Contents lists available at IOCS

Science Midwifery

journal homepage: www.midwifery.iocspublisher.org

Determinant of malaria reinfection

Muhamad Sahiddin[1], Zeth Roberth Felle[2]
[1,2]Nursing Department, Health Polytechnic of Jayapura, Jayapura, Indonesia

ARTICLE INFO

Article history:

Received Oct 18, 2022
Revised Nov 4, 2022
Accepted Nov 22, 2022

Keywords:

Malaria
Reinfection
Papua

ABSTRACT

Malaria reinfection is one of the concerns in the management of malaria in endemic areas. This study aims to determine the factors that influence the incidence of malaria reinfection. The study used an analytical observational approach with a cross-sectional study design which was conducted in Mei-June 2021 in Keerom Regency, Papua. The research sample amounted to 127 respondents who were selected using simple random sampling technique. Data analysis used fisher's exact test with a significance level of 0.05. The results showed that there was an effect of using mosquito repellent (p = 0.001), the habit of hanging clothes (p = 0.046) and the presence of standing water (p = 0.042) on the incidence of malaria reinfection. Meanwhile, adherence to taking malaria medication (p= 0.623), habit of going out (p= 0.441), habit of using mosquito nets (p= 1,000) and the presence of mosquito netting (p= 0.706) did not affect the incidence of malaria reinfection. It is necessary to conduct health education about the use of mosquito repellent, the habit of hanging clothes and intervention in the community's living environment.

Corresponding Author:

Muhamad Sahiddin,
Nursing Department,
Health Polytechnic of Jayapura,
Jalan Padang Bulan II, Jayapura, Indonesia
Email: msahiddin@gmail.com

INTRODUCTION

Malaria is one of the deadliest diseases in human history, transmitted to humans by mosquitoes of the genus Anopheles. According to Caputo and Garavelli (2016) malaria transmission requires interaction between the host, vector, and parasite. The four parasitic species responsible for malaria in humans are Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae, and Plasmodium vivax. WHO reporting that in 2000-2016 there has been a decline in global malaria rates, progress includes a 37% reduction in malaria cases, a 60% reduction in malaria mortality and a 65% decrease in mortality rates for children under 15 years, 10 countries those who had malaria infection in 2000 were free from malaria contamination and almost 60 countries have succeeded in reducing malaria cases by 75% or more, and this makes the Millennium Development Goals have been achieved in most countries in the world (WHO, 2016). Efforts to eliminate malaria are far from over, in 2015 more than 400,000 died from malaria, and 214 million new cases, in Africa 1 in 4 children cannot wear mosquito nets, and half of pregnant women are at risk of not receiving malaria treatment, and can it is said that the burden of morbidity and mortality of malaria is still relatively high.

According to a report it is known that the malaria API during 2009 – 2019 decreased from 1.8 per 1,000 population in 2009 to 0.84 per 1,000 population in 2018. Decrease in Annual Paracite Incidence (API). Papua Province with the highest API, which is 64.03 per 1,000 population. This number is very high when compared to other provinces. The other 3 provinces with the highest number of API per 1,000 were West Papua (7.38), East Nusa Tenggara (3.37) and Maluku (0.72). Most provinces, namely 31 provinces (91.2%) have API < 1 per 1,000 population. In 2018, 66% of cases in Indonesia came from Papua, West Papua, East Nusa Tenggara, and Maluku (Kemenkes RI, 2020).

Malaria API per 1,000 population is also the basis of the malaria endemity level which can be low (<1), moderate (1-5) and high (>5). In 2019 there were 160 districts/cities (31.9%) low endemic, 31 districts/cities (5.4,%) moderately endemic and 23 regencies/cities (4.3%) high endemic (Kemenkes RI, 2020). In Keerom, the malaria morbidity rate tends to decrease in 2019 at 21,930 and 17,901 in 2020 from a total population of 58,111 inhabitants (Dinas Kesehatan Kab. Keerom, 2020).

