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Environmental and Behavioral Factors in Malaria Endemic and Non- Endemic Villages of Jampea Island Districts, Selayar Island Regency Indonesia

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Jampea Island is included in the malaria intermediate endemic area, but this area is interested to study because there are 3 villages without malaria cases for the last three years. The aims of the study were to determine the difference in the physical environment and social behavior of malaria endemic and non-endemic villages in Jampea Island, Selayar Island Regency. This study was observational with cross sectional study design. The study was conducted in the village with endemic status, Bontobaru village and non-endemic, Ujung village. Respondents were 110 households. Data were analyzed proportional discrepancy test and logistic regression. The result of proportional discrepancy test identified the value of variables of water puddle, shrubs, ceiling, wall type, floor type, the use of wire netting, and evenings go out habit was p<0.05 which indicated a difference between malaria endemic and non-endemic villages in the Jampea Island. Based on logistic regression test, in endemic areas p-value of puddle variable was p<0,05, and in non-endemic areas evenings out behavior variables was p<0,05. Anopheles sp. larvae species found on the Jampea island were An. vagus, An. supbictus, An. indefinitus, and An. barbirostis. This study concluded that there were differences, the presence of puddle and shrubs was the most influential factors in endemic areas, while in non-endemic areas the behavior factor of going out at night was the most influential.

Keywords: Malaria Endemicity; Physical Environment; Preventive Behaviour.

Malaria is found in almost all regions in Indonesia, about 50 percent of the Indonesian population is prone to malaria, especially in rural areas and among the poor. The most malaria areas are located outside Java, especially eastern Indonesia, from East Nusa Tenggara to Maluku and Papua. The areas of Sumatra, Kalimantan and Sulawesi have moderate malaria transmission rates. Jakarta and Bali have malaria transmission rates between zero and low[1].

The transmission of malaria is caused by various factors, including: uncontrolled environmental changes that can lead to breeding places for malaria mosquitoes, the number of

Anopheles sp mosquitoes that have been confirmed as malaria vectors (17 species) from various habitats, population mobility to and from endemic areas, behavior that is allows for transmission, resistant parasites, and limited access to health services due to geographical, economic and resource barriers[2]. Disease is the result of an interactive relationship between humans and the environment, between behavior and environmental components that have the potential for disease. Disease patterns appear to differ from one population group to another due to differences in environmental conditions or the diversity of ecosystems and behavior of local residents[3].

The biggest risk factors for malaria infection were the low ratio of mosquito net beds per household, the construction of the walls of the house, and the density of the occupants of the house[4]. The high incidence of malaria is associated with living near rivers and the habit of sleeping late. A house that is clear of all vegetation within 50m and distant forest is lower risk[5]. Living in areas where there was ground water (OR = 2.1) and less than 1 km from their homes are more likely to be infected with malaria than those living far away at a distance of more than 1 km[6].

Jampea Island is an island that is separated from the mainland of the Selayar Islands Regency, with an API (Annual Parasite Incidence) of malaria, namely in 2016 of the API value = 0.12‰, that increased in 2017 of API = 0.6‰, and 2018 API of 1.43‰[7]. Jampea Island, as an archipelago located in a remote area with various environmental factors that support the emergence of malaria. Jampea Island is included in the area of moderate endemicity and low endemicity of malaria, but it is interesting to study further because there are villages in the last three years without any positive cases of malaria.

The study aimed to determine the differences in the physical environment outside the house, inside the house, and the behavior of people in malaria endemic and non-endemic areas on Jampea Island, Selayar Islands Regency.

MATERIALS AND METHODS

The study was conducted in two villages of Jampea Island, Selayar Islands Regency (Figure 1). The Malaria endemic village was Bontobaru Village because it had the highest Malaria API value among other villages for the last 3 years. The Malaria non-endemic villages was Ujung Village where there have been no malaria cases for the last three years.

The type of study was an observational study with a Cross Sectional Study design. The independent variables in this study were the physical environment variables outside the house, namely the presence of puddles, shrubs, cattle pen, and the physical environment variables in the house, namely the presence of ceilings, types of walls, ventilation, use of screen in ventilation, type of floor, density of occupants, and behavioral variables, namely going out at night, using mosquito nets and mosquito repellent. The intermediate variable was the density of anopheles larvae and their species, while the dependent variable was malaria endemicity.

The sample in this study amounted to 110 household, each of 58 household in Bontobaru Village and 52 household in Ujung Village. The sampling method is by systematic sampling.

Data analysis: Field observation data and interviews were analyzed using the SPSS 21 for Window program and statistical tests using bivariate proportion difference test and multivariate logistic regression.

