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The Relationship Between Sex and Age with the Suspected Incidence of Malaria Based on Rapid Diagnostic Test (RDT) Results in the Working Area of the Tanjung Leidong Health Centre, North Labuhanbatu District in 2023

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ABSTRACT

Background: Malaria is a global problem and it's incidence increasing every year. Malaria caused by several factors such as gender and age. Men are more at risk of malaria than woman and adults are more affected by malaria than children and the elderly. Methods: This study used observational analysis method with Cross-Sectional approach with total sampling technique, with 754 samples that fit the inclusion criteria. The data was analized with Chi-square test correlation analysis, and Risk metode to determine the Prevelence ratio value, and also the contingency coefficient test. Results: The most positive RDT results were found in men (62.4%) and (53.1%) were found in adult with the results of the chi-square test on the gender variable and RDT results obtained a value of p-value = 0.00 (p < 0.05) and OR = 14.9 (CI 95% 5,845-38,032) which means there is a relationship between gender and the incidence of malaria and men have a high risk of malaria 14.9 times greater than women. The results of the age variable test with the incidence of malaria using Coefficient Contingency with Spearman Correlation obtained a value of p = 0.000 (p <0.05) with an r-value = 0.194. These results indicate that there is a relationship between age and malaria incidence rates with a very weak correlation value. Discussion: man and adults are more affected by malaria due to outdoor physical activity, immune system influences, and hormonal system influences. Adults are more often affected by malaria due to lifestyle and daily activities.

Keywords: Gender, Age, Malaria, and RDTs

1. INTRODUCTION

Malaria is a deadly disease caused by a parasite that is transmitted to humans through the bite of an infected female Anopheles mosquito. The disease is both preventable and treatable. Five types of parasites cause malaria in humans, two of which pose the greatest threat: Plasmodium falciparum and Plasmodium vivax [20].

P. falciparum is the most dangerous type of malarial parasite and is most prevalent in Africa. P. vivax is the dominant malarial parasite in most countries outside Sub-Saharan Africa. Other malaria species that can infect humans are P. malariae, P. Ovale, and P. Knowlesi [20]. Over the past few years, P. knowlesi has become a major concern in malaria cases, especially in WHO countries in Southeast Asian regions such as Indonesia, Malaysia, and Thailand [20].

The World Health Organization (WHO) states that there will be approximately 249 million cases of malaria in the world by 2022, with the largest area on the African continent in Nigeria, with more than 66 million cases. Indonesia has more than one million cases and is second only to India, which has more than three million cases in the highest number of malaria cases in Southeast Asia. This data makes India and Indonesia account for about 94% of all malaria deaths in the continent [12].

The annual report on malaria in Indonesia for 2022 shows that the number of recorded sufferers was 443,530, which is less than 20 years ago. By the end of 2022, 372 districts/municipalities out of a total of 514 districts/municipalities met the requirements and were declared malaria-free. The remaining 142 districts/cities will still experience local transmission in their areas [6]. There are 29% low endemic, 4% medium endemic, and 5% high endemic districts in Indonesia in 2020 [2].

The number of positive cases of malaria in 2022 in North Sumatra Province quoted from the health profile data of North Sumatra Province in 2022 is 3,100, including 1,914 men with an Annual Parasite Incidence (API) of 0.25/1,000

population and 1,186 women with an API of 0.16/1,000 population. The achievement of malaria elimination districts/cities in North Sumatra remains in 21 districts/cities. There are still 12 other districts/cities that have not met the requirements for malaria elimination due to the presence of indigenous malaria cases [19]. Indigenous malaria itself is transmitted locally without indications of originating from outside the region, and there is no direct link to transmission from imported or foreign cases [12].

The graph of the number of positive malaria cases by district/city in North Sumatra Province in 2022 shows that North Labuhanbatu Regency ranked third with 703 cases, after Asahan Regency with 793 cases and Batu Bara Regency with 705 cases [19]. The number of malaria cases by sub-district in North Labuhanbatu Regency in 2021 shows that Kualuh Leidong Sub-district has the highest number of positive malaria cases in North Labuhanbatu Regency, namely 407 cases [19].