The incidence of malaria in a population can be seen using an epidemiological triangle approach (Singh, Mishra, Awasthi, Dash, & Das, 2009). The agent causing the disease is plasmodium which has the potential to cause malaria, Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae and Plasmodium ovale. temporary host) because in the human body there is only an asexual cycle and a definitive host (permanent host) because in the mosquito body there is a sexual cycle and the last is the environment which is influenced by climate change, sanitation, population density and others.

Malaria reinfection is one of the concerns in the management of malaria in endemic areas. Research related to reinfection has been carried out in several countries such as America by RLAE (Revista Latino-Americana de Efermagem) who examined the prevalence of malaria reinfection (Nascimento et al., 2019). Thailand, India, Peru and Brazil who studied malaria reinfection prevention using drugs Tafenoquine and primaqiune (Rajapakse, Rodrigo, & Fernando, 2015). Research needs to be done to identify the determinants of the incidence of malaria reinfection in areas that are endemic areas that allow residents who live in these areas to have stronger antibodies against the malaria parasite because the intensity of mosquito bites is quite high, especially for children born in this area. have high immunity to malaria, in addition, the authors see the need for observational measures to determine the effect of the determinants of malaria reinfection and to make behavioral changes or environmental modifications based on the results of the research obtained.

RESEARCH METHOD

The study used an analytical observational approach with a cross-sectional study design which was conducted in Mei-June 2021 in Keerom Regency, Papua. The study population was patients who came to the puskesmas who were diagnosed with malaria. The incidence of malaria is determined based on a doctor's diagnosis supported by the results of a microscopic examination of malaria. Determination of the sample size using the large formula Lemeshow, Jr, Klar, and Lwanga (1990) with α= 0.05, the proportion of variables = 0.5, the level of significance set = 1.96. The research sample amounted to 127 respondents who were selected using simple random sampling technique.

The research variables consisted of socio-demographic characteristics, the incidence of malaria reinfection and risk factors. Characteristics of respondents measured in the study were the respondent's residence, age, gender, education and occupation. The risk factors for malaria reinfection were adherence to malaria medication, habit of going out of the house, habit of using mosquito nets, habit of using mosquito repellent, habit of hanging clothes, presence of standing water, and use of mosquito netting. The incidence of malaria reinfection as the dependent variable of this study was determined based on the patient's status in the patient register with the results of the rapid diagnosis test (RDT malaria), which were categorized into reinfection and new patients. Collecting data using a questionnaire containing questions about the patient's social demographic

factors (5 questions) and the variables studied (14 questions). The study was carried out after obtaining an ethical worthy certificate with the number 008/KEPK-J/V/2021.
The collected data is processed by data processing in the form of cleaning, coding and input data in the Microsoft Excel master table. Researchers used SPSS version 20 software to perform data analysis. Data analysis consisted of univariate analysis and bivariate analysis. Univariate analysis used a frequency distribution table for each of the variables studied. Meanwhile, bivariate analysis was conducted to determine the effect of risk factors for adherence to malaria medication, habit of going out of the house, habit of using mosquito nets, habit of using mosquito repellent, habit of hanging clothes, presence of standing water, and use of mosquito netting on the incidence of malaria reinfection. The analysis used fisher's exact test with a significance level of 0.05.

RESULTS AND DISCUSSIONS

Results

Socio-demographic characteristics

Table 1. Socio-demographic characteristics

No.	Characteristics	n	%
1	Age		
	11-20	2	1,6
	21-30	26	20,5
	31-40	35	27,6
	41-50	35	27,6
	51-60	21	16,5
	> 60	8	6,3
2	Gender		
	Male	64	50.4
	Female	62	48.8
3	Education		
	Non	10	7,9
	Elementery school	16	12,6
	Junior high school	22	17,3
	Senior high school	69	54,3
	Diploma	5	3,9
	Bachelor	5	3,9
4	Occupation		
	Civil servant	4	3,1
	Private employees	5	3,9
	Self-employed	7	5,5
	Farmer	55	43,3
	Housewife	42	33,1
	Religious leaders	3	2,4
	Student	5	3,9
	None	1	0,8
	Laborers	5	3,9
	Total	127	100,0

Table 1 showed that most of the respondents are 31-40 years old and 41-50 years old (27.6% respectively) and are male (50.4%). Based on the level of education and occupation, most of the respondents have high school education (54.3%) and work as farmers (43.3%).

