Factors related to dengue hemorrhagic fever incidence in Kadipiro, Surakarta, Indonesia

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Abstract

Background: Dengue hemorrhagic fever (DHF) has been an outbreak in Kadipiro village, Surakarta, Indonesia, for the last couple of years. Factors related to this incident are required to be understood in order to prevent mosquito presence and dengue transmission. Aims: The research aimed to identify the relationship between types of mosquito breeding sites, knowledge about mosquito breeding site control, and house environment with an incidence of DHF in Kadipiro village. Settings and Design: This study was analytical observational research with a cross-sectional approach. The number of samples was 195 houses selected using a stratified random sampling. Methods and Material: The data were collected through observation of mosquito breeding sites and house environment whereas interviews to understand the knowledge about mosquito breeding site control and DHF incident on each houses for the last year. Statistical analysis used: The data were then analyzed with a chi-square test at a 95% Confidence Level and logistic regression test. Results: The results showed that the larvae density in the village was high, with HI=58.9%, CI=10.91%, BI=87.69%, and ABJ=41.02%. The types of mosquito breeding sites had no relationship with the DHF incidence (p=0.105), however DHF incidence was related to knowledge about mosquito breeding site control (p=0.03, OR=0.223, 95%CI=0.057-0.865), and house environment (p=0.018, OR=1.924, 95%CI=1.120-3.304). Conclusions: Knowledge about mosquito breeding site control is a protective factor that prevents the DHF incidence (0.2 times) and house environment that is close to perennial may increase the risk of DHF incidence (1.9 times).
Keywords: Dengue Hemorrhagic Fever incidence, mosquito breeding sites, knowledge about mosquito control, environmental conditions.

Key Messages:

Factors related to Dengue Hemorrhagic Fever incidence are required to be understood. This study concluded that knowledge about mosquito breeding site control is a protective factor that prevents the DHF incidence (0.2 times) and house environment that is close to perennial may increase the risk of DHF incidence (1.9 times).

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Introduction

Dengue Hemorrhagic Fever (DHF) is a global public health problem. It is an infectious disease through the bite of the Aedes aegypti or Aedes albopictus mosquitoes. In almost countries, it is an endemic disease, especially in tropical and subtropical countries, such as Africa, America, the East Mediterranean, Southeast Asia, and the West Pacific. Approximately 3.9 billion people are at risk of dengue infection [1]. In Indonesia, in 2017, 493 deaths occurred due to the DHF disease. The Central Java province had the 3rd highest cases, about 7,400 cases. Specifically, Surakarta city had a high number of DHF cases as many as 146 people infected, with an DHF incidence rate (IR) of 26.1 per 100,000 population and case fatality rate (CFR) >1% in 2017. This IR and CFR were categorized high [2].

Surakarta City is an endemic area for DHF. In Banjarsari district, 146 cases of dengue fever were found in 2017, with the morbidity rate (IR) of 26.1 per 100,000 population [3]. Lately, in 2019, there were 7 DHF cases identified in Kadipiro village. The data suggest that the DHF is still a problem that needs to be addressed. In respond to the absence of vaccinations and effective drugs for dengue virus, dengue fever control and prevention are still focused on reducing the mosquito population [4]. Aedes albopictus and Aedes aegypti are the vectors that transmit the dengue virus. Ae.albopictus originating from East Asia and the Pacific island spreads out to all countries except Antarctica. Ae. albopictus or Asian tiger mosquito is the most invasive insect species globally with a substantial biting activity and high potential of disease vector [5]. Types of mosquito breeding sites, a lack of knowledge, and environmental conditions may cause a high population of the vectors and increase dengue fever risks. The most potential breeding site is water storage (container) used for daily needs such as baths, drums, barrels/ jars, and others. Flower vases, decorative plant pots, rubbish, used bottles, used cans, and other unused items are a potential place for Aedes spp breeding. Mosquitoes generally live in dark, wide open areas unexposed to direct sunlight.

Kadipiro village, located in Banjarsari district Surakarta, is a lowland with relatively high rainfall and is one of the endemic areas for DHF. Due to weather, environmental factors are also considered affecting dengue transmission, especially the neighboring environment. Physical, biological, and social environments support mosquitoes to reproduce (Sarfraz et al., 2012). Many factors influence dengue
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fever in some areas; understanding the factors will help the DHF transmission controlled. Factors that influence DHF incidences are the changing and reproducible vector population and house environment condition. Therefore, this study aimed to understand better environmental factors related to the DHF incidence in Kadipiro, Surakarta.