Individual risk factors that are thought to play a role in the occurrence of malaria include age, sex, education, occupation, and population migration. The prevalence of malaria infection is higher in men than in women who generally only perform activities at home, especially at night, while men perform more daily activities outside the home, such as working as fishermen, and the habit of leaving the house at night to carry out night patrols; at that time, the female Anopheles mosquito actively looks for blood [8]. Apart from the activities and lifestyles mentioned earlier, women also have a stronger immune response to parasites than men; therefor, they are less likely to develop malaria [4]. Estradiol, which is widely present in women, has immunostimulatory properties, whereas testosterone, which is widely present in men, has immunosuppressive activity [11].

Research [7] in the eastern Indonesian provinces of Maluku, North Maluku, West Papua, East Nusa Tenggara, and Papua has concluded that women reported malaria less often than men based on gender in the five provinces. Different results were obtained from the analysis conducted [3] based on the 2018 Riskesdas data. The results for female respondents suffering from malaria were 13,827 (51.9%), while male respondents were 12,830 (48.1%). The results of the study [7] show that men are 1.107 times more likely than women to experience malaria (OR 1.107; 95% CI 1.020-1.202).

In the adult age group, the number of malaria sufferers is higher than that in the immature age group, because this age group is a productive age group, and at that age, it is possible to work and travel outside the home, so the opportunity for contact with malaria vectors is greater. Malaria is reported to primarily affect adults, in Southeast Asia region [8]. Children under five years of age are also at risk of malaria because their immune response to malaria is longer than that of adolescents [10]

Research [7] in the eastern provinces of Indonesia, namely Maluku, North Maluku, West Papua, East Nusa Tenggara, and Papua, related to the age of malaria patients, concluded that most patients found were adult patients (25 years and over) in five provinces, except in Papua. The analysis conducted [3] based on the 2018 Riskesdas data showed that the majority of respondents suffering from malaria were aged> 24 years, with 14,769 (55.4%). From the results of the grouping conducted by [7] in their research based on age criteria, the incidence of malaria is dominated by the group of patients aged 11-20 years.

Microscopic examination of peripheral blood smears is still the main method for diagnosing malaria, but has low sensitivity for detecting low-density parasitemia. Microscopy requires trained personnel, reagents, and adequate laboratory equipment. Meanwhile, conventional malaria rapid diagnostic tests (RDTs) are easy to use, cheap, fast, and can be used in the field, but have limitations in detecting low-density and asymptomatic infections. Rapid diagnostic tests can detect gamete-produced antigens (pLDH) so that they can already give positive results in patients who only contain gametes [16].

In a study conducted by (Tulak, 2021) regarding the validity value of malaria examination with RDT, it was stated that RDT is still effective as a malaria diagnostic tool that can detect malaria quickly and accurately, especially in highly endemic areas, by showing results that are not different from microscopic examination of the same patient. According to an employee at the North Labuhanbatu Health Office who worked in the malaria program during my initial survey, malaria testing in North Labuhanbatu, including at the Tanjung Leidong Health Centre, is only available for RDT testing without microscopic examination in the enforcement of malaria cases. This is because of the lack of trained resources (laboratory analysts) who can perform and read the results of microscopic examinations.

The description of the problems above is a reference for researchers to conduct research to prove the relationship between sex and age and the incidence of malaria at the Tanjung Leidong Health Centre, North Labuhanbatu Regency. The results of this study are expected to be used as a reference for risk factors based on age and sex, as well as being the latest reference for future researchers.

