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Research Report

INCIDENCE OF DENGUE HEMORRHAGIC FEVER (DHF) IN SEMARANG COASTAL AREA: EPIDEMIOLOGY DESCRIPTIVE CASE AND BIONOMIC VECTOR

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ABSTRACT

Semarang Utara sub-district is located on the coast of the Java Sea. The coastal area is characterized by high salt content on both the ground and the water compare to other areas. The high salt content environment should have limited the breeding of Dengue Hemorrhagic Fever (DHF) vectors; yet, quite high incidents of DHF cases are reported taken place in Semarang coastal area. The aim of this study was to describe the epidemiology of DHF incidence, characteristic of cases, and bionomics vector in the coastal area of Semarang Utara sub-district. This study was applied descriptive observational design to analyze samples consisting of 62 dengue cases and 184 houses. The research variables consisted of coordinate of DHF cases, water salinity, House Index (HI), Container Index (CI), and Aedes species. Data were processed using SPSS in a bivariate manner; while, mapping was analyzed spatially using ArcGIS 10.3. A total of 184 houses were surveyed and 55 cases of DHF were identified. Most cases occurred in 6 -16 year age group (47.3%), water salinity ranged from 2-3%, indicating that the water in the coastal area tended to be brackish water. The results of the Pearson Correlation test showed that there was no relationship between HI and Incidence of DHF in Semarang Utara sub-district. Aedes aegypti was identified in a positive container, otherwise Aedes albopictus was not found. DHF cases mostly occurred in school age groups, and were distributed in all villages near or far from the beach. DHF vector could breed in areas with little brackish water, so that dengue transmission might occur in this area.

Keywords: *DHF, Aedes Aegypti, Aedes Albopictus, Bionomic Vector, Semarang Beach*

ABSTRAK

Kecamatan Semarang Utara terletak di pantai Laut Jawa. Kondisi daerah pantai dicirikan dengan kandungan garam baik di tanah dan air menjadi lebih tinggi dibandingkan area lain. Lingkungan dengan kadar garam yang tinggi dapat membatasi perkembangbiakan dari vektor Demam Berdarah Dengue (DBD), namun laporan kasus DBD di wilayah pantai Semarang selalu ada dengan insiden yang cukup tinggi. Penelitian ini bertujuan untuk mendeskripsikan epidemiologi kejadian DBD di wilayah pesisir Kecamatan Semarang Utara, karakteristik responden serta vektor bionomik. Penelitian ini menggunakan desain deskriptif observasional. Sampel penelitian sebanyak 62 kasus DBD dan 184 rumah sekitar kasus. Variabel penelitian meliputi koordinat kasus DBD, salinitas air, House Index (HI), Container Index (CI) dan spesies Aedes. Data diolah menggunakan SPSS secara bivariat, sedangkan pemetaan dianalisis spasial menggunakan ArcGis 10.3. Sebanyak 55 kasus DBD teridentifikasi dan 184 rumah telah disurvei. Sebagian besar kasus dalam kelompok usia 6-16 tahun (47,3%). Salinitas air berkisar 2-3 ‰, tingkat salinitas ini menunjukkan air di wilayah pantai cenderung dikategorikan air payau. Hasil uji Pearson Correlation menunjukkan tidak ada hubungan antara HI dengan Incidence Rate (IR) DBD di Kecamatan Semarang Utara. Aedes aegypti teridentifikasi dalam kontainer yang positif sebaliknya tidak ditemukan Aedes albopictus. Kasus DBD sebagian besar terjadi pada kelompok usia sekolah, dan terdistribusi di semua kelurahan baik dekat atau jauh dari pantai. Vektor DBD dapat berkembangbiak di wilayah yang airnya sedikit payau, sehingga penularan DBD dapat terjadi di wilayah ini.

