

DISTRIBUTION OF ENVIRONMENTAL FACTOR TO MALARIA INCIDENCE IN MUARA ENIM REGENCY

By Mohammad Zulkarnain

DISTRIBUTION OF ENVIRONMENTAL FACTOR TO MALARIA INCIDENCE IN MUARA ENIM REGENCY

Elvi Sunarsih^{1*}, Muhammad Zulkarnain², Laila Hanum³, Rostika Flora¹

¹Environmental Science Study Program, Universitas Sriwijaya, Palembang, Indonesia

²Public Health Science, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

³Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya, Palembang, Indonesia

Corresponding Email: elvisunarsih@fkm.unsri.ac.id

ABSTRACT

One of the factors causing malaria transmission is the habitat and the environment of each region that can be observed from the population density, land use, and elevation. The aim study is to analyze the malaria incidence, the socio-demographic factors, the frequency distribution of the environmental variability, such as water quality, air quality, social behavior, the relationship between the socio-demographic factors, and the factor with the highest risk of malaria incidence in Muara Enim Regency. This study used a qualitative study design with an analytical survey method and case-control approach. Results of the study are (1) the number of malaria cases in Muara Enim Regency in 2019 was 52 people (32.9%) and the number of controls was 106 people (67.1%). (2) The socio-demographic factors (age and sex) are correlated with malaria incidence, while education is not correlated with malaria incidence and employment status is a protective factor, (3) the frequency distribution of water quality shows that the water has an average pH of 8.39, a turbidity of 3.27, an Electrical Conductivity of water of 22.88, water hardness of 58.13 with an SD of 18.77, indicating that the water quality in Muara Enim Regency supports the growth of Anopheles larvae, (4) the frequency distribution of air quality has an average air temperature of 30.58, an average air humidity of 70, an average wind velocity of 22.75, indicating that the air quality supports the high number of malaria cases, (5) the social environmental factor or the habit of having outdoor activities at night is correlated with malaria incidence, while the habit of using a mosquito net, mosquito repellent, hanging clothes are not correlated with malaria incidence and the use of a wire mesh is the protective factor, (6) the most dominant factor of malaria incidence is having outdoor activities at night with an OR of 15.214; 95% CI of 5.241-44.168. The habit of having outdoor activities at night is a statistically significant variable; the result of multivariate analysis is the factor with the highest risk of malaria incidence with a p-value of less than 0.0001, an OR of 15.214, 95% CI of 5.241-44.168. The result of this study is relevant to the World Malaria Report from WHO (2018); these respondents' practices are extremely logical as the risk factor of malaria incidence because of the activity of Anopheles mosquitos in seeking blood and transmitting sporozoites to other people happens at night. Thus, everyone who has the habit of having outdoor activities at night will certainly be bitten by mosquitoes. The condition for the people's practice in Muara Enim Regency showed the risk of being bitten by mosquitoes at night because the people in that location mostly have outdoor activities at night. As its implication, those who have a habit of having outdoor activities at night will have the risk of being bitten by the mosquitoes act as malaria vector and suffered from malaria. The socio-demographic factors, such as sex and age, are correlated with malaria incidence, while employment status and education are not correlated with malaria incidence and the factor causing malaria is the habit of having outdoor activities at night.

Keywords: Environmental Factor, Malaria Incidence, Muara Enim Regency

ABSTRAK

Faktor penyebab penyebaran kasus malaria salah satunya adalah habitat dan lingkungan dari setiap wilayah yang dapat di tinjau dari kepadatan penduduk, penggunaan lahan dan ketinggian. Tujuan penelitian adalah untuk menganalisis kasus malaria, faktor karakteristik sosio demografi, distribusi frekuensi variabilitas lingkungan kualitas air, distribusi frekuensi faktor lingkungan kualitas udara, distribusi frekuensi faktor lingkungan sosial/ perilaku, hubungan faktor sosio demografi, dan faktor yang paling beresiko terhadap kejadian malaria di Kabupaten Muara Enim. Metodologi dalam penelitian ini menggunakan desain penelitian kuantitatif dengan metode penelitian survey analitik dan pendekatan *case control*. Hasil: (1) Kasus malaria di Kabupaten Muara Enim tahun 2019 didapatkan

