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RESEARCH ARTICLES

Epidemiological and Entomological Investigation of Chikungunya Outbreak, in Serdang Bedagai District, North Sumatera Province, Indonesia, 2013

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Abstract

Background: Chikungunya is a serious emerging arbovirus in Indonesia. On 12 October 2013, an outbreak of chikungunya was reported in Serdang Bedagai District, North Sumatera, Indonesia.

Objective: An epidemiological investigation was conducted to identify the risk factors for the outbreak and recommend control measures.

Methods: A 1:1 matched case-control study was conducted. A case of chikungunya was defined as a previously well resident of Sei Suka Subdistrict who had clinical symptoms of chikungunya fever such as fever, arthralgia, myalgia, rash and headache of at least two days duration between 8 August and 17 November 2013. Cases were identified by active case finding through the affected area; a control was defined as a neighbor of a case that did not have clinical signs and symptoms of chikungunya, matched for age and gender. Blood samples were tested using ELISA assay to confirm the presence of anti-CHIKV specific IgM antibody.

Results: Total of 94 cases and 94 controls were included in the case control study. Age ranged from 1 year to 76 years (median 35 years) and 57% were female. In multivariate analyses, being a household contact of a chikungunya case (adjusted OR=11.4, 95%CI=4.69-27.55) and lack of routinely eliminating mosquito breeding sites were risk factors (adjusted OR=3.3, 95%CI=1.50-7.05). Six out of ten cases were positive for CHIKV IgM antibody.

Conclusions: In this confirmed outbreak of chikungunya, using anti mosquito measures were protective, reinforcing the need for routine elimination of mosquito breeding sites as well as control measures in affected households and communities.

Introduction

Chikungunya fever is a viral illness caused by an arbovirus of the family *Togaviridae* and genus *Alphavirus* and can transmit to people through the bite of *Aedes* mosquito (1, 2). *Aedes aegypti* and *Aedes albopictus* are the main vector of the disease (3, 4). The incubation period of the disease ranges from 2-12 days (5, 6). The United Republic of Tanzania, Africa was the first country that reported the disease in 1952 (6-8). The name chikungunya was derived from Kimakonde dialect of Makonde people, which translates to “that which bends up”, indicating the stooped appearance of patient with severe joint pain and a syndrome typically characterized by fever, headache, myalgia, and rash.

Chikungunya fever is one of the most common emerging vector-borne diseases with a high morbidity rate, prolonged polyarthritis in some cases and substantial socioeconomic impact (4, 9). It causes a large public health impact in countries in Africa and Southeast Asia. Indonesia has some of the greatest chikungunya burden in Southeast Asia. Samarinda city, East Kalimantan was the first area that reported chikungunya cases based on clinical symptoms in 1973, with the first virologically confirmed cases reported in Jambi in 1982 (10, 11). The disease rapidly moved to other provinces in Indonesia, and since 1985 all provinces have reported chikungunya outbreaks (6). Many chikungunya outbreaks have been reported in North Sumatera, West Java, Central Java, West Kalimantan, Bali, and other parts of the country (11-14). The main risk factors of these outbreaks were failure to routinely eliminate mosquitoes breeding sites (15-17), lack of use of personal protective measures against mosquitoes (12, 17), hanging out worn clothes (6, 17), and having a household contact with chikungunya (17).

On 12 October 2013, the District Health Office of Serdang Bedagai reported an outbreak of chikungunya in Sei Suka Subdistrict. Surveillance officers from North Sumatera Provincial Health Office and Serdang Bedagai District Health Office jointly conducted an investigation from 13 to 17 November 2013 to identify the risk factors and recommend control measures.

Methods

Study design and setting

This was a matched case-control with a ratio of 1:1 cases/controls. A case of chikungunya was defined as a previously well resident of Sei Suka Subdistrict who had major clinical symptoms of chikungunya fever such as fever, arthralgia, myalgia, rash and headache of at least two days duration between 8 August and 17 November 2013, identified by active case finding through the affected area. The study period was based on the first reported case until the end of the chikungunya outbreak. The criteria for declaring the end of the outbreak was two times of incubation period (3-7 days) of chikungunya cases. A control was a neighbor of the cases, who did not have clinical symptoms of chikungunya during the study period. Medical reports from health facilities were reviewed to make sure that cases and controls were correctly classified. To control confounding variables, cases and controls were matched for age and gender.

Data collection

A house-to-house investigation was carried out to identify cases and controls in Sei Suka Subdistrict. The standard chikungunya outbreak investigation questionnaire from the Ministry of Health (MoH) of Republic of Indonesia, including data on demographic profiles, sanitation practices, clinical symptoms, and all potential risk factors was administered to all cases and controls.

