







The Declined Trend of Malaria over a Ten-year Period in the Rural East Nusa Tenggara Province, Indonesia: A Medical Record Analysis

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Abstract

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BACKGROUND: Malaria still remains a major public health problem globally including in Indonesia. At present, most of malaria cases are in the eastern part of the country. However, there is no information yet regarding the trends of malaria prevalence at rural health institution particularly at Mangili Public Health Centre.

AIM: This study aims to explore the trend of malaria prevalence over a 10-year period.

METHODS: A retrospective study was carried out in the center. The laboratory record books from January 2013 to December 2022 were carefully reviewed to identify malaria cases based on the sex, age, type of *Plasmodium*, year, and month when the patients diagnosed malaria microscopically. The trend analysis was applied to identify the trend of malaria over the period under review.

RESULTS: Over the past 10 years, 19,938 blood films were requested for malaria diagnosis at the health center. From this number, 3,679 (18.5%, with 95% confidence interval (CI): 17.2–19.7) were microscopically confirmed malaria cases. From the total cases, prevalence of *Plasmodium falciparum* (Pf), vivax and mix infection was 85.5% with 95% CI: 84.3–86.8; 6.39% with 95% CI: 3.26–9.51; and 7.58% with 95% CI: 4.48–10.7, respectively. The number of malaria cases reached a peak in January, while it was the lowest in October. Overall trend on the prevalence of malaria decreased significantly; however, the prevalence of Pf increased considerably during COVID-19 pandemic. The prevalence of Pf, vivax, and mixed infection was higher in male, age group ≥ 15 , and student than their counterpart.

CONCLUSION: Malaria remains high in this area with Pf that is the dominant species followed by mixed infection. Scaling up malaria control and prevention activities is very crucial to significantly reduce the burden of malaria and to boost malaria elimination in this region.

Introduction

Malaria is a significant global health issue distributing across 84 malaria endemic nations [1] and leading for causes of death in many developing countries [2]. The current data of the World Health Organization (WHO) indicate that the number of malaria cases in 2021 was about 247 million. The majority of the cases (95%) were in African countries, while other cases were in other countries including 2% from nations in the region of South-east Asia. The region's action plan indicates that by 2030, the entire region will be declared a malaria-free zone [3]. Of the 11 nations in this area, the WHO has provided a certificate for malaria-free status to both Maldives and Sri Lanka. One indicator compulsory to accomplish the certificate is that there should have been no local malaria cases over the preceding 3 consecutive years [4]. The highest burden of malaria in this region in 2021 was in India and Indonesia, accounting to 79.2% and 16.6% of the region's total cases, respectively [1].

Indonesia which has 38 provinces administratively has a national commitment to achieve a malaria elimination area by 2030 [5]. All districts in the country have been classified as malaria-free zone, low, moderate, and high malaria endemic settings (MES) based on their annual parasite incidence (API). API was defined as the number of malaria cases confirmed microscopically per thousand people [5]. The current API indicates that in 2021, the national API was 1.1/1000 population and this figure differs throughout the country [6]. Most of the districts in the western part of the country have API value <0.05 and have been categorized as malaria-free zone, while in the eastern part of the country, most of districts have API value more than 0.1 including the top three of highest value of API was in Papua, West Papua and East Nusa Tenggara (ENT) Province with the value 80.5, 7.56, and 1.69 per thousand population, respectively [6].

ENT Province is an archipelago province consisting of five main islands including Flores, Timor, Lembata, Alor, and Sumba [7]. The total number of

malaria cases in 2022 was 15,830 cases with most of the cases (84%) was in the Sumba Island [8]. The island consists of four districts which three of them, South-west Sumba, East Sumba, and West Sumba districts are categorized as high MES. Almost 50% of malaria cases in Sumba Island were contributed from the Eastern part of the island [8]. The cases were scattered in all sub district of East Sumba district allowing 100% of the 248,776 total population in the region could have a risk of contracting the disease [9]. The rate of malaria risk and transmission vary between season [10] with the highest in December and the lowest in April [11]. Moreover, the incidence and prevalence of malaria differs depending on environmental and sociodemographic factors including gender and age group [7]. Therefore, monitoring the burden of malaria and the trend in endemic area is essential to examine the measures and the impact of any intervention. However, such useful data remain limited in several endemic areas of the Eastern part of Sumba.