Table 2. Univariate analysis results

No.	Variabel	n	%
1	Compliance with taking medication		

	Not obey	25	19,7
	Obey	102	80,3
2	Night out habits		
	Yes	65	51,2
	No	62	48,8
3	Habit of using mosquito net		
	Yes	125	98,4
	No	2	1,6
4	Use of mosquito repellent		
	Yes	26	20,5
	No	101	79,5
5	Habit of hanging cloth		
	Yes	80	63,0
	No	47	37,0
6	The presence of puddles		
	Yes	77	60,6
	No	50	39,4
7	The presence of mosquito netting		
	Yes	60	47,2
	No	67	52,8
8	The incidence of malaria reinfection		
	Reinfection	120	94,5
	New patient	7	5,5
	Total	127	100,0

Table 2 showed that most patients have adherence to taking malaria medication (80.3%), have a habit of going out at night (52.1%), using mosquito nets when sleeping (98.4%), not using mosquito repellent (79.5%).), the patient's habit of hanging (63%), there is a puddle of water in the home environment (60.6%) and does not have mosquito netting on the window (52.8%). Most of the respondents were malaria reinfection patients (94.5%).

Tabel 3. Determinants of malaria reinfection

Risk factors	The incidence of malaria reinfection				Total		P value
	Reinfection		New patient				
	n	%	n	%	n	%	
Compliance with taking medication							
Not obey	23	92,0	2	8,0	25	100	0.623
Obey	97	95,1	5	4,9	102	100	
Night out habits							
Yes	60	92,3	5	7,7	65	100	0.441
No	60	96,8	2	3,2	62	100	
Habit of using mosquito net							
Yes	118	94,4	7	5,6	125	100	1.000
No	2	100	0	0,0	2	100	
Use of mosquito repellent							
Yes	25	96,2	1	3,8	26	100	0.001
No	95	94,1	6	5,9	101	100	
Habit of hanging cloth							
Yes	73	91,3	7	8,8	80	100	0.046
No	47	100	0	0,0	47	100	
The presence of puddles							
Yes	70	90,9	7	9,1	77	100	0,042
No	50	100	0	0,0	50	100	
The presence of mosquito netting							

Yes	56	93,3	4	6,7	60	100	0.706
No	64	95.5	3	4,5	67	100	

Table 3 showed that the incidence of malaria reinfection occurred mostly in respondents who had adherence to taking malaria medication (95.1%), had the habit of using mosquito nets (94.4%), did not use mosquito repellent (94.1%), had the habit of hanging clothes (91.3%), there are puddles of water in the home environment (90.9%) and there is no mosquito net on the windows (95.5%). Fisher's exact test results showed that there was an effect of using mosquito repellent (p = 0.001), habit of hanging clothes (p = 0.046) and the presence of standing water (p = 0.042) on the incidence of malaria reinfection. Meanwhile, adherence to taking malaria medication (p= 0.623), habit of going out (p= 0.441), habit of using mosquito nets (p= 1.000) and the presence of mosquito netting (p= 0.706) did not affect the incidence of malaria reinfection.

Discussion

Treatment adherence requires the cooperation or active participation of patients with health professionals to get good results in treatment. The results of this study are in line with research conducted by Shafira and Krisanti (2020) which stated that there was no relationship between adherence to taking malaria medication and a history of malaria. Analysis of medication adherence with the incidence of malaria by Yawan (2006) said the opposite is true that there is a significant relationship between medication adherence and the incidence of malaria. The malaria treatment applied includes basic treatment to kill all stages of the parasite in the human body to obtain clinical and parasitological cure (Baird, Maguire, & Price, 2012). However, the influencing factors depend on the patient's immunity and the high transmission of plasmodium malaria infection from mosquito bites, while the severity is still influenced by the type of plasmodium, the area of origin of infection, age, nutrition and previous treatment (Muti'ah, 2012).