Data and statistical analysis

Age and gender specific attack rates (AR) and case fatality rates (CFR) during the outbreak were calculated to evaluate severity of the outbreak. AR was calculated as the proportion of those who became ill divided by the number of population at risk for the infection. The highest AR defined the most affected group. CFR was calculated as the proportion of deaths associated with infection divided by the total number of cases. The AR and CFR were expressed as percentages (%).

To assess the risk factors associated with the chikungunya outbreak, a two-step logistic regression was employed. In the first step, all variables were analyzed in an unadjusted analysis. Then, all variables with p-value < 0.25 were included in the multivariate model. The 95% confidence interval (CI) is used to estimate the precision of the OR. The estimated crude OR was used in the univariate analysis, and the adjusted OR was used in the multivariate analysis. Risk factors examined included having a household contact with chikungunya, routine elimination of mosquito breeding sites, hanging out of worn clothes and use of personal protective measures (long sleeved clothing and insect repellent) against mosquitoes.

Laboratory investigation

Venous blood samples were collected from ten chikungunya cases, selected at random, that presented with fever, rash, myalgia and arthralgia after three days of fever. Samples were tested to confirm the cause of the outbreak. The samples were transferred to the National Institute of Health Research and Development of Ministry of Health of Indonesia to confirm the diagnosis. The blood samples were tested using enzyme-linked immunosorbent (ELISA) assay to confirm the present of anti-CHIKV specific IgM antibody.

Entomological investigation

Entomological investigation was conducted by entomologists from the District Health Office of Serdang Bedagai by observing water containers in and surrounding each selected house, recording whether larvae were observed, and collecting larvae if present. The entomologist determined the species of mosquito larvae and calculated the entomology indices as below: house index (HI), container index (CI) and Breteau index (BI) (6).

$$HI = \frac{\text{Number of houses infested}}{\text{Number of houses inspected}} \times 100$$

$$CI = \frac{\text{Number of positive containers}}{\text{Number of containers inspected}} \times 100$$

$$BI = \frac{\text{Number of positive containers}}{\text{Number of houses inspected}} \times 100$$

Ethics

Ethics clearance was not required as this investigation was part of an emergency response to an outbreak. However, participants provided verbal informed consent prior to interviews and blood sample collection

Results

Case characteristics

The total number of chikungunya cases identified in Sei Suka Subdistrict was 94. The age ranged from 1 year to 76 years (median 35 years) and 57% were female. All cases presented with fever, rash and arthralgia (100%) and other associated common symptoms such as headache (34%), and red eyes (15%).

The epidemiological investigation was conducted on 13 October - 17 November 2013. From the investigation, the team determined that the first chikungunya case was reported on 8 August 2013. The outbreak occured for more than ten weeks, peaked between 15 August 2013 and 2 October 2013, and the last case was identified on 24 October 2013 (Figure 1). The most affected age group was 15-44 year (AR: 4.94%) and gender was female (AR: 4.28%). The total attack rate (AR) in this area was 3.82%. There were no deaths reported, so the case fatality rate was 0%. (Table 1).

Figure 1. Chikungunya fever cases by date of onset in Sei Suka Subdistrict, Serdang Bedagai District, North Sumatera, Indonesia, from 8 August to 17 November 2013 (n=94)

