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Dominant Malaria Risk Factors in Keerom Papua, Indonesia: A Prospective Cohort Study Analyzed by Multivariate Logistic Regression

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***Abstract*- Introduction:** Keerom regency is the most prevalent malaria in Papua (17.7%). The control program launched since 1963 were not able to decrease the prevalence. It is necessary to find out the dominant malaria risk factors in order to enhance the malaria control program.

Methods:

A prospective cohort prognostic study followed 606 subjects for three months to find out the malaria dominant risk factors. Prior to finding the dominant risk factors, bivariate analysis using chi square and multivariate logistic regression were used in this study.

Results:

Among 15 identified risk factors (namely sex, age, ethnic group, education, duration of stay at Keerom, nutritional status, socio economic status, forest activity, drug prevention, using insecticide, using insecticide treated nets, night time activity, animals around the house, the distant of breeding places and health centers from house), only 6 risk factors considered as dominant risk factors. The dominant risk factors are socio economic status (RR 1,430 95% CI 1,025- 1,995), night time activity (RR 1,624 95% CI 1,030-2,561), sex (RR 1,543 95% CI 1,116-2,133), forest activity (RR 0,587 95% CI 0,369-0,943), nutritional status (RR 1,405 95% CI 1,017-1,941) and duration of stay at Keerom (RR 2,519 95% CI 1,462-4,340).

Conclusion:

There were 6 risk factors considered as dominant risk factors in Keerom. Hopefully this finding could be used to enhance the malaria control program in Keerom.

***Index Terms*-** Dominant risk factors, malaria

I. Introduction

Indonesia was considered has the highest malaria prevalence and incidence in South East Asia. The population at risk was 31,427,995 out of 244,420,912 people or 12.86% and causing Malaria Mortality Rate of 0.83/100,000. This number posted Indonesia as the third country after Timor Leste (4.90/100,000) and Myanmar (2.40/100,000). This condition could be understood since the Annual Parasite Incidence of Indonesia was $4.37^0/_{00.}$ compared to Timor Leste and Myanmar which has the Annual Parasite Incidence of $43.93^0/_{00}$ and $10.21^0/_{00}$ respectively [1]

Based on clinical finding, the national prevalence of malaria in Indonesia was 2.85%. This prevalence mainly contributed by 3 provinces namely West Papua (26.1%), Papua (18.7%) and East Nusa Tenggara (12.0%). A survey conducted by Ministry of Health showed the average prevalence in Papua was 65.5% (diagnosed clinically) or 18.7% (smear examination). Among the 29 regencies in Papua, Keerom showed the highest prevalence (82.1% clinically and 17.7% smear examination) [2, 3].

The purposes of this study are to find out the dominant malaria risk factors in Keerom in order to enhance the malaria control in Keerom. As much as possible literatures from all over the malaria countries were used to collect the risk factors so they could be used to find out the dominant risk factors in Keerom.

II. Methods

A prospective cohort study for 3 months was done. The data were analysed with bivariate and logistic regression in order to find out the main malaria risk factors.

Study area:

The study was carried out at Keerom Regency, Papua, Indonesia. Keerom with 46,282 inhabitants is located in the southern part of Jayapura which is the capital of Papua [4]. Keerom is divided into six districts (Web, Senggi, Waris, Arso, Arso Timur, Skanto). The regency is located in low land area 4 m above sea level. The climate and weather are homogeneous all over Keerom. Hence, climate and weather are not considered having any influences in this study.

Subjects:

Twenty five blocks census and 10 families in every block census were chosen randomly from 6 districts. The average number of family member is 4.289, so that the number of subjects chosen was around 1.000. However a total of 777 subjects were able to collect in this study.

A questionnaire inquiring for malaria risk factors was administered and physical and smear examination for malaria were done to all subjects (including collection of body weight, height and urine test for β HCG). The positive malaria subjects were excluded from study and the remaining (606 subjects) followed for 3 months for prospective cohort study.

Those considered as malaria risk factors are sex, age, ethnic group, education level, duration of stay at Keerom, nutritional status, socio economic status, forest activity, drug prevention, using insecticide, using insecticide treated bed nets, night time activity, animals around the house, the distant of breeding places and Health Centers from house.

There are many ethnics group who lived in Keerom. Some of them are local people with several tribes and the others are ethnics who came from other part on Indonesia. For simplicity the ethnics in Keerom was divided in two ethnics group, the Papuans (the local people) and Non Papuans (from other part of Indonesia).

The nutritional status in this study was measured by age (0-5; 6-17 and 18+ years), weights and heights according to WHO and Blössner et al [5, 6]. Therefore in this study ages was grouped into this manner. Nutritional status was defined as poor (under nourished and overweight) and normal. People in poor nutritional status prompt to easily getting malaria.