Most Anopheles mosquitoes are crepuscular which means they are active at dusk or dawn and nocturnal which means they are active at night so that mosquito-biting activities are often active throughout the night (Bashar, Sarker, Asasuzzaman, Rahman, & Howlader, 2020). The results of this study are in line with the research by Hasyim, Camelia, and Fajar (2014) which said that there was no relationship between the habit of going out at night with the incidence of malaria. Anjasmoro (2013) also said that the habit of going out at night increases the risk of contact between healthy people and nocturnal plasmodium-carrying mosquitoes that bite actively at night, although there is no relationship between the habit of going out at night and the incidence of malaria.

Based on the research of Sutarto (2017) that there is a relationship between the habit of going out at night and the incidence of malaria which explains that activities at night will suffer from malaria 2.562 times compared to those who do not do activities outside the house at night. Personal protection against mosquito bites can be done by using a repellent (anti-mosquito) or using long pants and long-sleeved shirts that effectively protect against mosquito bites when doing activities outside the home.

Malaria eradication efforts are relatively difficult to do because of the widespread breeding places for mosquitoes, limited human resources and costs, so that the effort that can be done is to prevent parasitic transmission which aims as a barrier to reduce human contact with mosquitoes, both individuals and families in one house (Enayati & Hemingway, 2010). One of the actions that can be taken is to use a mosquito net while sleeping at night.

The results of this study are in line with the research conducted by Wantini and Susanti (2017) that there is no significant relationship between the incidence of malaria in the working area of the Rajabasa Health Center, South Lampung. Supported by Habibi, Ramlis, and Wulandari (2019) in an epidemiological study in outbreak areas which revealed that although sleeping using a mosquito net at night, most of the respondents said that it was uncomfortable to sleep using a

mosquito net. The use of mosquito nets is only used at certain times, for example when you feel there are many mosquitoes.

Environmental control factors and malaria protection vectors such as sleeping using mosquito nets were not associated with the incidence of malaria. Hasyim et al. (2014) said that the use of mosquito nets related to malaria cases in research in the South Sumatra area was not a standard Insectisidie Treated Mosquito Nets (ITNs) so that contact with mosquitoes was still possible. However, in Sutarto (2017) which summarizes research conducted in Belitung Regency, Bandar Lampung City and Donggala, it is said that there is a significant relationship between the use of mosquito nets and the incidence of malaria. Using mosquito nets while sleeping at night will reduce the frequency of mosquito bites that occur in humans. However, according to Arsin (2012), keep in mind that not only during sleep mosquito bites can occur, people in endemic areas do a lot of activities outside their homes in the early hours of the morning. The wood workers have started their activities in the forest, from evening to night the farmers are still working to water and harvest. The same thing is done by the indigenous people, most of whom are still looking for necessities of life in the forest and the youth very often gather outside their homes to just look for the internet network. This is similar to the study by Sari, Sucipto, and Hajimi (2014) on mosquito repellents in Toho Pontianak which said there was no relationship between the use of mosquito repellents and the incidence of malaria because mosquito repellents were used only at certain times so that protection was less than optimal. This is also supported by research by Anjasmoro (2013) regarding the use of mosquito repellent in Purbalingga which says there is no relationship between the use of mosquito repellents with the incidence of malaria, because the majority use mosquito coils that are only placed in the room, this allows contact to occur. with mosquitoes when activities are carried out in other rooms.

The results showed that there was an effect of using mosquito repellent with the incidence of malaria reinfection. Anti-mosquito repellent that is applied to parts of the body that are not protected by clothing, and does not disturb the user's comfort. The results of research by Syahrain, Kapantow, and Joseph (2014) found that there was a significant relationship between the use of mosquito repellents and the incidence of malaria, where people who did not use mosquito repellents were 6 times more at risk than those who used mosquito repellents.