Risk of malaria was high in the East Sumba district, in which all sub-districts are prone to malaria transmission. For instance, an analysis of 1-year data of malaria patients in 2015 admitted in the Public Hospital of Umbu Rara Meha in the capital city of East Sumba district revealed that the prevalence of *Plasmodium falciparum* (Pf) was higher than *Plasmodium vivax* (Pv) and more than half of the cases was contributed by Waingapu city [12]. Another cross-sectional study of 262 patients admitted at Lindimara Hospital of East Sumba from July to December 2014 indicated that the prevalence of malaria in female was higher than in male with most of the patient suffered with a single infection of Pf [13]. Then, a retrospective study to analyze 2-year trend of malaria in the East Sumba district revealed that the prevalence of malaria in 2018 and 2019 was higher in male than female [14]. Strikingly, a total of 5537 malaria cases were recorded in East Sumba District from January 2021 to December 2022 [8]. In spite of the general public health significance and the widespread incidence of malaria in all sub-districts of East Sumba, the general trend of malaria prevalence in the past 10 years has not been investigated. The evaluation of the morbidity pattern of malaria in endemic areas would help policymaker to understand the dynamic of diseases transmission and to design the effective intervention tailored with local condition to boost malaria elimination in the district. Furthermore, there is no information yet regarding the trends of malaria prevalence at the health centers and particularly at Mangili Public Health Centre in the past 10 years, while the national government of Indonesia has declared a national commitment to achieve malaria elimination zone since 2009 [5]. Therefore, the aim of this study was to evaluate the trend of malaria and transmission pattern regard sociodemographic factors and season in the past 10 years at Mangili Public Health Centre of East Sumba. Therefore, the present study addressed the above gaps with the hope to provide a significant

contribution to boost the achievement of malaria elimination in the province by helping policy makers in designing the right intervention tailored with local condition in the ENT Province Indonesia.

Materials and Methods

Study settings

A retrospective study was performed from August to October 2023 to determine a 10-year trend analysis of malaria prevalence in the working areas of Mangili Public Health Centre by assessing malaria blood film of malaria patients admitted in the center from January 2013 to December 2022. This health center is situated on the Pahunga Lodu Sub-district covering eight villages. The sub-district has a total area of 349.8 km. The location of the sub district is about 119 km in the Eastern part of Waingapu City, having an elevation of 216 m above sea level. Based on the 2020 census conducted by Central Bureau Statistics of East Sumba District, the sub-district has a total population of 13,066 of whom 51% are males and 49% females [15].

Data collection procedure

Medical record of malaria patients registered at the Mangili Public Health Centre from January 2013 to December 2022 was investigated in the coordination between the head of malaria section of the Health Department of East Sumba District and the Head of Mangili Public Health Centre. In collaboration with the malaria program manager of the center, individual data such as total clinically treated, confirmed cases in month and year, types of malaria species, and sociodemographic data (age, sex) were composed. The inclusion criteria for this study were that all malaria patients confirmed by rapid diagnostic test and microscopic. Data such as the number of malaria cases diagnosed in month and year, types of *Plasmodium* species, and sociodemographic data on sex and age group were included in the analysis regardless of pregnancy status and other infectious diseases of patients. Any missing data from inclusion criteria were excluded from this study. In this study, malaria data based on *Plasmodium* types, month, year, age group, and gender were available from 2013 to 2022, while data for *Plasmodium* types based on the gender, age group, occupation, pregnant status, and cases findings were only available from 2019 to 2022. Therefore, data for this study could present well the trend of malaria on the study area during the period under review.

