Larvae Density and Environmental Condition as Risk Factors to Dengue Incidence in Semarang City, Indonesia

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Larvae Density and Environmental Condition as Risk Factors to Dengue Incidence in Semarang City, Indonesia

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Abstract. Dengue Hemorrhagic Fever (DHF) is a disease caused by a virus transmitted by a mosquito vector of *Aedes*. As Semarang city of Indonesia has dense population and is located in a low altitude area, Semarang is identified to be a high endemic area of DHF. The objective of this study was to describe the risk factors of DHF, specifically larva density and environmental condition, using spatial analysis. The descriptively observational research with cross sectional approach was used and samples were taken using proportional stratified random sampling technique in Tembalang sub-district on 100 households. Data obtained through questionnaires, observations, and measurements were analyzed by spatial method. The result showed that the description of the risk factor was as follows: larva density (CI) was still above the national standard of Indonesia by 5%. The behavior of respondent of Semarang city belonged to the category of poor, and the majority of respondents were not routinely doing elimination of mosquito breeding sites.

1. Introduction

Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS) is a disease caused by a virus transmitted through mosquito vectors, and spreads quickly [1]. Three types of diseases caused by dengue virus are Dengue Fever (DD), DHF, and DSS. Dengue virus belongs to group B Arthropod Virus (Arbovirosis) that has 4 serotypes: Den-1, Den-2, Den-3, and Den-4 [2,3]. Every year, it is estimated that there are about 390 million dengue infections worldwide, from which three quarters of DHF sufferers are in the Asia-Pacific region [4].

In Central Java Province, Indonesia, DHF is still a health problem. The city of Semarang, of Central Java Province, is an endemic area and has the highest cases compared to the cases in other districts/cities. The incidence of DHF in Central Java Province in 2016 was 43.4 per 100,000 population, and the Case Fatality Rate was 1.46% [5,6]. Meanwhile, the incidence of DHF in Semarang City was 98.61 per 100,000 population in 2015, and 25.22 per 100,000 inhabitants in 2016 [6]. In the Semarang City, the highest incidence of DHF was identified in Tembalang sub-district as many as 194.04 per 100,000 population in 2015, and 207.57 per 100,000 population in 2016 [7]. The data report in Dengue Program in Indonesia, DHF and DSS make one data as a DHF cases.

Epidemiological studies of DHF reveal that the factors associated with DHF are host factors including age, immunity status, and nutritional status; agent factor that is dengue virus, which is

transmitted through *Aedes aegypti* and *Aedes albopictus* mosquito vectors; while, environmental factors are geographic conditions (height from the sea level, rainfall, wind speed, humidity, season/climate) and demography [8,9]. Other factors proven to play a role in increasing the spread of dengue cases are vector density, continually increasing population, uncontrollable urbanization, an increase in transportation facilities, unhealthy community behavior towards the environment, as well as climate change [4,10].

This study examined the factors of *Aedes* sp vector and environment related to the incidence of DHF in Tembalang sub district, Semarang, Indonesia. This study was conducted using spatial analysis; an analysis and description based on geographical disease data [2]. Utilization of spatial analysis of the incidence of DHF is expected to provide benefits in describing the pattern of the spread of DHF in a region.

2. Materials and methods

This descriptive study with a cross sectional approach was conducted in one of the sub-districts in Semarang City, namely Tembalang sub district, which is considered the DHF endemic district as the highest incidence of DHF has been identified in this region.

The research sample was 100 households registered as permanent residents' domicile in 12 villages under the administration of Tembalang sub district. To describe the distribution of DHF and spatial environmental factors, village unit was used for the 12 villages in Tembalang sub district. The respondents were the head of the family or housewives. The variables measured were the DHF incidence, larvae density, environmental parameters such as temperature and humidity, population density, and population behavior in eradicating mosquito breeding sites (EMB). Data were analyzed descriptively and displayed in the form of maps and tables.

3. Results and discussion

3.1. Larvae Density and Environmental Factors in Tembalang Sub District, Semarang

The results of the entomological survey showed that the larva density was quite high in Tembalang sub district as measured by Container Index (CI) with the average larvae density or the CI was 9.83% per village; while, the national standard was less than 5%. The CI is calculated by the percentage of the positive number of containers divided by the number of containers examined. From the perspective of standard program of vector control, the larvae density in the villages of Tembalang sub district was mostly dense (8 villages from 12 villages were identified to be having high larvae density). High density is categorized when the CI in a region is 5% or more (standard of national vector control program) [6,7].

The types of containers mostly observed were bathtubs, some were made from ceramic, and ceramics are easier to clean and not easily to be mossy (48%); while, the least containers to be observed were made of cement (20%). The larvae found in the containers were further identified their species in the entomology laboratory of Diponegoro University, and the results showed that all (100%) were identified as *Ae. aegypti*.

Physical environmental parameters observed were water pH, temperature, and humidity. Ninety percent of the water used by respondents had the average water pH of 6.812. Meanwhile, the environmental air temperature around the respondents' house was in usual interval (25^{o}-35^{o}C), and the average humidity was 53.95% (indoor) and 53.35% (outdoor). The average altitude of the respondents' residence was 92.16 meter above the sea level.