sebanyak 52 orang (32,9%) dan kontrol sebanyak 106 (67,1%). (2) Faktor sosiodemografi (umur, jenis kelamin) ada hubungan dengan kasus malaria, sedangkan pendidikan tidak ada hubungan dengan kasus malaria dan pekerjaan sebagai factor protektif, (3) Distribusi frekuensi kualitas air di dapatkan rata-rata PH air sebesar 8,39, tingkat kekeruhan sebesar 3,27, daya hantar listrik air sebesar 22,88, tingkat kesadahan (TDS) air sebesar 58,13 dengan SD sebesar 18,77 artinya kualitas air di kabupaten Muara Enim mendukung terhadap pertumbuhan jentik nyamuk *Anopheles*, (4) Distribusi frekuensi kualitas udara di dapatkan rata-rata suhu udara sebesar 30,58, Rata-rata kelembaban udara didapatkan sebesar 70, Rata-rata kecepatan angin sebesar 22,75 artinya kualitas udara mendukung terhadap tingginya kasus malaria, (5) Faktor lingkungan social atau perilaku kebiasaan keluar rumah pada malam hari ada hubungan dengan kasus malaria, sedangkan kebiasaan menggunakan kelambu, kebiasaan menggunakan obat anti nyamuk, kebiasaan menggantung pakaian tidak ada hubungan dengan kasus malaria sedangkan penggunaan kawat kasa sebagai factor protektif, (6) Faktor yang paling dominan terhadap kasus malaria adalah kebiasaan keluar rumah pada malam hari dengan OR: 15,214; 95%CI: 5,241-44,168). Pembahasan: kebiasaan keluar rumah pada malam hari merupakan variable yang bermakna secara statistic, hasil analisis multivariat merupakan variable yang paling beresiko dengan kasus malaria dengan nilai $p\text{-value} < 0,0001$; $OR = 15,214$, 95% CI= 5,241-44,168. Hasil penelitian ini relevan dengan *World Malaria Report* dari WHO (2018), praktek responden seperti ini sangat logis sebagai faktor risiko kejadian malaria karena aktivitas nyamuk *Anopheles* dalam mencari darah dan menularkan sporozoit pada manusia lain terjadi pada malam hari. Sehingga siapapun yang mempunyai kebiasaan keluar pada malam hari pasti mempunyai risiko digigit oleh nyamuk. Kondisi praktek masyarakat di Kabupaten Muara Enim menunjukkan risiko digigit nyamuk pada malam hari karena masyarakat di lokasi tersebut banyak melakukan aktivitas di malam hari. Sebagai implikasinya, mereka yang mempunyai kebiasaan keluar pada malam hari akan menanggung risiko digigit nyamuk vektor malaria dan menderita malaria. Kesimpulan: Faktor sosiodemografi jenis kelamin dan umur ada hubungan dengan kasus malaria, sedangkan pekerjaan dan Pendidikan tidak ada hubungan dengan kasus malaria sedangkan faktor yang berisiko terhadap kasus malaria adalah kebiasaan keluar rumah pada malam hari.

Kata Kunci : Faktor Lingkungan, Kasus Malaria, Kabupaten Muara Enim

Introduction

Malaria is one of the re-emerging diseases (the reappearance of a disease massively). To date, malaria becomes a serious threat for the people living in tropical and sub-tropical regions. It can infect all age groups, and the age group that is prone to be infected with malaria is infants, under-five year children, and pregnant women (Depkes RI, 2011). In general, malaria is transmitted through a female *Anopheles* mosquito bite that sucks blood to grow her eggs. *Anopheles* mostly and actively bites at night. For the last few years, an extraordinary condition reappears in malaria-endemic regions in some areas in Indonesia. The increased number of malaria cases is affected by climate change that is related to physical, chemical, biological, and social environment as well as people's behavior (Chaves *et al.*, 2016)

