Clinical Features, Surveillance and Determinant Factors of Malaria Outbreak in Usili Village, Southwest Papua, Indonesia

Andrew Ivan Humonobe*[a], Nadiyah Kamilia[b] and Sintong Halomoan Sianturi[c]
Faculty of Medicine, University of Papua, Aimas-Klamono Street Km.28, Sorong Regency, Indonesia

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Abstract: Malaria is a global health concern including in Indonesia. In early 2023, Sorong Regency Health Office reported that there was a malaria outbreak in Usili Village, Southwest Papua, Indonesia. A total of 38 cases were confirmed positive by rapid diagnostic test (RDT) and microscopic examination. This study aimed to describe clinical features, surveillance system and determinant factors that contributed to the outbreak. A mix-method study was conducted. Clinical features and surveillance were designed with qualitative descriptive, while determinant factors of malaria used case control design. A total of 144 individuals were participated in this study. Results showed that 68.7% of the case was uncomplicated malaria. Risk factor analysis illustrated that working status (OR 2.1; 95% CI 1.005-2.765), night outdoor activities (OR 1.6; 95% CI 0.650 - 1.805), using mosquito net (OR 1.9; 95% CI 0.005-2.765) were contributed to the case. Surveillance variables revealed incomplete data reporting, unreliable data collection, and a postponed epidemiology investigation. We draw conclusion that the majority cases of this outbreak were clinically uncomplicated malaria. The outbreak was linked to determinant factors like outdoor activities, mosquito net use, and working status. This study also emphasizes the shortcomings of the surveillance system in preventing malaria.

1 INTRODUCTION

Malaria is one of infectious disease affects globally which lead to increasing morbidity and mortality. *World Malaria Report 2022* released by WHO states that there were 247 million cases of malaria in 2021, which resulted in 619,000 deaths (WHO, 2022). Nine countries in South-East Asia are endemic for malaria, which accounts for 22% of malaria deaths and 15.6% of cases in the region. With an estimated 811,636 cases, Indonesia has the second-highest number of malaria cases in this region. (WHO, 2022, 2021b). Annual malaria report showed that there was an increasing malaria incidence in 2021 roughly up to thirty percent giving escalated number from 304,607 to 400,253 positive cases in 2022, dominantly occurred in Papua region which contributed to 90% of national total cases (Indonesian Ministry of Health, 2023).

Malaria is a parasitic infection of *Plasmodium sp* in human. This parasite is transmitted by the *Anopheline* mosquito that leads to acute-life threatening disease (Buck and Finnigan, 2023). Human infection is known to occur in five *Plasmodium* species including *P. vivax, P. falciparum*, *P. ovale, P. knowlesi, and P. malariae* (Buck and Finnigan, 2023; Tangpukdee et al., 2009). Furthermore, *P. falciparum* and *P. vivax* were the most prevalent species in Indonesia (Bria et al., 2021). Malaria transmission is a complex web of interactions exists between human hosts, *Anopheline* mosquitoes, *Plasmodium* parasites, and local socio-ecological conditions (Dhewantara et al., 2019). Malaria risk factors include the use of mosquito nets, spraying insecticide, age, home construction conditions, altitude and weather conditions (Mosha et al., 2020; Sulistyawati et al., 2020).

Typical malaria symptoms are chills, fever and sweating. Other additional manifestation include headache, dizziness, vomiting, diarrhea, muscle pain,

[a] https://orcid.org/0009-0008-3043-5466
[b] https://orcid.org/0009-0003-1964-1203
[c] https://orcid.org/0009-0004-4049-7290

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lack of appetite, weakness, jaundice and even impaired consciousness. Malaria can, however, occasionally present with no symptoms (Bartoloni and Zammarchi, 2012; Bria et al., 2021).

The primary method for identifying malaria is by examining microscopic findings, which is considered the gold standard. However, there are instances where misdiagnosis can occur, particularly when the level of parasites in the blood is low or if the identification of the specific species is incorrect (Kang et al., 2017; Tangpukdee et al., 2009). To address this issue, rapid diagnostic testing (RDT) is frequently employed in isolated locations with limited access to microscopic examination expertise (Diallo et al., 2017; Tangpukdee et al., 2009).