The social environment associated with population density showed that the average population density of Tembalang sub district was 7,392 people/km^2, with the most densely populated was Jangli Village with 10,876 people/km^2. Respondents' MBE behaviour was still low (82%) (table 1). Many respondents left their water shelters open (84%), while 53% of the respondents did not drain the bathtub every three days. The majority of the respondents (46%) did not leave used goods in their yard; the respondents rarely used larvicide (85%) and maintained larva-eating fish (82%).

Table 1. Mosquito Breeding site Eradication (MBE) Behaviour in Tembalang sub district, Semarang.

Classification	**Yes**		**No**	
	f	%	f	%
Permanent bathtub use	70	70.0	30	30.0
Use of TPA cover	16	16.0	84	84.0
Drain the bath once every 3 days	47	47.0	53	53.0
Recycling used goods	46	46.0	54	54.0
Larvacide use	15	15.0	85	85.0
Culturing larvae eating fish	18	18.0	82	82.0

3.2 DHF incident in Tembalang sub district

Respondents of the study interviewed about the history of DHF showed 11% claimed to have had DHF. The data DHF cases got from the data report of health office of Semarang City. The number of DHF cases is reported more than the data from this survey. The DHF cases and the positive container distribution described in the villages in Tembalang sub district is presented in figure 1 and figure 2.

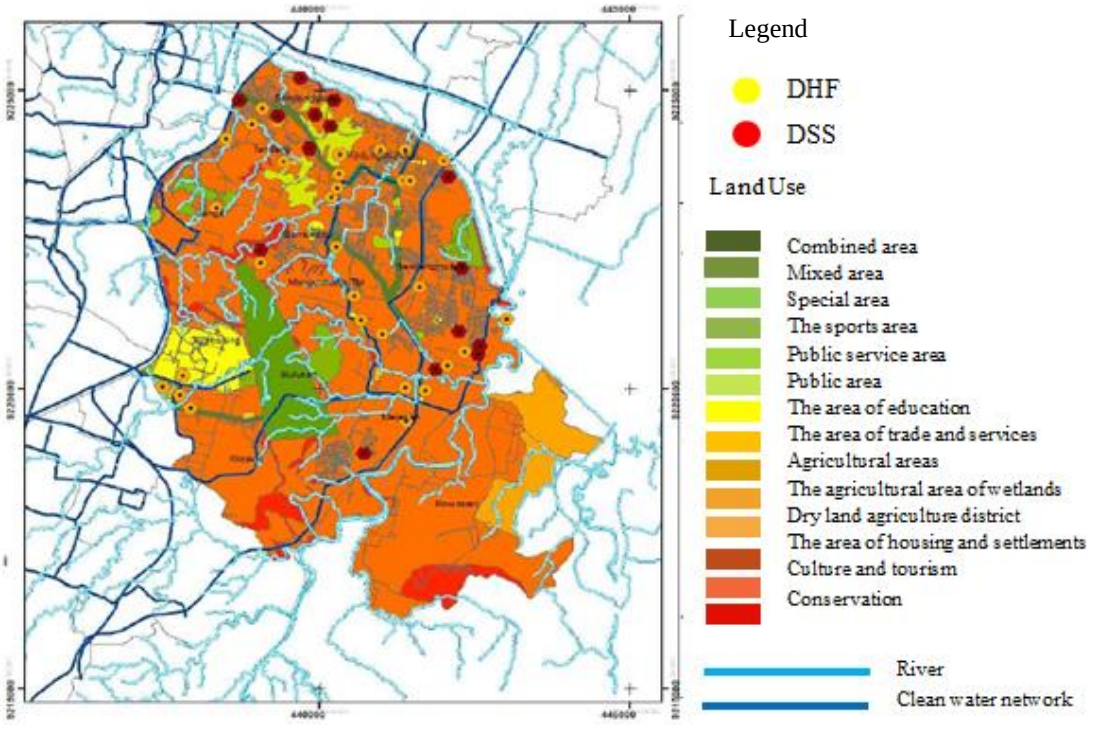

Figure 1. DHF distribution in all villages of Tembalang sub district.

Distribution DHF and DSS cases was found in Sendangguwo, Sendang mulyo, Kedungmundu, Meteseh and Tembalang villages (figure 1). They are an endemic with high cases of DHF and DSS. DHF cases tend to be found near the house with a positive larva (figure 2).