RESULTS

There were 67.2% houses in malaria endemic areas that had puddle, 31.0% had shrubs, 70.7% had cattle pens, 77.6% houses did not have ceiling, 89.7% had walls made of wood/bamboo, none of the houses used screens for ventilation, 86.2% had board/ground floors, 63.8% of houses classified as densely populated, 53.4% had night out behavior, 86.2% were use mosquito nets, and 43.1% use mosquito coil, while houses in non-endemic areas only 17.3% had puddle, 7.7% had shrubs, 55.8% had cattle pens. 53.8% had no ceiling, 59.6% had wood/ bamboo walls. 13.5% used screen for ventilation, 59.6% had board/ ground floors, 53.8% houses were classified as densely populated, 23.1% had a habit of going out at night, 80.8% used mosquito nets, and 53.8% used mosquito coils. (See Table 1).

In endemic areas, out of 39 puddles that had potential as habitat for Anopheles

larvae observed, 11 (28.2%) positive habitats for Anopheles larvae were found in lagoons, ponds, and swamps, in small ditches. Meanwhile, in non-endemic areas, out of 9 puddles that have the potential as habitat for Anopheles larvae, only 1 (11.1%) positive habitat for Anopheles larvae was observed, namely the rice field type. In both endemic and non-endemic areas, the average larval density level is above 1, which is between 1.4 – 5.8. Four species of Anopheles were found, namely *An. subpictus, An.vagus, An. indefinitus*, and *An. barbirostris*. *An. subpictus* species were more commonly found in almost all breeding habitats compared to other species. (Table 2)

The results of the proportion test stated that there were significant differences in the presence of puddle (ground water) (p = 0.000), the presence of shrubs (p = 0.01), the presence of house ceilings (p = 0.009), the type of house walls (p = 0.000), the use of screen on ventilation (p=0.007), type of floor (p=0.002), and night out behavior (p=0.001) between endemic areas and non-endemic areas of malaria on Jampea Island. On the other hand, there was no significant difference in the presence of cattle pen (p=0.108), occupancy density (0.294), behavior using mosquito nets (p=0.446), and behavior using mosquito coil (p=0.224) between endemic areas and non-endemic areas for malaria on Jampea Island (as shown in Table 1). Based on the results of the logistic regression test, the presence of puddles and shrubs were the most influential factor in endemic areas, while in non-endemic areas the behavior of going out at night was the most influential. (Table 3)

DISCUSSION

The study found that there were differences in the presence of puddle (ground water), the presence of shrubs, the presence of house ceilings, types of house walls, screens for ventilation, types of floors, and night out behavior between endemic areas and non-endemic areas of malaria on Jampea Island. On the other hand, there was no significant difference in the presence of cattle pens, density of occupants of the house, behavior of using mosquito nets, and behavior of using mosquito coil between endemic areas and non-endemic areas of malaria on Jampea Island. The larval species of Anopheles sp. found on Jampea Island, namely *An. vagus, An. supbictus, An. indefinitus,* and *An. barbirostis*.

The results of the physical environment outside the house, namely puddle (ground water) distance was similar to study of Bello and Hassan[8]; Firman et al[9]; Rejeki et al[10], that the distance of mosquito breeding sites (lagoons) observed around the house (0-1000 m) that affected (or became as risk factors) the incidence of malaria. The similar results with Suarni's study[11], that the presence of shrubs was an environmental factor that affect the

