Malaria Risk Factors in Banjarnegara, Indonesia: A matched case-control study

ABSTRACT

Context: This research is performed in Banjarnegara, a malaria endemic area in Indonesia. Considering the incidence of malaria in Indonesia in the last ten years, it is essential to assess the potential risk factors to maintain the cases and to accelerate malaria elimination.

Aims: This study examined the potential risk factors from the human socio-economic aspect and human behavior for malaria cases.

Settings and Design: This is a match case-control study conducted in 34 cases and 34 controls in Banjarmangu Subdistrict, Banjarnegara, Indonesia. The subjects for the two groups were based on the routine report of Banjarmangu I public health center from July 2017–March 2018. Inclusion and exclusion criteria were applied to select the subject.

Statistical analysis: Logistic regression was used to seek the association among the variables.

Results: This research found that installing wire netting, not sleeping under a bed net, and consuming higher transportation costs were significant protective factors for malaria cases. Having lower family income was significant as a potential risk factor for malaria cases (OR=10.68, p-value = 0.04).

Conclusions: This study may explain that economic income was the essential aspect of malaria prevention as it contributed to the other health issues, such as health-seeking behavior.

Keywords: Malaria, risk factor, behavior, socioeconomic, Banjarnegara, Indonesia

1. INTRODUCTION

Malaria caused by a parasite and transmitted to humans through mosquito biting by infected female Anopheles. This disease is frighteningly severe in tropical and subtropical countries. In 2017, WHO reported 219 million malaria cases globally, with 435,000 mortalities.[1] WHO African countries contributed to 92% of the Malaria burden, while the South-East Asia Region contributed to 5% of the total cases.[2]

To strengthen malaria control and elimination, several efforts have been developed with massive funding sources. Globally, in 2017, an estimated US$ 3.1 billion was invested in malaria prevention labors such as the distribution of insecticide-treated mosquito bed-nets, rapid malaria diagnostic tests, and artemisinin-based combination therapy (ACT).[2] Identifying the potential risk factors for malaria transmission in this particular region by considering the local situation is essential to support current prevention measures, as well as for cost-effectiveness reasons.[3]

In Indonesia, has been struggling from malaria since the 1800[s 4] and be one of malaria endemic country in South East Asia. Since then, malaria has spread over the country, with almost half of the population residing in malaria-prone areas.[5] To against malaria, the government developed Malaria eradication programs in 1952, targeted malaria free by 2030.[6] A successful milestone was reached in 2017, indicated by more than 50% of the districts in Indonesia declared had malaria

free.[7] To improve and sustain this attainment, it is essential to monitor and understand the malaria potential risk factors to keep the program on the right track.

Several studies have assessed the possible risk factors for malaria across the districts in Indonesia, and they have investigated some aspects, such as environmental, human behavior, vector, and the virus.[8,9,10] Malaria patterns in Indonesia shifted in the last ten years, as indicated by the reduction of the Annual Parasite Incidence (API) during 2008–2015.[11,12] Coinciding with this declining, the persistence of prevention and control aimed to achieve malaria elimination has to be forced, mainly by relying on the knowledge and information about potential risk factors.

This study aimed to identify potential risk factors from human socio-economic and behavior for malaria cases to inform policymakers about providing malaria prevention and control with considering the current risk factors.

2. SUBJECTS AND METHODS

2.1 Study design and setting

This was a matched case-control study to examine the potential environmental and individual risk factors for the incidence of malaria in Banjarnegara, Indonesia, from July 2017–March 2018. This study was conducted in Banjarmangu I public health center (PHC) — one of 35 PHCs in Banjarnegara—that consisted of nine villages with a total population of 22,980.[13] Data collection was conducted in June–July 2018.

Banjarmangu is a subdistrict situated in Banjarnegara, Central Java, Indonesia. This area's attitude is between 300–800 meters above sea level; most of the area is mountains and hills with the river as the primary water source. This area experiences a tropical climate.[14] The average temperature ranges between 20–26°C with a mean annual rainfall of about 3.000 millimeters/year.[15] Of 43,096 people who reside in Banjarmangu, most of them work in agriculture for products such as paddy, salak, and vegetables.[14]

2.2 Participants

The sample was calculated using https://epitools.ausvet.com.au/ for case-control design by considering 0.15 expected proportion in controls; the odd ration was assumed 4.6 (confidence interval 1.78, 11.86) for sleeping under the bed net,[16] a confidence level of 0.95, and the desired power of 0.80. The calculation result was 34 for each group. We developed a 1:1 ratio between cases and controls. Accordingly, 68 samples were recruited.