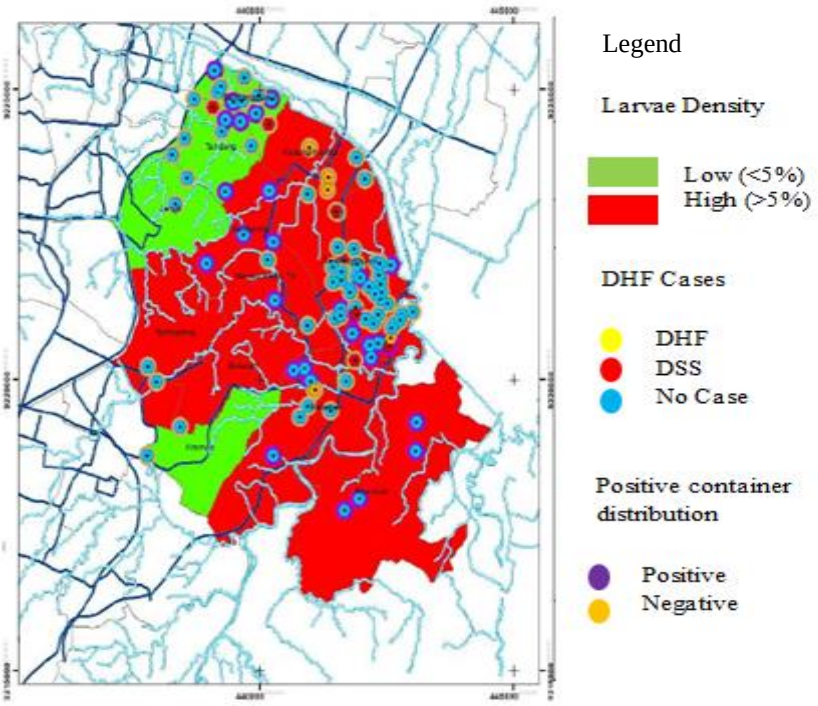

Figure 2. Positive container distribution in all villages.

One of the indicators of assessing success of vectors is by observing the density of larvae in the area whether or not the area is at risk for dengue transmission. Larvae density can be identified from Container Index (CI), House Index (HI), and Breteau Index (BI) in an area performing vector control [7].

Container Index (CI) describes the number of reservoirs found positive for larvae from the water reservoirs examined [10]. If the CI of an area is more than 5%, the area has a high risk [2]; whereas, if the CI is less than 5%, the area is safe from the transmission of dengue virus [11]. Various types of landfill found are likely to be used as a breeding place for DHF vectors. In this study, the CI of the 12 villages in Tembalang sub district was 9.83%, meaning that the vector density in the study area was quite high; while the type of the vector was *Ae. aegypti*.

Larvae density was closely related to the availability of breeding place, and *Ae. aegypti* preferred a container in the form of a water reservoir as the breeding place. Meanwhile, the availability of containers was closely associated with the behaviour of the community in collecting water. Nearly 83% of the people were categorized as having low MBE behaviour such as covering, washing the container, and recycling of household waste (called 3M plus on the local dengue program in Semarang). Many did not store water, close the water reservoir, and clean the container for at least 2 times per week.

Poor behaviour could worsen when the community increases; thus, a dense population environment greatly affected vector density in a region. Besides affecting vector density, poor behaviour and population density would also facilitate the transmission of DHF from one person to another vulnerable person. The higher population density and the closer the distance of houses, the more intensive the dengue disease spreads, especially in urban areas compared to rural areas [12]. Research finding of Prasetyowati showed that the IR (incidence Rate) of DHF in Bondowoso Regency with a population density of > 100,000 people/km^2 was still above the national standards. The dengue fever cluster spreading causes a densely populated area suffers higher possibility to be infected by DHF [12].

Prevention of dengue transmission has been carried out by breaking the chain of DHF transmission. Among the efforts are to eradicate mosquito breeding site (EMB) by means of "3M" plus, larvaciding, and fogging [2]. The EMB activities could be done by eliminating mosquito-breeding sites and

recognizing mosquito bionomics in breeding. Semarang has dense population and suitable environment condition that encourages mosquito breeding easily [13].

The *Ae. aegypti* mosquitoes preferred to choose egg-laying places in a very specific habitat, which was influenced by container base material. The types of basic ingredients containers attracting the vector laid their eggs (oviposition) were cement, metal, soil, ceramics, and plastic as a breeding site of vectors. Cement based material is easily to be mossy, has rough surface and porous [14].This condition caused vector to prefer laying their eggs.

Physical environment such as temperature and humidity determined the life of *Ae. aegypti*. Tolerance to ambient temperature depends on mosquito species and geographical location such as tropical, sub-tropical, equator, and cold regions [5]. The optimal temperature for mosquito to grow and breed is in the range of 25^0C-35^0C [10]. The finding revealed that the air temperature in Tembalang sub-district is in the range of 27.8^0C-35^0C. In high humidity, mosquitoes generally live longer and spread faster, and they can survive at 60%-80% humidity [5]. Although the humidity in the study area was lower than 60%, *Ae. aegypti* identified adapted well to less than 60% humidity.

4. Conclusion

Ae. aegypti in Tembalang sub-district Semarang has a high capacity as a vector based on bionomic and biologic characteristics. Environmental factors, both related to the physical and social environment, strongly support the development of *Ae. aegypti*. Low community behaviour in eliminating mosquito breeding sites and temperature, humidity is a factor related to mosquito density in Tembalang District, Semarang. The high number of dengue cases in Tembalang District tends to be related to vector density based on the Container Index (CI) parameter.

5. References

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