Environmental Risk F actors of Malaria Cases, at Lahat Regency, South Sumatra Province, Indonesia

by Hamzah Hasyim

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Hamzah Hasyim, S.KM, M.KM
Faculty of Public Health
Sriwijaya University
Ogan Ilir Regency, South Sumatra Province, Indonesia
hamzah.hasyim@gmail.com

Anita Camelia, S.KM, M.KKK.
Nur Alam Fajar, S.Sos., M.Kes.
Faculty of Public Health
Sriwijaya University
Ogan Ilir Regency, South Sumatra Province, Indonesia

Abstract—Combat Malaria is one of goals achievement MDGs. Lahat Regency is one of malaria endemic area in South Sumatra Province with a prevalence of 16.4% and AMI of 22.08 respectively. The purpose of this study was to determine the significance among the environmentally risky factors with the incidence of malaria. The retrospective study of case control reports was carried out of 240 respondents with a ratio of 1:2 cases group and control group. Summary of result ware association between breeding place and malaria cases (p value= 0.000), some variables are not significance with the incidence of malaria, such as firstly the distance of the house to the breeding place (p value = 0.145), secondly utilization of mosquito nets (p value = 0.291), thirdly use of anti-mosquito (p value = 0.411) and fourthly habit of going out at night (p value= 0.439). From the results of multivariate analysis of variables affect the malaria incidence is the breeding place, with odds ratio is 5.034 (95% CI: 2.65 to 9.56). The best strategy to control malaria disease in Lahat Regency is to reduce the breeding place of the mosquito through promoting the environmental management as the preventive action.

Keywords: *Risk factors; survey; malaria*

I. INTRODUCTION

Malaria is an infectious disease caused by a parasite (plasmodium) which is transmitted from human to human by the bite of infected female Anopheles mosquitoes. The female Anopheles mosquito becomes infected by ingesting blood containing the sexual forms of the parasite plasmodium. After developing in the mosquito, the plasmodium is inoculated into humans when the mosquito next feeds (bites). The first stage of plasmodium development in humans takes place in the liver. When the more mature plasmodium escapes from the liver and enter the bloodstream, they infect red blood cells and multiply, causing the red blood cells to burst open after about 2 to 3 days and to release a new crop of parasites (plasmodium). The cycle of invasion, multiplication, and red blood cell rupture may be repeated many times. Four species of the parasite plasmodium are responsible for malaria in humans: *Plasmodium vivax, Plasmodium malariae, Plasmodium ovale*, and *Plasmodium falciparum*. Malaria continues to be endemic in many parts of the tropics and subtropics. Today, the number of cases is rising worldwide. Malarial parasites cause clinical illness in an estimated 300 to 500 million people every year and cause 1.5 to 2.7 million deaths per year. Most of the imported infections are acquired from tropical Africa. (http://www.healthcentral.com). Malaria is a major health problem in Indonesia and is one of the top ten diseases in Indonesia [1, 2]. Prevalence of malaria increased is not only happening in the countries of Southeast Asia, Africa, South America, Europe and even the United States, but also in Indonesia, including in South Sumatera Province. [3, 4]. According from WHO that there are more than 2400 million people or 40% of world population lives in malaria endemic areas, with the prevalence of malaria worldwide is estimated at between 300-500 millions per year and three million cases of them experienced severe complications and mortality[5]. In South Sumatra Province, there 34,052 cases of malaria, with the AMI in three regency endemic areas were OKU, (AMI 27.07) Lahat (AMI 22.08) and Muara Enim (AMI 17.53) [6]