The nature of mosquitoes that like to stick or hide in acidic places makes the behavior of not hanging up disposable clothes to be one of the 10 ideal behaviors for preventing malaria (Arsin, 2012). This is in line with research by Nurbayani (2013) which says there is a significant relationship between the habit of hanging clothes with the incidence of malaria in the work area of the Mayong I Public Health Center Jepara, this is also supported by Arsyad (2015) who said the risk factor for the incidence of malaria is to provide a damp and dark place in the house through the habit of hanging out disposable clothes. Then Lerebulan, Bawotong, and Rottie (2013) emphasized that the bad habit of hanging clothes on the back of room doors, windows, walls, bathrooms, chairs, beds or anywhere else can increase the incidence of malaria. After the female Anopheles mosquito sucks blood, it will rest temporarily inside or outside the house while waiting for the maturation of its eggs.

The grouping of blood-sucking behavior into human blood-sucking (anthropophilic), animal-blood-sucking (zoophilic), and human and animal-blood-sucking (anthropozoophilic). Meanwhile, resting behavior is grouped into resting at home (endophilic) and resting outside the home (exophilic) (Kemenkes RI, 2017) The community in the study area is the majority of workers who are required to be out of the house for a long time as can be seen in table 3, the majority of the respondents' occupations are farmers as much as 43.3% followed by 33.1% are housewives which means also will farm even if not for a long period of time in a day, so things like hanging clothes will be a shortcut to reduce the work of washing clothes, save time and be easier to do.

The existence of standing water is very beneficial for the mosquito breeding cycle from eggs to pupae. Enayati and Hemingway (2010) said that malaria requires water media, the types of puddles found by researchers in the research area are sewers, swamps, excavated holes, potholes,

and lots of ponds. found in the vicinity of the village of Bibiosi bate. The results of this study are in line with research by Rangkuti and Sulistyani (2017) which says that the existence of breeding places that are difficult to avoid, such as the condition of the ditch of household waste that is not smooth, the former excavations that are not stockpiled and also the pond that is not maintained can make mosquitoes can thrive. breed easily.

Watmanlusy, Raharjo, and Nurjazuli (2019) said that the close relationship between standing water, which explains that mosquito density has a close relationship with rainfall, which gives rise to many puddles (breeding places) which increase the mosquito population significantly. People who live >500 meters from rivers, swamps, puddles, ditches, animal footprints, used drums, and excavations have a 10,054 times greater risk of getting malaria compared to people who live >500 meters away. Different things are said in Saputro and Siwiendrayanti (2015) in his research which says that standing water is not a risk factor for malaria because puddles are directly related to the soil and at the time of data collection the specimens in the puddles were not seen.

Mosquitoes need water media to reproduce from the egg to the pupa stage. Zogo et al. (2019) explains that the effect of sunlight on the growth of larvae (larvae) of malaria mosquitoes varies. There are Anopheles who like the open (exposed to direct sunlight), for example An. hyrcanus spp and An. pinctutatus spp and some prefer the shade An. Sundaicus while those that can live both in the shade and in the sun are An. Barbirostic. Likewise, with the flow of water, there are malaria mosquitoes that like calm (stagnant) water such as Anopheles Letifer and there are also mosquitoes that like slow flowing water such as Anopheles barbirostris who like breeding where the water is static or slow flowing and there are also those who like fast-flowing water such as Anopheles Minimus. .

In the research area, there are 2 types of standing water, the first is standing water which can be handled by draining and closing it like in a water reservoir and making environmental modifications such as adding larvae-eating fish to saturated puddles. However, the types of puddles that are quite difficult to handle are areas of puddles and places at risk of puddles such as roads that have a muddy soil structure which can be flooded at any time when it rains, creating new holes due to vehicle wheels or the footprints of livestock, this becomes a problem. one of the crucial parts that are difficult to handle because it requires large costs if you have to do the hoarding.

Wire netting can be a barrier for mosquitoes to enter the house. Installing wire netting on home ventilation can minimize the possibility of contact between mosquitoes outside the house and residents in the house (Mustafa, Saleh, & Djawa, 2018). However, the results of this study are different from the research by (Mustafa et al. (2018)) which shows a relationship between the installation of wire gauze and the incidence of malaria. Many people in this area do not install wire netting because they think that using mosquito nets will not be bitten by mosquitoes and even if someone installs wire screens and even then it is not carried out throughout the ventilation of the house, this causes mosquitoes to still be very free to enter the house which can result in the possibility of for contact with mosquito bites can be even higher.

