Risk Factors of Dengue Fever Outbreak in Karo District, North Sumatera, Indonesia

Faktor-faktor Risiko Kejadian Luar Biasa Demam Dengue di Kabupaten Karo, Sumatera Utara, Indonesia

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Abstract. Dengue fever (DF) infection continues to present a serious public health problem in North Sumatera, Indonesia. The outbreak was reported in Merek Sub-district, Karo District during April-May 2017. The aim of the study was to conduct an epidemiological investigation in order to identify the risk factors for recommendation of DF control. An observational study with a matched case control design was used. A case group was defined as any resident of Merek sub-district suffering from major clinical symptoms of DF from April – May, 2017 such as fever, severe headache, pain behind eyes, muscle and joint pains, and rash. A control group was defined as neighbors of the patient DF with no clinical signs and symptoms of DF. In addition, an interview was conducted on both case and control groups. Each group was 37 respondents. The age of the case group ranged from 2 year to 37 years (median= 12 years). The multivariate analyses showed that presence of mosquito breeding sites (OR=4.87, 95%CI=1.33-17.85) and habit of hanging worn clothes (OR=5.12, 95%CI=1.25-21.03) were significant risk factors. It is recommended to eliminate mosquito breeding sites routinely and to avoid the habit of hanging worn clothes. In addition, the strict surveillance of DF should be carried out regularly.

Keywords: DF, outbreak, Karo district, case-control study
**Introduction**

Dengue fever (DF) is an arbovirus disease caused by any of four serotypes of dengue virus (DEN-1, DEN-2, DEN-3, DEN-4) transmitted between people via the bite of infected Aedes mosquito.\(^1\)\(^-\)\(^3\)

It is found in tropical and sub-tropical regions, predominantly in urban and semi-urban areas.\(^1\)\(^,\)\(^2\)\(^,\)\(^4\)

Symptoms of infection usually is commenced in the day 4 - 10 days after the mosquito bite and last for 2 - 7 days.\(^1\)\(^,\)\(^3\)\(^,\)\(^4\) Infection with one dengue serotype provide lifelong immunity against that particular serotype, but there is no cross-protective immunity to other serotype.\(^1\)\(^,\)\(^7\)

In Indonesia, DF is an emerging vector-borne disease of high public health significance.\(^6\)\(^,\)\(^7\)

Control and prevention program of this disease was started in 1974. It was one of notifiable diseases and became an integral part of health services in the context of primary health care in all provinces. Medical practitioners who diagnosed DF cases must report the cases to the nearest district health office/primary health center (Puskesmas).\(^7\)

The DF control and prevention program collected surveillance information such as areas of endemities, season of transmission and the progress of disease in communities.\(^6\)\(^,\)\(^8\)\(^,\)\(^9\)

In North Sumatera Province, DF remains a public health problem.\(^4\) It is a cyclical diseases with the peak of incidence occurs during rainy season (September-January).\(^1\)\(^,\)\(^10\)\(^,\)\(^11\)

While the case fatality rate (CFR) of DF is decreasing, the incidence rate (IR) is increasing every five year. There were still many outbreaks in several districts in North Sumatera each year. In 2017, 31 out of 33 districts (90.9%) were endemic of DF and one of them was Karo District.\(^6\)

Merek is one of sub-districts in Karo District. It is one of tourist destination in North Sumatera located in the northern part of Lake Toba (Figure I). There were no DF cases in the sub district until 2016 with the incidence rate (IR) was 0 (zero) per 100,000 population, although the IR of Karo District was 91.53. This was higher than the IR of national DF program indicator (IR < 49 per 100,000 population).\(^6\)

Unfortunately, an outbreak of DF in Merek was reported by District Health Office of Karo on April 25, 2017. As a popular tourist destination, it can ultimately impact the health of travelers and decreasing of its number. Thus, this study aimed to confirm the outbreak and identify the risk factors of DF and provide a recommendation for DF control.

**Method**

An observational analytical study with matched case control design was used in the study. The investigation was conducted in Merek Sub-district, North Sumatera, Indonesia from April - May 2017. A case of DF was defined as any resident of Merek Sub-district who had suffered from acute febrile illness of 2-7 days duration with two or more of the following manifestations: headache, retro-orbital pain, myalgia, arthralgia, rash, hemorrhagic manifestations, leucopenia,\(^1\) between April 21 – May 12, 2017 by active case finding through the affected area. A control was defined as neighbors of cases who did not have clinical signs and symptoms of DF and were matched for age and sex. A house to house visit was conducted to find cases and controls in the affected area.

The dependent variable was the incidence of DF outbreak. The independent variables were presence of mosquito breeding sites in and around house such as bathtub, water dispenser, jars, tray under the refrigerator, flower vases, and other disposable containers; activity around house in the morning and late afternoon; habit of hanging worn clothes; and not using personal protective measures against mosquitoes. Data collection carried out by interview with a standard questionnaire (outbreak investigation questionnaire from Ministry of Health of the Republic of Indonesia) that included data on demographic profiles and sanitation practices was administered to all cases and controls. All the respondents were informed about the study and signed the informed consent.