Malaria is among the top ten most recent years, In Lahat regency, with prevalence of 16.4% in 2010. Based on quarterly data in 2011, from 30 health centers located in the region Lahat Regency, such as community health services in Bandar Jaya, Selawi, Pagar Agung, and Pseksu have highest a number of clinical malaria[7] Risk factors environmental malaria from same research such as prevalence of fever associated with parasitaemia was highly seasonal, with a peak at the beginning of the wet season. [8] Bed net use and drug consumption were negatively correlated with malariometric indices.[10] There is a statistically significant difference between variable El Niño and malaria epidemics in Colombia, Guyana, Peru and Venezuela that flooding engenders malaria epidemics in the dry coastal region of northern Peru, while droughts favor the development of epidemics in Colombia and Guyana and epidemics lag a drought by 1 year in Venezuela. In Brazil, French Guiana and Ecuador, where we did not detect an ENSO/malaria signal, non-climatic factors such as insecticide sprayings, variation in availability of anti-malaria drugs and population migration are likely to play a stronger role in malaria epidemics than ENSO-generated climatic anomalies[11]. The process of transmission of malaria in an area covering three main factors namely, the patients either

with or without clinical symptoms, presence or absence and the presence of the vector mosquito or human health, physical environmental factors, chemical, biological and socio-cultural community is very influential on the spread malaria disease. Environmental influences, changes in weather and climate, deforestation and the area that a lot of standing water, bushes and an unhealthy environment and causes environmental interactions that affect the growth of the agent of malaria[6, 12, 13)]

Lahat regency have characteristics which is an area of plantations (coffee, rubber and palm oil) and industry, located in tropical regions with humidity and high rainfall. High frequency of deforestation for the purposes of plantations and the large puddles of water from mining and quarrying industry is a breeding and resting potential breeding place for vectors malaria [7).]

II. MATERIALS AND METHODS

A. Research Design

The research design used was the case-control study aiming at the determining the significance between environmentally risky factors and the incidence of malaria in Lahat Regency. Individuals who have the disease under study, also called cases, are compared to individuals free of disease (controls) regarding past exposures. Exposure differences between cases and controls are helpful to find potential risk or protective factors. The purpose is to determine if there are one or more factors associated with the disease under study. [14)] Case-control study design was chosen because it can explain the connection time and the principle of causality a significance between variables under study so that the possibility of temporal ambiguity (temporal ambiguity) can be minimized. Cases and controls are usually selected from the same source population so that both groups had relatively comparable characteristics except disease status [15)]

B. Population and Sample

Study population (case group) is a resident of Lahat regency, in 2011 who were diagnosed as suffering from malaria based. Study population (control group) is a resident of Lahat regency, in 2011 that are not diagnosed with malaria. In this study case and control groups that included as many as 1:2, the justification of making comparisons is to increase the strength of the study (power of study)

C. Large Samples

The sample size required using the following calculation of Odds Ratio (OR) hypothesis [16)]

$$N = \frac{\{Z_{1-\alpha/2}\sqrt{2P_2(1-P_2)} + Z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\}^2}{(P_1-P_2)^2} \quad (1)$$

$$P_1 = \frac{(OR)P_2}{(OR)P_2 + (1-P_2)} \quad (2)$$

TABLE I. THE SAMPLE SIZE REQUIRED USING HYPOTHETICAL CALCULATIONS OF OR

Variabel	OR	P2	Sample (1 : 2)
Breeding Place	1,82	0,48 (Ikrayama, et al, 2005)	80 x 3 = 240
the distance of the house to the breeding place	6,1	0,33 (Friaraiyatini, et al, 2006)	9 x 3 = 27
Utilization of mosquito nets	2,4	0,65 (Erdinal et al, 2006)	57 x 3 = 171
habit of going out at night	5,54	0,14 (Ikrayama, et al, 2005)	11 x 3 = 33
use of anti-mosquito	2,3	0,55 (Erdinal et al, 2006)	48 x 3 =144

Based on the above table[12, 17, 18),] the required minimum sample obtained in this study as many as 240 people, with a comparison of cases and controls supplied with as much as 1:2 (80 people for the cases group and 160 for the control group).