2. METHOD

The type of research conducted in this study was observational analysis with a cross-sectional design that aimed to determine the relationship of risk factors (gender and age) of a malaria disease that has occurred in the working area of the Tanjung Leidong Health Centre, Kualuh Leidong District, North Labuhanbatu Regency, where each data point was taken at the same time. This research was conducted from March 2024 to August 2024. The study was conducted at the Health Office of the North Labuhanbatu Regency, North Sumatra. The population considered in this study was all people in the Tanjung Leidong Puskesmas working area, Kualuh Leidong District. The data collection method in this study was documented using secondary data on malaria patients from January to December 2023, with or without complications, who had outpatient or inpatient care at the Tanjung Leidong Health Centre, whose data were obtained from the North

Labuhanbatu Regency Health Office. Perform a data analysis for each variable to describe the condition of one variable. Each research variable (independent and dependent) is displayed in the form of narratives and graphs. Sex as an independent variable and the incidence rate of malaria based on the results of the Rapid Diagnostic Test as the dependent variable were tested with non-parametric statistical tests using SPSS version 25. Age as an independent variable and the incidence rate of malaria based on the results of the Rapid Diagnostic Test as the dependent variable were tested using non-parametric statistical tests using SPSS version 25.

3. RESULTS AND DISCUSSION

This research was conducted at the North Labuhanbatu Regency Health Office using secondary data provided by the Tanjung Leidong Health Centre, North Labuhanbatu Regency. Puskesmas Tanjung Leidong is located in the Kualuh Leidong sub-district, Labuhanbatu Utara Regency, which has seven villages: Air Hitam, Teluk Pulai Dalam, Teluk Pulai Luar, Kelapa Sebatang, Pangkalan Lunang, Tanjung Leidong, and Simandulang. The Kualuh Leidong Sub-district is bordered to the north by the Asahan Regency and the Malacca Strait, to the east by the Kualuh Hilir Sub-district, to the south by the Kualuh Hulu Sub-district, and to the west by the Asahan Regency. The total population of Kualuh Leidong Sub-district in 2023 is 35,892 people, with a male population of 18,278 and a female population of 17,614.

3.1. Data Analysis Results

Univariate analysis was used to descriptively analyze the collected data in the form of frequency distribution tables as follows:

Table 1. Sample characteristics by gender

No	Gender	Total	Presentase (%)
1	Man	444	58,9
2	Woman	310	41,1
	Total	754	100

Table 1 shows that the sample characteristics based on gender in 754 samples of positive and negative malaria patients examined using the Rapid Diagnostic Test (RDT) in 2023 in the Tanjung Leidong Puskesmas work area were more men, namely 444 samples (58.9%), than women, with 310 samples (41.1%).

Table 2. Sample characteristics by age

No	Age	Total	Percentage
1	Baby (<5 years)	41	5,4
2	Children (5-9 years old)	88	11,7
3	Teen (10-18)	174	23,1
4	Adult (19-59 years old)	419	55,6
5	Elderly (>60 years old)	32	4,2
	Total	754	100

Table 2 shows that based on age characteristics, samples aged 19-59 years (adults) were the most samples, namely 416 samples (55.6%) followed by samples aged 5-9 (children) as many as 88 samples (11.7%).

Table 3 shows sample data in the Tanjung Leidong Puskesmas work area in 2023. Of the total 754 samples, there were 704 malaria positive samples based on RDT testing (93.4%) The most positive patients were diagnosed in September with 187 cases, followed by October with 146 cases.

Table 3. Overview of malaria incidence rates based on positive Rapid Diagnostic Test (RDT) results in 2023

Positive RDT Result ***(Plasmodium Vivax 99,71%)***	**Total (n)**	**Persentase %**
January	0	0
February	0	0
March	0	0
April	13	1,72
May	34	4,5
June	24	3,18
July	71	9,41
August	120	15,91
September	187	24,8
October	146	19,36
November	72	9,54
Desember	37	4,9
Total	704	93,4%

Table 4. Overview of malaria incidence rates based on negative Rapid Diagnostic Test (RDT) results in 2023

Negative RDT Result	**Total (n)**	**Persentase (%)**
January	5	0,66
February	0	0
March	10	1,32
April	0	0
May	0	0
June	0	0
July	0	0
August	9	1,19
September	10	1,32
October	9	1,19
November	6	0,79
Desember	1	0,13
Total	50	6,6

Table 4 Of the total 754 samples, there were 50 negative malaria samples based on RDT examination (6.6%), it can also be seen that patients with negative RDT results were mostly found in March and September, with 10 cases each (1.32%).