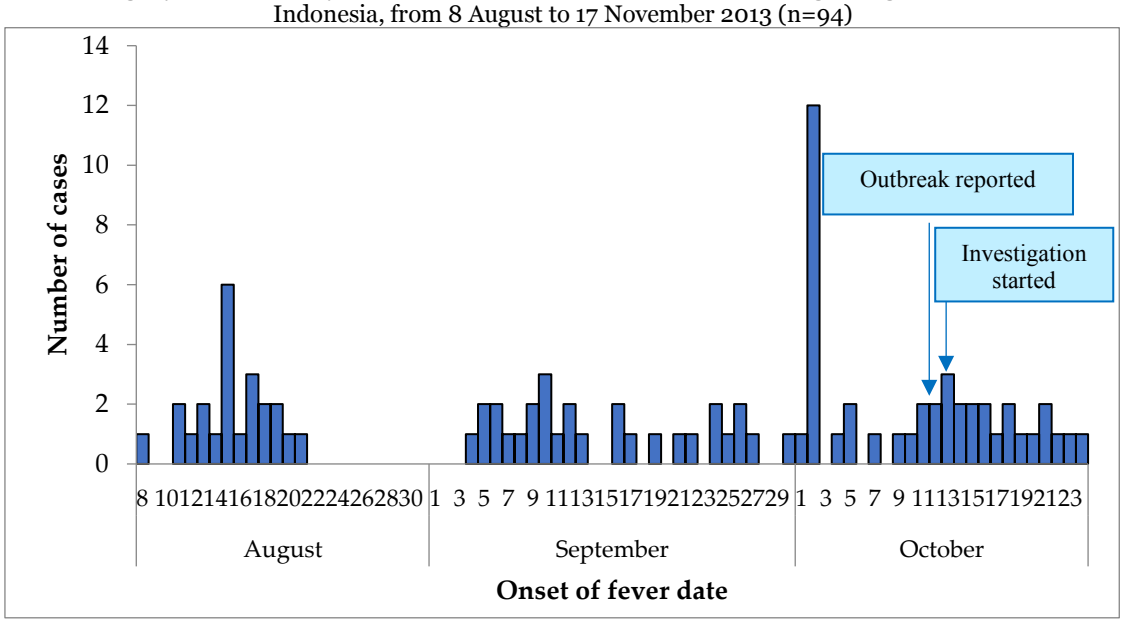

Table 1. Number of cases and deaths, attack rates, and case fatality rates of chikungunya fever outbreak in Sei Suka Subdistrict, Serdang Bedagai District, North Sumatera, Indonesia, 8 August-17 November 2013 (n=94)

Variable	Population at risk (n=2462)	Number of case (n=94)	Number of death	Attack rate (%)	Case fatality rate (%)
Age group (year)					
<1	90	0	-	-	-
1-4	281	7	-	2.49	-
5-14	339	8	-	2.36	-
15-44	1153	57	-	4.94	-
>44	599	22	-	3.67	-
Gender					
Male	1200	40	-	3.33	-
Female	1262	54	-	4.28	-

Table 2. Characteristics of cases (n=94) and controls (n=94) of chikungunya outbreak in Sei Suka Subdistrict, Serdang Bedagai, North Sumatera, Indonesia, 8 August-17 November 2013

Characteristic	Number of cases (%)	Number of controls (%)
Age group (year)		
1-4	7 (7.4)	7 (7.4)
5-14	8 (8.5)	8 (8.5)
15-44	57 (60.7)	57 (60.7)
>44	22 (23.4)	22 (23.4)
Gender		
Male	40 (42.6)	40 (42.6)
Female	54 (57.4)	54 (57.4)
Level of education		
None	7 (7.4)	8 (8.5)
Primary	13 (13.8)	15 (16.0)
Secondary	70 (74.5)	65 (69.1)
Tertiary	4 (4.3)	6 (6.4)
Occupation		
None	9 (9.6)	10 (10.7)
Student	28 (29.8)	30 (31.9)
Businessman	8 (8.5)	5 (5.3)
Employee	9 (9.6)	13 (13.8)
Farmer	30 (31.9)	25 (26.6)
Housewife	10 (10.6)	11 (11.7)

Table 3. Factors associated with chikungunya fever outbreak in Sei Suka Subdistrict, Serdang Bedagai, North Sumatera, Indonesia, 8 August-17 November 2013

Variable	p-value	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)
Hanging out worn clothes	0.006	2.6 (1.29-5.22)	0.546	1.3 (0.56-2.98)
Lack of personal protective measures against mosquitoes	0.006	2.8 (1.38-5.73)	0.423	2.8 (0.59-3.41)
Lack of routinely eliminating mosquito breeding sites	0.001	3.5 (1.76-7.17)	0.030	3.3 (1.50-7.05)
Household contact of chikungunya case	0.000	11.9 (4.99-28.42)	0.000	11.4 (4.69-27.55)

Case-control study

There were 94 cases and 94 controls included in the case control study. There was no significant difference between cases and controls (Table 1). In the bivariate analyses, being a household contact with a chikungunya case was the strongest risk factor (OR=11.9, 95%CI=4.99-28.42). Other statistically significant risk factors included lack of use of personal protective measures against mosquitoes (OR=3.5, 95%CI=1.76-7.17), lack of routinely eliminating mosquito breeding sites (OR=2.8, 95%CI=1.38-5.73) and hanging out worn clothes (OR=2.6, 95%CI=1.29-5.22).

The findings in the multivariate analyses showed that being a household contact of a chikungunya case (adjusted OR= 11.4, 95%CI=4.69-27.55) and lack of routinely eliminating mosquito breeding sites (adjusted OR= 3.3, 95%CI= 1.50-7.05) were significantly associated as risk factors for chikungunya (Table 3).

