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Malarial risk factor identification in southern Minahasa, North Celebes Manado-Indonesia



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ABSTRACT

Background: Mosquito is known as a vector for several parasitic diseases particularly Malaria. Currently, it is still one of medical urgency and one of millennium development goal of WHO. There are many risk factors of Malaria but knowing which one poses the most risk for local people is deemed necessary.

Methods: An observational-analytical case-control study was conducted in several regions of Southern Minahasa district evaluating several risk factors namely knowledge of Malaria, the presence of livestock pen, night-time activity, mosquito net usage, and house wall construction. All of the data were analyzed by using SPSS 16.

Results: All of the variables examined showed significant association with the risk of Malaria. Low level of knowledge of Malaria, infrequent

use of mosquito net and loose house wall construction were associated with higher risk for Malaria with house wall construction posed the greatest risk (OR:3,154; CI: 1,430-6,56). On the other hand, the presence of livestock pen and night time activity were associated with significantly lower risk of Malaria compared to control group (livestock pen: OR: 0,448; CI: 0,210-0,957; night-time activity: OR: 0,273; CI: 0,119-0,623).

Conclusion: Low level of knowledge of Malaria, infrequent use of mosquito net and loose house wall construction appeared to increase the risk of Malaria but the presence of livestock pen and night time activity might act as protective factors in Southern Minahasa District, North Celebes, Indonesia.

Keywords: Mosquito, Malaria, Risk Factors, Southern Minahasa

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BACKGROUND

Mosquito is known as a vector for several parasitic diseases such as Malaria, filarial disease, and dengue fever among others. Among them, Malaria is the most crucial one due to its prevalence and mortality. It is one of re-emerging disease that plague people who live in the tropical and subtropical area. In fact, it is one of disease that included in millennium development goal of WHO. The magnitude of Malaria is reflected by its prevalence in which 300-650 million people are estimated to contract the disease in 2006 with mortality rates at 1-3 million people annually which are mostly children and pregnant women. In Indonesia, the mortality rate of Malaria reaches 42.000 people annually.^{1,2}

Malaria is endemic in eastern Indonesia since the climate and ecosystem are suitable for Anopheles reproduction. However, despite the high mortality rate, the incidence of Malaria is declining nationally. The evidence of decreasing trend could be seen in the record of incidence of Malaria which was falling from 2 million in 2006 into 1.75 million in 2007. However, the same pattern does not happen in North Celebes especially Minahasa district. In 2007, there was a Malaria outbreak in Minahasa in which 1256 people infected and 74 died.³ The number of Malarial cases in North Celebes was

also increased from 17.881 in 1991 to 100.005 in 1995 with AMI reach 37.25/1000 inhabitant which included North Celebes in MIA category. All of those facts placed North Celebes as the third province with the most Malarial cases in Indonesia.⁴ Furthermore, the most prevalent Plasmodium in North Celebes is *Plasmodium falciparum* which constitutes 71.5% of cases.⁵

Most of the Malaria endemic areas are located in a remote location with the inappropriate environmental condition, inadequate transportation facilities, little health care coverage, and also the unhealthy habit of the people.⁶ Aside from those factors, the knowledge of residents also influences the risk of local populations toward Malaria. The knowledge about the disease affects the people to adopt a new habit and measure to prevent it. The evidence for this notion could be seen in a report by Rubianti et.al which showed that the level of knowledge was significantly related to the risk of contracting Malaria with the OR of low knowledge at 1.99 (p=0.02).⁷ The knowledge will ultimately affect the habits which alter the exposure to mosquito significantly. The habit that we meant were night-time activity, not using the mosquito net, hanging too many clutches in the room, not using an anti-mosquito agent, and not closing the

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window at night.⁸ In North Celebes, currently, no study evaluates these factors. Meanwhile, revealing which behavioral factors that play the greatest role could bring great benefit in this region which has a high prevalence of Malaria.

METHODS

Study Design and Location

An observational-analytical case-control study was conducted in several regions of Southern Minahasa district from April to September 2016. We aimed to evaluate the risk of each behavioral factor toward increasing risk of Malaria.

Study Population

The study population was the local inhabitant that visit local primary health care centers with established diagnosis of Malaria (confirmed by laboratory examination). The total sampling method was used in which all Malarial patients would be included until reaching the minimum number of sample. In this research, we required 56 people in control group and the other 56 in the case group. For case group, we included local inhabitant who had diagnosed with Malaria, communicable and agrees to participate. Those who were not responsive or confirmed to have diseases other than Malaria was excluded. For the control group, we include local people who did not have a history of Malaria.