D. Data Analysis

Multiple Logistic Regression test was used to analyze several independent variables with one used in dependent variable is dichotomous categories modeling test of Multiple Logistic Regression was developed from the logistic function with a value of Z is a linear summation of constants (α) plus the added β1X1 β2X2 and so on. In this case X is the independent variable. The model of Multiple Logistic Regression can be shown by the equation below [19)]

$$f(Z) = \frac{1}{1+e^{-(\alpha+\beta 1X1+\beta 2X2+\ldots+\beta iXi)}} \quad (3)$$

III. RESULTS AND DISCUSSION

TABLE II. BIVARIAT ANALYSIS

Variables	Malaria				P	OR	95%
	Yes		No				
	N	%	N	%			
Breeding Place 1.Yes 2.No	65 15	46.76 14.85	74 86	53.24 85.15	0,000	5,04	2,65-9,57
The distance of the house to the breeding place 1. 5 s/d 10 m 2. 11 s/d 20 m 3. >20 m	47 12 6	45.19 66.67 35.29	57 6 11	54.81 33.33 64.71	0,145	0,66 0,27 1,00	0,23-1,92 0,07-1,10
Utilization of mosquito nets 1.Yes 2.No	31 49	29.25 36.57	75 85	70.75 63.43	0,291	1,40	0,81-2,41
Use of anti-mosquito 1.Yes 2.No	65 15	32.02 40.54	138 22	67.98 59.46	0,411	1,45	0,71-2,97
Habit of going out at night 1.Yes 2.No	17 63	39.53 31.98	26 134	60.47	0,439	1,39	0,70-2,75

Source: Primary data results of research

IV. Risk Factors of Malaria

According the results of research statistical tests for breeding place has p value =0.000 that mean there significance between breeding place and Malaria with OR 5.04. This result is consistent with others research that found that the obtained a significance between the breeding place of malaria cases. From one of research wrote that mosquito density was estimated by night-biting indoor catches carried out during 1 yr in three regencies, with four collecting houses in each, along a transect from 0 (at the valley bottom) to 350 m (at the hilltop). These findings explain why malaria transmission is heterogeneous inside the regencies and occurs mainly around swamps in the valleys.[20] In the other research field observations in northern coastal Peru, where the prevalence of malaria is high during the agricultural season, suggested that the risk of disease varied according to the characteristics of the house and the house environment. Residual spraying of houses in the previous 6 months, living more than 100 m from a canal, a level of education equal to primary school or above and working in agriculture conferred significant protection from the risk of developing clinical malaria [21]

From result of research these factors were usage of mosquito net (OR = 10,67, 95 % CI = 0,11-0,81), existence of cattle (OR = 13,89, 95 % CI = 3,7-51,8), pesticide/ insecticide usage (OR = 9,53, 95 % CI = 1.89-47,93) and repellent usage (OR = 9,53, 95 % CI = 4,33-62,23). (22) The statistical analysis used the content analysis. The result of this research shows that the education (p value = 0,007), the knowledge (p value = 0,001) and the attitude (p value = 0,031), have significant relationship with the practice of the head of the neighborhood. The income (p value = 0,084) and the work period (p value = 0,367) have no significant relationship with the practice of the head of the neighborhood. The knowledge has significant relationship with the attitude of the head of the neighborhood (p value = 0,036).[23] Bivariate analysis showed that puddles (OR=2,909, 95% CI=1,328-6,37), the use of mosquito net (OR=4,060 95% CI=1,761- 9,360) and the use of mosquito repellent when sleeping (OR=4,210, 95% CI=1,798-,855) were significantly influence the occurrence of malaria [24]