Kata kunci: *DBD, Aedes Aegypti, Aedes Albopictus, Bionomik vector, Pantai Semarang*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a disease caused by dengue virus and can be transmitted through the bite of *Aedes aegypti* or *Aedes albopictus* mosquitoes.[1] Factors that play an important role in the transmission of dengue virus infection are humans, intermediary vectors, and environment.[1] In addition, factors of population density, rainfall, humidity, wind speed, air temperature, and altitude can also affect the rapid spread of dengue transmission.[2]

DHF is a contagious disease that becomes a health problem in the city of Semarang. Based on the health profile data of Semarang City, the incidence of dengue fever in Semarang City tends to be fluctuated with high numbers. The incidence of DHF in Semarang City decreased to 18.14 per 100,000 population[3,4,5,6,7] in 2016 and 2017 due to the changes in the operational definition of dengue cases as of October 1, 2016. Currently, DHF case is defined as a case with dengue fever (DF) symptoms followed by an increase in hematocrit š 20% without taking into account the results of serological examination.[7] However, these conditions do not eliminate the risk of dengue disease occurrence in the city of Semarang because of the population of DHF vector, *Ae. aegypti*, still not fully maintained and controlled.

Ae. aegypti mosquito is the main vector of dengue disease. Theoretically, *Ae. aegypti* mosquitoes reproduce in clear water that does not touch soil. However, the results of recent studies suggest that the *Ae. aegypti* larvae are able to survive in the clear water from precipitated water in the ditch.[8] In addition, the growth of *Ae. aegypti* also depends on the chemical conditions of the environment. *Ae. aegypti mosquitoes* can survive in containers containing water with normal pH ranging from 5.8 to 8.6 and water with salinity concentration of 0-0.7%.

The most recent research conducted in Brazil was showed that *Ae. aegypti* is able to adapt to certain salinity conditions in littoral, coastal, and highland areas.[9] Meanwhile, data generated from experimental studies in Semarang City was showed that *Ae. aegypti* can develop both in various water pH conditions from pH 4 to pH 10 and in water salinity ranging from 0% to 6%.[8]

North Semarang sub-district, one of the areas in Semarang City lying on the coast of the Java Sea, has high salt content in both soil and water compare to other regions. This condition should have made Semarang Utara sub-district free from DHF endemic because high Na Cl concentrations resulted in an imbalance between larval body fluid and medium brood fluid. The difference in osmosis pressure causes the mortality of larvae on Instar II.[8] However, data from the Semarang City Health Office showed that some villages in the Semarang Utara sub-district have been categorized as DHF endemic areas.

North Semarang sub-district borders with the Java Sea in the north, with Semarang Tengah sub-district in the south, with Semarang Timur sub-district in the east, and with Semarang Barat sub-district in the west. Semarang Utara sub-district consists of 9 villages, 89 sub villages, and 708 neighborhoods. Within 10.9 km^2, in 2014, the population density was 11,272 per million, and the number of household was 32,000 each of which had 4 family members, even one house might dwell more than one households; one of the most populated are in Semarang.

Given this situation, research needs to be done to describe epidemiological conditions of the incidence of DHF from the perspective of the characteristics of the people, of the place, and of the time. The characteristic of the people was described by age, occupation, and history of the patient's activity before being diagnosed to be exposed to DHF. Meanwhile, as environmental factors are important to detect the presence of DHF vectors, vector density was observed. In addition, the characteristic of the time studied was related to climate at the time the DHF occurred in patients. Therefore, the aim of this study was to describe the epidemiology of the incidence of DHF in the coastal area of Semarang, based on characteristic and behavior of cases, also bionomic of the vector.

METHOD AND MATERIAL

This study took place in the coastal area in Semarang Utara sub-district of Central Java Province and was conducted in 2017. The population was those who exposed to DHF and Dengue Shock Syndrome (DSS) as many as 62 patients. Total sampling method was used to describe the Semarang Utara sub-district.

As this study described the epidemiological conditions of the incidence of dengue in the Semarang Utara sub-district, larvae survey was used to determine the density of vectors in a particular region. The number of houses surveyed was calculated using purposive sampling method.

The theory used to determine the number of houses was within the mosquito fly distance is ± 100 meters; therefore, it was estimated that mosquitoes could transmit the dengue virus at a radius of 100 meters around the sufferer. As a result, surveyed larvae was carried out on 4 houses around the patient's home, either from the North, East, West, or south and the number of houses to be surveyed was 248 houses. The cases of DHF was diagnosed by medical team in hospital and supported by clinical laboratory test.