Climate change has a big impact on vector-borne disease. The frequency of the occurrence of a disease, such as malaria and dengue fever, increases. The population with low adaptability will be vulnerable to diarrhea, malnutrition, and the distribution pattern of some diseases that are transmitted through insects and animals (Craig, Le Sueur and Snow, 1999) Temperature is negatively correlated with dengue hemorrhagic fever incidence, so the increase in air temperature per week will decrease the number

of Dengue Hemorrhagic Fever cases. Changes in the weather affect the stable ecosystem formation on the growth of malaria vectors (Beier *et al.*, 2008)

The number of clinical malaria cases in South Sumatra province in 2015 was 36,201. The number of laboratory-confirmed cases was 28,491 and the number of patients who are tested positive for malaria was 2,055 cases with an API score of 0.26 per 1,000 populations in 2015. This score is categorized in the low case incidence for malaria. The number of malaria confirmed positive cases in Muara Enim Regency is one of the highest in South Sumatra Province with an API score of 0.18 per 1,000 populations in 2019 (Dinas Kesehatan Provinsi Sumatera Selatan, 2018)

Muara Enim Regency has 22 sub-districts covering 10 urban villages and 245 villages from a total population of 616,037 people. In 2019, the number of malaria cases in Muara Enim Regency reached 112 cases and occupied the top second rank after South Ogan Komering Ulu (the data taken from the Provincial Health Office in 2019). From the age of those confirmed positive for malaria in Muara Enim Regency is varied; the result of microscopic examination obtains 42 people, the *Rapid Diagnostic Test* (RDT) obtains 70 people and the highest rate occurs in those at the age of 15-64 years old (the data taken from the Health Office of South Sumatera in 2019). The geographic characteristic of a region in Muara Enim Regency is an agricultural area with an area of 7,483.06 km². The various topographic condition and plateaus in the southwest is a part of Bukit Barisan Mountains stretching from Central Semende Darat sub-district and Tanjung Agung sub-district. The central flatland area, located in the central part (Muara Enim, Ujan Mas, Benakat, Gunung Megang, Rambang Dangku, Rambang, Lubai) continuing to the northeast, has a swamp area that directly faces the Musi river flow, including Gelumbang sub-district, Rotan and Muara Belida rivers (Dinas Kesehatan Provinsi Sumatera Selatan, 2018)

The factors associated with the increased number of malaria cases is environmental factor, habitat, and people's behavior, whereby the surrounding environment has rain puddles, puddles around houses, opened ventilations with no water closet and lack of clean water supply and the like. This condition strongly affects the growth of malaria disease through anopheles mosquitos (Laihad, Harijanto and Poespoprodjo, 2018).

Method

The design of this study was quantitative using an analytical survey method with a case-control approach conducted in 2 stages. The population in this study were all malaria cases from the result of the microscopic test confirmed positive for malaria. The data were taken from the Health Office of Muara Enim and Public Health Centers in Muara Enim Regency. The sample in this study consisted of 2 types,

people and locations. The data collection was done directly by doing a home visit at noon. The data analysis was done using univariate analysis, bivariate analysis (chi-square test), multivariate analysis, and multiple logistic regression analysis.

Result

A. Univariate Analysis

Table 1. The Frequency Distribution of Malaria Incidence in Muara Enim Regency

Category	Frequency	Percentage
Group Category		
Case	52	32.9
Control	106	67.1

The analysis result using a ratio of 1:2 for the case and control groups showed that the percentage of respondents for the case group was 32.9% and the remaining or around 67.1% was the respondent for the control group.

Table 2. The Frequency Distribution of Age as One of the Socio-demographic Characteristics

Mean	Standard deviation	Minimum - maximum
39.49	14.04	1.2 - 80

The majority of the respondents in this study were 39.49 years old with a standard deviation (SD) of 14.04. The youngest respondent was 1.4 years old and the oldest was 80 years old.

