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Incidence of dengue fever, climate and vector density in Denpasar

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ABSTRACT

Background and purpose: Until 2009, Denpasar consistently had the highest rates of dengue fever in Bali. However, from 2010 onwards, dengue rates in Denpasar have declined and in 2017 ranked 7th for incidences of dengue fever in Bali. This study aims to determine the trend and the difference of dengue fever incidence rates, vector density and climate for the period 2007-2017.

Methods: This study employed a secondary analysis of dengue fever incidence rates, climate data and vector density from 2007 to 2017. Data on dengue fever incidence, vector density and the number of field workers (known as *juru pemantau jentik* or *jumantik*) were obtained from the Denpasar City Health Office. Climate data for 2007-2017 were obtained from the Bali Province Meteorological, Climatological and Geophysical Agency. The data were analyzed by comparing the dengue fever incidence rates, climate data, and vector-density data of the period 2007-2012 and 2013-2017.

Results: Incidences of dengue fever in Denpasar have declined since 2013. Climate-related variables found to differ significantly were air temperature, humidity, wind speed and sunlight duration. Air temperature (p=0.03) and wind speed (p<0.01) were significantly higher in 2013-2017 compared to the period of 2007-2012. Humidity and sunlight duration were significantly lower (p<0.01) in 2013-2107 compared to the period of 2007-2012. Rainfall was lower in 2013-2017 compared to the period of 2007-2012, however, the difference was not significant (p=0.57). The proportion of larva-free households was significantly higher (p<0.01) in 2013-2017 (96.9%) compared to the period of 2009-2012 (95.3%). The data of house index (HI), container index (CI) and Breteau index (BI) cannot be compared between these two periods because they are only available for 2013-2017.

Conclusion: There has been a decrease in the incidence of dengue fever in Denpasar from 2013-2017 compared to 2007-2012. This is likely to be related to the performance of *jumantik* in the implementation of vector control programme (VCP) in Denpasar.

Keywords: Vector control program, climate, dengue fever, Denpasar

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INTRODUCTION

In 2015 the World Health Organization (WHO) reported that more than 3.2 billion people or more than 40% of the world's population across 128 countries were at risk of dengue infection with Indonesia at the highest risk in Southeast Asia.[1] In 2015, three Indonesian provinces reported the highest incidences of dengue fever were Bali with incidence rate (IR) of 257.75 per 100,000 population, East Kalimantan (IR=188.46 per 100,000 population) and North Kalimantan (IR=112.00 per 100,000 population).[2] Until 2009, Denpasar consistently reported the highest dengue fever incidence rates compared to other nine districts in Bali. Since 2010, the incidence rate of dengue fever in Denpasar has decreased and currently ranked seventh after Karangasem, Gianyar, Badung, Klungkung, Buleleng and Bangli Districts.[3-9]

The incidence of dengue fever is associated with climate (air temperature, rainfall, air humidity and wind speed),[10-16] population density,[17] vector density,[18] community behaviour and dengue prevention programs.[19,20] One effort to prevent the incidence of dengue fever is vector control program (VCP). One of the program's components is the eradication of mosquito breeding places campaign or called *pemberantasan sarang nyamuk* (*PSN*) that consisted of *3M Plus* activities of *menguras* (draining potable water), *mengubur* (burying water containers), *menutup* (covering water containers) and *menabur* (applying larvicide to potable water). This initiative requires community participation. In Indonesia, local-residents were recruited to be field workers (called *juru pemantau jentik* or *jumantik*) who carry out household surveillance of the *Aedes aegypti* mosquito larvae.[21]

In 2007 the Denpasar local government recruited 215 *jumantik* (5 per village) with a salary of IDR 450,000 per month. In 2013 the number of *jumantik* was increased to be 431 (10-11 people per village) with a salary of IDR 700,000 which was raised to IDR 900,000 in 2015-2016, and to IDR 1,005,000 in 2017. The tasks of *jumantik* include providing education to local residents (individual or group) and carrying out monitoring of larvae in houses/buildings with a target of 30 houses per day

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per *jumantik*. They also facilitated local community in implementing the *Aedes aegypti* vector control. With these tasks, it is expected that mosquito larvae can be reduced and/or the proportion of larva-free households can be increased.

The decrease of dengue fever incidence in Denpasar is suspected to be associated with those *jumantik* roles. This study aims to determine the trend and the difference of dengue fever incidence rates, vector density and climate for the period 2007-2017.