Data analysis were univariate, bivariate and multivariate analysis. Odds ratio (OR) and 95% confidence interval (CI) were calculated. The OR was addressed to determine risk factors. Matched case control was analyzed by using McNemar test. Conditional logistic regression was also performed for all variables and those with p-value < 0.05 were included in the multivariate model. The analysis was conducted by using Epi Info version 7.2.2.6.

An environmental investigation was conducted through observing water and sanitation practices of all cases and controls. Entomologists of District Health Office of Karo and Puskesmas (primary health center) Merek inspected potential breeding sites of mosquitoes in and around houses of cases and controls at Merek Sub-district. The entomologist identified mosquito larvae species. Environmental investigation was performed in Tongging sub-village. The total number of 100 households was...
randomly selected for calculation of the entomology indices as below: house index (HI), container index (CI) and Breteau index (BI). We compared the entomology indices with the goals of the Indonesia National Dengue Prevention and Control Program of <5% for all three indices.7

Results

From April-May 2017, a total of 37 cases of DF outbreak were enrolled in Merek Sub-district. Age ranged from 2-37 years (median = 12 years) and 57% of them were males. All the DF cases presented fever, and other associated common symptoms i.e. myalgia (92%), headache (90%), rash (80%), vomiting (62%) and arthralgia (57%). In addition, it was 73% (27/37) of patient with those symptoms were hospitalized. Of these, 20 cases (74.1%) were diagnosed with DF, while 7 cases (25.9%) were dengue hemorrhagic fever (DHF) based on World Health Organization South-East Asia Region (WHO-SEARO) dengue clinical manifestation.1 The total attack rate (AR) in the affected area was 1.8‰.

The first case reported on April 21, 2017 and a peak in the number of reported cases occurred on May 4, 2017. The investigation of outbreak DF was performed for more than 3 weeks, with the last case was identified on May 12, 2017 (Figure 2). There were two patients dead (CFR = 13.3%), one girl (12 year old) and one boy (6 year old).

Based on Table 1, it showed that the total number of respondents was 74 people (37 cases and 37 controls). The highest attack rate by age and sex variables was 1-4 years (4.4‰) and male (2‰) groups, respectively. There was no significant difference between cases and controls (p>0.05; Table 2).
Table 1. Number of cases, number of death, attack rate and CFR of DF outbreak cases in Merek Sub-district, Karo District, North Sumatera Province, Indonesia April 21- May 12, 2017 (n = 37)

| Variables | Population at risk N = 20,373 | No. of cases n = 37 | No. of deaths | Attack rate (‰) | CFR (%) |
|-----------|-----------------------------|---------------------|--------------|----------------|---------|
| Age groups (year) | | | | | |
| <1 | - | - | - | - | - |
| 1-4 | 446 | - | - | - | - |
| 5-14 | 4,126 | 15 | 2 | 3.6 | 13.3 |
| 15-44 | 9,019 | 10 | - | 1.1 | - |
| >44 | 4,974 | 4 | - | 0.8 | - |
| Sex | | | | | |
| Male | 10,437 | 21 | 1 | 2.0 | 4.8 |
| Female | 9,936 | 16 | 1 | 1.6 | 6.3 |

Table 2. Characteristic of cases (n=37) and controls (n=37) DF outbreak cases in Merek Sub-district, Karo District, North Sumatera Province, Indonesia April 21- May 12, 2017

| Characteristic | No. of cases (%) | No. of controls (%) | p-value |
|----------------|------------------|---------------------|---------|
| Level of education | | | | |
| None | 7 (18.9) | 7 (18.9) | 0.984 |
| Preschool | 4 (10.8) | 5 (13.5) | |
| Primary school | 14 (37.9) | 13 (35.2) | |
| Middle school | 1 (2.7) | 2 (5.4) | |
| High school | 8 (21.6) | 8 (21.6) | |
| University | 3 (8.1) | 2 (5.4) | |
| Occupation | | | | |
| None | 10 (27.1) | 11 (29.7) | 0.987 |
| Student | 16 (43.2) | 15 (40.6) | |
| Farmer | 7 (18.9) | 8 (21.6) | |
| Businessman | 3 (8.1) | 2 (5.4) | |
| Housewife | 1 (2.7) | 1 (2.7) | |

The bivariate analyses showed that presence of mosquito breeding sites (OR = 5.95, 95%CI=1.80-19.70) and habit of hanging worn clothes (OR=6.40, 95%CI=1.86-22.07) were statistically significant risk factors. After the bivariate analysis, the data were subsequently analyzed using multivariate analysis to calculate adjusted OR. All variables with p-value ≤0.25 from the bivariate analysis were included. The multivariate analyses showed that presence of mosquito breeding sites (OR=4.87, 95%CI=1.33-17.85) and habit of hanging worn clothes (OR=5.12, 95%CI=1.246-21.03) were significant risk factors for DF outbreak cases (Table 3). It was found that multiple breeding sites of Aedes around of cases’ house such as coconut shells, discarded tires, plastic bottles and other artificial water containers. Majority of cases had no proper waste disposal. Entomologist confirmed that the collected larvae of mosquitoes were Aedes larvae. The result of entomology indices were 35%, 17%, and 28%, respectively were above the national standard of HI, CI, and BI <5%.2