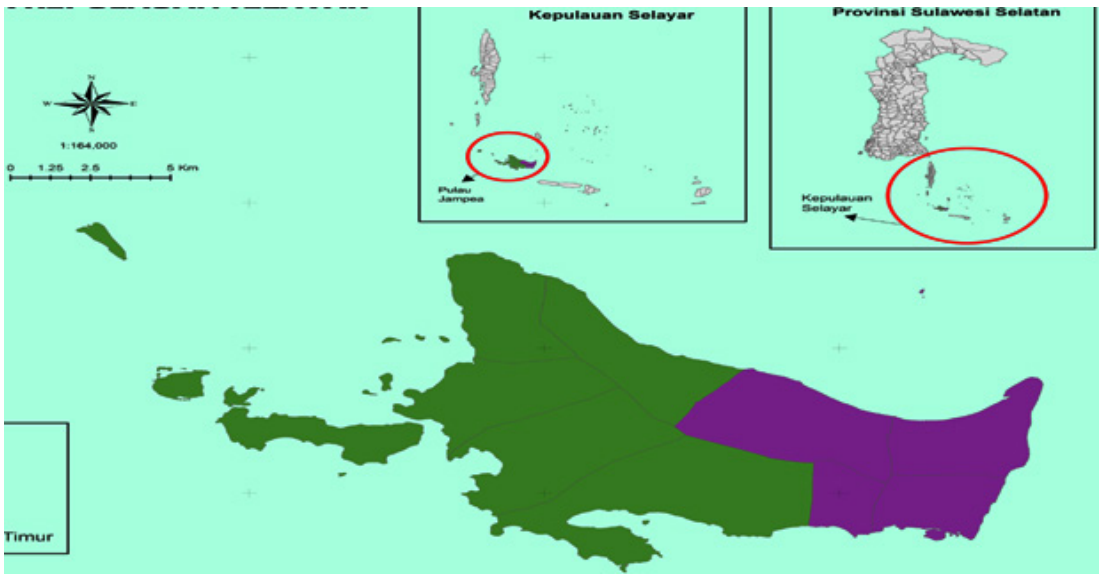

Fig. 1. Map of study location on Jampea Island

Table 1. Recapitulation of Bivariate Analysis Results of Environmental and Behavioral Factors

Variables	Category	Endemic		Non-endemic		No	Z	Siqnificant		Note
		n	%	n	%	n	%	Value		
Puddle	Present	39	67,2	9	17,3	48	43,6			siqnificant
None	19	32,8	43	82,7	62	56,4	6,114	0,000		
Total	58	100	52	100	110	100				
Shrubs	present	18	31,0	4	7,7	22	20,0			siqnificant
None	40	69,0	48	92,3	88	80,0	2,635	0.01		
Total	58	100	52	100	110	100				
Cattle	Present	41	70,7	29	55,8	70	63,6			Not
pen	None	17	29,3	23	44,2	40	36,4	1,621	0.108	
Total	58	100	52	100	110	100				
Ceiling	Present	13	22,4	24	46,2	37	33,6			siqnificant
None	45	77,6	28	53,8	73	66,4	-2,667	0.009		
Total	58	100	52	100	110	100				
Wall	Cement	6	10,3	21	40,4	27	24,5			siqnificant
Type	Wood/bambo	52	89,7	31	59,6	83	75,5	-3,770	0.000	
Total	58	100	52	100	110	100				
Ventilation	Present	58	100	52	100	110	100			siqnificant
None	0	0	0	0	0	0	–	–		
Jumlah	58	100	52	100	110	100				
Screen on	Use	0	0	7	13,5	7	6,4			siqnificant
Ventilation	None	58	100	45	86,5	103	93,6	-2,817	0.007	
Jumlah	58	100	52	100	110	100				
Floor	Cement	8	13,8	21	40,4	29	26,4			siqnificant
Type	Board/ground	50	86,2	31	59,6	81	73,6	-3,223	0.002	
Total	58	100	52	100	110	100				
Occupancy	Solid	37	63,8	28	53,8	65	59,1			Not
density	Not	21	36,2	24	46,2	45	40,9	1,005	0.294	
Total	58	100	52	100	110	100				
Night out	Yes	31	53,4	12	23,1	43	39,1			siqnificant
behavior	Not	27	46,6	40	76,9	67	60,9	3,429	0.001	
Jumlah	58	100	52	100	110	100				
Mosquito	Use	50	86,2	42	80,8	92	83,6			Not
Net	Not	8	13,8	10	19,2	18	16,4	0,765	0.446	
Total	58	100	52	100	110	100				
Mosquito	Use	25	43,1	28	53,8	53	48,2			Not
coil	Not	33	56,9	24	46,2	57	51,8	-1,122	0.224	
Total	58	100	52	100	110	100				

Source: Primary data

level of malaria endemicity. The presence of shrubs was a resting place for the Anopheles mosquito. However, the similar study conducted by Rejeki et al[10], stated that the presence of cattle pens did not affect the incidence of malaria.

The physical environment inside the house, namely the presence of ceilings was similar with Rejeki et al[10]; Charla's study[12] that the presence of a ceiling was a factor that affect the incidence of malaria. The presence of a ceiling provides protection against the entry of malaria mosquitos into the house. Rejeki et al[10]; Siregar and Saragih's study[13] revealed the similar results that the walls of wooden/bamboo houses were at risk of malaria transmission. The use of screen in ventilation in several studies revealed a significant relationship with the incidence of malaria. The results of the study by Apriliani et al[14], that most (83.9%) did not use screen in the ventilation of malaria sufferers' homes. The study of Bello et al[8] showed that the high prevalence of Malaria without screens on the windows/doors of the house.

