR and HI but there was association between RR and HI.

**Discussion**

Rainy season provides a larger breeding sites for dengue vector, especially favoring the vector-borne life cycles, including *Ae.aegypti*. In Selangor, Malaysia, a monthly rainfall of 300 mm or more would cause a major dengue outbreak in the state after a lag period of about two to three months.

This study showed there was no association between NC and RR in Jakarta 2008-2010. It means that high level of RR in a month did not implicate in high NC, and vice versa. Nevertheless, the DHF outbreak occur 2 to 3 months after high level of RR because high rainfall flush of the *Aedes* larvae and adult.59 *Aedes* density and distribution will increase if the RR decrease which is 2-3 month after the highest RR.

Chakravarti *et al* reveal the same result as DHF outbreak in Delhi coincided mainly with the post monsoon period of subnormal rainfall, which then followed by relatively
heavy rainfall during the monsoon period. On the contrary, Sripugdee \textit{et al}.\textsuperscript{11} discovered a high correlation between DHF incidence rate, RR and the number of RD since relative humidity was higher during rainy season in Thailand.

In this study, there was no association between the NC and HI in Jakarta 2008-2010 because \textit{Aedes} larvae need 8-12 days to develop into adult mosquito, then infected by dengue virus from the sick person and become capable of transmitting it to healthy people. Moreover, the infected mosquito needs 8-10 days more for the viral incubation period before they are able to transmit the virus. The incubation period in human host prolongs the time needed about 4-7 days from the transmission into acute fever which then would be diagnosed as DHF.\textsuperscript{13} In addition, \textit{Ae. aegypti} is a multiple biter mosquito and is able to infect 5-6 persons in a short time.

This study showed there was an association between RR and HI. A previous study also revealed that HI and RR had positive association since the larval density and distribution fluctuates according to seasonal climatic change due to the increasing number of available potential breeding sites in rainy season.\textsuperscript{7} Strickman \textit{et al}.\textsuperscript{13} and Yotopranoto \textit{et al}.\textsuperscript{14} suggested that rising of mosquito population during rainy season (higher RR) because of increased breeding sites.

\textit{Aedes} larvae were known to be able to survive, no matter what condition of infested container, especially after the rain ceases. The larva survival rate became higher when it is acclimated in an extreme condition, such as lower or higher pH of the infested-container or the ionic composition.\textsuperscript{15} Other suggestion states that larva can still thrive to mature adults in a very small amount of aquatic media. Yet, as stated before, exceeding rain intensity can lead to flood instead of creating a new hatching and breeding site for \textit{Aedes}, which probably destroys the previously infested sites.

This study showed that almost all the RR peak in 2008 and 2009 or any increasing RR responded well by an increasing evidence of HI representing the larval distribution. However, data from 2010 were different as the result of successful health campaign and social education of DHF prevention performed around April 2010. This action lower the \textit{Ae.aegypti} larva population and the number of DHF cases after the RR peak of the year. The effect of it could be observed in all remarkably in Central, South, West, and East Jakarta, while North Jakarta had the same rate of HI and NC due to community incompliance.

Well-prepared health campaign and dengue control programme were considered to be the prototype for the DHF warning system in order to prevent dengue outbreak in community. This study indicated that RR pattern almost always precede the community outbreak occurring in the following two or three months. However, the HI kept in pace with the rainfall dynamic. This evidence proved that the disease transmission from egg to vector-human transmission need sufficient time. Moreover, the trend of RR in the following months which were lower and more stable, favored the vector's breeding and protect the larva from being flushed away (appertain with the RR of the month). Begin from this situation, health campaign against dengue infection and mosquito breeding control programmes are expected to have an effective risk-reduction of dengue transmission and prevent the outbreak in the community.\textsuperscript{16}

As stated above, DHF preventions have been conducted in the form of social health campaign concerning for the community outbreak in the past. Encouraged by NC seen in March 2010 (2570 cases), governmental health ministries cooperating with health professionals conducted a Jakarta road campaign against DHF, which had been held in April-May 2010. Thus, there was a declining number of DHF cases along 2010 for the later months. This social warning campaign brought many advantages, such as improving awareness of the community to anticipate from DHF by maintaining their health and environment, enhancing knowledge for community about sign, symptoms, and danger of DHF. In addition, this campaign aimed to set up the participation of government to anticipate and prevent DHF cases, lower governmental health budget, and also reduce the morbidity and mortality of DHF as well. However, since the outburst of DHF cases in the community went just before the campaign performed, thus it became ineffective to prevent the prior DHF outbreak.

In association with the previously health campaign statement, it is essential to make an alarming system targeting government, health providers, and society as well, in order to prepare the anticipation of the upcoming DHF outbreak. The early warning system (EWS) proposed from this study is rainfall observation. The most advantageous alarming time to start the EWS is in November, which account for the most minimal NC. Around November to December, NC start to rise again then, around January and February, it will be followed by a rise in RR and HI.

Constructing the health campaign, water container man-agement, social education for self-protection against mosquito bites one month earlier provides a sufficient time for the environmental and community based DHF prevention. The larva and breeding sites control programme offer a common effective output as well as if it were included in the EWS.

The proposed system, however, composed of a joint corporation arranged by various departmental units, like Climatology and Health Department. Some benefits can be obtained from EWS, namely establishing health and independent society; setting up an earlier, well-prepared health institute to anticipate the surge of DHF patients; lowering national health cost due to incidence reducing-effect; decreasing other vector-borne related disease such as chikungunya, Japanese B. encephalitis, etc.\textsuperscript{16}

A good coordination among climatology center, health departments, professional workers, and social policy maker, account for the further consideration before the implementa-
tion of EWS to ensure that the information can be updated fast, accurately, and properly. Related to the benefits offered from EWS, there will be a significant reduction in DHF incidence and DHF will be no longer a health problem.

Finally, the authors realize the study limitations about the exclusion of several data due to dependency on primary staff performance in collecting the required component. Another shortcoming factors was due to inequality of collected data received from the Health Department of Jakarta, in which the DHF cases of 2008 has not been reexamined by further epidemiological investigation, compared to DHF cases of 2009 and 2010.

Conclusion

The DHF trend was observed to vary in peak NC from March to May; it is seen in May 2008 and in March 2009 and March 2010. There were no association between the RR and NC, and also between the HI and NC but there was an association between RR and HI. There was an association between RR pattern and NC suggested the EWS should depend on prediction of RR to prevent the later outbreak of DHF.

This study proposed to initiate the EWS in the beginning of November, just before the rising in RR and larvae population, represented by HI. The actions that should be performed to reduce DHF cases and improve the EWS use in Jakarta, includes raising awareness for DHF peak incidence, particularly in March to May or in the raising of RR or predicted rainy season; controlling the mosquito-breeding sites must be implemented since November and to be maintained along the rainy season.

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References