Table 3. The Frequency Distribution of Sex, Education, and Employment Status

Variable	Frequency	Percentage
Sex		
Female	105	66.5
Male	53	33.5
Education		
Low	75	47.5
High	83	52.5
Employment Status		
Unemployed	67	42.4
Employed	91	57.6

Based on the socio-demographic factors, the majority of the respondents were females of 66.5%; the percentage for the respondents who were senior graduates or higher was 52.5%, and the percentage for the respondents who were employees was 57.6%.

Table 4. The Frequency Distribution of Environmental Variability for Water Quality (pH, Turbidity, Electrical Conductivity of Water, and Water Hardness)

Variable	Mean	Standard deviation	Minimum - maximum
pH	8.39	0.93	7.11-10.12
Turbidity	3.27	1.32	1.82-6.5
Electrical conductivity of water	22.88	12.92	8.6-48.1
Water Hardness	58.13	18.77	32-87.1

The average pH in this study was 8.39 with an SD of 0.93. The lowest pH was 7.11 and the highest pH was 10.12. The average turbidity in this study was 3.27 with an SD of 1.32. The lowest turbidity was 1.82 and the highest was 6.5. The average electrical conductivity of water in this study was 22.88 with an SD of 12.92. The lowest electrical conductivity of water was 8.6 and the highest electrical conductivity of water was 48.1. The average water hardness in this study was 58.13 with an SD of 18.77. The lowest water hardness was 32 and the highest water hardness was 87.1.

Table 5. The Frequency Distribution of Environmental Variability for Air Quality (Temperature, Humidity, and Wind Velocity)

Variable	Mean	Standard Deviation	Minimum-maximum
Temperature	30.58	1.24	28-32
Humidity	70	4.77	57-76
Wind Velocity	22.75	0.97	22-24

The average air temperature in this study was 30.58 with an SD of 1.24. The lowest air temperature was 28 and the highest air temperature was 32. The average air humidity in this study was 70 with an SD of 4.77. The lowest air humidity was 57 and the highest air humidity was 76. Meanwhile, the average wind velocity in this study was 22.75 with an SD of 0.97. The lowest wind velocity was 22 and the highest wind velocity was 24.

Table 6. The Frequency Distribution of Social Environment or the Respondents' Behavior

Variable	Frequency	Percentage
The habit of having outdoor activities at night		
Yes	125	79.1
No	33	20.9
The habit of using a mosquito net		
No	49	31

Yes	109	69
The habit of using mosquito repellent		
No	55	34.8
Yes	103	65.2
The habit of hanging clothes		
Yes	104	65.8
No	54	34.2
Using a wire mesh		
No	120	75.9
Yes	38	24.1

Based on the factor of social environment or behavior, the majority of the respondents had the habit of having outdoor activities at night of 79.1%; the percentage of the respondents who had the habit of using a mosquito net was 69%. The proportion of the respondents who had the habit of using mosquito repellent was 65.2%. The percentage of the respondents who had the habit of hanging clothes was 65.8%, and the percentage of those who did not use a wire mesh was 75.9%.

B. Bivariate Analysis

Table 7. The Correlation of Socio-demographic Factors with Malaria Incidence in Muara Enim Regency

Variable	Malaria Incidence		P-value	Odds ratio (95%CI)	
	Case (n=52)	Control (n=106)			
	Frequency	Percentage	Frequency	Percentage	
Sex					
Female	27	51.9	78	73.6	0.011 (0.194-0.776)
Male	25	48.1	28	26.4	
Employment Status					
Employed	30	57.7	61	57.5	1 (0.514 - 1.969)
Unemployed	22	42.3	45	42.5	
Education					
Low	24	46.2	51	48.1	0.950 (0.475 - 1.798)
High	28	53.8	55	51.9	

The analysis result in table 7 shows that the percentage of female respondents in the case group is 51.9% while the percentage of male respondents in the control group is 48.1%. The result of the chi-square test showed that sex was correlated with malaria incidence in Muara Enim Regency (p -value = 0.011; OR = 0.388). The analysis result for employment status showed that employment status was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p -value = 1; OR = 1.006). The

analysis result for education showed that education was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p-value = 0.475; OR = 0.925).