Indonesia's malaria control program goal is to completely eradicate malaria by 2030, achieving malaria-free status gradually. Three primary actions were to raise annual blood examination rate (ABER) and decrease the annual parasite incidence (API) and positivity rate (PR). The actions done are to certify each region for malaria, beginning at the district or city and moving up to the province, region, and national levels. These indicate that the following conditions must be met in order: (1) no indigenous cases for three years in a row; (2) PR of less than 5%; and (3) API of less than 1 per 100,000 (Herawati et al., 2023).

Malaria surveillance program starts with patient registration and data collection at Public Health Center (PHC). Next, PHC generates monthly reports on malaria based on the disease's cases it has identified and its outpatient services. PHC is in charge of data analysis and the production of a report on the trends and distribution of the disease for the local area. PHCs notify the district malaria control officer of any malaria-related issues, and the officer compiles the data into district health profile. Details regarding the annual and monthly cases of malaria reported at village level are included in the health profile. Then, sub-directorate of malaria control at directorate of vector-borne diseases in Indonesian Ministry of Health receives aggregated malaria reports from the district health office, which then forwards them to the provincial health office three times a year (Elyazar et al., 2011).

In early 2023, unpublished data from Sorong Regency Health Office reported that there was a malaria outbreak in Usili Village as many as 38 positive cases, whereas previously there had been no history of malaria infection in the region. The transmission scheme was indigenous. Usili Village is located in Aimas District, Sorong Regency, Southwest Papua Province and positioned in the working area of Malawili PHC under Sorong Regency Health Office supervision. This study aimed to describe clinical aspects, implementation of surveillance system and other risk factors that play role in the emergence of malaria outbreaks in Usili Village, Southwest Papua.

2 METHOD

This study was designed with a mixed method. Clinical features and surveillance variables were observed with qualitative descriptive design using interview and secondary data analysis. Surveillance data was collected from Malawili PHC and Sorong Regency Health Office. In order to depicting determinant factors of malaria, an analytical study with a case-control design with a ratio of 1:2 was used. Data collection was carried out from primary and secondary source. Secondary data was taken from Malawili PHC medical record. Meanwhile, primary data was obtained by using questionnaire. A total of 144 participants from Usili Village was recruited in this study, 48 people were grouped as positive malaria (confirmed through microscopic finding or RDT from medical record) while 96 people were control. Samples were selected using the stratified random sampling.

3 RESULT

3.1 Clinical Features

Malaria can present with a range of clinical manifestations, from mild to potentially fatal. During the interviews with all of the positively confirmed participants, symptoms such as fever, chills, headache, muscle soreness, nausea, vomiting, diarrhea, weakness, jaundice, and seizures were reported. In Figure 1, it is clear that all (100%) responders who tested positive for malaria had fever. Additionally, a majority of these individuals experienced chills (93.75%) and nausea (87.5%). Other reported symptoms included headache (68.75%), muscle pain (41.67%), weakness (35.42%), vomiting (25%), diarrhea (20.83%), seizures (22.92%), and jaundice (8.33%). By considering the last set of clinical symptoms, it is reasonable to assume that approximately 31.25% (corresponding to 15 individuals) had severe malaria, while the remaining 68.75% (33 individuals) exhibited uncomplicated malaria.

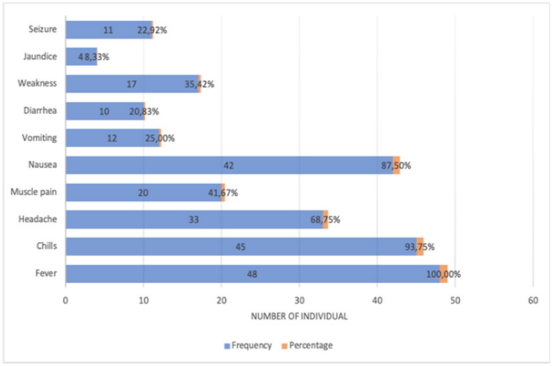

Figure 1: Clinical symptoms of malaria positive respondents

3.2 Surveillance System Management

Planning, implementing, and evaluating public health practices are all part of public health surveillance, which is reliant on ongoing, systematic data collection, analysis, and interpretation (Centers for Disease Prevention and Control, 2022).