Table 5. Frequency distribution of Rapid Diagnostic Test (RDT) results based on sample gender

		Quick Diagnostic Test Results					
		Positive		**Negative**		**Total**	
	Gender	n	%	n	%	N	%
1	Man	439265	62,4	5	10	444	58.9
2	Woman		37,6	45	90	310	41,1
	Total	704	100	50	100	754	100

Table 5 shows that out of 754 samples that have been examined by Rapid Diagnostic Test (RDT) examination, there are 704 malaria positive samples, 439 samples are male (62.4%) and the remaining 265 samples are female (37.6%). In malaria negative samples, 5 samples were male (10%) and 45 samples were female (90%).

Table 6. Frequency distribution of Rapid Diagnostic Test (RDT) results based on sample age

No		**Hasil *Rapid Diagnostic Test***					
		Positive		**Negative**		**Total**	
	Age	n	%	n	%	N	%
1	Baby (<5 Years old)	40	5,7	1	2	41	5,4
2	Children (5-9 Years old)	88	12,5	0	0	88	11,7
3	Teen (10-18 Years old)	173	24,6	1	2	174	23,1
4	Adult (19-59 Years old)	374	53,1	45	90	419	55,6
5	Elderly (>60 Years old)	29	4,1	3	6	32	4,2
	Total	704	100	50	100	754	100

Table 6 shows that the samples that were positive for malaria through Rapid Diagnostic Test (RDT) examination based on age were 374 adult samples (53.1%) which was the highest percentage of positive malaria, followed by 173 adolescent samples (24.6%), 88 samples of children (12.5%), then 40 samples of infants and toddlers (5.7%), and the remaining 29 samples >60 years 4.1%.

For samples with negative RDT results, adults showed the highest percentage of 45 samples (90%), then 3 samples in the elderly (6%), infants and toddlers (2%), and adolescents (2%) each as many as one sample, and children became the age with the lowest percentage of negative malaria, namely 0 samples or (0%).

Bivariate analysis was conducted to determine the relationship between the independent and dependent variables, namely sex and age, and the incidence of malaria based on the results of the Rapid Diagnostic Test (RDT) in the working area of Puskesmas Tanjung Leidong, North Labuhanbatu Regency.

The statistical test used was the chi-square (X2), with a degree of significance (α) of 5%. To be able to perform the chi-square test, it must fulfil several requirements, namely that no observed cell value is 0 and no cell has an expected value <5. The results of the complete bivariate analysis are show in the table below.:

Table 7. Relationship between Gender and Malaria Incidence Rates Based on Rapid Diagnostic Test (RDT) Results

No	Gender	Incidence Rate Malaria Based on RDT Result				*p-value*	PR	CI 95%
		Positif		Negatif				
		f	%	f	%			
1	Man	439	62,4	5	10	0,000	14,9	5,845-38,032
2	Woman	265	37,6	45	90			
	Total	704	100	50	100			

Table 7 shows the results of this test using the Chi-square test because both variables are nominal, so they are not normally distributed. This variable fulfils the chi-square requirements, namely, looking for relationships using a 2×2 table, and there is no expected count value <5. The test results were obtained with a p-value = 0.00 (p-value <0.05); thus, it can be concluded that there is a significant difference, meaning that there is a relationship between sex and Malaria Incidence Rates Based on RDT Results in the Tanjung Leidong Health Centre working area, North Labuhanbatu Regency.

These two variables were also tested using the risk method to determine the value of the prevalence ratio to determine the influence of sex on the incidence rate of malaria. The Prevalence-ratio value obtained from the test results was 14.9 with a 95% Confidence Interval (CI) value of 5.845-38.032, which indicates that males are 14.9 times more likely to suffer from malaria than females.

Table 8. Relationship between age and malaria incidence rate based on Rapid Diagnostic Test (RDT) results.