All patients accused of malaria were tested microscopically to determine whether they suffered

from the disease. The test was also meant to classify the type of *Plasmodium*.

Statistical analysis

All data were verified for its completeness. The retrospective malaria data were recapitulated using figures and tables. Specifically, the total malaria case in the past 10 years (from January 2013 to December 2022) and malaria case by age and sex was summarized using table. Sociodemographic data of participants were described by descriptive statistics. The proportion of malaria infection in each year and its 95% confidence interval (CI) was computed from 2013 to 2022. The percentage of malaria infection based on the *Plasmodium* types and its 95% CI was computed for the whole period under review, while due to the availability of the data, the proportion of *Plasmodium* types based on age group, gender, main occupation, and pregnant status was computed from 2019 to 2022. Furthermore, trend analysis was used to compare *Plasmodium* types composition in each year and to assess seasonal transmission of malaria during the period under review. Data were analyzed using SPSS.

Ethics approval and consent to participate

This study was approved by the Health Research Ethics Committee of Nusa Cendana University (reference number 29/UN15.16/KEPK/2023). Permission letter was further obtained from the governor of ENTP, regent of East Sumba District, and the Health Department of East Sumba District. The head of Mangili Public Health Centre had been provided with sufficient information in relation with the purposes, risk, and advantage of the study before the research team start to collect data.

Results

Retrospective malaria data

A total of 19,938 blood films were prepared and scrutinized from malaria suspected patients at the Mangili Health Centre from January 2013 to December 2022. Of the total examined blood films, 18.5% (3679) with 95% confidence interval (CI): 17.2–19.7 were confirmed malaria cases microscopically. The highest number of malaria-suspected patients was in 2014 with 3227 patients, while the lowest was in 2016 with 1067 patients. From the medical record, it was found that the highest number of confirmed malaria cases was observed in 2014, accounting for 1397 positive cases. Overall, there was a significant reduction in the trend of malaria prevalence over the ten-year period at Mangili

Health Centre, from 31.7% with 95% CI: 28.4–35.0 at the beginning of the period (2013) to 6.08% with 95% CI: 2.48–9.69 at the end of period (2022). The highest malaria prevalence was recorded in 2014 at 43.3% with 95% CI: 40.7–45.9, meanwhile it was the lowest in 2022 at 6.08% with 95% CI: 2.48–9.69.

Regarding to the *Plasmodium* species of the patients, it was found that the majority of the cases in Mangili Public Health Centre were due to a single infection of Pf, accounting for 85.5% with 95% CI: 84.3–86.8, followed by mixed infection (Pf and Pv) and Pv single infection accounted for 7.58% with 95% CI: 4.48–10.7 and 6.39% with 95% CI: 3.26–9.51, respectively. The trend of Pf prevalence decreased slightly from 98.2% with 95% CI: 97.2–99.1 at the initial point in 2013 to 80.5% with 95% CI: 73.8–87.1 at the final point of the review (2022). The highest prevalence of single infection of Pf was observed in 2013, while it was the lowest in 2020 at 39.9% with 95% CI: 27.8–52.0. Furthermore, the highest prevalence of single infection of Pv was noticed in 2017 at 9.78% with 95% CI: 0.57–19.0, while for mixed infection due to Pf and Pv, the highest prevalence was in 2020 at 47.5% with 95% CI: 36.2–58.8. It is interesting to note that during the COVID-19 period (from 2020 to 2022), the prevalence of single infection due to Pf shows an increasing trend from 39.9% with 95% CI: 27.8–52.0 in 2020 to 80.5% with 95% CI: 73.8–87.1 in 2022, meanwhile the prevalence of mixed infection due to mixed infection of Pf and vivax depicted the downward trend from 47.5% with 95% CI: 36.2–58.8 in 2020 to 13.0% with 95% CI: 0.00–27.1 in 2022 as indicated in Table 1.