The study was similar with study by Ayele[15], which showed that malaria was found to be higher in ground floor houses. The study conducted in rural Rajashtan, India suggests that the floor was the main resting place in both DDT-sprayed and unsprayed villages[16]. The results of this study were reinforced by the study of Theresia et al[17], that respondents who live in houses where the

Table 2. Distribution of Anopheles sp. Larva Densities in Malaria endemic and non-endemic areas in Jampea Island

Location	Type Breeding Place	Larvae Density (no larvae/5 dips)	Species of *Anopheles sp.*
Endemic village	Ditch 6	9	*An,vagus*
	Ditch 9	7	*An.supbictus*
	Lagoon 1	13	*An.supbictus*
	Lagoon 2	12	*An.supbictus*
	Lagoon 4	20	*An.supbictusAn.indefinitus*
	Lagoon 7	13	*An.supbictusAn.indefinitus*
	Fish Pond 3	29	*An.supbictus*
	Fish pond 4	21	*An.supbictus*
	Fish Pond 10	24	*An.subpictus*
	Swamp 2	10	*An.barbirostis*
Non-endemic	Swamp 6Ricefield	129	*An.supbictus*
			An.barbirostis
			An.supbictus

Source: primary data

Table 3. Multivariate Analysis Results

Variables	B	Sig.	Exp (B)	95% C.I.for Lower	EXP(B) Upper
Puddle	3,503	,000	33,213	7,707	143,133
Shrubs	1,608	,042	4,994	1,059	23,547
Cattle pen	,473	,436	1,604	,488	5,267
Ceiling	-,862	,183	,422	,119	1,503
Wall type	-1,348	,082	,260	,057	1,188
Wire netting	-19,037	,999	,000	,000	.
Floor type	-,676	,298	,509	,143	1,816
Night outdoor	1,345	,002	3,840	1,673	8,815
Mosquito coil	-,441	,276	,643	,291	1,422

house floor has holes made of boards/wood had a 1.5 times risk of suffering from malaria compared to people who live in houses where the house floor was not contained holes made of boards/wood. The study was different from the study of Haque[4], which states that the biggest risk factor for the incidence of malaria was the density of the occupants of the house.

The result of behavioral variables, namely going out at night was similar with study by Firman et al[9]; Siregar and Saragih[13]; Fien et al[18] that the habit of going out at night had a positive influence to the incidence of Malaria. The results using mosquito nets were similar to those of Firman et al[9]; Suharjo[19], that the habit of using mosquito nets has no significant effect on the incidence of malaria. Whereas the study of Bello et al[8]; Siregar and Saragih[13]; Apriliani et al[14] that not using mosquito nets/insecticides was a risk factor for the incidence of Malaria. The study was similar to that of Firman et al[9]; Rejeki et al[10]; Apriliani et al[14]. stated that the habit of using mosquito coil had no significant effect on the incidence of malaria.

Larval density was an important factor because it had the potential to become adult mosquitoes as malaria vectors. Based on the results of the study, it was illustrated that of the 4 Anopheles species found, An. subpictus in almost all habitats, An.vagus in the ditch habitat type, An.indefinitus in the lagoon type, and An.barbirostis in the swamp type. The density level was relatively the same and high in all breeding sites for Anopheles sp. The results confirm the fact about the presence of malaria on Jampea Island, especially in Bontobaru Village because the average mosquito breeding site was positive for Anopheles larvae. The study was similar with the study of Indriani[20], in Selayar Islands Regency, the most common Anopheles species were *An. subpictus* and *An.vagus*. From all habitat points in two villages on Jampea Island, the highest density was found in the fish pond type habitat in Bontobaru Village. The most commonly found species was An. subpictus. The factor that causes the high density of larvae in pond-type habitats was due to the characteristics of the waters that are suitable for larval breeding. The ponds in Bontobaru Village that were observed were unproductive ponds that contained a lot of mass as larval nutrition and shelter from predators, while the ponds were productive ponds but surrounded by many plants so that they were very potential as larval habitat. These results were similar with study conducted by Marhadi[21-23], reporting that of the 7 types of positive breeding sites for Anopheles sp larvae there were only 2 (28.6%) in the solid category, 5 (14.3%) in the less dense category, larvae An. subpictus was found in areas of high malaria incidence with densities of 1 and 2 larvae/20 dip, An.vagus larvae were found in areas of high malaria incidence, with densities of 35 larvae/20 dip, while An. indefinitus larvae were also found in areas of high malaria incidence, and medium with a density of 1,2,3 and 7 larva/20 dip.

CONCLUSION

Finally, we concluded that there were differences in the presence of puddle, the presence of shrubs, the presence of ceilings, types of walls, types of floors, use of screen, and the habit of going out at night between endemic and non-endemic areas of malaria. Based on the results of the logistic regression test, the presence of puddle and shrubs was the most influential factors in endemic areas, while in non-endemic areas the behavior factor of going out at night was the most influential. The larval species of *Anopheles sp.* found on Jampea Island, namely *An.vagus, An. supbictus, An. indefinitus,* and *An. barbirostis.*

It was recommended to seek counseling and community empowerment so that the house environment was free from puddle, shrubs, reducing the habit of going out at night and efforts to prevent malaria by health promotion officers at the local health center.

Conflict of Interest

The authors declare no conflict of interest.

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