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Prevention of Dengue Hemorrhagic Fever (DHF) Associated with the *Aedes aegypti* Larvae Presence based on the Type of Water Source

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ABSTRACT

Aedes aegypti as the vector of Dengue Hemorrhagic Fever (DHF) disease likes to breed in the water containers. The larvae of *A. aegypti* mostly found in the bath water containers. The presence of *A. aegypti* larvae could be caused by the type of water source, the container's color, material, location, lid existence and the container's drain frequency. This study aimed to determine the association of water source type with larvae presence and the additional factors. This study used observational analytic with case control design. The case group consisted of households were using well water and the control group consisted of households were using tap water with a sample size of 130 households for each group. The sample collected by proportional random sampling in five villages. The data were analyzed by regression logistic test. The significant variables which associated with the presence of larvae were the water source type (OR = 1.923), container's color (OR = 2.345), container's location (OR = 2.241), container's lid existence (OR = 2.122) and the container's drain frequency (OR = 2.260). This study did not consider the significant association of the container's material. The dominant variable associated with the presence of larvae was the container's drain frequency which was controlled by the water source type, container's color and container's location.

Keywords: *Aedes aegypti, larvae, water source, containers*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a mosquito-borne disease caused by one of the four serotypes dengue viruses. These viruses are transmitted from person to person by *Aedes aegypti*. The disease has become a serious public health problem in the world because it has caused death and epidemic, especially in Asia [1-2]. Indonesia is one of the countries in Asia with the highest DHF incidence and mortality that has increased year by year [2].

Case Fatality Rate (CFR) of DHF in Indonesia was 0.86% in 2012 and decreased in 2013 (CFR = 0.77%). However, DHF cases increased again in 2014 (CFR = 0.90%). It was even higher than in 2012 [3, 4, 5]. One of the provinces in Indonesia, with increased cases of DHF and became an outbreak in 2015 is South Kalimantan [6].

Banjar district is a region in South Kalimantan, where in 2015 the cases of DHF increased more than 10 times compared to those in 2014. Banjar district has 23 public health centers and 11 of them are endemic areas of DHF (47.8%). An endemic area with the highest cases is Martapura public health center. It includes 5 villages, which are Tanjung Rema Darat, Sekumpul, Sungai Paring, Indrasari and Tanjung Rema [7].

DHF control is primarily dependent on the control of *A. aegypti*, since no vaccine is yet available for the prevention of dengue infection and there are no specific drugs for its treatment. The most effective of vector control is environmental management, which includes planning, organizing, carrying out, and monitoring activities. From this point of view, it is very important to know the suitable environment for the vector. It is well known, that the live of the larvae vector depends on wa-

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ter quality [8]. Which is one important factor that is a determinant of life in the water. It is determined by observations of various physical and chemical parameters [9].

A research by Gisela, et al. [10] concluded that the water quality can affect the laying of eggs by the mosquito of *A. aegypti*. The mosquito's eggs will develop under conditions suitable with water characteristics. In addition, organic materials, microbial and water insect community contained in the water of breeding sites (container) also affects the life cycle of *A. aegypti* [11].

The quality and content of the breeding place cannot be separated from the water source. Based on the preliminary study on 10 houses in the district of Martapura, it is known that most people use well water (85.2%) and only 14.8% water from taps. The result of a research by Upik, et al [12] showed that there are no significant differences related to pH, salinity and temperature between well water and tap water. However, the content of chlorine in tap water possibly tends to be higher because it has passed through the disinfection process or water treatment.

The results of larvae survey in 10 households using well water showed that 6 houses were found to have larvae (60%). In addition, from the survey of larvae presence in 10 households using tap water source, it is known that only 2 houses were found to have larvae (20%). The results showed that the larvae are more common in well water rather than tap water source.

The existence of larvae can also be influenced by the characteristics of container, including color, materials, position and lid existence. Besides those factors, the frequency of drain container can also affect the existence of larvae [13, 12, 14]. Martapura health center is an endemic area of DHF. It is thought to be related to factors associated with the presence of larvae but no studies have examined it.

MATERIALS AND METHODS

Study design

This study used an analytical observational with the case control approach. The case group consisted of households using well water and the control group consisted of households using tap water.

Sample size and sampling technique

The sample sizes in this study includes two groups of about 260 households, 130 households in each group. The households were obtained from five villages with the highest incidence of DHF in Martapura sub-district. They were Tanjung Rema Darat, Sekumpul, Sungai Paring, Indrasari and Tanjung Rema. Sampling technique used proportional random sampling to represent for each villages.

Data collection

Observations were conducted to obtain the data of larvae existence, container's color, materials, location and lid existence. The category result for larvae existence was found or not found, for container's color was dark or bright, for materials were consist of cement, ceramics, plastic or metal. The category result for location of the container was in inside or outside the house and for the lid existence was available or not available.

Interviews were conducted directly to the homeowners about the source of water type and the container's drain frequency. The water source type category is well water or tap water and the drain frequency is once in > 7 days and once in ≤ 7 days.