Although Malawi PHC has carried out malaria surveillance in accordance with national guidelines, there are some inconsistencies in the way it has been carried out. Table 1 shows this in the following.

Table 1: Surveillance data taken from Malawili PHC.

Surveillance data	Result
Data simplicity	Easy to get
Data quality	Incomplete data
Data stability	Unreliable
System representation	Distributed over all population
Reporting schedule	Delayed investigation

3.3 Analysis of Malaria Determinant Factors

Table 2 shows the characteristics of respondents and the type of infection in the people of Usili Village. In total, 144 people were included in the study. The type of infection that occurs is mostly by *P. vivax* (45.83%), *P. falciparum* (37.5%) and mixed malaria (16.67%). Based on the characteristics of the respondents, the most (70.83%) are those who are actively working, 36.11% are not in school, 63.89% have nighttime activities outside the home, and 51.39% do not use mosquito nets while sleeping.

Table 2: Type of malaria and characteristic of participants in Usili Village.

Characteristics	Frequency (n)	Percentage (%)
Type of malaria infection		
P. falciparum	18	37.50
P. vivax	22	45.83
Mixed malaria	8	16.67
Working		
Yes	102	70.83
No	42	29.17
Education level		
Not joining school	52	36.11
Primary school	40	27.78
Middle school	15	10.42
High school	20	13.89
University	17	11.81
Night outdoor activities		
Yes	92	63.89
No	52	36.11
Use of mosquito nets		
Yes	70	48.61
No	74	51.39

Table 3 presents working status factor and the occurrence of malaria. Out of the 48 individuals who have malaria, 50% of them are engaged in some form of work, while the remaining 50% are not employed. Interestingly, among those who work, 81.91% do not have a malaria infection. Statistical results indicate a significant association between people who do not work and experience malaria (p = <0.001; OR CI 95% = 2.1 (1.005-2.765). These findings indicate that the risk of contracting malaria is 2.1 times higher in non-working individuals than in working individuals.

Table 3: Bivariate analysis of working status and malaria incidence.

Working	Malaria infection		*p*
	Positive	Negative	
Yes	24 (50.0%)	78 (81.91%)	<0.001 OR 2.1 95% CI(1.005-2.765)*
No	24 (50.0%)	18 (18.11%)	

*chi-square analysis

Table 4 describes education level factor and malaria incidence in Usili Village. Based on the data of respondents who are positive for malaria, 18.75% are individuals who are not in school, 27.08% are only up to primary education, 41.67% are only up to secondary education, 6.25% are high school and 6.25% are up to higher education. There was no significant result displayed in the statistical analysis (p=0.114; OR 1.308 95% CI=(1.005-1.702)) although the odds ratio showed that people with low education level were at risk 1.308 times higher than individuals with high levels of education.

Table 4: Bivariate analysis of education level with malaria incidence.

Education level	Malaria infection		*p*
	Positive	Negative	
Not joining school	9 (18.75%)	43 (44.79%)	0.114 OR 1.308 95% CI(1.005-1.702)*
Primary school	13 (27.08%)	27 (28.12%)	
Middle school	20 (41.67%)	12 (12.5%)	
High school	3 (6.25%)	17 (17.7%)	
University	3 (6.25%)	4 (4.16%)	

*chi-square analysis

According to the data shown on Table 5, up to 52.08% (25 persons) of those who engage in nighttime activities outside of their homes suffer from malaria, compared to 47.91% (23 people) of those who do not. There is a statistically significant correlation ($p<0.05$) between malaria incidence and activity during the night. These findings also indicate that there is a 1.6-fold increase in the risk of malaria infection in individuals who are active at night.

Table 5: Bivariate analysis of night outdoor activities with the incidence of malaria.