CONCLUSION

The incidence of malaria reinfection is influenced by the use of mosquito repellent, the habit of hanging clothes and the presence of standing water. The level of use of insect repellent and the habit of hanging clothes are aspects of patient behavior that affect susceptibility to mosquito bites. Meanwhile, environmental aspects in the form of standing water play a role in mosquito breeding. It is necessary to conduct health education about the use of mosquito repellent, the habit of hanging clothes and intervention in the community's living environment. In further research, it is possible to analyze the genetic factors of the Papuan people as malaria endemic areas.

ACKNOWLEDGEMENTS

Thank you to the Keerom District Health Office for granting research permits in the Keerom District area.

References

Anjasmoro, R. (2013). Faktor-faktor yang berhubungan dengan kejadian malaria di wilayah kerja Puskesmas Rembang Kabupaten Purbalingga. *Jurnal Kesehatan Masyarakat Universitas Diponegoro, 2*(1), 18851.

Arsin, A. (2012). *Malaria di Indonesia: Tinjauan aspek epidemiologi*. Makassar: Masagena Press.

Arsyad, G. (2015). Faktor-faktor yang berhubungan dengan kejadian malaria di Desa Tongoa Kecamaran Palolo Kabupaten Sigi. *Jurnal Ilmu Kesehatan, 1*(19), 935-1014.

Baird, J. K., Maguire, J. D., & Price, R. N. (2012). Diagnosis and treatment of Plasmodium vivax malaria. *Advances in parasitology, 80*, 203-270.

Bashar, K., Sarker, A., Asasuzzaman, M., Rahman, S., & Howlader, A. J. (2020). Host preference and nocturnal biting activity of mosquitoes collected in Dhaka, Bangladesh. *International Journal of Mosquito Research, 7*(3), 1-8.

Caputo, A., & Garavelli, P. L. (2016). Climate, environment and transmission of malaria. *Infez Med, 2*, 93-104.

Dinas Kesehatan Kab. Keerom. (2020). Laporan Kasus Malaria di Kabupaten Keerom. Arso: Dinas Kesehatan Kab. Keerom.

Enayati, A., & Hemingway, J. (2010). Malaria management: past, present, and future. *Annual review of entomology, 55*(1), 569-591.

Habibi, J., Ramlis, R., & Wulandari, W. (2019). Determinan kejadian malaria. *Jurnal Ilmu Kesehatan Masyarakat, 8*(03), 136-142.

Hasyim, H., Camelia, A., & Fajar, N. A. (2014). Determinan kejadian malaria di wilayah endemis. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*, 291-294.

Kemenkes RI. (2017). *Peraturan Menteri Kesehatan nomor 50 tahun 2017 tentang Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan untuk Vektor dan Binatang Pembawa Penyakit Serta Pengendaliannya*. Jakarta: Kementerian Kesehatan RI.

Kemenkes RI. (2020). Profil Kesehatan Indonesia 2019. Jakarta: Kementerian Kesehatan RI.

Lemeshow, S., Jr, D. W. H., Klar, J., & Lwanga, S. K. (1990). *Adequacy of Sample Size in Health Studies*. Chichester West Sussex England: John Wiley & Sons Ltd.

Lerebulan, N., Bawotong, J., & Rottie, J. (2013). Hubungan kebiasaan masyarakat Desa Tumbur dengan kejadian malaria di Wilayah Kerja Puskesmas Kecamatan Wertamrian Kabupaten Maluku Tenggara Barat. *Jurnal keperawatan, 1*(1).

Mustafa, M., Saleh, F. M., & Djawa, R. (2018). Penggunaan kelambu berinsektisida dan kawat kasa dengan kejadian malaria di Kelurahan Sangaji. *Media Publikasi Promosi Kesehatan Indonesia (MPPKI), 1*(3), 93-98.

Muti'ah, R. (2012). Penyakit Malaria dan mekanisme kerja obat-obat antimalaria. *Alchemy, 2*(1), 80-91.