Table 8. The Correlation of Age with Malaria Incidence in Muara Enim Regency

Variable	n	Mean Score	Average difference	Standard Deviation	P - value	95% Confidence Interval (lower - upper)
Case	52	35.3	61.8	15.9	0,009	-10.78 - -1.56
Control	106	41.5		12.6		

The analysis result in table 8 shows that the average age is significantly and statistically different between the case group and the control group. In the general population, the researchers 95% believed that age is one of the risk factors of malaria incidence in Muara Enim Regency with a Confidence Interval of -10.78 to -1.56. (95%CI: 1.56 – 10.78).

Table 9. The Correlation of Social Environment or the Respondents' Behavior with Malaria Incidence in Muara Enim Regency

Variable	Case (n=52)		Control (n=106)		P-value	Odds ratio (95% CI)
	Frequency	Percentage	Frequency	Percentage		
The habit of having outdoor activities at night						
Yes	26	50	7	6.6	<0.0001	14.14 (5.526-36.195)
No	26	50	99	93.4		
The habit of using a mosquito net						
No	17	32.7	32	30.2	0.891	1.123 (0.551 - 2.290)
Yes	35	67.3	74	69.8		
The habit of using mosquito repellent						
No	9	17.3	46	43.4	0.002	0.273 (0.121 - 0.617)
Yes	43	82.7	60	56.6		

The habit of hanging clothes						
Yes	36	69.2	68	64.2	0.650	1.257 (0.618 - 2.558)
No	16	30.8	38	35.8		
Using a wire mesh						
No	42	80.8	78	73.6	0.427	1.508 (0.668 - 3.402)
Yes	10	19.2	28	26.4		

The result of the chi-square test in Table 9 indicates that the habit of having outdoor activities at night is correlated with malaria incidence with a p-value of less than 0.0001 and an OR of 14.14 that is greater than alpha (α) of 0.05). The analysis result for the habit of using mosquito net showed that the habit was not correlated significantly and statistically with malaria incidence in Muara Enim Regency (p-value = 0.891; OR = 1.123). The analysis result for the habit of applying mosquito repellent showed that it was significantly and statistically correlated with malaria incidence in Muara Enim Regency (p-value = 0.002; OR = 0.273). The analysis result for the habit of hanging clothes showed that it was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p-value = 0.650; OR = 1.257). The analysis result for using a wire mesh showed that it was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p-value = 0.427; OR = 1.508).

C. Multivariate Analysis

The result of multivariate analysis in the final model showed that the most dominant variable for malaria incidence is the habit of having outdoor activities at night after being controlled by age, sex, employment status, and the habit of using mosquito repellent. Someone who did not have the habit of having outdoor activities at night had odds 15 times higher to suffer from malaria than those who had the habit of having outdoor activities at night (OR: 15.214; 95%CI: 5.241 – 44.168).

Table 10. Multivariate Analysis

Variable	P-value	Adjusted Odds ratio	95% CI
Age	0.012	0.959	0.929 - 0.991
Education	-	-	-
Sex	0.032	0.349	0.133 - 0.912
Employment status	0.442	0.691	0.269 - 1.773
The habit of having outdoor activities at night	<0.0001	15.214	5.241 - 44.168
The habit of using a mosquito net	-	-	-
The habit of using mosquito repellent	0.019	0.296	0.107 - 0.817
The habit of hanging clothes	-	-	-

Using a wire mesh	0.136	2.206	0.779 - 6.245
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Discussion

A. The Correlation of Socio-demographic Factors (Sex, Employment status, Education, and Age) with Malaria Incidence

The analysis result showed sex was correlated with malaria incidence in Muara Enim Regency (p -value = 0.011; OR = 0.388). The result showed that the number of female respondents was higher than the number of male respondents. A female has an odds 0.4 times lower to suffer from malaria than a male (OR= 0.388). The result of multivariate analysis using the Logistic Regression method showed that sex was significantly correlated with malaria incidence in Muara Enim Regency. This study is in line with Rachmiawati and Rombe (2018) stating that Plasmodium species can infect males and females. Several pieces of literature mentioned that the infection in females was higher than infection in males because it was associated with pregnant women. The infection by parasites in pregnant women frequently happens due to the changes in the cellular and humoral immune systems and the increase in cortisol levels is assumed to occur during the pregnancy.