Examined Variables

We evaluate several behavioral and environmental risk factors of Malaria in the study population. It included knowledge of Malaria, the presence of

livestock pen, night-time activity, mosquito net usage, and house wall construction. For knowledge, we classify the subjects based on a comparison of subject's answer to median score, and the subject could classify into sufficient and not sufficient. To evaluate the frequency of night-time activity, we use four as the boundary between frequent and not frequent category. Subjects will be classified as having livestock pen/stable if there is a livestock pen within 100 m radius from their house. Meanwhile, to assess the frequency of mosquito net usage, the frequency of 4 to 7 days a week for at least 8 hours was used to classify the subjects as a frequent category. Otherwise, the subjects will be classified as not frequent. For house wall construction, evaluation was conducted based on the density of the wall or the presence of hole larger than 1.5 cm.

Statistical Analysis

All of the data was compiled and analyze descriptively to find the proportion of each factor within the case and control group. Then, bivariate analysis was conducted to determine the odds ratio and its confidence interval (95%) for each variable. A p-value smaller than 0.05 was considered as significant, and all of the processes of statistical analysis were calculated using SPSS version 16.

RESULT

Relationship between the Levels of Knowledge of Malaria with the Risk of Malaria

Regarding the association between the levels of knowledge of Malaria with the risk of Malaria, we found a strong association between these variables. In general view, it is easily identifiable that the percentage of well-informed subjects was greater in control group compared with case group and vice versa. The association was very significant with OR at 2.778 (95%CI: 1,292-5,970) which could consider as a moderate risk factor.

Association between the Frequencies of Night-Time Activity with the Risk of Malaria

In contrast with the level of knowledge, there is no significant association between the frequencies of going out in the night with the risk of Malaria. In fact, subjects in the case group tend to have higher outside activity than the control group. The result of risk assessment also appeared to be protective with OR:0.273, which means that the malarial risk of the case group was around four times smaller than the control group.

Table 1 Respondent distribution and risk assessment between the levels of knowledge with the risk of Malaria

Level of Knowledge	Case		Control		Amount		P-Value	OR (CI 95%)
	n	%	n	%	n	%		
Insufficient	35	62,5	21	37,5	56	50	0,008	2,778 (1,292-5,970)
Sufficient	21	37,5	35	62,5	56	50		
Sum	56	100	56	100	112	100		

Table 2 Respondent distribution and risk assessment between night activity and the risk of Malaria

Level of Night-Time Activity	Case		Control		Amount		P-Value	OR (CI 95%)
	n	%	n	%	n	%		
Frequent	12	21,4	28	50	40	37,7	0,002	0,273 (0,119-0,623)
Not Frequent	44	78,6	28	50	72	64,3		
Sum	56	100	56	100	112	100		

Table 3 Proportion table of subject according to the rate of usage of mosquito net and its association with the risk of Malaria

Mosquito net usage	Case		Control		Amount		P-Value	OR (CI 95%)
	n	%	n	%	n	%		
Not Frequent	46	82,1	36	64,3	82	73,2	0,033	2,556 (1,065-6,133)
Frequent	10	17,9	20	35,7	30	26,8		
Sum	56	100	56	100	112	100		

Table 4 Distribution table of the subjects based on the construction of house wall and its association with the risk of Malaria

House Wall Construction	Case		Control		Amount		P-Value P	OR (CI 95%)
	n	%	n	%	n	%		
Loose	30	53,6	15	26,8	45	40,2	0,004	3,154 (1,430-6,56)
Dense	26	46,4	41	73,2	67	59,8		
Sum	56	100	56	100	112	100		

Table 5 The distribution of respondent based on the presence of livestock pen near the house and its association with the risk of Malaria

Keberadaan Kandang Ternak	Kasus		Kontrol		Jumlah		Nilai P	OR (CI 95%)
	n	%	n	%	n	%		
Ada	20	35,7	31	55,4	51	45,5	0,037	0,448 (0,210-0,957)
Tidak Ada	36	64,3	25	44,6	61	54,5		
Jumlah	56	100	56	100	112	100		

Association between Mosquito Net Usages with the Risk of Malaria

On the other hand, the usage of mosquito net was associated with Malaria incident. It appears that the percentage of Malaria was greater in those who not use a mosquito net. Risk assessment also showed that those who did not use mosquito net had more than double the risk of Malaria.

Association between the House Wall Constructions with the Risk of Malaria

As for mosquito net usage, the construction of house wall is also a significant risk factor for Malaria. From the distribution table, it roughly appears that the distribution of subjects who had loose house wall was higher in the case group and vice versa. Risk assessment confirmed our finding which showed OR at 3.154 with 95% CI at 1,430-6,56.

Association between the Presences of Livestock Pen with the Risk of Malaria

Regarding the presence of livestock pen, we found an interesting finding for its relationship with Malaria. The chi-square test showed a significant association, but risk assessment proved that it had

a protective effect. We found the OR at 0.448 which indicates a lower risk compared to control.