The socio economic status in this study defined as the amount of expenses per person per month with the cut off value of IDR.280000 or $23.3 [7].

The education was influencing malaria occurrence as shown in Sulawesi (Indonesia), some countries in Africa and Vietnam [8-11]. Thang divided the education level to None, Primary school and Secondary school or higher. These levels of education were used in this study as well.

Statistical analysis:

Data were double entered, checked and cleaned. The data set analyzed with Statistical Product for Service Solutions (SPSS) version 19. Descriptive statistics and chi-square test were used to test for significant difference ($p<0.05$). A logistic regression was used to carry out a multivariate analysis for the malaria risk factors.

Ethical consideration:

The study was approved by the ethical committee of Faculty Medicine Hasanuddin University, Makassar, Indonesia. The fundamental principles of ethics in research on human participants were upheld throughout the study. The research procedures were disclosed to the participants and informed consent was sought from them or their legal representatives. Nobody was coerced into the study and if individuals wished to withdraw, they were allowed to do so without prejudice.

III. Results

There were 777 people in the study, but after checked their malaria condition with blood smear examination, 171 people excluded from the study. The cohort started with 606 negative smear examination people who were then followed up for 3 months to check their malaria condition again.

Among the 606 participants (Table 1), 72.4% were represented by Non Papuans and mostly above 18 years of age. Keerom is new developed regency and inhabited by 76.6% people who stayed no longer than 2 years. Most of the people worked as government officials especially the Non Papuans and only 23.1% as forest workers either as peasant or hunter. People whose living expenses under IDR.280000 were 25.9% and the rest considered living above the poverty line. In total 32.2% of the population were in poor nutrition status (under nourished and overweight). Keerom still a remote area surrounding with jungle, accordingly only 8.1% people have night time activity.

The environment factors in relation with malaria occurrence were the distant of breeding places and the distant of Health Center to house. The distant of breeding places that was less than 500 m from housing (22.8%) considered at high risk. Similarly the distant of health center more than 500 m (23.4%). More than half population (67.3%) used ITN (Insecticide Treated Nets) and few additional people were sleeping without bed net. As commonly happens, animals around the house could protect against mosquito bite especially the zoophilic anopheles and in turn could prevent malaria occurrence. Without understanding of this knowledge more than half people in Keerom breed their animals around their house (56.3%).

Most people have negative blood smear examination after 3 months followed up (80.2%) the additional people (19.8%) were positive. This finding slightly higher than the results of the former survey conducted in Keerom (17.7%) [3]

To find out the dominant malaria risk factors, a bivariate and multivariate analysis was done. The bivariate analysis showed that 10 out of 15 risk factors have $p < 0.05$ (Table 2). Those with $p< 0.05$ could be further analyzed by backward stepwise multivariate logistic regression. However, only 6 risk factors considered as the main risk factors connected to the malaria occurrence (Table 3).

IV. Discussion

Keerom is a new regency and gave a plenty opportunities for works. Many people came to Keerom from other part of Papua and Indonesia for work. Almost all of them were susceptible to malaria and have no immunity at all. Therefore malaria prevalence in Keerom was very high. Several efforts have been done to control, however the prevalence still very high. The last survey done in this area reveal the prevalence of 17.7% [3]. The main effort to eliminate malaria in Keerom was media campaign, prevention against mosquito bite such as insecticide, ITN (Insecticide Treated Nets) and Indoors Residual Spraying.

Some aspects have to be taken into consideration in choosing risk factors analyzed in the study. In addition the risk factors have to be chosen statistically and based on the literatures. There were 10 out of 15 risk factors could be found using chi square test as shown in Table 2.

If female factor considered as reference, it showed that male likely 1.543 times having malaria than female. This finding was correspond to the former study in Papua [3].

The Papuans commonly practicing subsistence agriculture and exploit forest product, yet the Non Papuans who are transmigrated from Java mostly work as government official and as peasant in the forest. The Papuans is more resistant to malaria than the Non Papuans [12]. This condition was in relation with the duration of stay in endemic area and the immunity against malaria. Accordingly people who were stayed longer than 2 years in Papua were more resistant to malaria than those who were stayed less than 2 years [13]. In this study, ethnic groups considered as a risk factor. Non Papuans has higher prevalence than Papuans. It could be understood since the Non Papuans, who came from non-endemic area, has low immunity against malaria than Papuans unless they already stayed longer in Papua [12].

Duration of stay in Keerom has a big influence in malaria occurrence as shown in Table 2. This finding very much correspond to the study of Barcus et al [13] where immunity to malaria is the main factor influencing malaria occurrence.