Subjects and Methods

This study was analytical observational research with a cross-sectional approach, conducted in Kadipiro village, Surakarta, Indonesia. The population was all houses in Kadipiro village. A stratified random sampling was performed to select 195 houses as samples. Each house represented an occupant who had DHF history or had not DHF history. Questionnaires were distributed to collect data on respondents’ knowledge about mosquito control (draining and closing water reservoirs and burying rubbish), and DHF history. An observational form was used to record mosquito larva indices, types of mosquito breeding sites (water buckets, water tubs, water drums, bird water cups, rubbish, clay water jars, flower vases, dispensers, refrigerator water drops), and house environment (attached to each other, close to perennial, close to open drainage, close to a river).

The larval density index was measured through breeding sites observation to understand the current situation. The measured index included House Index (HI: the percentage of infested houses per a number of inspected houses), Container Index (CI: the percentage of infested containers per a number of inspected containers), and Breteau Indice (BI: the percentage of infested containers per a number of inspected houses). The independent variables were types of mosquito breeding sites (Water bucket, water drum, water tub, bird water cup, rubbish, clay water jar, flower vase, dispenser, and refrigerator), knowledge about mosquito breeding sites control (draining a water tank, closing a water tank, and burying used goods) and house environment (attached house, house close to perennial areas, open drainage, and a river). The dependent variable was the DHF incidence in Kadipiro village. The data were then analyzed using a Chi-square test at a 95% Confidence Interval level and logistic regression test.

Results

Kadipiro village is one of the working areas of the Primary Healthcare Center of Gambirsari, Surakarta city, Indonesia. There were 23,268 people or 6,000 families in this village. The average village temperature was 30°C. The larval density observation from 195 houses and 1,562 containers observed showed a high of larval density with HI of 58.97%, CI of 10.91%, and BI of 87.69%. Regarding the score of HI and BI, the Density Figure (DF) was 7, which was relatively high. Most of the larvae lived in the open water buckets and water tubs to collect waters.
There were 115 houses with a larva infestation of 195 houses, and 171 infested containers were found out of 1,567 containers. Based on Fig.1, the highest infested containers were buckets (323) and water drums (296). The water buckets had an infestation rate of about 16%, but the dispenser had the highest infestation rate (22%) while the water tub was the second highest infested containers (19%).

Types of mosquito breeding sites did not correlate with the DHF incidence in Kadipiro village (p=0.105). Although water buckets and water tub had the highest number of infested containers, the number of DHF incidence showed no statistical difference.

As shown in Table 1, 152 people with a good knowledge about mosquito breeding sites control, had no family members with a DHF history. Five people had insufficient knowledge and members who had a DHF history. Statistically, there was a correlation between knowledge about mosquitoes

<table>
<thead>
<tr>
<th>Mosquito control knowledge</th>
<th>DHF incidence</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non DHF patients</td>
<td>DHF patients</td>
<td>N</td>
</tr>
<tr>
<td>High</td>
<td>152</td>
<td>96.2%</td>
<td>6</td>
</tr>
<tr>
<td>Low</td>
<td>32</td>
<td>86.5%</td>
<td>5</td>
</tr>
</tbody>
</table>

OR=0.223 95%CI=0.057-0.865
breeding site control and DHF incidence (p=0.03; OR=0.223; 95%CI=0.057-0.865). Family members with good knowledge about mosquito control were 0.223 times at risk of exposure to DHF infection. Good knowledge is supposed to protect them from the DHF infection.

Table 2. Correlation between house condition and DHF incidence

<table>
<thead>
<tr>
<th>House Environment</th>
<th>DHF Incidence</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non DHF patients</td>
<td>DHF patients</td>
<td></td>
</tr>
<tr>
<td>Attached house</td>
<td>N</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Close to perennial</td>
<td>130</td>
<td>97.7%</td>
<td>3</td>
</tr>
<tr>
<td>Close to open drainage</td>
<td>33</td>
<td>86.8%</td>
<td>5</td>
</tr>
<tr>
<td>Close to river</td>
<td>18</td>
<td>90%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>75%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>OR= 1.924</td>
<td>95%CI= 1.120 – 3.304</td>
<td></td>
</tr>
</tbody>
</table>

House environment was significantly correlated with the DHF incidence (p=0.018; OR=1.924;95%CI= 1.120–3.304). Table 2 shows five families whose houses were close to perennial areas had the DHF incidence. On the other hand, the lowest DHF incidence happened to families living near a river. Houses close to perennial areas are likely to have a greater risk of exposure to the DHF disease at 1.924 times.