Entomological investigation

During the entomoligcal investigation, the team observerd an abundace of breeding sites of Aedes in the backyards and surroundings of the chikungunya cases' houses. The majority of the cases of chikungunya had improper waste disposal in their homes. The entomologist confirmed that the mosquito larvae that were collected were *Aedes albopictus and Aedes aegypti* . The result of entomology indices were 38% for HI, 25% for CI, and 40% for BI, while all were above the national standard indices of less than 5% (6).

Laboratory investigation

During the epidemiological investigation, ten blood samples were collected from cases who were willing to be tested to confirm the present of anti-CHIKV-specific IgM antibody. The test confirmed that six were positive for CHIKV confirming the outbreak of chikungunya.

Discussion

This outbreak of chikungunya had been occurring for more than two months before it was detected. There were already 75 cases before the outbreak was reported. The delay between the emergence of the outbreak's index case and the detection of the outbreak by public health authorities was due to the low sensitivity of public health surveillance and lack of resources (18-21). Public health surveillance should have high sensitivity to detect and respond rapidly to the public health problems in the community (4, 18-20).

The epidemiological investigation revealed an outbreak of chikungunya fever in Sei Suka Subdistrict, Serdang Bedagai District, North Sumatera from 8 August to 17 November 2013. The last reported chikungunya case was on 24 October 2013. The District Health Office of Serdang Bedagai declared the end of the outbreak on 17 November 2013, after 24 days from the last reported case. The main risk factors of the outbreak were being a household contact of a chikungunya case and lack of routinely eliminating mosquito breeding sites.

Being a household contact of a chikungunya case was the strongest risk factor of the chikungunya outbreak. The CHIKV is transmitted through the bite of infected female mosquito, so this suggests that household contacts are at risk of the same exposure as cases. Patients infected with chikungunya can be the reservoir of infection for others in the household (22). Therefore, to minimize this risk of infection in the household, the vector population and vector contact must be minimized. When there is a chikungunya case it can increase risk of chikungunya to other members of the household (7, 8, 23). It has been previously noted that there is an increased risk of chikungunya in other member of the household (24). All chikungunya fever cases should sleep under bed nets during the viremic phase to limit the spread of infection (9). Our results are consistent with other outbreaks of chikungunya fever in the Philippines and Puerto Rico which showed that sharing a household with a chikungunya case was the main risk factor (22, 25).

Lack of routinely eliminating mosquito breeding sites was found to be another risk factor of chikungunya fever. During the environmental investigation, we observed multiple breeding sites in the backyards such as discarded tires, plastic bottles, coconut-shells, vehicular tyres, pots and other water containers. *Aedes* mosquito use natural and artificial water containers to lay their eggs on the sides of the containers. After hatching, larvae grow and develop into pupae in about a week and into adult mosquitos in two days. The breeding sites can contribute to high entomological indices (HI, CI, and BI). High entomological inidces indicate a high risk for dengue

and chikungunya outbreaks (26-28). Without the existence of breeding sites, the lifecycle of *Aedes* can be interrupted and the mosquitoes will have less opportunities to lay eggs and cannot develop through their aquatic life stages (5, 6). Eliminating mosquito breeding sites should be conducted routinely in high risk areas (4). The greater the number of mosquito breeding sites, the more sensitive and vulnerable the area is to chikungunya transmission (3, 7, 13).

The most effective method of controlling *Aedes* larvae is by removing or treating open containers that can serve as larval habitats in the environment (6, 13). Prevention and control relies primarily on preventing the mosquitoes from breeding. This activity needs unrelenting contribution from the whole of affected communities (4, 24). High numbers of disposable water containers has been shown to be a risk in other chikungunya outbreaks in another countries and in Indonesia as well, as it increases breeding sites for *Aedes* (6, 12, 16, 25, 29-32).

Strengths and limitations

This epidemiological investigation used neighbourhood controls. It can represent the exposure in the neighbourhood that produced each case, and therefore tends to control for known and unknown confounding factors that exist in the population.
There was limited testing of clinical specimens in this study. Since not all chikungunya cases were laboratory confirmed, some of them might be affected by other illnesses with similar manifestations.

Conclusion

An outbreak of chikungunya fever was confirmed in Sei Suka Subdistrict, Serdang Bedagai, North Sumatera. Being a household contact of a chikungunya case and not routinely eliminating mosquito breeding sites were the strongest risk factors associated with the outbreak.

Recommendations

During the outbreak, vector control activities against larvae and adult mosquitoes and intensive information, education and communication (IEC) campaigns to take measures to avoid mosquito bites were performed in the affected communities. Strict surveillance of chikungunya fever should be conducted for early detection, prevention and control of chikungunya fever in the future.

Competing Interests

The authors have no competing interests to declare.

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