The other risk factor was education level. The education level together with knowledge and behavior gave a big contribution to malaria occurrence [8, 9, 11]. The lower education level should have the higher malaria prevalence, but this study showed the other way round (Table 2). This situation could be happened since many others factor influenced the malaria occurrence in Keerom and have to be analyzed further.
Many studies showed that nutritional status influenced the malaria occurrence and vice versa [14, 15]. Poor nutritional status prompts to high occurrence of malaria than the normal nutritional status, as shown in this study (Table 2) and correspond to the former study in Papua [3].

The other risk factor is socio economic status. There is a relationship between malaria and socio economic status [15-17]. In Vietnam and some other countries the main malaria risk factor was poverty [11, 17]. In this study the lower socio economic status more likely to have malaria occurrence 1.430 times than the higher socio economic status (p=0.038).

According to Thang, malaria prevalence was higher in people who have forest activity [11]. In this study we found that the prevalence was lower in people who have not forest activity. Since Keerom is newly developed regency, many people from non-endemic area came for works, many forests were opened to find more space and many people live near the forest. Accordingly this situation caused a high prevalence of malaria. This situation could influence the relation between forest activity and malaria occurrence in Keerom.

The above explanation could also explain why the night time activity and not using ITN have a lower prevalence in this study and why this study not correspond to the former study by Abdella and Safeukui-Noubissi [10, 18].

The last factor included in the bivariate analysis was breeding places distant. In this study we found that the breeding place distant was a malaria risk factor similar to study by Alemu and Barbieri [19, 20].

The bivariate analysis and logistic regression eliminated those 10 risk factors and the remaining 6 factors considered as main risk factors namely sex, socio economic status, night time activity, forest activity, duration of stay and nutritional status.

V. Conclusions

There are 6 dominant malaria risk factors in Keerom. Hopefully these 6 risk factors could be used to enhance malaria control program in Keerom.

Authors' Contributions

All the authors participated significantly in the analysis, drafting of the manuscript and writing the final version of the paper. BS conceptualized the study. NN, AA and AN contributed towards the statistical analysis.

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Table 1 Baseline characteristic of the study population

	Study population n = 606	n	%
1	Ethnic groups		
	- Non Papuans	439	72.4
	- Papuans *)	167	27.6
2	Sex		
	- Female	328	54.1
	- Male*)	278	45.9
3	Age groups		
	- 0-5 years	18	3.0
	- 6-17 years	81	13.4
	- >18 years *)	507	83.7
4	Duration of stay		
	- < 2 years	464	76.6
	- > 2 years *)	142	23.4
5	Education level		
	- None	76	12.5
	- Primary school	207	34.2
	- Secondary school or higher *)	323	53.3
6	Socio economic status (based on the expenses per person per months		
	- < IDR.280,000	157	25.9
	- > IDR.280,000 *)	449	74.1
7	Forest activity		
	- Yes	140	23.1
	- No *)	466	76.9
8	Night time activity		
	- Yes	49	8.1
	- No *)	557	91.9
9	Drug prevention		
	- No	378	62.4
	- Yes *)	228	37.6
10	Using insecticide		
	- No	335	55.3
	- Yes *)	271	44.7
11	Using Insecticide Treated Nets (ITN)		
	- No	198	32.7
	- Yes *)	408	67.3
12	Animals around the house		
	- No	265	43.7
	- Yes *)	341	56.3
13	Nutritional status		
	- Poor	195	32.2
	- Normal *)	411	67.8
14	Distant to breeding places		
	- < 500 m	138	22.8
	- > 500 m *)	468	77.2
15	Distant to health services (health centers)		
	- > 500 m	142	23.4

	- 250-500 m	132	21.8
	- < 250 m *)	332	54.8
16	Blood smear examination		
	- Positive	120	19.8
	- Negative	486	80.2

*)Reference

Table 2 Risk factors, bivariate analysis

Variables	Blood smear examination				p value	RR	95% CI	
	Positive		Negative				Min	Max
	n	%	n	%				
Sex								
Male	68	24,5	210	75,5	**0,008**	1,543	1,116	2,133
Female*)	52	15,9	276	84,1				
Age								
0-5 y	4	22,2	14	77,8	0,804			
6-17 y	18	22,2	63	77,8				
>18 y*)	98	19,3	409	80,7				
Ethnic groups								
Non Papuans	95	21,6	344	78,4	**0,006**	1,446	0,966	2,163
Papuans*)	25	15,0	142	85,0				
Education level								
None	11	14,5	65	85,5	**0,016**			
Primary school	31	15,0	176	85,0				
>Secondary school*)	78	24,1	245	75,9				
Duration of stay								
≤2 years	107	23,1	357	76,9	**0,000**	2,519	1,462	4,340
>2 years*)	13	9,2	129	90,8				
Nutritional status								
Poor	48	24,6	147	75,4	**0,041**	1,405	1,017	1,941
Normal*)	72	17,5	339	82,5				
Socio economic status								
< IDR.280000	40	25,5	117	74,5	**0,038**	1,430	1,025	1,995
> IDR.280000	80	17,8	369	82,2				
Forest activity								
Yes	18	12,9	122	87,1	**0,019**	0,587	0,369	0,934
No*)	102	21,9	364	78,1				
Drug prevention								
No	72	19,0	306	81,0	0,549	0,905	0,653	1,254
Yes*)	48	21,1	180	78,9				
Using insecticide								
No	57	17,0	278	83,0	0,056	0,732	0,531	1,008
Yes*)	63	23,2	208	76,8				
ITN								
No	30	15,2	168	84,8	**0,045**	0,687	0,471	1,001
Yes*)	90	22,1	318	77,9				
Night time activity								
Yes	15	30,6	34	69,4	**0,048**	1,624	1,030	2,561
No*)	237	34,8	445	65,2				
Animals around the house					0,754	1,053	0,763	1,453
No	54	20,4	211	79,6				
Yes*)	66	19,4	275	80,6				
Breeding places distant					**0,009**	1,572	1,125	2,196