Discussion

Mosquito larval density in Kadipiro village, Surakarta

The larva index (HI) shows that the Aedes sp larval density was higher than that obtained by the Indonesian Ministry of Health (HI<5%). The mosquito population has been estimated by many researchers using dengue index, such as House Index (HI), Container Index (CI), and Breteau Index (BI), to predict their relationships with each of the habitat parameters [6]. The observed larval density in Kadipiro sub-district presents that House Index (HI) was 58.9% with a Density Figure (DF) of 7, (high density), Container Index (CI) was 10.91% with a DF of 4 (medium density), and Breteau Index (BI) was 87.69%, with a DF of 7 (high density). Besides, the larval free rate in Kadipiro Village, Surakarta City was 41.1% (100%-HI). The higher the density figure (DF), the higher the risk of vector-borne disease transmission. The larval indices, such as HI, BI, and CI, are considered more qualitative and often used in the Aedes albopictus density assessment of dengue control [7]. BI indicating a relationship between infested containers and observed houses was considered the best to predict dengue fever risks [4]. It is reliable to understand the larval density in an area. On the other hand, Codeco et al.[8] suggest that investigated traps performed better than the HI in measuring mosquito abundance in seasonal variation.

The larval density may contribute to increase adult mosquito population and dengue transmission in the village. The inhabitants should consider breeding site control measures to reduce
its population. The observed containers are suitable breeding sites for *Ae.aegypti*, but further identification of other sites are required. *Ae. albopictus* prefers to breed in a natural and artificial container such as tree holes, bamboo blocks, discarded tires, and mud pots. However, a previous study has indicated that *Ae.albopictus* had low correlation with the larva indices likely due to meteorological factors, average temperature, precipitation, average humidity, and average wind speed [9]. This present study does not discuss adult mosquito density, while previous studies have indicated that the larval indices did not accord one another or with the adult mosquito density [7]. The correlation between larva and adult population may depend on years, seasons, or geographic areas [4]. Nevertheless, controlling measures for removing mosquito breeding sites and adult mosquitoes are necessary to stop dengue fever transmission.

**Correlation between types of mosquito breeding sites and DHF incidence**

This study does not suggest any significant correlation between types of mosquito breeding sites and DHF incidence (p>0.05). Four families with a DHF history had larvae-infested buckets. Most of the residents used buckets as water storage for daily needs; however, they did not close them properly, and most buckets remained unused. Open buckets inside the house were lack of direct sunlight, that potentially become Aedes mosquitoes breeding sites. Houses with low light, high humidity, and close distance to other houses could facilitate mosquito breeding. Beside water bucket, water tub also had a high positive rate (19%) Wang et al.[9] have revealed that tire water tanks had the highest infestation rate (48.34%) and followed by garbage water (47.62%). Water containers, especially water jars, were favorable larval breeding habitats for *Ae.aegypti*. whereas rubbish and plastic containers were considered primary *Ae. alpopictus* breeding sites throughout the dry season [10]. Based on Meena and Choudary [11] study showed that discarded tires were the most preferred microhabitat for *Aedes albopictus* breeding followed by metal pots and mud pots. Typical containers such as clay water jars and rubbish are outside houses also become *Ae. albopictus* breeding sites. *Ae.albopictus* normally breeds in artificial water containers or natural water-holding containers with clean water [12]. In this present study, types of containers had no correlation with the DHF incidence, but knowledge about mosquito breeding site control correlated with the DHF incidence.