Night outdoor activities	Malaria infection		*p*
	Positive	Negative	
Yes	25 (52.08%)	67 (69.79%)	0.037 OR 1.6 95% CI(0.650-1.805)*
No	23 (47.91%)	29 (30.20%)	

*chi-square analysis

The chance of contracting malaria while using mosquito nets is shown in Table 6. Considering the findings of this research, 70.83% of the population who do not use mosquito nets are at risk of developing malaria, while 29.16% of people who use less mosquito nets are affected by malaria. Significant findings from statistical analysis indicated a relationship between the prevalence of malaria and the use of mosquito nets (p=0.001). This research also shows that sleeping without a mosquito net increases the risk of malaria by 1.9 times compared to sleeping with one.

Table 6: Bivariate analysis of mosquito net use activities and malaria incidence.

Mosquito net usage	Malaria infection		*p*
	Positive	Negative	
Yes	14 (29.16%)	56 (58.33%)	0.001 OR 1.9 95%CI(0.005-2.765)*
No	34 (70.83%)	40 (41.67%)	

*chi-square analysis

4 DISCUSSION

The objectives of this study were to look into a malaria outbreak, characterize clinical characteristics, identify risk factors, and look into health centers' malaria surveillance.

Diagnosing malaria can be challenging. In this study it appears that all patients experienced common symptom such as fever. Based on WHO guidelines all patients who have a fever or a history of fever can be suspected of being infected with malaria. Nevertheless, diagnosis based only on clinical symptoms has low specificity and can lead to overtreatment. To get a definite diagnosis should be carried out further examination of microscopic blood smear examination or with RDT (WHO, 2023). It was discovered that the majority of the malaria outbreaks in Usili Village were caused by *P. vivax* infection, with *P. falciparum* infections coming in second and mixed malaria making up the least. According to the clinical symptoms reported, the majority of cases of malaria experienced by residents of Usili Village in this study are uncomplicated cases with a lesser number of severe cases. This finding is in accordance with the results that appear that most malaria infections that occur in the village is caused by *P.vivax* (45.83%). Additionally, *P. vivax* tends to cause less parasitemia and is less severe than *P. falciparum*, according to the study (Baird, 2013; Menkin-Smith and Winders, 2023). Although no additional laboratory tests were performed in these cases, the severe malaria cases in this study were based on those who experienced symptoms such as

jaundice and seizures (Bartoloni and Zammarchi, 2012).

In this study, we use five attributes—data quality, data stability, system representativeness, timeliness, and surveillance system simplicity—to evaluate the surveillance success indicators based on WHO guidelines (Centers for Disease Prevention and Control, 2022; Nsubuga et al., 2006). System simplicity can be assessed by looking at indicators such as ease of defining cases, collecting, recording and reporting data. The case definition used by the Malawili PHC is in accordance with the national guidelines for malaria management, where case enforcement is based on anamesis and laboratory diagnosis. It is necessary to underline the importance of correct diagnosis in establishing the definition of malaria cases (Indonesian Ministry of Health, 2019; WHO, 2023). Malawili PHC is already good at screening and confirmation activities.

The validity and completeness of the data entered into the epidemiological surveillance system can be used to assess the quality of the data. Data is said to be complete if the confirmation case is filled in completely and validates to health facilities that report confirmed cases of malaria (Centers for Disease Prevention and Control, 2022). The data available in the Malawili PHC surveillance are monthly situation monitoring, individual basic data reports, monthly reports by summing patients/deaths including some basic eradication/countermeasures activities every month to the Sorong Regency Health Office. However, the weakness in the presentation of the data is made data stratification determination of malaria endemicity sub-district level by making the sub-district table by summing malaria patients. This is similar to the results of other studies in the Kupang area which found that PHC in Kupang regency had not made an endemicity map of the area, so it was considered incompatible with the role of PHC as a work unit in the surveillance system to carry out malaria in the working area by village (stratification) annually where the dissemination of information by the health office and PHC was only in the form of reports, and did not publish malaria bulletins/magazines. Cross-organizational meetings have also not been conducted by the health office. This is not in accordance with the role of the district/city health office as a work unit in the surveillance system, namely distributing malaria information across programs and across sectors (Desita et al., 2021).