≤500 m	38	27,5	100	72,5	
>500 m*)	82	17,5	386	82,5	
Health centers distant					
>500 m	30	21,1	112	78,9	0,898
250-500 m	26	19,7	106	80,3	
< 250 m*)	64	19,3	268	80,7	

Table 3 Backward stepwise logistic regression of the malaria risk factors

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	Socio economic status(1)	.389	.257	2.298	1	.130	1.476	.892	2.442
	Night time activity(1)	.717	.358	4.009	1	.045	2.049	1.015	4.136
	Sex(1)	.599	.216	7.665	1	.006	1.820	1.191	2.780
	Education level			1.979	2	.372			
	Education level (1)	-.271	.386	.495	1	.482	.762	.358	1.624
	Education level (2)	-.359	.263	1.864	1	.172	.699	.417	1.169
	Forest activity(1)	-.363	.321	1.280	1	.258	.696	.371	1.305
	ITN(1)	-.325	.257	1.594	1	.207	.723	.437	1.196
	Breeding places distant(1)	.238	.267	.791	1	.374	1.268	.751	2.141
	Nutrition status(1)	.631	.229	7.582	1	.006	1.880	1.200	2.947
	Duration of stay(1)	1.091	.331	10.848	1	.001	2.977	1.555	5.698
	Constant	-2.747	.391	49.447	1	.000	.064		
Step 2[a]	Socio economic status(1)	.483	.234	4.266	1	.039	1.621	1.025	2.563
	Night time activity(1)	.753	.355	4.498	1	.034	2.124	1.059	4.262
	Sex(1)	.597	.216	7.641	1	.006	1.817	1.190	2.774
	Education level			2.274	2	.321			
	Education level (1)	-.311	.383	.660	1	.417	.733	.346	1.552
	Education level (2)	-.377	.261	2.080	1	.149	.686	.411	1.145
	Forest activity(1)	-.402	.318	1.599	1	.206	.669	.359	1.247
	ITN(1)	-.303	.256	1.398	1	.237	.739	.447	1.220
	Nutrition status(1)	.613	.228	7.231	1	.007	1.846	1.181	2.885
	Duration of stay(1)	1.120	.330	11.527	1	.001	3.066	1.606	5.855
	Constant	-2.722	.390	48.838	1	.000	.066		
Step 3[a]	Socio economic status(1)	.492	.233	4.453	1	.035	1.635	1.036	2.583
	Night time activity(1)	.721	.351	4.229	1	.040	2.057	1.034	4.090
	Sex(1)	.614	.215	8.150	1	.004	1.848	1.212	2.816
	Forest activity(1)	-.537	.305	3.107	1	.078	.584	.322	1.062
	ITN(1)	-.332	.250	1.755	1	.185	.718	.439	1.172
	Nutrition status(1)	.562	.225	6.260	1	.012	1.754	1.129	2.724
	Duration of stay(1)	1.210	.325	13.869	1	.000	3.354	1.774	6.340
	Constant	-2.902	.373	60.399	1	.000	.055		
Step 4[a]	Socio economic status(1)	.479	.232	4.243	1	.039	1.614	1.024	2.546
	Night time activity(1)	.725	.352	4.252	1	.039	2.064	1.037	4.112
	Sex(1)	.608	.214	8.042	1	.005	1.837	1.207	2.796
	Forest activity(1)	-.652	.292	4.979	1	.026	.521	.294	.924
	Nutrition status(1)	.564	.224	6.326	1	.012	1.757	1.132	2.726
	Duration of stay(1)	1.219	.324	14.123	1	.000	3.384	1.792	6.391
	Constant	-2.978	.370	64.941	1	.000	.051		

a. Variable(s) entered on step 1: Socio economic status, Night time activity, Sex, Education level, Forest activity, ITN, Breeding places distant, Nutrition status, Duration of stay.