The analysis result for employment status obtained that employment status was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p -value = 1; OR = 1.006) CI 95% (0.514-1.969). Employment status, in a broad definition, is the main activity performed by people, and in a narrow definition, it is used for a certain duty or job that can earn some money for someone. Employment status is observed for the possibility of being specifically exposed and the degree of exposure as well as the degree of risk based on the nature of the occupation; it will certainly affect the work environment and the employees' socio-economy in a certain job. It can be inferred that employment status is a confounding variable. It can be seen from the changes in the OR score of sex of 13.4% or greater than 10% in the multivariate analysis. This indicates that employment status provides a mixed effect on malaria incidence in Muara Enim Regency (Babba, 2007).

The analysis result for education level obtained that education was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p -value = 0.950; OR = 0.925). It indicates that people with a low education level are prone to suffer from malaria 0.9 times higher than those with a high education level. It is in line with a study by (Sulistyawati, 2007), stating that people with a low education level are susceptible to suffer from malaria of 1.8 times higher than those with a high education level. This result is also in line with a study conducted by Sir et al (2007), stating that education is correlated with

malaria incidence ($p = < 0.05$). According to the study, the group with a low education level has a risk of suffering from malaria incidence of 4.4 times higher than those with a high education level (Sir *et al.*, 2016).

The analysis result for age obtained that age was correlated with malaria incidence in Muara Enim Regency (p -value = 0.009) with a Confidence Interval of 10.78 to 1.56. (95% CI: 1.56 – 10.78). Most respondents in the case group were older (35.3 years old) than the respondents in the control group (41.5). This indicates that there is a significant difference in the average age statistically between the case group and the control group. It is in line with a study by Sunarsih *et al* (2020), stating that the respondents that mostly suffer from malaria are adults compared to youths; this age group is a productive age group that allows them to work and have outdoor activities, so they have a higher possibility to have contact with malaria mosquitoes (Sunarsih *et al.*, 2020).


B. The Correlation of Social Environment or the Respondents' Behavior (the Habit of Having Outdoor Activities at Night, Using a Mosquito Net, Using Mosquito Repellent, Wearing Clothes, and the Use of a Wire Mesh) with Malaria Incidence

The result of chi-square analysis showed that the habit of having outdoor activities at night was correlated with malaria incidence with a p -value of less than 0.0001 and an OR of 14.14 or greater than alpha ($\alpha=0.05$). Moreover, the multivariate analysis obtained that the habit of having outdoor activities at night was the most dominant variable for malaria incidence (p -value= <0.0001; OR=15.214, 95% CI= 5.241-44.168) after being controlled by age, sex, employment status, and the habit of using mosquito repellent. According to Ekawana (2013), the habit of having outdoor activities at night is a behavior that can increase the risk of being infected with malaria disease because malaria mosquitoes are exophagic or the mosquitoes that feed outdoor, especially at night at around 18.00 WIB-04.00 WIB. The contact with Anopheles mosquitoes as malaria vectors with individuals can increase the individuals' susceptibility to being infected with malaria disease. This study is in line with a study by Sunarsih (2009) concluding that the habit of having outdoor activities at night is significantly correlated with malaria incidence with a p -value of 0.0001 and Odds Ratio (OR) with CI 95% and OR: 4.4 (2.140-9.046); the OR score of 4.4 predicts that someone who has the habit of having outdoor activities at night has a risk of being infected with malaria of 4.4 times higher than those who do not have the habit of having outdoor activities at night. The association of the respondents' habit of having outdoor activities at night with malaria incidence is reinforced with the result of multivariate analysis using logistic regression. The habit of having outdoor

activities is one of the risk factors of malaria incidence with a regression coefficient (β) of 1.239 and a p -value=0.002 with an OR (CI 95% OR) of 3.454 (1.564-7.628) (Sunarsih, 2015).