Seasonal variation of Plasmodium types

The trend of the number of malaria cases based on season and month in the past 10 years was presented in Figure 1. Overall, the number of malaria cases has been reported in all month and season. The outcome of this study indicated that the highest number of the cases was in January, accounting for 583 cases, while it was the lowest in October with 147 cases. The transmission of malaria shows an increasing trend from the beginning of the rainy season in October until reach a peak in January, then it decreased gradually until the end of rain season in April. During the transition period from rainy season to dry season, the number of malaria cases rose gradually from 323 cases in April to 397 cases in May. After that, the number of malaria cases decreased until the end of dry season. In relation to the *Plasmodium* types, this study depicted that the number of single infection due to Pf showed a decreased trend during the dry season, while it was increased significantly during the rainy season. The trend of malaria cases due to a single infection of Pv and mixed infection (due to vivax and falciparum) does not show fluctuated throughout the year; however, the maximum point was reached in different times. The highest number of mixed infection

Table 1: Profile of 10-year malaria cases report from Mangili Health Centres of East Sumba District of East Nusa Tenggara from 2013 to 2022

Year	Total of blood films examined	Total number of cases		Pf	Pv	Mix (Pf+Pv)			
		n	% (95% CI)						
2013	2428	770	31.7 (28.4, 35.0)	756	98.2 (97.2, 99.1)	13	1.69 (0.00, 8.69)	1	0.13 (0.00, 7.19)
2014	3227	1397	43.3 (40.7, 45.9)	1310	93.8 (92.5, 95.1)	75	5.37 (0.27, 10.5)	0	0.00 (0.00, 0.00)
2015	1263	195	15.4 (10.4, 20.5)	171	87.7 (82.8, 92.6)	24	12.3 (0.00, 25.5)	0	0.00 (0.00, 0.00)
2016	1067	168	15.7 (10.2, 21.3)	149	88.7 (83.6, 93.8)	11	6.55 (0.00, 21.2)	8	4.76 (0.00, 19.5)
2017	1701	409	24.0 (19.9, 28.2)	273	66.7 (61.2, 72.3)	40	9.78 (0.57, 19.0)	94	23.0 (14.5, 31.5)
2018	1859	133	7.15 (2.77, 11.5)	107	80.5 (72.9, 88.0)	10	7.52 (0.00, 23.9)	14	10.5 (0.00, 26.6)
2019	2231	192	8.61 (4.64, 12.6)	121	63.0 (54.4, 71.6)	23	12.0 (0.00, 25.3)	48	25.0 (12.8, 37.3)
2020	2097	158	7.53 (3.42, 11.7)	63	39.9 (27.8, 52.0)	20	12.7 (0.00, 27.2)	75	47.5 (36.2, 58.8)
2021	1287	88	6.84 (1.56, 12.1)	61	69.3 (57.7, 80.9)	8	9.09 (0.00, 29.0)	17	19.3 (0.55, 38.1)
2022	2778	169	6.08 (2.48, 9.69)	136	80.5 (73.8, 87.1)	11	6.51 (0.00, 21.1)	22	13.0 (0.00, 27.1)
Total	19938	3679	18.5 (17.2, 19.7)	3147	85.5 (84.3, 86.8)	235	6.39 (3.26, 9.51)	279	7.58 (4.48, 10.7)

Pf=*Plasmodium falciparum*, Pv=*Plasmodium vivax*, The data source: Mangili Public Health Centre and Health Department of East Sumba District, East Nusa Tenggara Province, Indonesia.

