Dominant risk factors for malaria at Puskesmas Labuhan Ruku, Talawi Batu Bara, Indonesia

P C Eyanoer*

Department of Community and Preventive Medicine, Universitas Sumatera Utara, Medan, Indonesia
*Corresponding author: putrice00@yahoo.com

Abstract. Malaria is a disease which increases in number almost every year. Morbidity rate of malaria tends to decline from 4.1 to 0.85 per 1000 population at risk in 2005 to 2015. In North Sumatera alone three areas found with the highest incidences are District of Madina, Batubara, and Asahan. However such high number do not parallel with the utilization of health services in the area. This study is an analytic study with case-control design to analyse the contribution of environmental and social factors that potentially cause malaria among people living in malaria-endemic areas. The recruited samples are 146 samples. All cases are registered patient at Puskesmas Labuhan Ruku while controls are from the neighboring area. The result showed that incidence of malaria is most affected by the habit of repellent used and being outside of the house in the evening.

1. Introduction

World Malaria Report in 2015 mentioned that there were 212 million new cases of malaria worldwide. [1] In Indonesia, malaria morbidity from the years, 2005-2015 are likely to decline from 4.1 per 1,000 population at risk in 2005 to 0.85 per 1,000 population at risk in 2015. Three areas identified with the highest incidence of malaria in North Sumatera are Madina, Batubara and Asahan districts. Ministry of Health in 2016 reported that Batubara has the highest incidence with 1.525 cases.

The global commitment to Sustainable Development Goals (SDGs) put efforts as well to eradicate malaria until 2030. In distribution, malaria had three factors: the transmission chain of intermediate hosts and host definitive, agent (P. falciparum, P. vivax, P. ovale, P. malariae) and environment (physical environment, chemical, biological, social, cultural). Quite some studies have proved that a malaria control activity is to break the chain of transmission, by eliminating the breeding places of Anopheles mosquitoes. Breeding places had two types which are the permanent type (swamps, springs, fields with mountain streams, ponds) and temporary type (the river mouth covered with sand at the beach, a pool of brackish water at the beach, rain puddles, rice field). [2] Residents area around Batubara are know to be compatible with breeding places. The existence of mangrove forest located on the coast and houses with stilts underneath stagnant water are potential for breeding places. This environmental condition worsens with socio-cultural factors. Most residents are fond of being outside the house even at night time due to unconducive weather condition which knows to be hot and humid most o the time. Secondary data also showed a very low utilization of health care facilities in the area. These study objectives are then to evaluate what are dominant environment factors affecting malaria occurrence in the area of Puskesmas Labuhan Ruku, Talawi Batubara.
2. Methods
A case-control study was in March 2017. There is a total of 146 samples from Puskesmas Labuhan Ruku Batubara district. Seventy-three malaria patients are selected consecutively from medical record of Puskesmas Labuhan Ruku while another 73 controls are from their neighbor. Neighboring controls are those who lived within 10 km from the house of cases. Data on environmental and social determinants have collected thru interview with the respondents and re-checked using a checklist. Questionnaires used had been tested for validity and reliability among 50 respondents with a similar characteristic which registered in Puskesmas Tanjung Tiram. A multivariate analysis is performed to identify the strength of association between all determinants to malaria occurrence and presented regarding odds ratios.

3. Results

3.1. Distribution and Association of Determinants with Malaria occurrence
All determinants observed in this study are in Table 1 above. The result showed that all determinants found dominant in cases of malaria compare to controls. Among cases of malaria, the presence of puddles has the lowest proportion (86.3%) while both habits of being outside the house at nighttime and use of bed net have the highest proportion (97.3%).

Results of the bivariate analysis showed that all environmental determinants associated with malaria occurrence (p<0.05) and none of the social determinants associated (p>0.05). The use of house netting associated with malaria occurrence (OR:17.60;95%CI:6.40-21.09) followed by habits of being outside the house at night time (OR:14.37;95%CI:10.62-34.17). Meanwhile, the presence of livestock barn to housing has the least association (OR:4.40;95%CI:3.85-15.20).