Data stability relates to the reliability and availability of surveillance system. The capacity to accurately gather, arrange, and deliver data is known as reliability. Conversely, availability is the capacity to function when called upon (Centers for Disease Prevention and Control, 2022). The Malawili PHC does not report weekly and monthly cases to the Sorong Regency Health Office. Data is received if there are cases from outbreak reports and new cases resulting from epidemiological investigations in the field. The Sorong Regency Health Office does not receive individual case data directly from Malawili PHC unless the PHC diagnoses individual data from referral health facilities. This is related to the absence of cross-sector involvement to carry out laboratory and RDT examinations in primary care facilities around the Aimas district. Surveillance data stability refers to the consistency and reliability of data collected through a health surveillance system. Reporting consistency factors influencing the stability of surveillance data at the Malawili PHC are consistency in reporting data to responsible entities, such as health office, ensuring that information is available and can be used for decision making and then related to officer training where officers must know that one of their duties is to improve networking with health service facilities.

Timeliness of surveillance refers to the extent to which surveillance data is collected, analyzed and reported according to a predetermined schedule. This timeliness has a pivotal role in surveillance system effectiveness and response to public health issues. Case reporting confirm malaria according to agreement that is less than 24 hours, while reporting case recaps per sub-district by the public health center that is the 4th of every month and agreed to require a maximum of 24 hours to immediately carry out an epidemiological investigation (Centers for Disease Prevention and Control, 2022; Indonesian Ministry of Health, 2019). However, when the observation was carried out there was a delay in the report from the hospital and more than 24 hours was needed to carry out an epidemiological investigation.

The risk factors most associated with malaria cases in Usili Village are night outdoor activities, working status and using mosquito nets. Outdoor activities at night can have implications for the risk of malaria transmission, especially since the Anopheles mosquito, which is a vector of the disease, is generally active at night, especially at dusk and early morning. A person's chance of contracting malaria is increased if they spend a lot of time outside at night in an area where Anopheles mosquito vectors are common (Sulistyawati et al., 2020). This result is in line with other studies conducted at the Remu PHC in Sorong City with a sample of 84 people where it was found that there was a significant relationship

between nighttime activities outside the home with the risk of malaria infection (OR 3.411 95% CI (1.363-8.542)). This is due to the activities of people who often go out of the house at night, namely people who have a lot of work so they come home at night, as students who study at night, as motorbike taxi drivers, mothers who do social gatherings or who outbreak in Usili Village. This result is in line with research observed at Remu PHC Sorong City, where based on bivariate analysis conducted, there is a connection between the risk of getting malaria and the use of mosquito nets. (p=0.042; OR 2.562 95% CI = 1.025-6.406)) (Papilaya et al., 2015). Based on interviews with respondents in the positive malaria group and the control group said that although they had been given mosquito nets from health workers from the Malawili PHC, they did not use them because they felt uncomfortable and the room became hot when using mosquito nets at night and there were even those who sold and discarded mosquito nets that had been given.

This study also found that working status have a relationship with malaria incidence. We observed that people who do not work typically spend their time doing household chores and running the risk of contracting malaria. People who are less active for a long time at home have a high chance of exposure to Anopheles mosquitoes. This is because the houses of Usili Village residents are located in a swamp area which is a suitable condition for the breeding of anopheles mosquitoes as malaria vectors (Munthe et al., 2022).

5 CONCLUSIONS

The first malaria outbreak in Usili Village, Southwest Papua was contributed by several weaknesses in the worship at night. and most groups of young people, even children, who often hang out, walk around and date at night, without wearing protective clothing such as jackets/long sleeves/trousers/sarongs can be at risk of contracting malaria (Papilaya et al., 2015).

The factor of not using mosquito nets also contributed to the malaria surveillance system and malaria prevention programs, including: shortcomings of surveillance system at the Malawili PHC in recording and reporting incomplete cases, unreliable data collection and management, furthermore receiving and sending case reports was not on time. In addition, there are still many residents who are not aware of malaria prevention that are seen in the sub-optimal use of mosquito nets, high outdoor activity at night and passive activities in the house also become risk factors in this malaria outbreak.

In an effort to improve malaria control so that similar outbreaks do not occur in Sorong regency, the quality of reporting must be supported by effort to strengthen networks that are integrated with health offices and health facilities. Vector control programs also need careful supervision such as submitting procedures and circulars on clear duties related to the implementation of health promotion on intensive malaria prevention.

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