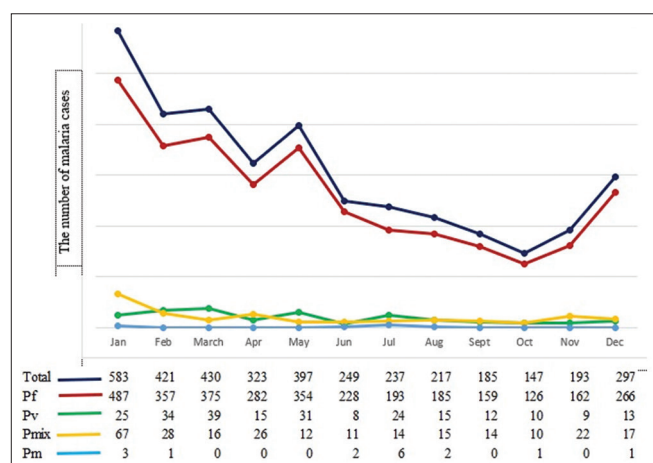


Figure 1: Monthly trends of malaria for a 10-year period at Mangili Health Centre from 2013 to 2022

(Pf and Pv) was in January, while it was in March for Pv as shown in Figure 1.

The data source: Mangili Public Health Centre and Health Department of East Sumba District, East Nusa Tenggara Province, Indonesia

Trend of malaria cases by age group

Based on the record review over the 10 years from 2013 to 2022 in the location of the study, it was found that malaria was reported in all age groups. The highest burden of malaria in each year over the period under review was in the adult group which has age more than 15 years old. The highest number of malaria cases in the group of children <5 years, 5–9 years, 10–14 years, and adult group was observed in 2014, contributing to 207 cases, 379 cases, 279 cases, and 532 cases, respectively. After the period of 2014, the number of malaria cases decreased for all age groups until the end the period as indicated in Figure 2.

The data source: Mangili Public Health Centre and Health Department of East Sumba District, East Nusa Tenggara Province, Indonesia

Trend of malaria case in gender

During the period from 2013 to 2022, the number of malaria infection in male was higher than in female

except in 2018, where the number of cases between male and female was almost comparable. The number of malaria cases in male in 2013 was 401 cases. This figure was almost double in 2014, accounting for 744 cases. After that the cases in the male group decreased significantly to 85 cases in 2016. This figure rose sharply to 210 cases in 2017, after that the number of cases in male group decreased until the end of period under review. The number of malaria cases in female group also provided a downward trend with the highest cases was in 2014, accounting for 653 cases and the lowest number was in 2021 with 39 cases as shown in Figure 3.

The data source: Mangili Public Health Centre and Health Department of East Sumba District, East Nusa Tenggara Province, Indonesia

Trend of malaria cases by socio-demographic

The distribution of malaria patients and *Plasmodium* species based on sociodemographic and other variables in Mangili Public Health Centre for the 4-year period from 2019 to 2022 was displayed in Table 2. Overall, the number of malaria cases reported in the center during the period under review was 605 cases. The prevalence of malaria was higher in male than in female (56.9% vs. 43.1%). Regarding to age group, the prevalence of malaria in adult group (people with age more than 15 years old) was the highest (41.5%) of other age groups. Almost half of the malaria patients in this health center were working as student (47.8%). There were ten patients who were pregnant suffered from malaria during the period under review. Almost all malaria cases (95.5%) in Mangili Health Centre were found during the patients attending the center. Other cases were identified when malaria section of the center conducted some programs including visiting home, contact survey, and mass blood survey, accounting for 2.81% (17 cases), 1.32% (8 cases), and 0.33 (2 cases), respectively.

