

## Mosquito Nets Use in South Central Timor District is Significantly Liked to Incidence of Malaria

Nisa Fauziah,<sup>1,2</sup> Reyhan Luthfierza Fauzan,<sup>3</sup> Naufal Fakhri Nugraha,<sup>3</sup> Lia Faridah,<sup>1</sup> Jontari Hutagalung<sup>4</sup>

<sup>1</sup>Division Parasitology, Department of Biomedical Sciences, Faculty of Medicine Universitas Padjadjaran, Indonesia

<sup>2</sup>Program Study of Clinical Parasitologist, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia

<sup>3</sup>Faculty of Medicine, Universitas Padjadjaran, Indonesia

<sup>4</sup>Parasitology Laboratory, Center for Biomedical and Basic Health Technology, National Institute of Health Research and Development, Ministry of Health, Indonesia

### Abstract

Ninety percent of malaria cases in Indonesia come from Papua, West Papua, and East Nusa Tenggara provinces. The country has declared a target of malaria elimination by 2030. Malaria elimination efforts have been performed through case finding, treatment, surveillance, and risk factor prevention and control. Personal protection is crucial in preventing and reducing the risk for malaria infection. This study aimed to assess the significance of personal protection against mosquitoes in eastern Indonesia. This was a cross-sectional study using the secondary data from a previous study of malaria in eastern Indonesia in 2013–2014. Data were collected using a questionnaires and direct observation and analyzed using the chi-square with  $\alpha$  0.05 and 95% CI. A total of 551 data were collected (180 positive vs 371 negative). The use of mosquito nets at night (p-value: 0.038; OR: 3.127) has a significant relationship with the incidence of malaria while the use of ventilation screen (p-value: 0.191; OR: 0.839), vector shelter (p-value: 0.493; OR: 0.852), and mosquito repellent (p-value: 0.564; OR: 1.585) did not have significant relationships to the incidence of malaria. Mass distribution of mosquito nets by the local governments can constitute one of the efforts to prevent and control malaria in South Central Timor District.

**Keywords:** Malaria, mosquito nets, South Central Timor District

### Introduction

Malaria is a vector-borne disease that is transmitted through the *Anopheles spp.* mosquito. Malaria in humans is usually caused by 5 types of *Plasmodium* which are *Plasmodium falciparum*, *P. malariae*, *P. ovale*, *P. vivax*, and *P. knowlesi*. Among the 5 *Plasmodium* species that cause malaria in humans, *P. falciparum* is the most common and the most dangerous.<sup>1</sup> The main symptom of malaria is acute fever with an incubation period of 7 days or more. In addition to the main symptoms, there are also other symptoms such as anemia, chills, headache, pain, weakness and lethargy, vomiting, coughing, diarrhea and abdominal pain. If not treated immediately, more severe symptoms will appear, such as acute kidney failure, pulmonary edema, seizures, which will continue into coma and death.<sup>2</sup>

In Indonesia, the prevalence of malaria in 2018 is 0.4%. The three provinces with the highest malaria prevalence are Papua, West Papua and East Nusa Tenggara (NTT). As many as 90% of cases came from Papua, West Papua and East Nusa Tenggara provinces.<sup>3</sup> The number of malaria in NTT in 2018 was 18,386 cases. From the 16 districts spread across the province of NTT, South Central Timor District has the highest malaria cases with a total of 1,055 cases. The annual parasite incidence (API) is 5.6 per 1,000 population in the past 10 years. Indonesia targets the achievement of malaria elimination by 2030 in stages. The eastern part of Indonesia is a high endemic area that requires a special approach in malaria elimination. The central government encourages local governments to commit to controlling and providing active support for malaria prevention. Intensification and extensification efforts were carried out by conducting blood tests and contact surveys.<sup>4</sup>

Malaria cases in Indonesia continue to decline, but from 2014 until 2018, there was a stagnation in malaria elimination. The geographical conditions complicate the malaria

### Corresponding Author:

Lia Faridah,  
Division Parasitology, Department of Biomedical Sciences,  
Faculty of Medicine, Universitas Padjadjaran, Indonesia  
Email: lia.faridah@unpad.ac.id

elimination in Indonesia. In NTT, one of the problems of malaria transmission is the vector is not inhibited enough with personal protection, especially in the house.<sup>3</sup>

The case of malaria is thought to be related to the condition of the environment including the people's houses, due to *Anopheles spp.* mosquitoes, although more active outdoors but indoors activities are also high.<sup>5</sup> The blood-sucking behavior starts in the afternoon, and most bites happened around 09.00 PM to 03.00 AM.<sup>4</sup> Environmental conditions around the house also affect when there are mosquito breeding places and shelters around the house. *Anopheles spp.* mosquitoes usually breed in gutters and pools of clear water. Because the house is a place of human settlement in the long term, the transmission of malaria through mosquito vectors will be more likely to occur.<sup>5</sup>