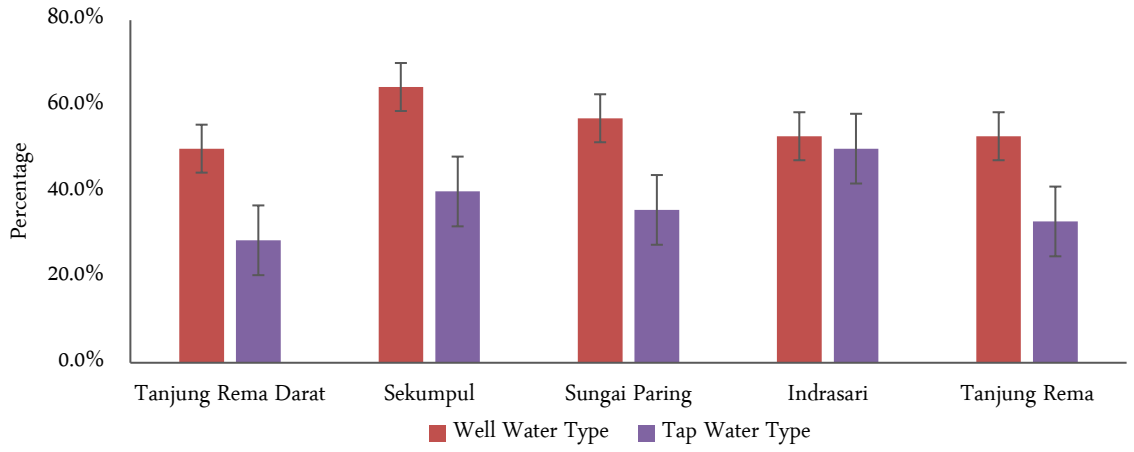

Figure 1. Observation result of larvae existence in well water and tap water for each village

Statistical analysis

The data was analyzed using a chi-square test for the association of containers characteristics to larvae presence (bivariate analysis) and a regression logistic test to identify the factors which where dominantly associated with the larvae presence (multivariate analysis).

RESULTS AND DISCUSSION

In this study, the observation result found that in the 260 household's bath water containers, larvae were found in a total of 123 households (47.3%). Among the households where larvae were found, 72 households (58.5%) were using well water and all the observed villages showed that larvae presence was more common in the well water type (Figure 1).

The well water is preferred by mosquitoes as breeding places because the quality of well water generally is very suitable for the development of mosquito larvae and pupae. Most of the quality of well water is relatively clear, low salinity, and the pH is at approximately neutral level, which ranges from pH 6.9 to 8.0 and also generally it contains many microbes and other microscopic organisms as a major food source for the larvae [15].

The results of this study are consistent with the results of Damanik's research [16] which mentions that the larvae are most commonly found in well water (averagely 68.89 larvae) and only a few are found in tap water (averagely 12.67 larvae). According to Adifian [17], the adaptability of *A. aegypti* mosquitoes to breed in the water wells is 16.54% in the larva stage and 33.32% in the pupa stage. This is because the well water containing the appropriate parameters and organic compounds to breed

Fewer larvae are found in tap water because it has been through the process of water treatment such as added chlorine, alum, or other chemicals so that mosquito eggs cannot develop [15]. The content of chlorine in the tap water could be expected to eliminate the presence of larvae. This is because chlorine can kill microorganisms contained in the water and cause the unavailability of food for larvae. The purpose of water chlorination is to destroy the bacteria through germicidal chlorine [18].

The addition of chlorine in the water can also affect the content of water quality such as pH. The addition of sodium hypochlorite will increase the alkalinity of the water so that the pH will be higher. Besides, Calcium Hypochlorite will raise the pH and total hardness of wa ter [18].

Each container was also described based on their characteristics. The characteristics were including the color, location, lid existence, materials and its drain frequency (Table 1).

Table 1. The bath water containers characteristics

Bath water containers characteristics	Frequency	%
Larvae existence		
Found	123	47.3
Not Found	137	52.7
Color		
Dark	171	65.8
Light	89	34.2
Material		
Cement	10	3.8
Ceramics	140	53.8
Plastic	108	41.5
Metal	2	0.8
Location		
Inside	201	77.3
Outside	59	22.7
Lid Existence		
Available	211	81.2
Not Available	49	18.8
The Container's Drain Frequency		
once in > 7 d	131	50.4
once in $\leq$ 7 d	129	49.6

A multivariate analysis, logistic regression test, 1st model showed that the lid existence had p-value = 0.052 and should be taken out from the model (Table 3). The result of the 2nd model showed that the bath water container's drain frequency was the most associated factor to the larvae presence (OR = 3.07, 95% CI = 1.763-5.356). It was controlled by another factors, they were the water source type (OR = 2.29, 95% CI = 1.320-3.979), color (OR = 2.36, 95% CI = 1.341-4.139) and location (OR = 2.25, 95% CI = 1.058-4.800) (Table 4).