3.2. Regression Analysis of Malaria Determinants
All determinants which found significant from bivariate analysis then further entered into multivariate analysis. Five out of nine determinants are found significantly associated with malaria occurrence at the first step of the analysis. These variables are the use of bed net (OR:3.50;95%CI:1.19-4.67), the presence of ventilation (OR:3.22;95%CI:1.78-4.67), use of mosquito repellent (OR:2.91;95%CI:1.61-6.97), habits of being outside the house at nighttime (OR:2.53;95%CI:1.09-3.78), and habits of hanging used clothes (OR:1.19;95%CI:1.68-5.91). Logistic regression with backward selection method yields to final determinants and shown in Table 1 below.

Table 1. Determinants of malaria in puskesmas labuhan ruku batubara.

| Characteristics                      | Cases    | Controls   |  p    | OR (95% CI) |
|--------------------------------------|----------|------------|-------|-------------|
| Presence of puddles                  |          |            |       |             |
| Presence                             | 63 (86.3)| 6 (8.2%)   | 0.002 | 8.68 (7.76-24.42) |
| Absence                              | 10 (13.7)| 67 (91.8%) |       |             |
| House walls                          |          |            |       |             |
| At risk                              | 66 (90.4%)| 10 (13.7%)| 0.006 | 9.04 (3.56-19.80) |
| Not at risk                          | 7 (9.6%) | 63 (86.3%) |       |             |
| House ventilation                    |          |            |       |             |
| Standardized                         | 65 (89.0%)| 4 (5.5%)   | 0.009 | 11.58 (4.22-17.46) |
| Un-standardized                      | 8 (11.0%)| 69 (94.5%) |       |             |
| The use of wire netting              |          |            |       |             |
| Yes                                  | 69 (94.5%)| 6 (8.2%)   | 0.021 | 17.60 (6.40-21.09) |
| No                                   | 4 (5.5%) | 67 (91.8%) |       |             |
| The use of mosquito repellent        |          |            |       |             |
| Yes                                  | 67 (91.8%)| 4 (5.5%)   | 0.037 | 9.73 (2.83-25.89) |
| No                                   | 6 (8.2%) | 69 (94.5%) |       |             |
| Habit of being outside the house at nighttime | 71 (97.3%)| 2 (2.0%)   | 0.006 | 14.37 (10.62-34.17) |
The use of mosquito repellent
Yes 71(97.3%) 2(2.7%) 0.011 3.10(1.52-5.59)
No 2(2.7%) 71(97.3%)

Habits of being outside the house at nighttime
Yes 68(93.2%) 0(0%) 0.018 3.01(1.16-5.81)
No 5(7.8%) 73(100%)

Presence of livestock barns
Close to housing 70(95.9) 6(8.2%) 0.002 4.40(3.85-15.20)
Far from housing 3(4.1%) 67(91.8%)

Taking drug as recommended
Yes 66(90.4%) 73(100%) 0.858 0.26(0.05-1.32)
No 7(9.6%) 0(0%)

Willingness to have medical check
Yes 68(93.2%) 73(100%) 0.975 0.18(0.02-1.68)
No 5(6.8%) 0(0%)

Table 2. Final determinants in the model.

| Determinants                        | \( p \)  | \( OR(95\%CI) \) |
|-------------------------------------|----------|------------------|
| The use of mosquito repellent       | 0.011    | 3.10(1.52-5.59)  |
| Habits of being outside the house at nighttime | 0.018    | 3.01(1.16-5.81)  |

4. Discussion

4.1. The association determinants of malaria occurrence

Analysis on the presence of puddles within housing area found that the malaria occurrence will be 8.6 times more common compared to those without puddles. Stagnant water in the puddles would reduce incoming or penetration of sunlight onto the soil surface thus the surrounding environment will be shaded and moist. This increase breeding places for mosquitoes. This situation found worsen high during rainy season due to the increase of relative humidity simultaneously then improve the ability to survive of the mosquito. The result of this study in line with a study done in Puskesmas Sarmiby which found a statistically significant correlation between the presence of stagnant water with the incidence of malaria (\( p\)-value:0.00; OR:6.82; 95%CI:2.82-16.51).[3] Another study in Jayapura and Purworejo also stated similar result with \( p\)-value:0.04;OR:1.77;95%CI:1.01-3.10 and \( p\)-value: 0.005; OR: 3.23; 95% CI:1.49-7.01, respectively.[4-5] The layout of settlements within the village/ township does associate with the occurrence of malaria. People within housing area which has numbers of mosquito breeding places would 2.8 times more to experience malaria compare to those without breeding places.[6]