The study objectives were to investigate breeding places, vector species of malaria and length of flying influence of Anopheles mosquito to malaria incidence among children under five years. The study was an observation al research with cross sectional design, which conducted in Lombok Regency. The sample size was 347 children under five years. The study showed that most of children's age (47.3%) was 37–59 months with no differences according to sex. The nature of breeding places were 134,70 – 750 m2 in average width, with algae, grass and moss area in water biota and mostly muddy on turbidity level except at breeding places in two sub-villages. The study founded two genuses of mosquitoes, Culex and Anopheles. The species of Anopheles that are found in the study area are An. Sundaicus, An.subpictus, An. Aconitus, An. Barbirostris, An. Minimus dan An. Anullaris. There are 9 sub villages near from the breeding places (less than 1000 m), 7 sub-villages with middle distance from the breeding places (1000 – 2000 m) and 8 sub-villages far from it (more than 2000 m). The risk of malaria occurrence was 1.78 more for children who lived near from breeding places than children who lived far from it. [25] Factors studied mosquito breeding sites were living next to large cattle barns, the use of bed net, anti-mosquito chemical, wire netting and repellent. The result of the study suggested that there are five variables related to occurrence of malaria, namely mosquito breeding sites with p value = 0,006 (OR 2,8 ; 95% CI 1,381-5,512), living next to large cattle with p value = 0,001 (OR 3,2 ; 95% CI 1,650-6,693), the use of bed net with p value = 0,017 (OR 2,4 ; 95% CI 1,226 – 4,845), the use of anti-mosquito chemicals with p value = 0,026 (OR 2,3; 95% CI 1,158 – 4,564) and the use of wire netting with p value = 0,027 (OR 2,3 ; 95% CI 1,153-4,513). Multivariate analysis showed that most dominant factors is living next to large cattle, followed by mosquito breeding sites and the use of anti-mosquito chemical.[2] From the results of statistical tests obtained (p value =0.145, so it can be concluded that the 95% confidence level, there is no a significance between distance breeding place with cases of malaria. Its not significant occur because of the homogeneity of variables, which should be made to fly the farthest distance the classification of mosquitoes, so that in the control group that did not exist around the house is still possible breeding places of contact with Anopheles mosquito. In contrast to the results of other studies that found a significance between the distance vector breeding places and residence (dwelling) on the incidence of malaria in infants. This is possible because the location is closed to is a place with a highest number of vectors. In addition, the risk of transmission of malaria depends on the Anopheles mosquito flight range is limited, usually no more than 2-3 mile from where vector breeding places ([26]) There is significance between the use of bed nets in Malaria cases. The results of statistical tests obtained (p value =0.291, so it can be concluded that the 95% confidence level, no association between the use of bed nets to malaria cases. This not significant occurs because the nets were used instead of standard insecticide treated mosquito nets (ITNs), so it is still possible contact with anopheles , in some studies in Africa are known benefits of using insecticide treated mosquito nets (ITNs) have a role in malaria control in Africa.[27] Obtained different results that the risk factors that contribute to the incidence of malaria is a habit not to use mosquito nets when sleeping (OR = 3.5). The results of statistical tests obtained (p value =0.41, so it can be concluded that the 95% confidence level, no association between use of anti-mosquito and malaria cases. It's not significant occurs because the general use of anti-mosquito before the peak mosquito activity, so it is still possible contact with the Anopheles. In the case different result with research from Budarja 2001, in Sori muda, 2007, in East Kupang regency get the risk of malaria for people who do not use mosquito repellent at night by 3.5 times, so does the incidence of malaria is a risk factor: the habit of not using drugs Mosquito repellent (OR = 12.4, 95% CI = 1.33 to 13.18)[28] Measures to prevent mosquito bites include deterrence of insects, insecticides, bed nets, because the parasite increasingly resistant to various drugs and no regimen

chemoprophylaxis that completely protects. Anopheles mosquitoes feed primarily from dusk until dawn, so that people should limit out of the house at that time and sleep using mosquito nets. There is significance between habit of going out at night and the case of malaria. The results of statistical tests obtained p value =0.439, so it can be concluded that the 95% confidence level, no association between use of anti-mosquito and malaria cases. Anopheles mosquitoes to feed by biting humans, because most of the Anopheles mosquito is active at dusk or dawn, or nocturnal (active at night), then the mosquito biting activity is always active during at the night, starting at 06:00 pm until 06:00 a.m and peaked at 12.00 pm - 01.00 pm, but there are also Anopheles mosquitoes are active in the middle of the night until late morning. Almost all respondents perform activities outside the house at night either cases or controls, such as going to the mosque to perform prayers in congregation, there is no a significance between habit of going out at night with suspected malaria incidence because of the Anopheles mosquito biting activity is generally more at 08.00 pm, while the respondents usually go home at the bottom at 08.00 pm. The activity of sucking blood balabacencis tended all night, but the peak at around 1:00 p.m. to 03:00 p.m. an activity peak blood sucking. Maculatus tends to increase at night at around 10:00 p.m. according from Sori muda, 2007 wrote, that the prevention of malaria can be done personally by wearing repellent and long sleeves, a very effective way to protect themselves from mosquito bites, while doing the activity outside house on night .[29]

