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RESEARCH ARTICLE
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Physical Environment and Malaria Incidence in Sowek Health Center

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ABSTRACT

In 2022, the working area of the Sowek Health Center again experienced an increase in malaria cases from 4,33 per1000 population in 2021 to 22,72 cases per1000 population. This increase is inseparable from the role of physical environmental factors and the presence of a chemical environment that supports the breeding of Anopheles, so this study was made to identify physical environmental factors and chemical environmental characteristics associated with the incidence of malaria in the work area of the Sowek Health Center. This study is an observational analytical study with a case-control approach. The sample size was 130 people consisting of 65 cases and 65 controls. Data collection through interviews using questionnaires as well as water quality meters and refractometers for chemical environment measurements. Data analysis using the Chi-Square test found a relationship between the existence of sago gathering places(p-value=0.041), the condition of the walls of the house(p-value=0.018) and the condition of the ceiling of the house(p-value=0.018) with the incidence of malaria and supported by the pH of the breeding place between 4,1-8,5 and salinity 0-15$^{0}/_{00}$. Therefore, there is a need for environmental control efforts to reduce the number of malaria pain in the working area of the Sowek Health Center.

Keywords: physical environment; chemical environment; malaria

INTRODUCTION

Malaria is the most common mosquito-vector-borne infectious disease in the world and remains a public health problem today. This disease has an impact on decreasing the quality of human resources and has a strong influence on the emergence of various social and economic problems[(1)], because it affects all age groups both men and women, and causes a high incidence of death for infants, toddlers and pregnant women and can affect the productive day of society.[(2)] Malaria is still an important tropical parasitic disease and health problem in the world today because it is the number 4 killer in the world after respiratory tract infections, HIV, and diarrhea.[(3)] WHO estimates that currently there are 2.3 billion or 41% of the world's population living in high-risk areas, especially in tropical and subtropical countries. The incidence of malaria per year in the world ranges from 350-500 million cases with 1.1 million cases of death and the majority of deaths occur in children under 5 years old and pregnant women.[(4)]

Indonesia is one of the 9 malaria-emitting countries in the Asian region and is the 2nd largest contributor to malaria cases after India[(5)], although overall in the last 5 years, there has been an estimated decrease in cases from 1.1 million cases in 2015 to 658,000 cases in 2019, but this disease must still get attention because there are still 10.7 million Indonesians living in endemic areas and high in malaria[(4)]. In 2020 data from the Ministry of Health recorded a malaria morbidity rate in Indonesia of 254,050 cases with API 0.9 per 1000 population, with most cases coming from eastern Indonesia, namely East Nusa Tenggara with 15,304 cases, West Papua with 9,970 cases, and Papua with 216,841 cases or 85% of national cases.[(6)] The fluctuation of malaria cases in Indonesia in addition to access to diverse medical services is also due to the geographical location of Indonesia which has a tropical and sub-tropical climate as a preferred habitat for Anopheles mosquitoes, climate change related to the physical, chemical, and biological and social environment and community behavior is a trigger factor for the increase in malaria cases.[(7,8)]

Papua is the region that contributes the highest malaria cases in Indonesia every year. The high incidence of malaria in Papua is caused by the high population of Anopheles mosquitoes which are vectors of malaria, where Papua is home to 4 species of Anopheles mosquitoes, namely An.koliensis, An.punctulatus, An.bancrofti and An. Farauti.[9] In addition, weather factors that often change and are erratic, malaria symptoms that resemble mild illness that make it difficult for people to identify if they are infected, lack of preventive measures that result in the emergence of malaria relapse cases and community residences that are still at risk because they are surrounded by mosquito nests that come from the many puddles that appear when rainfall increases, and unclean environment.[10]

Supiori Regency is one of the regions in Papua Province that contributes to malaria cases although in recent years this case can be reduced to API <1 per 1000 population in 2018, but since 2019 there has been an increase in the number of cases even though it is still at a moderate endemic level with API 1-5 per 1000 population and in 2022 it has risen to a level 1 high endemic area with API 6.99 per 1000 population.[11] The working area of the Sowek Health Center is one of the contributors, with surveillance data showing that although in recent years malaria cases can be reduced from 241 cases (API 51.40) in 2013 to 28 cases (API 4.33) in 2021, 2022 there was a significant increase in cases to 147 cases with API 22.72 per 1000 population or an increase of 5 times compared to the previous year.[12]