The larvae presence mostly was found in the dark color of container (54.4%). It indicated that the *A. aegypti* mosquito prefers dark container as a place to breed. Aedes mosquitoes prefer to breed in a dark place because the dark colors can give a sense of security and calmness in mosquitoes during the spawning. Therefore, more eggs are placed in dark-colored containers rather than the light-colored container [19].

These study results are consistent with Upik's research [12], that the larvae are more common in the container unpainted and dark. In addition, according to a study by Budiyanto [13], it is known that there is a

Table 2. Association analysis of bath water container characteristics to the larvae existence

The bath water containers characteristics	*The larvae presence*		*p-value*	*Remarks*
	Found (%)	*Not found (%)*		
Water Source Type				
Well water	55.4	44.6	0.013	Correlated
Tap water	39.2	60.8		
Color				
Dark	54.4	45.6	0.002	Correlated
Light	33.7	66.3		
Material				
Cement	60	40	0.741	Non-
Ceramics	48.6	51.4		Correlated
Plastic	44.4	55.6		
Metal	50	50		
Location				
Inside	51.7	48.3	0.035	Correlated
Outside	32.2	67.8		
Lid Existence				
Available	50.7	49.3	0.034	Correlated
Not Available	32.7	67.3		
The Container's Drain Frequency				
once in >7d	57.3	42.7	0.002	Correlated
once in ≤7d	37.2	62.8		

Table 3. The logistic regression 1st model for association of water bath container's characteristic to larvae presence

The bath water containers characteristics	*p-value*	*Odd Ratio (OR)*	*95% CI*
Water Source Type	0.005	2.215	1.270-3.864
Color	0.003	2.372	1.346-4.181
Location	0.035	2.288	1.062-4.929
Lid Existence	0.052	1.987	0.994-3.973
The Container's Drain Frequency	0.000	3.011	1.720-5.271

Table 4. The logistic regression 2nd model for association of water bath container's characteristic to larvae presence

The bath water containers characteristics	*p-value*	*Odd Ratio (OR)*	*95% CI*
Water Source Type	0.003	2.292	1.320-3.979
Color	0.003	2.356	1.341-4.139
Location	0.035	2.253	1.058-4.800
The Container's Drain Frequency	0.000	3.073	1.763-5.356

significant correlation between the presences of mosquito larvae with the containers color.

Upon the location of bath water containers, larvae mostly found inside of the households (77.3%). This shows that the containers contained inside the house preferable as the *A. aegypti* mosquito breeding place. The results of a research by Setiawan [20], found that the containers are located inside the house has a chance to be found larva 4.74 times compared to the containers which located outside. Budiyanto's research [13] note that most of the containers were found larvae located inside home (92.3%). Moreover, Fauziah's research [21] has shown a significant relationship between the locations of the container with the existence of larva.

Mosquito larvae are found more in the container that was in the house because it is influenced by the condition of the house which darker than the outside. Air tends to damp in the house because the light inten-

sity is less. Mosquitoes feel more secure and calm to lay eggs in moist conditions [22].

The larvae presence mostly found in the bath water container which the lid existence was not available (50.7%). According to a research by Hasyimi [23], one of the causes a container become the breeding place is the lid not exists. Wanti's research [24], found that the containers which containing larvae in endemic areas are mostly containers without lids (71.5%). Mosquitoes are easier to get in and out of containers without lids so that the larvae found more than a sealed container.

The containers drain frequency mostly once in more than 7 days (57.3%). This is because people rarely to drain it to save the water so that eventually become a potential breeding places and increasing the density of larvae. Sukamto's research [25], found that the tub which cleaned in an irregular manner by people can cause A. aegypti mosquitoes lay their eggs and breed freely.

The results of this study cannot prove the association between the base materials of container with the existence of larva. The containers material will determine its surface. A female mosquito prefers to lay their eggs in containers with a rough surface. But these results indicate that the containers are made of cement, ceramic, plastic or metal can still be found larvae. The existence of these larvae may be due to other factors associated among other sources of water, the color of the container, location, availability and frequency of draining the container lid.

This study has shown a significant relationship between the frequency of draining water reservoirs with the existence of larva with OR = 3.07 (p-value = 0.000). This shows that the containers are drained once in more than 7 days have an opportunity 3.07 times higher than the container discovered larvae were drained once in less than or equal to 7 days. The result of Setiawan's research [20], that there is a significant correlation between the drain frequencies of the container with the existence of larva.

CONCLUSION

The dominant variable associated with the presence of larvae was the container's drain frequency which was controlled by the water source type, container's color and container's location, so it is suggested to have a regular cleaning of the containers at least once in a week and the use of the containers should not be in potential characteristics to become the mosquitoes breeding site. As in water bath container should be in light color and placed near a window or a place exposed to direct sunlight, and given the lid so that mosquitoes could not get in to breed.

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