**Correlation between knowledge about mosquito breeding site control and DHF incidence**

This study revealed a correlation between knowledge about mosquitoes breeding site control and DHF incidence. Population density, community behavior, climate, community immunity, and others influenced the high HI, CI, BI or DF. This study has shown that the community did not realize the importance of maintaining clean water storage, thereby creating chances for *Aedes aegypti* larvae to reproduce quickly. Seeing this fact, health workers need to optimize the DHF working groups that has been formed. The lack of knowledge about breeding site control is one factor causing the low level of community participation in the implementation of the control program, which includes draining water tubs periodically, closing water containers, and burying rubbish. Therefore, the community with good knowledge will be aware of the control measures for preventing mosquitoes-breeding sites.
Knowledge will be more manifested in behavior, meaning good knowledge will increase the community health status. Educating the community about the measures will affect knowledge, attitudes, and actions, which will raise the community’s awareness of dengue prevention behavior. Vector surveillance for Aedes sp breeding sites has been regulated in most villages; however, not all villages run it well. Constantianus et al. [13] have found a direct relationship between knowledge of dengue prevention and maintaining container practices. Most people think that effort eliminating mosquitoes should be undertaken when mosquito presence cause nuisance or outbreaks, however this perception is opposite to previous studies suggesting that preventing mosquito breeding place is important to avoid DHF transmission. Therefore, health education is a required supplementary program to reduce unexpected outbreak and the mosquito population.

Correlation between house environment and DHF incidence

House environment had a positive correlation with the DHF incidence. The results showed the number of houses close to perennial areas was 38 houses, and five of them had a DHF history on their family members who lived in five of the houses ever had a DHF history (13.2%). Four families lived near a river, and one of them had a DHF history (25%). The number of bamboo perennial areas and shady trees are the most possible place for mosquito breeding. A high-density settlement eases dengue transmission. The closer the distance from one house to another, the easier mosquitoes move and spread. The typical mosquito in the perennial areas is Aedes albopictus. Meena and Choudary [11] have shown that discarded tires were the most dominant microhabitat for Aedes albopictus breeding, and the other sites were metal pots and mud pots. Extensive urbanization can cause the high number of non-biodegradable containers facilitating Aedes albopictus breeding habitat. House environment may increase the risk of the DHF vector contact. This study indicates families who live near a river and perennial areas were 1.9 times higher at risk of DHF incidence.

Ae. albopictus mostly live in natural containers or outdoor artificial habitats containing more organic debris. In contrast, Aedes aegypti favors clean water in domestic containers or near human dwellings [14]. The observed houses were mostly attached to each other (133 houses), of which three had a DHF history (2.2%). Urban areas usually have a dense population, abundant artificial containers, low vegetation, and shades around the buildings [15]. Besides, Yoon et al. [16] have suggested that certain houses with high DENV transmission risks may disproportionately contribute to virus transmission around the neighboring houses, likely due to local human and mosquito movement. Supporting this statement, Tsuda et al. [15] believe that houses built close one another and the roof extended to the neighboring houses were likely to cover outdoor space and have no exposure to direct sunlight. These environmental conditions made outdoor spaces as humid and dark as indoors where female larvae may oviposit.

In this study, perennial vegetation involves banana trees, mango trees, hedgerows, gnetum gnemon trees, and Leucaena trees, typically present in an open area. In recent studies, more significant growth of such vegetation were proven to correlate with the demanding population of Ae.albopictus and Ae.aegypti positively. In line with this study, Anosike et al. [17] have found that woody trees were favorable for Ae. albopictus growth. On the other hand, Sarfraz et al. [18] have
investigated that gasoline stations or workshops, rice paddy, marsh or swamp, and deciduous forests played a significant role in dengue vector growth. The apparent factor of numerous infectious disease was mostly facilitated by environmental factors, such as land-use change or climate [19]. The spatial distribution of vector-borne diseases was likely determined by the vector or geographical characteristics of the reservoir hosts and their habitat preferences [20]; however, the spatial distribution was not investigated in this study. Sarfraz et al. [18] have found a positive correlation between the number of containers infected with dengue and BI in certain months. The steady favorable habitat due to moderate microclimate and breeding sites (leaves, tree trunks, and tree holes) may facilitate Ae.albopictus growth. Deciduous forest, horticulture, and perennial areas that had a strong relationship with dengue indices indicate that they were potential habitats for Aedes [18]. Relative humidity was an important meteorological factor in mosquito life cycle, especially in lowland plains [21]. Typical rivers in Indonesia are also partially full of shady vegetation, and some may be contaminated with rubbish from upstream. More importantly, the stagnant and stuck rubbish on the river bank could be Aedes spp breeding sites. Regardless the significant risks of near-river or near-perennial settlement, managing containers around the areas are likely a plausible way to reduce mosquito breeding sites and decrease the DHF transmission.

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References