The risk of this region to the incidence of malaria is inseparable from the role of physical environmental factors where people live and also the chemical environment that supports the breeding of Anopheles mosquitoes. Seeing the above, this study aims to identify physical environmental factors and describe the characteristics of the chemical environment associated with the incidence of malaria in the work area of the Sowek Health Center

METHODS

This study was an observational analytical study with a case-control approach to examine the relationship between the effects of certain health conditions and certain risk factors. The study was conducted in the working area of the Sowek Health Center from April-May 2023, with the study case population being all people who were declared to have malaria based on the results of blood tests at the Sowek Health Center in 2022 as many as 147 patients and the control population were patients who sought treatment at the Sowek Health Center and were diagnosed not with malaria, with a sample size of 130 respondents consisting of 65 case respondents and 65 control respondents. Sampling was done by simple random sampling.

The independent variables in this study were the presence of sago gathering places, the abundace of breeding places, environmental temperature, environmental humidity, the condition of the walls of the house and the condition of the ceiling of the house, the confounding variables that will be described characteristics were pH and salinity of the breeding place and the dependent variable was the incidence of malaria. Data collection techniques in this study were interviews using questionnaires and direct observation of the respondents' environment and pH and salinity measurements of breeding places using water quality meters and refractometers. Then the data were analyzed descriptively to see the frequency of respondent characteristics, physical environmental characteristics and chemical environment characteristics and bivariate analysis to see the relationship between independent variables to malaria incidence using the Chi-square test.

RESULTS

Table 1 shows that the age group is dominated by respondents aged 10-17 years as much as 35.4% and 18-35 years as much as 36.2%. Male gender contributed the most respondents with 50.8% and for the education level most respondents had a high school education (35.4%) and the fewest respondents had a college education (7.7%).

Table 1. Distribution of respondent characteristics

No	Characteristics of respondents	Frequency	Percentage
1	Age		
	• 10-17	46	35.4
	• 18-35	47	36.2
	• 36-50	21	16.2
	• > 50	16	12.3
2	Gender		
	• Man	66	50.8
	• Woman	64	49.2
3	Education level		
	• Primary school	34	26.2
	• Junior high school	40	30.8
	• Senior high school	46	35.4
	• Collage	10	7.7

Table 2. Distribution of physical environment

No	Physical environment	Frequency	Percentage
1	The existence of sago gathering place		
	• Yes	44	33.8
	• Not	86	66.2
2	The abundance of breeding places		
	• ≥3	58	44.6
	• <3	72	55.4
3	environmental temperature		
	• 20^0C-30^0C	69	53.1
	• <20^0C atau >30^0C	61	46.9
4	Environmental humidity		
	• 60-100%	130	100
	• <60%	0	0
5	The condition of the walls of the house		
	• Has gaps	82	63.1
	• Tight wall	48	36.9
6	Ceiling condition		
	• Unqualified	95	73.1
	• Qualify	35	26.9

For the characteristics of the physical environment shown in Table 2, it was found that around 33.8% of respondents' houses found the existence of sago gathering places, in addition to breeding places ≥3 were also found in 44.6% of respondents. For temperature, 53.1% of respondents have an environmental temperature ranging from 20^0C-30^0C with air humidity of 100% in the range of 60-100%. As for the condition of the house, 63.1% of respondents have a cracked wall in the house and 73.1% of respondents have an unqualified ceiling.

Table 3. Distribution of chemical environmental

No	Chemical environment	Frequency	Percentage	Minimum	Maximum
1	The pH of breeding place				
	• <7,0	26	20.0		
	• 7,0-8,0	63	48.5	4.1	8.5
	• >8,0	15	11.5		
2	The salinity of breeding place				
	• Freshwater	85	65.4	0.0	15.0
	• Brackish	19	14.6		

Of the 130 respondents observed by their home environment, 104 respondents found a breeding place, while 26 other respondents did not have a breeding place around their homes. The measurement results found that most breeding places have a pH between 7,0-8,0 (48,5%) with salinity in the form of freshwater (67,1%).