Like other vector-borne diseases, several ways have been taken to prevent malaria, such as reducing the habitat available for the development of mosquito larvae, mosquito larvae control, and control of adult mosquito populations. Another way is increasing personal protection from mosquito bites. Personal protection methods may be an effective way of preventing mosquito bites, and subsequently preventing the probability of exposure to mosquito-borne diseases. There are various types of protection, such as installing a ventilation screen and installing mosquito nets. Residents can also use anti-mosquito repellent while sleeping at night to prevent malaria mosquito bites because malaria vectors usually bite at night.<sup>6</sup>

The South Central Timor District has an area of 3,955.36 km<sup>2</sup>, consists of 32 districts which is inhabited by 469,980 million people. In terms of topography and geography of South Central Timor District, conditions the land surface dominated by mountainous and hilly with an average slope of above 50%, only a small portion which is the lowlands. Most of the land is forest (155.532 hectare). Some very large plains are then used by local communities as agricultural land or rice fields. Thus most of the population are farmers.<sup>7</sup>

In South Central Timor District, the endemicity of malaria is still high, with eleven Districts that have API value of <1‰, six districts that have API value of 1-5‰, and five districts that have API value of >5‰.<sup>3</sup> This shows that the elimination of malaria in South Central Timor District is harder. Several reasons are due to the majority of people having low-income occupations, living by gardening or farming, and

environmental conditions dominated by dry and swampy areas (where the malaria vector breeds). The local government has made efforts to carry out malaria elimination by conducting the discovery and management of malaria sufferers, epidemiological surveillance, and prevention and control of risk factors. One of the prevention efforts is distributing insecticide-treated mosquito nets en masse and vector control.<sup>4</sup>

The previous studies usually concern about vector shelter but lack in personal protection in the community facing malaria in Indonesia. In connection with this, a study on the analysis of the correlation between indoor personal protection and the incidence of malaria in the South Central Timor District was conducted. Hopefully, the result could help enforce the government policies for tackling the spread of malaria indoor, especially in East Nusa Tenggara.

## Methods

This was a cross-sectional study conducted in August 2013 to September 2014. This study was conducted in 5 sub-districts in South Central Timor District, East Nusa Tenggara Province, Indonesia based on their API, i.e. South Amanatun (API >5‰), Central Amanuban (API >5‰), South Amanuban (API 1-5‰), Batu Putih (API 1-5‰), and Oenino (API <1‰). The study population was all individuals residing in South Central Timor District, East Nusa Tenggara Province. Subject inclusion criteria are patients domiciled in South Central Timor District administrative area, patients over 14-year-old, patients not having tuberculosis and chronic disease. Exclusion criteria are incomplete patient data. Malaria cases are diagnosed by PCR tests.<sup>8</sup>

In this research, the sample size estimation was counted by sample size formula for comparative analytical research with a categorical scale with  $\alpha = 0.05$ ,  $\beta = 20\%$ ,  $P = 0.425$ ,  $Q = 0.675$ ,  $P_1 = 0.52$ ,  $P_2 = 0.33$ ,  $Q_1 = 0.48$ ,  $Q_2 = 0.67$  gained as big as 106 data per group. Data respondents were recruited through a systematic random sampling based on households from 5 sub-district in South Central Timor District. A total 551 subjects were recruited based on the inclusion criteria. The research instruments in this study are the form of questionnaire data and malaria PCR examination data. The variables are types of personal protection: the usage of mosquito net, ventilation screen, and mosquito repellent at night were collected. Data vector

shelter was also collected. Mosquito net are insecticide-treated nets distributed en masse by the local government as one of the malaria prevention programs.

The usage of mosquito net is said to be yes if mosquito nets are used when sleeping (06.00 PM to 06.00 AM), the usage of ventilation screen is said to be yes if all the ventilation in the house is using wire screen, The usage of mosquito repellent at night is said to be yes if using mosquito repellent (burn, rub, spray) when sleeping (06.00 PM to 06.00 AM), The presence of vector shelter is said to be yes if there is standing water, bushes, and gutters around the house (50 M).

The data collected will be processed anonymously and analyzed using IBM® SPSS® 25<sup>th</sup> version software. In a study that aims to examine whether there is a relationship between the two categories, that are the types of personal protection, vector shelter with malaria, a bivariate test (chi-square) will be conducted. The missing data will be excluded. Hypothesis test results to be assessed are p-values. If the p-value <0.05, the results of the data analysis are

significant, and there is a significant relationship between the two variables. Meanwhile, if the value of p-value >0.05, the results of the analysis are said to be insignificant, and there is no significant relationship between the two variables. This study use a confidence interval (CI) of 95%.