No	Age	Incidence Rate Malaria Based on RDT Result				*p-value*	*r*
		Positive		Negative			
		f	%	f	%		
1	Baby (<5 Years Old)	40	5,7	1	2	0,000	0,194
2	Children (5-9 Years Old)	88	12,5	0	0		
3	Teen (10-18 Years Old)	173	24,6	1	90		
4	Adult (19-59 Years Old)	374	53,1	45	6		
5	Elderly >60 Years Old)	29	4,1	3	100		

In Table 8, the correlation test is used with the contingency coefficient because both variables are nominal and ordinal, so the data are not normally distributed. These two variables do not meet the chi-square requirements because they do not use a 2×2 table; therefore, the contingency coefficient test is used as an alternative. From the results of the test conducted, a p-value of 0.00 (p-value <0.05) was obtained so that it can be concluded that there is a significant

difference, meaning that there is a relationship between age and the incidence of malaria based on RDT results in the Tanjung Leidong Puskesmas work area, North Labuhanbatu Regency.

The test conducted on these two variables shows the strength of the correlation with a value of r = 0.194 (r - value 0.0-0.199) which means that these two variables have a very weak correlation strength.

3.2. Discussion

The most malaria-positive sex category in this study was male as many as 439 out of the 704 positive samples. To determine the relationship between sex and malaria incidence rates, researchers used the chi-square test and *Risk* test to determine the *Prevalence ratio* value. The results of the chi-square test showed *p-value* of 0.000, which means that there is a significant relationship between sex and the incidence of malaria based on RDT results. From the *Risk* test results, the PR *(Prevalence Ratio)* value = 14.9, which means that men have a 14.9 times greater risk of being positive for malaria than women, with a 95% *Confidence Interval* (CI) value of 5.845-38.032.

According to the researchers, the high PR value (14.9) and the 95% CI value that has a long range (5.845-38.032) occurs because the number of malaria-positive samples (704 samples) with malaria-negative samples (50 samples) is not proportional; thus, when testing will show a high PR value and a range of *lower bound-upper bound* values at a far CI. This can occur because the research conducted uses a *cross-sectional* design, so that the samples used are based on data obtained at one time, and the number or comparison cannot be determined.

The results of this study are in line with the results of a previous study (Ramdzan et al., 2020) which showed that there is a relationship between gender and malaria incidence rates with a *p-value* <0.05. In this study (Ramdzan et al., 2020) also showed that out of 1222 samples, there were 410 positive for malaria, of which 356 were male and 54 were female. The results of the bivariate test, show the results of PR = 0.023, CI = (0.012-0.047) so that it can be interpreted that men are more at risk of malaria (0.023 times higher than women).

In the results of research on risk factors for malaria conducted (Sejati, A. A., Medyati, N., & Sandjaja, 2024), it was found that there was a relationship between gender and the incidence of malaria with a *p-value* = 0.033 (p <0.05). The sample consisted of 72 respondents, with 37 positive samples comprising 28 men and 9 women. The results of the bivariate test showed a value of PR = 1.045, CI 95% (1.045-3.334) which means that men are at risk of 1.045 times more malaria than women.

The higher incidence of malaria in men than in women is associated with men performing more daily activities outside the home than women at night, where the female Anopheles mosquito is actively looking for blood [8]. Apart from activities and lifestyles, women also have a stronger immune response to parasites than men, so they are less likely to develop malaria [4].

The age group with the most malaria cases in this study was the 19-59 years (adult) category with 374 samples and the 10-18 age group with 173 samples. These results were tested to determine whether there was a relationship between age and malaria incidence rates based on the RDT results. In this study, researchers used the correlation test and contingency coefficient test and found a p value of 0.000 and an r value of 0.194. These results indicate that age and malaria incidence rates based on the RDT results have a significant and correlated relationship or a very weak relationship. This means that the more adults who perform malaria testing with RDTs, the higher the malaria incidence rates.

This is in line with research conducted by (Ferrao et al., 2022) which has the results of the majority of malaria cases in the age group> 14 years, namely 24 of the 85 sample cases (29.2%), followed by the age range 5-14 years, namely 15 cases (17.6%). This result was tested using the coefficient contingency method with a value of p=0.000 (p<0.05), which indicates a relationship between age and malaria incidence.

The adolescent to adult age group has higher outdoor activities, so the possibility of contact with Anopheles mosquitoes, which are carriers of malaria parasites, is also higher (Triyana & Salmi, 2020).