Table 4. The relationship between the existence of sago gathering places with the incidence of malaria

The existence of a sago gathering palce	Case		Control		Total		p-value
	f	%	f	%	n	%	
Yes	16	24.6	28	43.1	44	33.8	0.041
Not	49	75.4	37	56.9	86	66.2	
Total	65	100	65	100	130	100	

Table 5. The relationship between the abundance of breeding places and the incidence of malaria

The abundance of breeding places	Case		Control		Total		p-value
	f	%	f	%	n	%	
≥3	34	52.3	24	36.9	58	44.6	0.112
<3	31	47.7	41	63.1	72	55.4	
Total	65	100	65	100	130	100	

Table 4 shows that of the 130 respondents. The 33.8% had a sago gathering place around their home and 24.6% had malaria. The results of statistical tests show p-value < 0.05 which means that there is a relationship between the existence of sago gathering places and the incidence of malaria in the work area of the Sowek Health Center.

Table 5 shows that there were 58 (44.6%) respondents who within a radius of ≤100m around their homes there was a breeding place ≥3. of which 52.3% had malaria and the rest did not. The results of statistical tests show a p-value >0.05. so it can be concluded that the abundance of breeding places is not related to the incidence of malaria in the work area of the Sowek Health Center.

Table 6. The relationship of environmental temperature with the incidence of malaria

Environmental temperature	Case		Control		Total		p-value
	f	%	f	%	n	%	
20^0C-30^0C	37	56.9	32	49.2	69	53.1	
<20^0C or >30^0C	28	43.1	33	50.8	61	46.9	0.482
Total	65	100	65	100	130	100	

Table 6 found from 130 respondents. 69 (53.1%) respondents had a home ambient temperature ranging from 20^0C-30^0C. of which 56.9% of respondents had malaria and 49.2% did not suffer from malaria. The results of statistical tests found a p-value>0.05. so it can be concluded that the environmental temperature is not related to the incidence of malaria in the work area of the Sowek Health Center.

Table 7. The relationship of environmental humidity with the incidence of malaria

Environmental humidity	Case		Control		Total		p-value
	f	%	f	%	n	%	
60-100%	65	100	65	100	130	100	
<60%	0	0	0	0	0	0	-
Total	65	100	65	100	130	100	

Table 7 shows that all respondents have the same environmental humidity. which ranges from 60-100%. so statistical tests of this variable cannot be done because there are cells that have an absolute value of 0. Therefore. H_0 is rejected which means that humidity is not related to the incidence of malaria in the working area of the Sowek Health Center.

Table 8. The relationship between the condition of the walls of the house with the incidence of malaria

House wall condition	Case		Control		Total		p-value
	f	%	f	%	n	%	
Has gaps	48	73.8	34	52.3	82	63.1	
Tight wall	17	26.2	31	47.7	48	36.9	0.018
Total	65	100	65	100	130	100	

Table 8 shows that of the 130 respondents. The 63.1% respondents had a hollow wall in the house. of which 48 (73.8%) people had malaria and the rest did not. The results of statistical tests found a p-value <0.05 which means this variable is related to the incidence of malaria in the work area of the Sowek Health Center.

Table 9. The relationship between the condition of the ceiling of the house and the incidence of malaria

The condition of the ceiling of the house	Case		Control		Total		p-value
	f	%	f	%	n	%	
Unqualified	54	83.1	41	63.1	95	73.1	
Qualify	11	16.9	24	36.9	35	26.9	0.018
Total	65	100	65	100	130	100	

Table 9 found that 73.1% of respondents owned houses that did not use ceilings and 83.1% of them had malaria and 63.1% did not. And the results of statistical tests also show that the condition of the ceiling of the house is related to the incidence of malaria in the work area of the Sowek Health Center.