In this study there were no interactions between independent variables, so that the model used is as follows:

$$Malaria = \frac{1}{1+e^{-1(0,130+1,616(BreedingPlace))}} \quad (4)$$

From this the results of multivariate analysis of variables that affect the mind that is the breeding place of malaria cases around the homes of respondents. Odds Ratio (OR) results of the study was 5.034 (95% CI: 2.65 to 9.56), this means that respondents who live around the breeding place has a chance 5.034 times the diagnosis of malaria compared with respondents around the house there are no breeding place after the controlled variables such us : the distance of the house to the breeding place, utilization of mosquito nets, habit of going out at night and use of anti-mosquito. From the model can also note the risk of malaria diagnosed in respondents who live around the breeding place. In this case the respondents who live around the breeding place were scored 1, so that it can calculate the p value (X) as follows:

$$P(X) = \frac{1}{1+e^{-1(0,130+1,616)}} = 0,85 \quad (5)$$

According of the equation above, respondents who live around the breeding place has a 85% chance of diagnosed malaria.

While the risk of malaria diagnosed in respondents who do not live around the breeding place, if respondents who do not live around the breeding place with the value 0 was

$$P(X) = \frac{1}{1+e^{-1(0,130)}} = 0,53 \quad (6)$$

According of the equation above, respondents who do not live around breeding place has a 53% chance of diagnosed malaria. This results is consistent with research from Sori muda, 2007, who found that in patients and Malaria risk is found larvae of mosquitoes around their home environment is greater than that do not suffer from malaria and the obtained value adjusted OR = 5.1 (95% CI: 2.4 -10.8). Human activity provides many of the brood are suitable for the growth of malaria vectors, such as puddles, ditches, puddles filled with rain water, rice fields with irrigation water flow. The role of entomology survey will be greater in eradication programs because it does not need to be covered 100%, so the kinds of activities that need to be implemented depends on the type and behavior of vectors in an area. Given the diversity of vectors and vector custom variations from one place to another place, it takes great effort and cost. Presence of water for irrigation around villages and houses played a major role in determining the risk of malaria. These observations were extended through an entomological study and a case–control study, (30) Temperature, humidity and rain density influenced (chi square test, $p<0.05$) the multiply of vector. Stay of breeding places supported the living of Anopheles sp. Cattle care with put of stable out dock can changed mosquitoes behavior from anthropophilic to zoophilic. Vegetation in research areas was potential as rest places of Anopheles sp. It is concluded that environment is indirect factor to influence mosquito density that cause of malaria incidence. Recommendations can be given are prevent mosquito's bites, spread the predator of Anopheles sp larva on breeding places, reporting the cases to health officer [31]

V. CONCLUSION AND SUGGESTION

A. Conclusion

1. The environmentally risky factors and the incidence of malaria in Lahat Regency, such as variable : breeding place, the distance of the house to the breeding place, utilization of mosquito nets, use of anti-mosquito and habit of going out at night
2. The most determinant malaria incidence in this research was the breeding place

B. Suggestion

1. Community and stakeholders active in malaria elimination as disease prevention and eradication of malaria, through cleaning of the breeding place, to keep the fish that are use as predators of mosquitoes, to reduce the population of Anopheles mosquito larvae and mapping the brood of mosquitoes for malaria vector control planning and broadening areas of research in different geographical conditions.

2. In malaria eradication need to be tailored to local conditions, including anopheles know the type of location, through a survey of disease vectors and reservoirs should be run simultaneously with the discovery and treatment of patients.
3. The opening of new areas of settlement construction in order to consider these aspects of a disease outbreak in the area.

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