Research variables measured in this study were age, occupation, illness history, behavior to eradicating mosquitoes nest (EMN), type of mosquito breeding place, water source, container location, water salinity, distance from the shoreline, Water salinity was measured by refracto meter equipment. House Index (HI), as well as Container Index (CI). HI is a percentage of houses identified positive larvae per total of examined houses. CI is a percentage of containers identified positive larvae per total of examined containers.

Bivariate analysis was carried out in testing HI; while, Pearson/Rank Spearman correlation test was used to test the incidence of DHF, all of which were analyzed using ArcGIS version 10.3 software. The data analyzed was exhibited the

coordinates of DHF cases and HI as well as the urban CI where the cases were located. Furthermore, the distance of the house of dengue cases to the North Semarang coastline were also described.

RESULT AND DISCUSSION

The incidence of DHF in the Coastal Area of North Semarang Sub-District

Semarang City Health Office reported 62 cases to be diagnosed both DHF and DSS in Semarang Utara sub-district in 2017. In the field, 55 cases of DHF were found; while, 7 other cases were not found as the sufferers had been moved to another place.

Table 1. Characteristics of DHF cases in north semarang sub-district in 2017

Characteristics	Frequency (n= 55)	Percentage (%)
1. Age (year)		
a. 1-4	7	12.7
b. 5-9	10	18.2
c. 10-14	14	25.5
d. 15-44	17	30.9
e. > 45	7	12.7
2. Occupation		
a. Jobless	40	72.7
b. Labor	1	1.8
c. Trader	9	9
d. Retired/Housewife	5	9.1
3. Education		
a. Not yet school	11	20
b. Not finish Elementary School	1	1.8
c. Elementary School	23	41.8
d. Secondary School	8	14.5
e. High School/ Vocational High School	8	14.5
f. University	4	7.3
4. Home distance from coastline		
a. ≤ 100 meter	5	9.1
a. > 100 meter	50	90.9

Based on Table 1. DHF cases in Semarang Utara sub-district were exposed to people aged from 2 years to 88 years, with the most age being 11 years (9.1%). The largest age group exposed (30.9%) is the age group of 15-44 years. As many as 72.7% of the people suffering from dengue cases in Semarang Utara sub-district have not worked, 41.8% complete elementary schools or are taking elementary education.

Case history of DHF was obtained through an in-depth interview to 55 respondents of the DHF patients or their family using open questions about activities carried out by DHF patients before being diagnosed with DHF. The result of the interview was showed that there were patients carrying out activities outside Semarang Utara sub-district before being diagnosed with DHF, whether they were traveling outside the district or out of town more than two days. In addition, there were patients who mostly spend their daily activities outside the Semarang Utara sub-district due to work or school. The fact also was showed that there were school-age who previously did not exposed to; yet, after being contacted with their friends who suffered from DHF, they started to be infected. From the distance of the house to coastline, 5 sufferers' houses were standing right to the coastline. In general, the distance of the house to the coastline ranging from 0 meter to 2,844 meters with 1,311.42 meters in average.

Behavior to Eradicating Mosquito Nests (PSN) in North Semarang Sub-District

To find out the behavior to eradicating mosquito nests (PSN), interviews were conducted with 55 respondents whose families were DHF sufferers.

Table 2. Behavior of Eradicating Mosquito Nests (PSN)

Behavior	Yes	Percentage (%)	No	Percentage (%)
Covering water container inside the house	9	16.4	46	83.6
Covering water container outside the house	49	89.1	6	10.9
Routinely draining water container	41	74.5	14	25.5
Brushing water container	25	45.5	30	54.5
Disposing of used goods	47	85.5	8	14.5
Recycling of used goods	5	9.1	50	90.9
Using insect repellent	47	85.5	8	14.5
Using bed nets	29	52.7	26	47.3
Using abate powder	8	14.5	47	85.5
Maintaining fish larvae eaters	8	14.5	47	85.5
Window/ventilation	45	81.8	10	18.2
Enough lighting	31	56.4	24	43.6
Hanging clothes	23	41.8	32	58.2
Another family hung clothes	23	41.8	32	58.2

Based on Table 2, the results of the interview showed that 90.9% of respondents did not recycle used goods, and 85.5% did not use abate powder. These habits might increase the risk of dengue vector mosquitoes to explode.