The total population in the Kualuh Leidong Sub-district in 2023 was 35892. The total number of malaria cases in the Tanjung Leidong Health Centre working area in 2023 was 704. Malaria incidence rates/malaria morbidity rates per 1000 population in one year can be used to determine the endemicity status of an area by looking for the Annual Parasite Incidence (API) value. Based on sources from (Organization., 2021), API is the number of positive cases of malaria per thousand people in one year. This API is used to determine trends in malaria morbidity and determine the endemicity of an area, and has the following formula:

$$\frac{\text{Number of malaria positive Patients}}{\text{Total Population in an Area}} \text{x1000 penduduk}$$

$$= \frac{704}{35.892} \text{x1000 penduduk}$$

$$= 0{,}019$$

From these results, the API value in the Tanjung Leidong Health Centre working area is 0.019, which means that out of 1000 residents there will be 19 people suffering from malaria. An API value of 0.019 (API <1) indicates that an area is categorized as a low-malaria endemic area in accordance with the provisions of the Ministry of Health of the Republic of Indonesia.

August, September, and October are the months when the highest incidence of malaria is found because it is the rainy season, in accordance with the results of previous studies (Lestari et al., 2020) with an increase in the number of Plasmodium vivax and Plasmodium falciparum malaria cases in Yogyakarta, which occurred during the rainy season.

Although the rainy season is one of the factors in the occurrence of malaria, the results of the study stated that there was no significant difference between the rainy and dry seasons on the incidence of malaria (p=0.316) (Lestari et al., 2020) stated that the impact of high rainfall in the rainy season increases the breeding ground for disease vectors, especially malaria.

4. CONCLUSION

There was a significant relationship between gender and the incidence of malaria based on RDT results in the Tanjung Leidong Health Centre working area, North Labuhanbatu Regency, with a value of p = 0.000 and PR = 14.9 (95% CI = 5.845-38.032). There was a significant relationship between age and the incidence of malaria based on RDT results in the Tanjung Leidong Puskesmas work area, North Labuhanbatu Regency, with a p-value of 0.000 and r-value of 0.194. The characteristics of positive malaria samples in the Tanjung Leidong Puskesmas work area found that the most common sex category was male, with 439 of 704 (62.4%) positive samples, and the most common age category was 19-59 years as many with 374 of 704 (53.1%) positive samples. The malaria incidence rate in the Kualuh Leidong Sub-district was 0.019 (API < 1/1000 population) and was classified as a low endemicity area in accordance with the provisions of the Ministry of Health of the Republic of Indonesia.

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REFERENCES

[1] Predictors of Malaria Incidence in Rural Eastern Indonesia. (2020). *Indian Journal of Forensic Medicine & Toxicology*. https://doi.org/10.37506/ijfmt.v14i4.12078

[2] Aida, P. N., Astuti, F. D., & Azka, A. (2023). Keanekaragaman Spesies dan Bionomik Anopheles spp. pada Daerah Endemis Malaria di Indonesia. *ASPIRATOR - Journal of Vector-Borne Diseases Studies*, *14*(2), 89–104. https://doi.org/10.58623/aspirator.v14i2.11

[3] Apriliani, Siregar, P. A., Tarigan, A. A., & Hasibuan, R. (2021). Analysis of Risk Factors Malaria Incidence in Indonesia (Data Analysis of Basic Health Research 2018). *International Archives of Medical Sciences and Public Health, 2(1), 98–107.*

[4] Cervantes-Candelas, L. A., Aguilar-Castro, J., Buendía-González, F. O., Fernández-Rivera, O., Nolasco-Pérez, T. de J., López-Padilla, M. S., Chavira-Ramírez, D. R., & Legorreta-Herrera, M. (2021). 17β-Estradiol Is Involved in the Sexual Dimorphism of the Immune Response to Malaria. *Frontiers in Endocrinology*, *12*. https://doi.org/10.3389/fendo.2021.643851

[5] Ferrao, J., Earland, D., Novela, A., Mendes, R., Ballat, M., Tungadza, A., & Searle, K. (2022). Modelling sociodemographic factors that affect malaria prevalence in Sussundenga, Mozambique: a cross-sectional study. *F1000Research*, *11*, 185. https://doi.org/10.12688/f1000research.75199.2