DISCUSSION

Today, malaria still one of a medical emergency in tropical countries and contributes to millions of death every year.⁹ WHO had already established necessary measures required for Malarial prevention and treatments.⁹ However, since Malaria tends to occur in the rural area, the knowledge about mosquito diversity and the risk factors that prevalent among local inhabitant is deemed necessary.⁷ From several kinds of literature, we identify some risk factors that increase the risk of Malaria and they were evaluated in our research: the level of knowledge of Malaria, the usage of mosquito net, the frequency of night activity, the presence of livestock pen, and house wall construction.⁸

We found that the level of knowledge about Malaria among local people was significantly associated with the risk of contracting Malaria. Specifically, insufficient knowledge about Malaria increased the risk of Malaria more than two times higher than control. Low level of education of the local people seems to be the underlying cause of this phenomenon. Most of the people in Southern Minahasa have junior high school level of education and thus poorly informed about Malaria. This lack of education and information had been investigated in several others local study in Indonesia. Bagaray et.al this association in Kei District of South-Eastern Maluku and found that people with insufficient knowledge of Malaria had higher risk contracting the disease.¹⁰ However, a study by Hidayat et.al in Batam city of Riau province found no association at all.¹¹ It seems that the level of knowledge only affects the risk of Malaria in a rural area instead of the urban area.⁷ There is also the possibility that the diversity of Anopheles species significantly influence the magnitude of the risk posed by the lack of knowledge of Malaria.¹¹

Night-time activity rate is currently perceived as one of the risk factors for Malaria. The evidence could be seen in Ghana where the incidence of Malaria remain high despite the widespread distribution of Insecticide-treated mosquito net (ITN) and Indoor Residual Sprayer (IRS).¹² The cause of this phenomenon was the high night-time activity of people in Ghana so even if they are protected inside the house, they are highly exposed outside. Furthermore, the majority of Anopheles species in Ghana, *Anopheles arabiensis*, is exophilic. In contrast, we did not find any significant association between night-time activities with the risk of Malaria. The night-time activity even seems to be

a protective factor against Malaria. The possible explanation is most *Anopheles* species in Southern Minahasa might be endophytic, or the exophytic species does not transmit Plasmodium.

In every region where mosquitoes pose a significant challenge, a mosquito net is one of the best methods to prevent mosquito bite and, hence, parasitic transmission.¹³ Most studies also showed that mosquito net, especially the insecticide impregnated ones, proved to be efficient in reducing the prevalence of Malaria.^{13,14,15} Lindblade et.al also provided the data of reduced Malaria incidence among children after the usage of ITN.¹³ Furthermore, Sharma et.al also revealed that ITN was superior to non-insecticide treated mosquito net in preventing Malaria transmission.¹⁵ Our finding was also consistent with those studies. We found that people that were not used mosquito net had 2.5 times higher risk of contracting Malaria. However, we did not evaluate whether the net was impregnated or not impregnated with insecticide.

Other than aforementioned Malarial risk factors, we also evaluated two other risk factors: wall structure and density and the presence of livestock pen.^{16,8} House wall density depends on the material used to build the wall. The wooden material, especially woven wood, usually results in the loose wall with many small holes. This type of construction would enable mosquito to enter the house via holes and thus poses a high risk to Malarial transmission. It also confirmed by several studies that assess various Malarial risks in Bangladesh and Uganda.^{8,17} They found that wall construction was a major risk factor of Malaria which increases the risk roughly 2 times higher than control.

On the other hand, the presence of livestock pen around the house provides significant protection against Malaria.^{16,18} The reason behind this notion is because *Anopheles* also have a tendency to feed on animals, so the presence of livestock pen will draw the mosquitoes attention and divert it from human settlements.¹⁶ Several studies had assessed the prophylaxis effect provided by livestock pen. In particular, Zohdy et.al found that *Anopheles* was 2.63 times more likely to be found in livestock pen compared to human settlements.¹⁸ Franco et.al also stated the potential application of livestock pen as one health intervention to prevent Malaria.¹⁶ However, no studies report the risk reduction provided by the presence of livestock pen. In our study, we found that it halve the risk of Malaria compared by those who lived far or without it. Nevertheless, the efficiency of livestock pen in preventing Malaria should be studied in combination with local species diversity since different species of *Anopheles* tend to have a different preference either toward animal or human.

CONCLUSION

In conclusion, the level of knowledge, the usage of mosquito net, wall density, and the rate of night-time activity were significant Malarial risk factors in Southern Minahasa. Meanwhile, the presence of livestock pen was a protective factor because it tends to divert the mosquito from human settlements. Nevertheless, the result should be interpreted carefully especially considering the diversity of *Anopheles* species and diversity among the endemic regions.

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