Most of the water container was made from plastic (41.8% respondents), and 61.8% respondents used non-tap water; instead, they are used water from deep well water, dug well water, and supplied water from Tanah Mas housing complex. As much as 50.9% of the water samples taken contained 2 % salt which was categorized as brackish water (the category of water according to the salt content in a row, namely water < 0.5 -; 0.5-30 %; and > 30 % is fresh water, brackish water, and salt water).[10]

Table 3. Characteristics and conditions of water container

Characteristic	Frequency	Percentage (%)
1. Container Material (n=55)		
· Plastic	23	41.8
· Ceramic	20	36.4
· Cement	12	21.8
2. Water Source (n=55)		
· Non Tap Water	34	61.8
· Tap Water	21	38.2
3. Salinity (n=5)		
· 0 ‰	11	20.0
· 1 ‰	28	50.9
· 2 ‰	13	23.6
· 3 ‰	3	5.5
4. *House Index* (n=184)		
· Low (HI < 10%)	6 villages	
· High (HI ≥ 10%)	3 villages	
5. *Container Index*		
· Low (CI < 5%)	6 villages	
· High (CI ≥ 5%)	3 villages	

Based on Table 3, to determine the density of dengue mosquito vector in each village in North Semarang sub-district, 184 houses scattered in all villages were surveyed. The results of HI and CI were grouped into high and low categories according to WHO provisions.[11,12] There were 3 villages with low HI and CI namely Bulu Lor, Plombokan, and Purwosari Villages; while, the other 6 villages had high HI and CI, namely Tanjungmas, Dadapsari, Kuningan, Bandarharjo, Panggung Kidul, and Panggung Lor.

Figure 1 shows villages with the value of the container index (CI) in each village in the sub-district of North Semarang. There are 3 villages with CI in the low category (CI < 5%), namely Bulu Lor, Plombokan, and Purwosari; while, the other 6 villages have high category of CI values (≥ 5% CI), namely Tanjungmas, Dadapsari, Kuningan, Bandarharjo, Panggung Kidul, and Panggung Lor.

Figure 1 shows villages with the value of the container index (CI) and HI in each village in the sub-district of Semarang Utara. There are 3 villages with CI in the low category (CI < 5%), namely Bulu Lor, Plombokan, and Purwosari; while, the other 6 villages have high category of CI values (≥ 5% CI), namely Tanjungmas, Dadapsari, Kuningan, Bandarharjo, Panggung Kidul, and Panggung Lor.