METHODS

This study employed a secondary data analysis for the period of 2007-2017 regarding the incidence of dengue fever, climate-related factors, vector density and number of *jumantik*. Data on vector density (other than data of larvae-free households) and *jumantik* incentives were only available for 2013-2017. The number of reported dengue fever cases per sub-district (*kecamatan)*, the number of *jumantik*, and vector density were obtained from Denpasar City Health Office. Monthly climate data for Denpasar (rainfall, air temperature, humidity and wind speed) were obtained from Bali Province Meteorological, Climatological and Geophysical Agency or called Badan Meteorologi, Klimatologi dan Geofisika *(*BMKG). Population data were obtained from the Denpasar Statistics Office.

The dengue fever incidence rate is calculated by dividing the number of cases per month by the number of population. Larvae-free households are calculated by dividing the number of houses negative for larvae by the total number of houses inspected. The house index (HI) is calculated by dividing the number of houses positive for larvae by the total number of houses inspected. The container index (CI) is calculated by dividing the number of containers positive for larvae by the number of containers examined. The Breteau index (BI) is calculated by dividing the number of containers tested positive for larvae by the total number of houses inspected.

Dengue fever incidence rates are presented per month, per year and per sub-district. Climate data and vector density are also presented per month and per year to determine the trends. This analysis also compared data from 2007-2012 and 2013-2017. The mean difference was calculated using Mann-Whitney U Test with a significance level of 0.05.

RESULTS

Figure 1 shows a declining trend in the dengue fever incidence rate for the period 2007-2017. The highest incidence rate was found around April-May. In the period 2007-2012, the mean of incidence rate was found to be 30.2 per 100,000 population and declined significantly in the period 2013-2017 to 17.0 per 100,000 population ($p<0.01$).

Figure 2 presents the dengue fever incidence rates per sub-district. It shows that in 2007, 2008 and 2013 the highest incidence rates were found in South Denpasar. In 2009, the highest incidence rate was found in West Denpasar, and in 2010, the highest rates were found in East and North Denpasar. Thus, every sub-district of Denpasar in the years examined has ever had the highest dengue fever incidence rates.

Figure 3 presents rainfall data by month and year for the period 2007-2017. Peak rainfall occurred during April-May, which also matches the pattern of dengue fever incidences that also peaked in April-May (Figure 2). Rainfall was lower in 2013-2017 with a mean of 154.8 mm compared to the period of 2007-2012 with a mean of 171.0 mm, however the difference was not statistically significant ($p=0.57$).

Four other climate variables, air temperature, humidity, wind speed and sunlight duration showed significant differences in the period 2007-2012 and

Table 1 Annual percentages of larvae-free households, HI, CI, and BI per year in Denpasar from 2009 to 2017

Year	Larvae-free households (%)	HI (%)	CI (%)	BI (%)
2009	94.5	-	-	-
2010	96.1	-	-	-
2011	95.5	-	-	-
2012	95.1	-	-	-
2013	96.8	3.2	1.8	4.3
2014	97.2	2.8	1.7	4.1
2015	97.0	3.0	1.6	4.1
2016	96.6	3.4	1.7	4.6
2017	96.9	3.1	1.6	4.2