The result showed that among cases, 90.4% of respondents lived in the house with the risk of malaria, and this would lead to 9.04 times of malaria occurrence among them. The WHO Media Centre (2013) mentioned that the absence of house accessories such as walls would cause the mosquitoes to come, relax, and bite humans in the house. House with good construction can reduce mosquito contact with humans to minimize the risk of disease transmitted by mosquitoes. Results of a study conducted in the eastern part of Thailand found a relationship between the type of house with malaria incidence (\( p\)=0.000).[7] Another study in Puskesmas Kambaniru stated a relationship between the state of wall/floor with malaria occurrence (\( p\)=0.000).[8] Houses with spaced wall to the floor are likely to suffer malaria 2.74 times compared to houses which are not. The spaces within walls would let the mosquito fly freely into the house thus increase the risk of malaria transmission. Based on observation
most houses within the study area are not permanently built. Some houses are with perforated walls, hollow floor, and no palates.

Eighty-nine percent of cases lived in houses with poor ventilation. The result of the analysis showed that this increases the occurrence of malaria by 11.58 times more. A study done in Lampung district showed that ventilation with no wire netting significantly associated with malaria occurrence. The result showed that respondents live within houses with no wire netting would experience malaria 17.60 times more compared to those houses with wire netting. Installation of wire netting on the ventilation would lessen mosquito contact with house occupants. The use of gauze on ventilation has proven to reduce contact between Anopheles and humans.[9] Another mentioned that people whose homes are not protected from the mosquitoes had 2.41 times more risk of contracting malaria compared with houses that are protected.

Results showed that 91.8% of cases never use mosquito repellent and the occurrence of malaria is 9.72 times more among them compared to controls. A study in Minahasa found that respondents who don’t often use mosquito repellent would 4.189 times more to suffer from malaria than respondents always use mosquito repellent. However, respondents who had used repellent might still be bitten by mosquitoes during outdoor activities at night due to the effective time of repellent.[10]

Habits to be outside the house until late at night, where the vector is echo-physiological and echo-phagic will facilitate mosquito bites. This study showed that those with such habits would experience malaria 14.37 times more compared to those who are not. People reside in the study area mostly like to be outside the house at night and did not dress due to surrounding weather which found more humid and hot. Most activities found in the area such as sailing or just huddled around with neighbors [11].

Several studies have shown that regular use of bed nets at night during sleep reduces the incidence of malaria. People who do not use nets on a regular basis are at risk of malaria 6.44 times compared to those who use bed nets.[10] A study in Thailand mentioned there are significant differences between the use of mosquito nets every night with malaria incidence (p=0.046).[14] In contrast, several studies showed no relationship between the habit of using nets with malaria incidence (p=0.000).[11,15] The use of bed nets is no better than the use of mosquito repellent in various ways since there are still opportunities for mosquitoes to come into the netting during the open and close of nets by users.

It is clear that from the result can be concluded that there is a significant relationship between actions of clothes hanging in the house with the incidence of malaria, while the influence of the action is not too big which only amounted to 2 times. Given the mosquito’s characteristic, there are several groups of mosquitoes that have properties which like sticking in damp and dim inside the house, for example, clinging to a wall or hanging clothes. It will increase the potential of the mosquito to human contact.

Living environment affects the increase of cases transmission. This study found numbers of mosquito breeding sites in the areas such as at the rice fields, ditches, and bushes, due to the majority of respondents are farmers.

A study found that non-compliance in drug therapy is a risk factor for malaria by 1.73 times compared with those who take medication with submissive behavior.[16] Although numbers of health centers establish to help reach out programs in health promotion and disease prevention there are still a lot of obstacles in the implementation which prevent them serving maximally.[17-18]

5. Conclusions
It can be concluded that out of all determinants collected both the use of mosquito repellent and habits of being outside the house at night time are significantly associated with malaria occurrence. It suggested that health officer of Puskesmas Labuhan Ruku should socialize the study results. It further would increase the attention of people reside in the malaria endemic area on the importance of repellent used or even minimizing outdoor activities during night time as to prevent contact with vectors of malaria.
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