This research is given ethical clearance from the Health Research Ethicl Committee Faculty of Medicine Universitas Padjadjaran, with ethic license number 1101/UN6.KEP/EC/2019.

### Results

A total of 551 data were collected for this study based on the inclusion and exclusion criteria. Table 1 shows that from 551 study subjects, 180 were positive for malaria, and 371 were negative for malaria based on PCR examination. Women suffer from malaria more than men. Sixty-four patient's positive malaria at the age >50 years. Malaria is found in small numbers at the age < 15 years old. Central Amanuban is a sub-district with the highest malaria positive, followed by

**Table 1 Characteristics of Respondents**

Characteristics	Malaria		Total n=551
	Positive n=180 (32.7%)	Negative n=371 (67.3%)	
Gender, n (%)			
Male	78 (43.3)	151 (40.7)	229 (41.6)
Female	102 (56.7)	220 (59.3)	322 (58.4)
Age groups (year old)			
≤15	3 (1.7)	8 (2.2)	11 (2)
16-20	4 (2.2)	10 (2.7)	14 (2.5)
21-30	18 (10.0)	63 (16.9)	81 (14.7)
31-40	47 (26.1)	103 (27.9)	150 (27.2)
41-50	44 (24.4)	89 (23.9)	133 (24.1)
>50	64 (35.6)	98 (26.4)	162 (29.4)
Subdistrict			
South Amanatun	25 (13.8)	73 (19.7)	98 (17.8)
Central Amanuban	45 (25)	55 (14.8)	100 (18.1)
South Amanuban	25 (13.8)	74 (19.9)	99 (18.0)
Batu Putih	42 (23.3)	77 (20.8)	119 (21.6)
Oenino	43 (23.9)	92 (24.8)	135 (24.6)

**Table 2 The Bivariate Analysis Test**

Characteristics	Malaria			P-value (OR)	95% CI	
	Positive n=180 (32,7%)	Negative n=371 (67,3%)	Total n=551		Lower	Upper
Using mosquito repellent						
Yes	17 (9.4)	41 (11)	58 (10.5)	0.564 (1.585)	1.022	2.456
No	163 (90.6)	330 (89)	493 (89.5)			
Using mosquito nets						
Yes	146 (81.1)	271 (73)	417 (75.6)	0.038 (3.127)	0.518	18.883
No	34 (18.9)	100 (27)	134 (24.4)			
Using ventilation screen						
Yes	3 (1.6)	2 (0.5)	5 (0.9)	0.191 (0.839)	0.463	1.523
No	177 (98.4)	359 (99.5)	546 (99.1)			
Presence of vector shelter						
Yes	143 (79.4)	304 (81.9)	447 (81.1)	0.493 (0.852)	0.544	1.333
No	37 (20.6)	67 (18.1)	104 (18.9)			

Oenino and Batu Putih.

Table 2 shows the bivariate analysis test. The usage of mosquito net with the negative finding of malaria showed a p-value of 0,038 (p-value <0.05), these results indicate that there is a significant relationship between those variables. The odds ratio using mosquito nets was 3,127, which significantly increased the risk to three times higher. While the variable of using mosquito repellent, using ventilation screen, and the presence of vector shelter showing a p-value 0.564; 0.191; 0.493 respectively that is a p-value >0.05, these results indicate that there is no significant relationship between those variables against malaria.

## Discussion

This study showed that women suffered malaria more than men. The result is similar to the study by Woldu et al,<sup>9</sup> that high risk in women was related to their role in the agricultural fields and their household activities. Demographic data showed most of the citizens are farmers, that includes women. Compared to men, women were more likely to work in wet aspects of agricultural activities.<sup>7</sup> Women are considered more at risk because they do household chores and socialize near the house, resulting in a longer exposure

time and a greater chance of becoming infected with malaria.<sup>10</sup>

Malaria mainly found at the age >50 years-old and very limited found at the age <15 years-old, could be related with the immune system. Many studies showed that pregnant women, infants, and those over 60 years old are at the greatest risk. Chukwuocha et al<sup>11</sup> found a high prevalence of malaria among the geriatrics, in South- Eastern, Nigeria. This has also made the older populations care less about the illness since it is not generally considered as serious. Based on data from 2020, more than 50% of the population in the South Central Timor District are <15 years old and >50 years old. The high population certainly requires attention and consideration by local government in the process of handling and controlling malaria.<sup>7</sup>