[6] Indonesia., K. K. R. (2023). *Laporan Tahunan Malaria 2022. Kemenkes RI, 1–51.*

[7] Ipa, M., Widawati, M., Laksono, A. D., Kusrini, I., & Dhewantara, P. W. (2020). Variation of preventive practices and its association with malaria infection in eastern Indonesia: Findings from community-based survey. *PLOS ONE*, *15*(5), e0232909. https://doi.org/10.1371/journal.pone.0232909

[8] Kemismar, Y. Y., Manurung, I. F. E., & Weraman, P. (2022). Risiko Karakteristik Orang dan Tempat Perindukan Vektor terhadap Kejadian Malaria di Kabupaten Manggarai Provinsi Nusa Tenggara Timur. *Jurnal Penelitian Kesehatan" SUARA FORIKES"(Journal of Health Research" Forikes Voice"), 13(1), 73–76.*

[9] Lestari, R. A. K., Lusiyana, N., & Nurochmah, F. S. (2020). The Distribution of Malaria with Seasonal in Kokap Yogyakarta 2012-2017. *E3S Web of Conferences*, *151*, 01018. https://doi.org/10.1051/e3sconf/202015101018

[10] Ningtyas, R., Martini, M., Wurjanto, M. A., & Hestiningsih, R. (2023). Analisis Faktor Risiko Kejadian Malaria pada Anak (Usia 0-18 Tahun) di Kabupaten Purworejo. *Jurnal Riset Kesehatan Masyarakat*, *3*(2), 59–70. https://doi.org/10.14710/jrkm.2023.19153

[11] Nolasco-Pérez, T. de J., Cervantes-Candelas, L. A., Buendía-González, F. O., Aguilar-Castro, J., Fernández-Rivera, O., Salazar-Castañón, V. H., & Legorreta-Herrera, M. (2023). Immunomodulatory effects of testosterone and letrozole during Plasmodium berghei ANKA infection. *Frontiers in Cellular and Infection Microbiology*, *13*. https://doi.org/10.3389/fcimb.2023.1146356

[12] Organization., W. H. (2023). *World Malaria Report 2023.*

[13] Organization., W. H. (2021). *WHO malaria terminology. In Global Malaria Programme.*

[14] Ramdzan, A. R., Ismail, A., & Mohd Zanib, Z. S. (2020). Prevalence of malaria and its risk factors in Sabah, Malaysia. *International Journal of Infectious Diseases*, *91*, 68–72. https://doi.org/10.1016/j.ijid.2019.11.026

[15] Sejati, A. A., Medyati, N., & Sandjaja, B. (2024). Risk Factors Of Malaria At Tanjung Ria Health Center , Jayapura City , Indonesia. *Jurnal Eduhealth, 15(03), 591–596. Https://Doi.Org/10.54209/Eduhealth.V15i0*. https://doi.org/https://doi.org/10.54209/eduhealth.v15i03

[16] Tatura, S. N. N. (2018). *Malaria. In Buku Ajar Infeksi & Penyakit Tropis (Edisi 4).* Badan Penerbit Ikatan Dokter

Anak Indonesia.
[17] Triyana, R., & Salmi, S. (2020). Profil Penyakit Malaria Di Rumah Sakit Islam Siti Rahmah Padang Tahun 2018. *Health & Medical Journal*, *2*(2), 08–15. https://doi.org/10.33854/heme.v2i2.546
[18] Tulak, Z. L. (2021). Validity of Rapid Diagnostic Test for Malaria Screening at Puskesmas Harapan Jayapura Regency. *MIRACLE Journal Of Public Health*, *4*(1), 21–28. https://doi.org/10.36566/mjph/Vol4.Iss1/245
[19] Utara., D. K. S. (2023). Profil Kesehatan Provinsi Sumatera Utara 2022. Dinas Kesehatan Sumatera Utara, 2, 1–466. *Dinas Kesehatan Sumatera Utara*, *2*, *1–466.*
[20] World Health Organization. (2022). *Malaria.*