Nascimento, T. L. d., Vasconcelos, S. P., Peres, Y., Oliveira, M. J. S. d., Taminato, M., & Souza, K. M. J. d. (2019). Prevalence of malaria relapse: systematic review with meta-analysis. *Revista latino-americana de enfermagem, 27*.

Nurbayani, L. (2013). Faktor risiko kejadian malaria di wilayah kerja Puskesmas Mayong I Kabupaten Jepara. *Jurnal Kesehatan Masyarakat Universitas Diponegoro, 2*(1), 18715.

Rajapakse, S., Rodrigo, C., & Fernando, S. D. (2015). Tafenoquine for preventing relapse in people with Plasmodium vivax malaria. *Cochrane database of systematic reviews, 4*.

Rangkuti, A. F., & Sulistyani, S. (2017). Faktor lingkungan dan perilaku yang berhubungan dengan kejadian malaria di Kecamatan Panyabungan Mandailing Natal Sumatera Utara. *BALABA: JURNAL LITBANG PENGENDALIAN PENYAKIT BERSUMBER BINATANG BANJARNEGARA, 13*(1), 1-10.

Saputro, K. P., & Siwiendrayanti, A. (2015). Hubungan lingkungan sekitar rumah dan praktik pencegahan dengan kejadian malaria di Desa Kendaga Kecamatan Banjarmangu Kabupaten Banjarnegara tahun 2013. *Unnes Journal of Public Health, 4*(2).

Sari, A., Sucipto, C. D., & Hajimi, H. (2014). Faktor determinan kejadian malaria di Kecamatan Toho Kabupaten Pontianak. *Jurnal Medikes (Media Informasi Kesehatan), 1*(1), 1-13.

Shafira, I. D., & Krisanti, I. G. (2020). Faktor-Faktor Kepatuhan Minum Obat pada Penderita Malaria Vivax di Puskesmas Hanura Kabupaten Pesawaran. *Jurnal Analis Kesehatan, 8*(2), 53-57.

Singh, V., Mishra, N., Awasthi, G., Dash, A. P., & Das, A. (2009). Why is it important to study malaria epidemiology in India? *Trends in parasitology, 25*(10), 452-457.

Sutarto, S. (2017). Faktor lingkungan, perilaku dan penyakit malaria. *AGROMEDICINE UNILA, 4*(1), 173-184.

Syahrain, S. W., Kapantow, N. H., & Joseph, W. (2014). *Faktor-faktor yang berhubungan dengan kejadian malaria di wilayah kerja puskesmas tuminting kota manado tahun 2014.* (Tesis), Universitas Sam Ratulangi, Manado.

Wantini, S., & Susanti, F. (2017). Faktor-Faktor Yang Berhubungan Dengan Kejadian Malaria Di Wilayah Kerja UPT Puskesmas Rajabasa Kecamatan Rajabasa Kabupaten Lampung Selatan. *Jurnal Analis Kesehatan, 3*(1), 327-338.

Watmanlusy, E., Raharjo, M., & Nurjazuli, N. (2019). Analisis Spasial Karakteristik Lingkungan dan Dinamika Kepadatan Anopheles sp. Pengaruhnya terhadap Kejadian Malaria di Kecamatan Seram Barat Kabupaten Seram Bagian Barat Maluku. *Jurnal Kesehatan Lingkungan Indonesia, 18*(1), 12-18.

WHO. (2016). Global Malaria Progress And Challenges In 2016. Genewa, Swiss: World Health Organization.

Yawan, S. F. (2006). Analisis Faktor Risiko Kejadian Malaria di Wilayah Kerja Puskesmas Bosnik Kecamatan Biak Timur Kabupaten Biak–Numfor Papua. *Jurnal Kesehatan Lingkungan Indonesia, 5*(2), 45-52.

Zogo, B., Tchiekoi, B. N. C., Koffi, A. A., Dahounto, A., Ahoua Alou, L. P., Dabiré, R. K., . . . Pennetier, C. (2019). Impact of sunlight exposure on the residual efficacy of biolarvicides Bacillus thuringiensis israelensis and Bacillus sphaericus against the main malaria vector, Anopheles gambiae. *Malaria Journal, 18*(1), 1-9.