The analysis result of using a mosquito net showed that the habit of using a mosquito net was not significantly and statistically correlated with malaria incidence in Muara Enim Regency (p -value = 0.891; OR = 1.123). The factor of using a mosquito net at night theoretically contributes to preventing malaria incidence. Thus, the result of this study showed the contrast empirical facts compared to other theories or results. However, in this study, there is no adequate evidence stating the factor of using a mosquito net at night is the protective factor of malaria incidence. It is because the respondents regularly use a mosquito net at night, but the habit of having outdoor activities at night may be bitten by mosquitoes. This study is in line with a study by Sunarsih (2009), obtaining that using a mosquito net is not correlated with malaria incidence in Pangkalbalam Public health center, Pangkalpinang, Bangka Belitung, with a p -value of 0.827 and *Odds Ratio* (OR) with CI 95% OR: 827 (0.351-1.947) (Sunarsih, 2015). The result of another study conducted by Barbara Matthys et al. (2006) showed the contrary result that sleep using Insecticide Treated Nets (ITN/ impregnated nets) was not correlated with malaria incidence. It is because having full coverage mosquito nets in the study site is not associated with the usage intensity when sleeping at night (Matthys *et al.*, 2006). Meanwhile, the result of a study conducted in Africa stated that the use of a mosquito net can decrease the risk of illness and mortality related to malaria disease. Subsequently, a study conducted by Alexander et al. (2005) in Colombia reveals that the use of Insecticide Treated Nets (ITN/ impregnated nets) when sleeping at night can prevent the risk of being infected with malaria disease compared to those who do not use it with an OR (95% CI OR) score of 0.44 (0.20-0.98) (Alexander *et al.*, 2005). Even though there is a controversy in the result, the use of a mosquito net during sleep at night still becomes an important effort in preventing malaria transmission. However, the use of a mosquito net will not be meaningful if it is not used regularly every night and other efforts that can prevent the risk of being bitten by mosquitoes.

The analysis result for the use of mosquito repellent showed that the use of mosquito repellent was correlated significantly and statistically correlated with malaria incidence in Muara Enim Regency (p -value = 0.002; OR = 0.273). This study also obtained information that the majority of the respondents (65.2%) had the habit of using mosquito repellent. The mosquito repellent used by most of the respondents in the study site was mosquito coils while the remaining used mosquito repellent lotions. The use of mosquito coils can repel mosquitoes, especially when sleeping inside the house. Nevertheless, the statistical test result showed that the habit of using mosquito repellent was not correlated with malaria incidence. It is because the respondents (both the case and control groups) are getting bitten by mosquitoes



when having outdoor activities even though they have used mosquito coils. This study is in line with the study by Sunarsih (2009) indicating that using mosquito repellent is not correlated with malaria incidence in Pangkalbalam Public Health Center, Pangkalpinang, with a *p-value* of 0.322 and *Odds Ratio* (OR) with CI 95% OR: 1.867 (0.867-5.077) (Sunarsih, 2015).

The analysis result for the habit of hanging clothes showed that it was not significantly correlated with malaria incidence in Muara Enim Regency (*p-value* = 0.650; OR = 1.257). This study is not in line with a study by Arsyad, (2015) stating that the habit of hanging clothes is correlated with malaria incidence. People who have the habit of hanging clothes have the risk opportunity of being infected with malaria of 0.273 times higher than those who do not have the habit of hanging clothes at home. The habit of hanging clothes is one of the risk factors of malaria incidence. A dimly lit place is one of the places preferred by mosquitoes to suck the blood; a wall is also one of the places where mosquitoes rest (Anasiru, 2016). Further, a study by Zulaikha, et al (2011) stated that after mosquitoes bite people, they need a place to rest, especially at night, and the most preferred place by mosquitoes after sucking the blood is clothes hung inside the house. The habit of hanging clothes theoretically can affect malaria incidence. However, the statistical test result showed that the habit of hanging clothes was not correlated with malaria incidence. It is because the respondents (both the case and the control groups) still have the habit of having outdoor activities even though they have such a behavior indicating that mosquitoes sticking to the clothes indirectly bite the respondents .