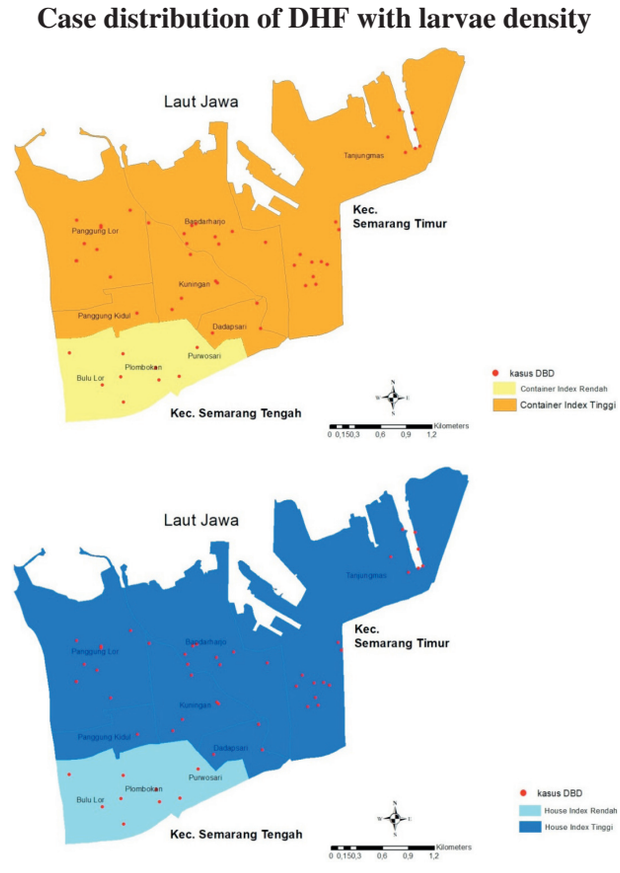

Figure 1. HI, CI, and dengue cases in North Semarang Sub-district

DISCUSSION

There were five homes of DHF sufferers in North Semarang Sub-district standing right on the coastline. Of the five houses, two houses were identified to be positive for having mosquito larvae. The closer distance between the house and the beach allows the mixing of ground water with seawater to make the region's water source brackish.[14] If the salt content of a water source is high, mosquito larvae will not be able to develop.[11,15] However, the fact showed that mosquito larvae were found in that region. After analyzing the salt content using refractometer, it was found that the salinity ranged from 2-3 ‰. Water is categorized as brackish water if it exceeds 0.5‰, so it can be concluded that the *Ae. aegypti* mosquito could live in brackish water.[11,15]

Other research finding reported that there was a significant change in ion transportation by anal papillae of the mosquito larvae living in the salt water.[16,17] The morphological and physiological changing showed that *Aedes aegypti* mosquito had been able to adapt to the

changing environment of the breeding place, especially the one having high content of salt.

Through in-depth interviews, it was identified that the water source used by residents in Tanjungmas area came from 1-2 main sources channeled by pipes to homes. The deep well water source was used by most of the residents. Water from the deep well should not have had salt or fresh water. However, in reality there had been a change in the quality of fresh groundwater to brackish in deep wells in the North Semarang region. This phenomenon was related to seawater intrusion or ancient salt dissolution trapped in sediment when rock sedimentation took place.[14]

Increased levels of seawater could increase the number of mosquitoes tolerant to salt content and allow mosquito vectors adaptation that were not tolerant to salt content to be tolerant to brackish water. This explained the increase in dengue cases in the coastal areas. The increased population living in the coastal area is predicted to be 134 people/ km^2 by 2050.[11,15,18] Therefore, if the control of vectors in coastal areas was not implemented properly, there would be an increase in dengue cases in that particular areas. An area is considered to be at high risk for dengue transmission if the container index is š 5% and the house index is š 10%,[19] based on which villages of Tanjungmas, Dadapsari, Kuningan, Bandarharjo, Panggung Kidul dan Panggung Lor were at high risk to DHF spreading. As shown in Figure 1, there was a tendency for DHF cases to be in the villages with high HI and CI. However, the results of the correlation test showed that the HI value did not correlate to the incidence of DHF in North Semarang sub-district. This proved that the HI value was not the main risk factor for the spread of DHF in the North Semarang sub-district. This finding was in line with the research result conducted in Sendangmulyo village of Semarang city.[20]

The interviews with patients concluded that the patients were infected with DHF after traveling outside the sub-district. Therefore, the spread of DHF in North Semarang sub-district did not originally come from inside of the sub-district but also from outside of the sub-district area; therefore, the high and low HI values did not affect the incidence of DHF.

CONCLUSION

DHF cases in the coastal areas of North Semarang occur in all villages areas both in and off the coast. DHF cases mostly occur in the 6-16 years age group, namely school age. The incidence of DHF is not related to monthly rainfall. The distribution of dengue cases in the North Semarang Sub-district is not related to high population density, House Index, and Container Index.

Aedes aegypti can live and breed in the coastal areas; even though, the water sources used show higher salt content or tend to be brackish. No *Aedes albopictus* is found at the coastal location. Survival *Aedes aegypti* can affect the transmission of DHF in the coastal areas of North Semarang. No exception in controlling DHF and its vector, coastal communities also need to carry out actively in PSN activities in their area.

CONFLICT OF INTEREST

There is no conflict of interest occurred in this study, both among researchers, and communities. This research has obtained permission from the Kesbangpolinmas office, the Health Office, as well as the sub-district to RT units to carry out the research. Respondents involved in the interview were provided informed consent to get their approval.

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