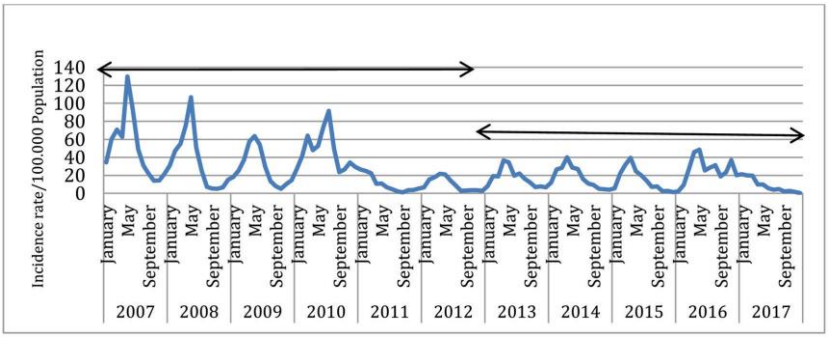

Figure 1 Incidence rate in Denpasar 2007-2017

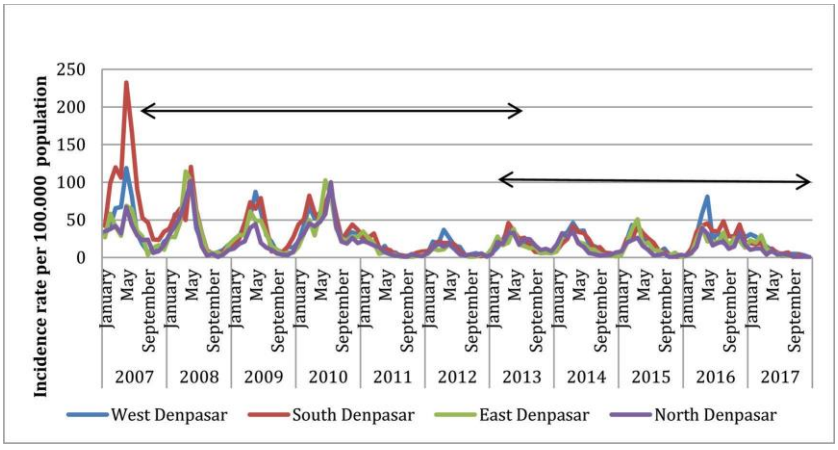

Figure 2 Incidence rate per Sub-district in Denpasar 2007-2017

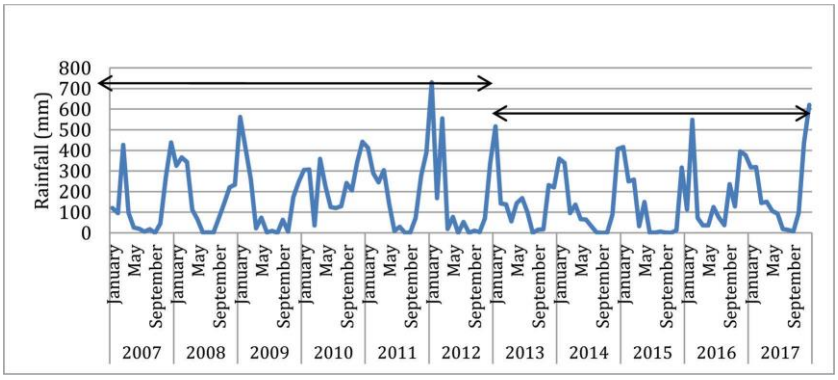

Figure 3 Rainfall in Denpasar 2007-2017

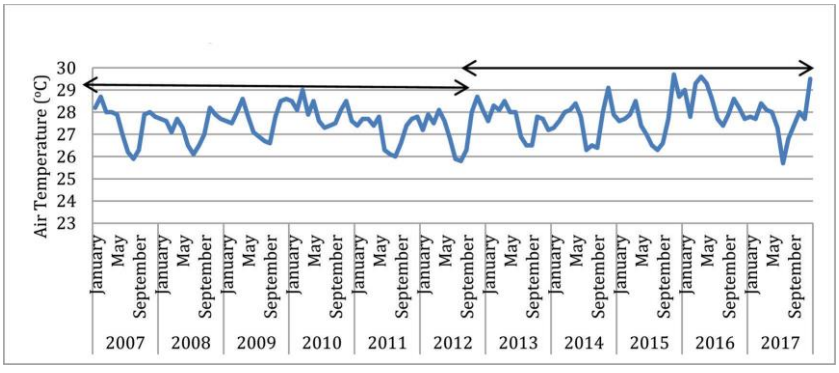

Figure 4 Air Temperature in Denpasar 2007-2017

the period 2013-2017. Air temperature (Figure 4) was significantly higher (p=0.03) in 2013-2017 with a mean of 27.8°C compared to the period of 2007-2012 with a mean of 27.5°C. Humidity (Figure 5) was significantly lower (p<0.01) in 2013-2107 with a mean of 78.0% compared to the period of 2007-2012 with a mean of 79.8%. Wind speed (Figure 6) was significantly higher (p<0.01) in 2013-2017 with a mean of 6.4 knots compared to the period of 2007-2012 with a mean of 5.6 knots. Sunlight duration (Figure 7) was significantly lower (p<0.01) in 2013-2017 with a mean of 65.0% compared to the period of 2007-2012 with a mean of 73.0%.

Table 1 presents the vector-density variables namely larvae-free households, HI, CI, and BI. The proportion of larva-free households was significantly higher (p<0.01) in 2013-2017 (96.9%) compared to the period of 2009-2012 (95.3%). The data of house index (HI), container index (CI) and Breteau index (BI) cannot be compared between these two periods because they are only available for 2013-2017. The HI, CI, and BI trends for the period 2013-2017 are similar every year.

DISCUSSION

For the period 2007-2017, dengue fever incidence rates for Denpasar declined, especially after 2012. However, this trend differs from other districts in Bali such as Badung, Buleleng and Gianyar where dengue fever incidence rates tended to increase during the period 2010-2016.[3-9] Further, dengue fever incidence rates among other provinces in Indonesia tended to increase during the period 2011-2015.[22]

Thus, if the decrease of dengue fever incidence rates in Denpasar was due to climatic factors, this should also be the case in other districts of Bali because they are geographically very close to Denpasar (especially Badung and Gianyar). In addition, our study shows that the mean of rainfall in Denpasar did not differ significantly between 2007-2012 and 2013-2017. Other climatic factors were found to differ between 2007-2012 and 2013-2017, namely an increase in temperature, an increase in humidity, a decrease in wind speed and a decrease in sunlight duration. These variables are more closely related to rainfall which is not significantly different in this study.