Table 3. Factors associated with DF outbreak cases, Merek Sub-district, Karo District, North Sumatera Province, Indonesia April 21- May 12, 2017

| Variables | Crude OR | 95% CI | Adjusted OR | 95% CI |
|-----------|----------|--------|-------------|--------|
| Presence of mosquito breeding sites | 5.95 | 1.80-19.70 | 4.87 | 1.33-17.85 |
| Habit of hanging worn clothes | 6.40 | 1.86-22.07 | 5.12 | 1.25-21.03 |
| Not using personal protective measures against mosquitoes | 3.03 | 0.88-10.43 | 1.21 | - |
| Activity around house in the morning and late afternoon | 0.28 | 0.05-1.54 | 0.38 | - |
Discussion

At both cases and control groups, the most affected age group was school-aged children. It indicated that children have less protective immunity system compared to adult possessing immunity of circulating serotypes.5,12,17 The ratio of male to female suffering from DF was 1:3:1. The result was in line with some previous studies in Semarang (Indonesia), Malaysia, Cambodia, India, and Taiwan reporting that number of males suffering from DF was generally higher than females.4,14-17 This could happen because males normally have outdoor activities or works than females. As a result, they might have chances to get mosquitoes bites.5,17

The main risk factors of DF outbreak in Karo District, North Sumatera were presence of mosquito breeding sites and habit of hanging worn clothes. Lack of sanitation and management of waste disposal in the affected area resulted in large number of disposable containers around the houses, and they will be suitable as Aedes aegypti breeding sites.15,18-20 This finding was also reported from the previous study by Harapan et al (2016), Sucipto et al (2015), Getachew et al (2015), and Sulaiman et al (2015) stating that presence of mosquito breeding sites was the main risk factor of DF incidence.4,15,19,21

In addition, the abundance of breeding sites for Aedes aegypti signified that the area was sensitive and vulnerable to DF transmission.4,22,23 Aedes aegypti breeding sites can be reduced by eliminating mosquito breeding sites routinely. It could interrupt the life cycle of mosquitoes, particularly for eggs and larval stages. When they are removed or covered with a fine mesh, the mosquitoes had less opportunities to lay eggs and could not develop through their aquatic life stages.7,13,22 If the elimination of mosquitoes breeding sites are not carried out, it will generate high entomology indices marked by level of HI, CI and BI values.18,24,25 The most effective way to control Aedes aegypti larvae could be conducted by removing or treating containers which might serve as larval habitats in environment.26,27 The prevention and control steps heavily relied on reducing the number of natural and artificial water-filled container habitats. They were able to support breeding sites of Aedes aegypti. The routine mobilization and community willingness are needed.12,26

Habit of hanging worn clothes was the second risk factor of DF outbreak in Karo District. This finding was similar to previous study performed by Sitepu et al (2018), Mubarok et al (2018), and Sucipto et al (2015) reporting that hanging worn clothes was one of risk factor for DF.14,20,27 Aedes aegypti prefers to rest indoors in the dark and humid houses or objects. The worn clothes having human odors, amino acids, lactic acids, sweats and other substances that attracts Aedes aegypti.13,22,28 Furthermore, the habit will increase the mosquito population. Hanging worn clothes was reported as a favorite resting place for Aedes aegypti after sucking human blood. After that, they would suck human blood again until the blood is enough for maturing their eggs.1,2,13 Personal protective measures (PPMs) is the way to prevent Aedes aegypti bites when they are most active (morning and late afternoon).1 PPMs available including-repellent creams, mosquito nets (plain or insecticide treated), mosquito coils, repellents, electric rackets, mats, smokeless coils, and wearing long-sleeved shirts and long trousers.1,29

Conclusion

An outbreak of DF was confirmed in Merek Sub-district, Karo District, North Sumatera. Presence of mosquito breeding sites and habit of hanging worn clothes were the most potential risk factors associated with the outbreak.

Recommendation

During the outbreak, fogging was conducted on May 1 and May 8, 2017. Intensive information, education, and communication (IEC) campaigns were carried out in the community, churches, mosques, schools as well and promoting behaviors to remove, destroy or manage mosquito larva habitats. In addition, as one of tourist destination in North Sumatera with the increase number of travelers in the coming years, it is recommended that community should conduct activities to eliminate mosquito breeding sites routinely in order to reduce the number of natural and artificial water-filled containers where support breeding of the mosquitoes and avoid habit of hanging worn clothes. The District Health Office of Karo should conduct a strict surveillance of DF and enhance multi-sectoral collaboration to prevent and control DF.

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Author’s contribution

FYS constructed the hypothesis or idea of research and/or article, planning the methodology to reach the conclusions and writing the article. ED conducted data analysis and interpretation and literature review. SK conducted data collection.

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