Case and control were selected from the outpatient register of Banjarmangu I public health center from July 2017–March 2018. Case population were 37 which is an outpatient who had been confirmed as malaria positive through blood sample examination and were listed in the medical record from July 2017–March 2018. Controls were all outpatients who had been established as malaria negative through blood sample examination and were listed in the report for the same period. One case was matched with one control on age, sex, and live in the same village. We excluded all the names of those who not reside in the research area.

2.3 Data collection procedure and research instrument

Door-to-door visits were conducted to the selected sample—both case and control according to the register. 'Yes-No' questions that tested with 0.92 Cronbach alpha were used to obtain participant responses. The questionnaire was divided into four sections: first, participant information: name, sex, age, education, and income level; second, access to health care: distance to health facility and transportation cost; third, prevention practice: the habit of nightly outdoor activity, bed net and repellent usage, and the habit of hanging cloth inside the house; and fourth, observation checklist: distance from cattle cage and the presence of wire netting on house ventilation. All selected samples decided to participate in this study.

2.4 Data analysis

All questionnaires were entered, cleaned, and coded in SPSS version 24. A proper variable was scored as 1 item, and the improper variable was scored as 0. Total scores were calculated, then grouped as poor and good based on the mean cut-off. A chi-square calculation was used to assess the association between dengue incidence and the exposure at $p<0.05$ significance level. Logistic regression was performed at multivariate analysis to identify the most potential risk factors.

3. RESULTS AND DISCUSSION

3.1 Participant characteristics

Sixty-eight respondents who were matched in age group and sex were recruited for this study: 34 cases and 34 controls. The detail respondent information is shown in Table 1.

Table 1. Participants characteristics of malaria study in Banjarmangu, Banjarnegara, Indonesia

Characteristic	Case and Control
Sex	*n (%)*
Male	38 (55.9)
Female	30 (44.1)
Age group (year)	
Minimum	6
Maximum	60
Mean	30.62

3.2 Relations between malaria and risk factor variables

The distribution of potential risk factors for malaria cases is presented in Table 2. Among the variables, having an outdoor activity at night from 6 pm to 10 pm was significantly associated with the cases.

Table 2. Bivariate analysis of the possible factors associated with the increased risk of dengue infection

Characteristic	**Case n (%)**	**Control n (%)**	**Crude OR (95% CI)**	***p*-value**
Engaging in an outdoor activity at night (6 p.m.-10 p.m.)				
Yes	24 (70.6)	13 (38.2)	3.87 (1.41-10.65)	0.01
No	10 (19.4)	21 (61.8)		
The habit of hanging clothes inside the house				
Yes	23 (67.6)	27 (79.4)	0.54 (0.18-1.62)	0.41
No	11 (32.4)	7 (20.6)		
Presence of wire netting in the in-house ventilation				
No	28 (82.4)	17 (50.0)	4.66 (1.54-14.14)	0.01
Yes	6 (17.6)	17 (50.0)		
Not sleeping under a bed net the previous night.				
No	26 (76.5)	10 (29.4)	7.80 (2.64-23.03)	0.00
Yes	8 (23.5)	24 (70.6)		
The presence of cattle cage within 100 m of the house				
No	17 (50.0)	16 (47.1)	1.12 (0.43- 2.91)	1.00
Yes	17 (50.0)	18 (52.9)		
Family monthly income				
Lower (< 1,240,000 IDR)	24 (70.6)	29 (85.3)	0.41 (0.12-1.37)	0.24
Higher (≥ 1,240,000 IDR)	10 (29.4)	5 (14.7)		
Education level				
Low (Primary and Junior high school)	30 (88.2)	28 (82.4)	1.60 (0.41-6.29)	0.73
High (Senior high school or above)	4 (11.8)	6 (17.6)		
Distance to health care closest health facility (hospital, public health centre, clinic)				
>5 km	0 (0.0)	2 (41.2)	*	0.49
<5 km	34 (100)	32 (94.1)		
Higher transportation cost				
Yes (> 6,500 IDR)	25 (73.5)	16 (47.1)	3.12 (1.13-8.63)	0.04
No (≤ 6,500 IDR)	9 (26.5)	18 (52.9)		
Insurance ownership				
No	17 (50.0)	14 (41.2)	1.42 (0.54-3.72)	0.62
Yes	17 (50.0)	20 (58.8)		

OR, odds ratio; CI, confidence interval.

People who have this behavior and without proper prevention was 3.87 times more likely to be cases (OR= 3.87, CI = 1.41-10.65). People who have not installed wire netting in their house ventilation was 4.66 times more likely to get malaria infection (OR= 4.66, CI = 1.54-1.41). Wire netting is significantly associated with malaria incidence. The cases are also

considered related to people who are not sleeping under a bed net, with 7.80 times higher risk compared to people who are using a bed net (OR =7.80, CI = 2.64-23.03). Regarding health care access, need a higher cost for getting health care facilities was significantly associated with malaria cases (OR = 3.12, CI = 1.13-8.63).