The analysis result for the use of a wire mesh showed that the use of a wire mesh was not significantly correlated with malaria incidence in Muara Enim Regency (*p-value* = 0.427; OR = 1.508). The study conducted by Hutajulu in Central Java in 2005 stated that the type of house was not significantly associated with malaria incidence, but the use of a wire mesh showed a significant association with the decline in the number of malaria cases. The wire mesh in the house ventilation is considered able to prevent mosquitoes from entering the house at night. Nevertheless, mosquitoes can still enter the house through other gaps between the house components. In this study, the wire mesh is not significantly associated with malaria incidence. The fact found in this study is that most of the respondents' houses have no wire mesh of 80.8% for the case group and 73.6% for the control group. This is an extremely desperate condition because the wire mesh installed in the house can be a barrier for the mosquitoes that may enter the house. Consequently, the house-dwellers can be protected from the risk of being bitten by mosquitoes. Therefore, the effort of increasing the people's awareness in Muara Enim Regency to install a wire mesh in their house is needed (Dale *et al.*, 2005).

C. Multivariate Analysis

The result of multivariate analysis obtained that the most dominant variable for malaria incidence was the habit of having outdoor activities at night ($p\text{-value} < 0.0001$; OR=15.214; 95% CI= 5.241-44.168) after being controlled by several variables, namely age, sex, employment status, and the habit of using mosquito repellent.

The result of this study is relevant to the World Malaria Report from WHO (2018); these respondents' practices are logical as the risk factor of malaria incidence because of the activity of Anopheles mosquitos in seeking blood and transmitting sporozoites to other people happens at night. Thus, everyone who has the habit of having outdoor activities at night will certainly have the risk of being bitten by mosquitoes. The people's practices in Muara Enim Regency showed a risk of being bitten by mosquitoes at night because most people in that location have outdoor activities at night. The implication is that those who have outdoor activities at night will have the risk of being bitten by mosquitoes as malaria vectors and suffer from malaria disease.

Having outdoor activities at night is one of the social risk factors related to malaria transmission. As stated by Homado (1992) that one of the three behavioral factors correlated with malaria disease is the risk factor of behavior causing the resistance of malaria treatment. Referring to the opinion, the habit of having outdoor activities at night is the social risk factor that plays a role in malaria transmission and incidence (Sunarsih, 2015). In a bionomic manner, mosquitoes as malaria vectors seek the blood (feeding) at night and the target is sucking the people's blood. A study conducted by Pat Dale et al. (2005) mentions that the high intensity of malaria transmission can happen in people who have outdoor activities at night (night-time outdoor activities) (Dale *et al.*, 2005).

Conclusion

The result of this study shows that (1) the number of malaria cases in Muara Enim Regency in 2019 is was 52 people (32.9%) and the total respondent in the control group is 106 people (67.1%) from 6 sub-districts, namely Lawing Kidul, Muara Enim, Gunung Megang, Ujan Mas, Tanjung Agung, and Benakat. (2) For the aspect of socio-demographic factors (sex, education, employment status, and age), it shows that most of the respondents are females (66.5%), senior high graduates and higher of 52.5%, employees of 57.6%, and 39.49 years old. (3) The frequency distribution of water quality shows that the water has an average pH of 8.39, turbidity of 3.27, Electrical Conductivity of water of 22.88, and water hardness of 58.13 with an SD of 18.77, indicating that the water quality in Muara Enim Regency supports the growth of Anopheles larvae. (4) The frequency distribution of air quality shows that the air has an average


temperature of 30.58, air humidity of 70, an average wind velocity of 22.75 indicating that the air quality supports the high number of malaria cases, (5) the social-environmental factor or the habit of having outdoor activities at night is correlated with malaria incidence, while the habit of using a mosquito net, mosquito repellent, hanging clothes are not correlated with malaria incidence and the use of a wire mesh is the protective factor, (6) the most dominant factor of malaria incidence is having outdoor activities at night with an OR of 15.214; 95% CI of 5.241-44.168.

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