DISCUSSION

The existence of a sago gathering place is a physical environmental factor associated with the incidence of malaria in the working area of the Sowek health center (p-value = 0.041). The existence of a sago gathering place is related to the existence of a breeding place around the respondent's house which was created due to the process of processing sago sticks into sago flour for public consumption. Sago is one of the staple foods of the Papuan people including the Sowek Community. and to be consumed sago must first be processed into sago flour. The sago starch extraction process will produce 3 types of waste. namely residues from sago fiber (pulp). sago bark. and squeezing residual water.[13] The results of field observations also found the presence of mosquito larvae in puddles in scattered sago stem fronds. basins of the remaining sago person footings. and sago puddles that were still deposited in sago pickaxes. However. larvae are not found in artificial springs around sago ingredients because of the presence of tadpoles. fish and small shrimp that are natural predators. Regarding the existence of breeding places. this study is in line with Nurbahani's research which also found a relationship between breeding places in the form of rice fields with the incidence of malaria (p-value = 0.037) in the working area of Puseksmas Mayong Jepara Regency.[14]

The condition of the house wall is also related to the incidence of malaria in the work area of the Sowek health center(p-value = 0.018). One of the requirements for a healthy rash according to the Ministry of Health is that the house is free from disease vectors such as flies. rats and mosquitoes. therefore the type and density of the walls of the house must receive attention because it can be a gap in the entry of disease vectors including the entry of mosquitoes to rest or find blood. The results of field observations found that although most respondents were already living in permanent homes. there were many gaps min for the air circulation system in the house but not covered by gauze so it became an entrance for Anopheles mosquitoes into the house. This study is in line with research conducted by Madayanti which also found a 3.872 times greater risk of malaria for respondents whose house walls were not tight than for respondents whose house walls were tight.[15]

Similarly. the walls of the house from field observations still found many respondents whose house buildings did not use ceilings or only part of the room used ceilings. this is because according to respondents the ceiling of the house is not a structure that is so important in the building of the house that it is enough to use zinc as a cover for the upper frame of the house that protects from heat and rain. The results of the analysis also showed a relationship between the condition of the ceiling of the house and the incidence of malaria in the working area of the Sowek Health Center (p-value = 0.018). where the results of this study were in line with Sepriyani's research which stated that respondents whose ceiling conditions did not meet the requirements were at 8 times greater risk of malaria than respondents whose walls were tight.[16]

As for the chemical environment category. the average pH of the breeding place found was at the ideal pH for breeding Anopheles mosquito larvae. namely pH 7-8. but Anopheles larvae were also found in puddles with pH <7 and >8. Where the lowest pH of 4.1 comes from puddles around the sago squeezing site. while the highest pH of 8.4 is found in puddles of unused used goods exposed to direct sunlight. In theory. larvae are not able to survive low or high water pH. but Kawulur's research found the ability of Anopheles in the Papua region to have a high tolerance to water temperature. pH and salinity.[17] This research is in line with research conducted by Ernamayanti which also found the presence of Anopheles larvae in puddles with pH 4.1 and 4.3 in peatland areas of Muara Kelantan Village. Siak Regency.[18] For water salinity itself. generally. larvae are in freshwater. but there are 20.3% of brackish water breeding also found the presence of larvae. Freshwater salinity comes from rainwater reservoirs and pans or buckets used by the community to collect water from springs. This type of breeding place is most commonly found in respondents' homes due to limited clean water facilities. while the salinity of brackish water is generally found in coconut shells or unused objects scattered around respondents' houses close to the sea and then mixed with fresh water when it rains and becomes a habitat for mosquitoes while the highest salinity comes from non-flowing swamp water behind respondents' houses.

The limitation of this study is the short time so that it only relies on respondents' answers and environmental conditions when data collection is carried out.

CONCLUSION

The existence of a sago gathering place. the condition of the walls of the house and the condition of the ceiling of the house are physical environmental factors related to the incidence of malaria in the working area of the Sowek Health Center. with a chemical environment that also supports mosquito breeding because of the ability of larvae that have tolerance to pH levels and salinity of the breeding place. For this reason. it is necessary to have environmental control efforts to optimize malaria control efforts that have been carried out by the Sowek health center.

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