Table 3. Logistic regression analysis after bivariate analysis (p≤0.25) of risk factors for malaria positivity

Variable	*p-value*	Adjusted OR (95% CI)
Presence of wire netting in the in-house ventilation	0.01	0.05 (0.00-0.49)
Not sleeping under a bed net	0.00	0.11 (0.02-0.44)
Consume higher transportation cost	0.01	0.17 (0.04-0.70)
Lower family income	0.04	10.68 (1.01-112.59)

In the multivariate calculation (Table 3), the existence of wire netting in house ventilation, not sleeping under a bed net, having higher transportation costs to the health facility, and having a lower income were significantly associated with malaria cases. Among them, only having a lower income was a potential risk factor for getting malaria (OR = 10.68, CI = 1.01-112.59).

Malaria is a neglected tropical disease that receives huge attention throughout the globe, as it spreads extensively due to people's mobility and environmental triggers, such as climate change that extends mosquito breeding places. Similar to other vector-borne diseases, the effective approach to prevent malaria infection is breaking interactions between humans and the mosquito. Accordingly, an understanding of the potential risk factors for malaria from human behavior and the environment are essential to delivering effective malaria prevention.

This study found strong associations between the existence of wire netting in the in-house ventilation and malaria cases. However, wire netting is protectives. Our result is different from a study in North Sumatera, Indonesia, that revealed wire mesh as a potential risk factor, with people who had not installed wire mesh 2.55 times more likely to get a malaria infection than those people who installed it.[17] Another study in Indonesia revealed wire netting was not a potential risk factor for malaria.[16] The three studies imply that the installation of wire netting reaches varying results within the different areas in Indonesia. This may be explained by different vectors for the areas that possibly have different biting behavior.[18] Wire netting/mesh in the house ventilation can reduce malaria because wire mesh plays roles as a barrier for Anopheles entering the house. This was confirmed by a study in Mozambique, who conducted a trial for testing the effects of wire netting on malaria prevention. They found that the mesh reduces mosquito entry rates to the house by 84%.[19]

In our study, the use of a bed net while sleeping is significantly associated with malaria infection, but it was a protective factor. This result is different from the former study in Purworejo, Indonesia, situated in a similar province to Banjarnergara.[16] The protectiveness of a bed net could be related to improper bed net conditions. Indeed, the cases slept under a bed net; however, a mosquito still can enter the bed net, for example, because of the presence of a hole in the bed net. Supposedly, the use of a bed net is pivotal to reducing malaria risk mainly for children under five and pregnant women. Children under five are susceptible to malaria infection due to the incomplete immunity of their body, and it potentially ends with mortality.[20] Pregnant women are also a vulnerable group for malaria because pregnancy reduces a woman's immunity.[21] Some studies in Southern Ethiopia have reported that the use of a rectangular bed net while sleeping was confirmed effective to reduce malaria risk infection in children under five.[22] While in Cameroon, it was reported that the prevalence of malaria among pregnant women and children who sleep without LLINs was increasing 4.46 and 35, respectively 35.[23]

Transportation cost is an issue for getting prompt health medications for malaria cases, particularly for poor people.[24] However, our study revealed that experience with higher transportation costs was a protective factor from malaria infection. This result probably reflects the malaria cases being able to pay the transportation cost, or perhaps they drove a car to the health facility by using their car or rented. As a result, the cost is more than our cut-off (6,500 IDR). Second, it could be answered by the strong potential risk factor in this study, which is family incomes. Having a lower family income will increase the odds of 10.68 times for getting malaria infection. Accordingly, people who have higher family income may be able to pay the transportation cost to the health facility to seek the treatment. Transportation cost was reported as significantly associated with the health-seeking behavior of the community that getting malaria infections.[25–27]

This research may have a limitation related to 1) the retrospective design, which is recall bias; however, we did an observation for some factors to control the answer and avoid misunderstandings; and 2) we did not involve the vector aspect of our calculation. Accordingly, the generalization of this result should be developed wisely. Despite that, this study obviously has strengths. Compared with other malaria risk factor studies, our study involved transportation cost and

family income in our assessment. These two variables are seldom assessed as potential risk factors together with an individual preventive measure.

4. CONCLUSION

This study presents the potential risk factors for getting malaria infection in the rural and mountainous landscape area. Our findings would contribute to the development of sufficient evidence-based malaria prevention policies. Future research should intensely study the relationship between malaria cases and health-seeking behavior among society, mainly related to transportation cost.

CONSENT

All authors declare that written informed consent was obtained from the respondent for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

The Ethics Board of Universitas Ahmad Dahlan-Indonesia has approved this study. IRB # 011805088.

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