It is likely that the decrease in dengue fever incidence rates in Denpasar is due to the decrease in the vector density. Vector density indicators are the larvae-free households, house index, container index, and the Breteau index. In this study, the only indicator that can be calculated for the two periods above is the larva-free household percentage;

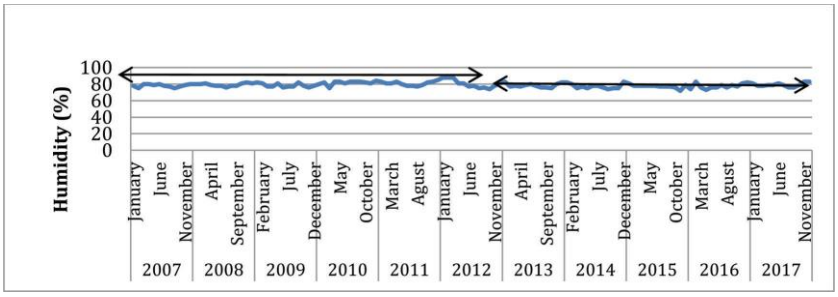

Figure 5 Humidity in Denpasar 2007-2017

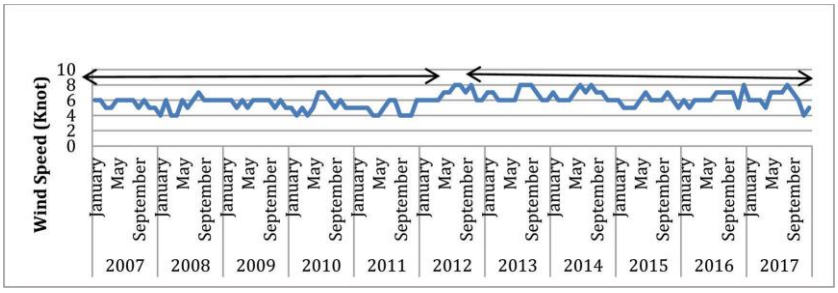

Figure 6 Wind Speed in Denpasar 2007-2017

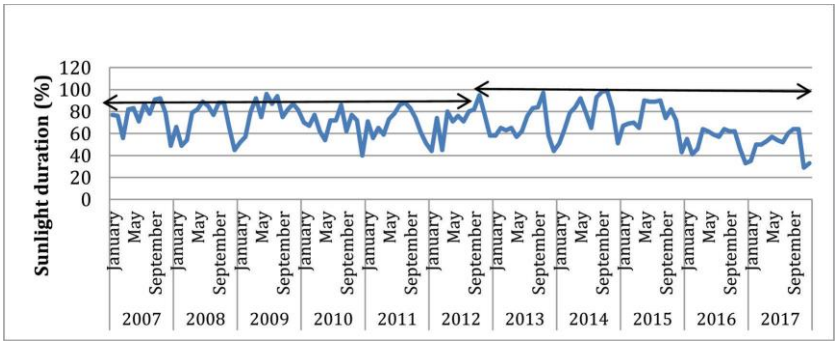

Figure 7 Sunlight Duration in Denpasar 2007-2017

other indicators cannot be compared because data is available only for 2013-2017. Larvae-free households increased significantly in 2013-2017 compared to 2007-2012. The rise in the larvae-free households is potentially associated with the increased number of *jumantik* in the period 2013-2017 compared to 2007-2012.

The findings of other studies in Indonesia and also in Denpasar show that *jumantik* are relatively successful in the prevention of dengue fever, especially in providing education to local residents and carrying out monitoring of larvae in houses.[19,23] Studies from other countries show that community-based environmental management is one of a number of effective vector control programs.[24,25]

Limitation of this study is that several other variables related to the incidence of dengue fever were not examined, including population density and population mobility. Data on vector density (other than data of larvae-free households) were only available for 2013-2017, thus cannot be compared with data in the period of 2007-2012. Some data may be under reported such as number of dengue cases and other data may be over reported such as larva-free households. Further study is needed with more comprehensive indicators to identify factors associated with the decline of dengue fever incidence.

CONCLUSION

A decrease in the dengue fever incidence rates in Denpasar is evident for the period 2013-2017 compared to 2007-2012. However, in the same period, there was an increase in dengue fever incidence rates in other provinces of Bali and other regions in Indonesia. This is likely related to the increase of larvae-free households or the success of household surveillance of *Aedes aegypti* mosquito larvae. Thus, reducing the incidence of dengue fever requires a comprehensive vector control program before other prevention methods are available.

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