In this study, a variable related to malaria incidence was the use of mosquito nets. Variable using mosquito nets in this study showed a significant relationship with the incidence of malaria (p-value 0.038). Mosquito nets were significant in accordance with research conducted by Nur and Mira.<sup>12</sup> in Papua who obtained a of p-value 0.032 (p-value <0.05). The use of mosquito nets during sleep is an effective effort to prevent and avoid contact between *Anopheles spp.* mosquitoes and healthy people while sleeping at night. Mosquito nets that are



not damaged or have holes can hold or prevent a person from being bitten by mosquitoes in addition to using mosquito repellent. Other study conducted by Rangkuti and Sulistaiani<sup>13</sup> in North Sumatera who obtained a p-value 0.000 (p-value <0.05). Not using mosquito nets at night will increase the chance of being infected with malaria by 4.2%. Mosquito nets have a positive effect in reducing the incidence of malaria. However, it is different from the research conducted by Isnaeni et al<sup>14</sup> who obtained a p-value of 0.123 (p-value >0.05), which suggests there is no correlation between the use of mosquito nets and the incidence of malaria. This can happen because it is influenced by the habit of going out at night and the environment around the house in the form of a garden which is used as a resting place for malaria vectors, thereby increasing the risk of infection and reducing the effectiveness of using mosquito nets.

Mosquito nets are effective to avoid contact with *Anopheles spp.* mosquitoes while sleeping at night because some *Anopheles spp.* mosquitoes are most active to suck blood from 09.00 PM to 03.00 AM.<sup>4,15</sup> There are several reasons mosquito net owners chose not to use a mosquito net on one or more nights such as discomfort, primarily due to heat, and perceived low mosquito density were the most widely identified reason for not using mosquito nets. Technical factors related to mosquito nets usage (i.e. not being able to hang a mosquito net or finding it inconvenient to hang) were also the reasons for not using mosquito nets.<sup>16</sup>

Variable using mosquito repellent in this study showed no significant relationship with the incidence of malaria (p-value 0.564). Mosquito repellent was no significant in accordance with research conducted by Nababan et al<sup>17</sup> in Purworejo who obtained a p-value of 0.720 (p-value >0.05). However, it is different from the study conducted by Isnaeni et al<sup>14</sup> in Purworejo, who obtained a p-value of 0.036 (p-value <0.05). Types of mosquito repellent used were repellent, burn, and electric. People do not use mosquito repellent because of the smoke that causes shortness of breath. While there is already a mosquito net, so there is no need for mosquito repellent. Use mosquito to repellent prevents mosquito bites and transmission of malaria.<sup>17</sup> Contact between malaria vectors with humans can be minimized with the use of mosquito repellent. The Majority of people only use mosquito repellent when in the bedroom, while the chances of contact with mosquitoes are not only in the bedroom but in other rooms.<sup>18</sup>

The variable of the use of ventilation screen in this study showed no significant relationship with the incidence of malaria (p-value 0.191). The Ventilation screen was no significant in accordance with research conducted by Rangkuti and Sulistyani<sup>13</sup> in North Sumatera, who obtained a p-value of 1.000 (p-value >0.05). However, it is different from the study conducted by Darmawansyah et al<sup>19</sup> in Bengkulu obtained a p-value of 0.016 (p-value <0.05). Home ventilation with air circulation that functions optimally is one of the characteristics of a healthy home. In conditions of open ventilation, mosquito will cause entry into the house. One way of prevention that can be used is to use a ventilation screen. The ventilation screen will provide a boundary so that mosquitoes from outside cannot enter the house.<sup>13</sup> For the local community, the installation of a ventilation screen is still not a priority. Many respondents did not install the ventilation screen even though they already knew the advantages of installing the ventilation screen. The installation of the screen in ventilation has not become a culture and is not considered important by the wider community. This is because respondents feel that there are still many other needs that are prioritized compared to buying ventilation screen.

The vector shelter variable in this study showed no significant relationship with the incidence of malaria. This is consistent with the study conducted by Santy et al<sup>20</sup> in West Kalimantan obtained a p-value of 0.141 (p-value >0.05). However, it is different from the study conducted by Nababan et al<sup>17</sup> in Purworejo obtained a p-value of 0.002 (p-value <0.05). Environmental conditions will greatly affect the incidence of malaria in an area. As the breeding grounds increase, the population of *Anopheles spp.* mosquitoes will increase and will further increase the risk of malaria. The closer the breeding habitat is to the house, the greater the risk of contracting malaria. Although in this study there was no significant relationship between the presence of breeding places for malaria mosquitoes around the respondent's house and the incidence of malaria, it was found that there were quite a number of breeding places for malaria mosquitoes around the respondent's house.

The limitation of this research is the data that comes from secondary data so it is limited in carrying out the analysis. This study was conducted only once to collect data, a cohort study is needed to see how much influence the

use of personal protective equipment has in malaria prevention and control.

This research concludes that mosquito nets significantly influence malaria cases in South Central Timor District. So, it is recommended to increase the habit of avoiding mosquito bites by using mosquito nets. Local governments are expected to carry out efforts to prevent and control malaria effectively. surveillance and blood tests, as well as mass distribution of mosquito nets, can be carried out to reduce the incidence of malaria.

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