Turning to the *Plasmodium* species, this study found that the prevalence of malaria due single infection of Pf and Pv was 63% (381/605) and 10.2% (62/605), respectively. While the prevalence of malaria due to mixed infection of Pf and Pv was 26.8% (162/605). From the total number of single infections of Pf and mixed

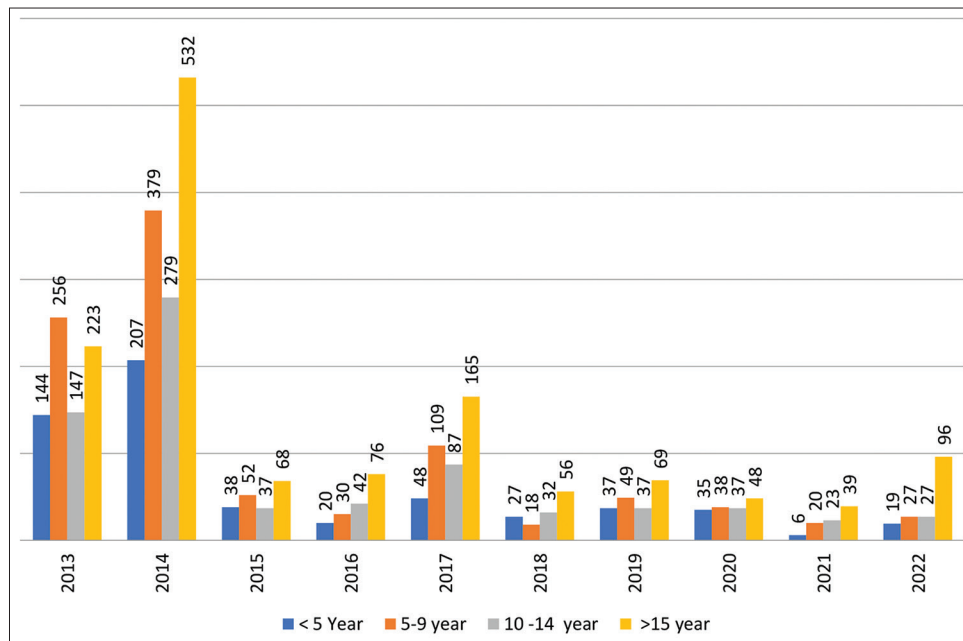


Figure 2: Trends of the number malaria patients based on the age group for a 10-year period at Mangili Health Centre from 2013 to 2022

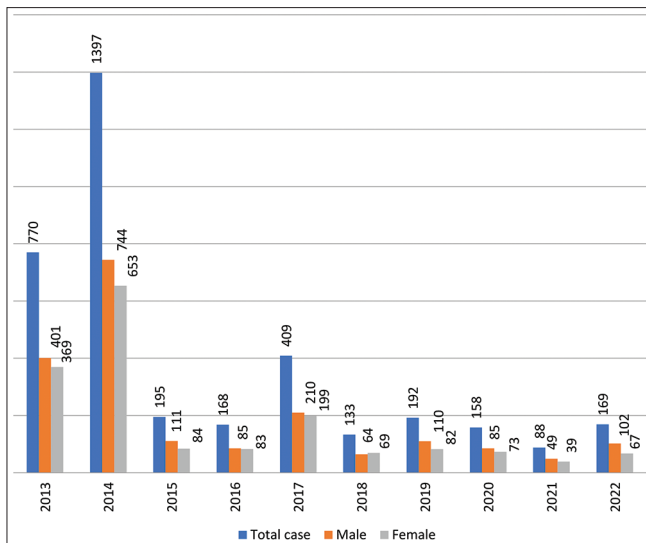


Figure 3: Distribution of malaria cases by gender in Mangili Health Centre of East Sumba District of East Nusa Tenggara for a 10-year period from 2013 to 2022

infection, its prevalence was higher in male than in female group (57.5% vs. 42.5%, 58% vs. 42%, respectively). While the prevalence of single infection due to Pv was the same between male and female group.

The distribution of *Plasmodium* types in Mangili Health Centre indicated that the prevalence of each *Plasmodium* type varies significantly among age groups. The highest prevalence of single infection due to Pf, Pv, and mixed infection was in the age group of adults, accounting for 44.6%, 40.3%, and 34.6%, respectively. This study showed that the prevalence of mixed infection was in line with the increase of the age of the patients with the lowest was in children less than five and the highest was in the adult groups. In relation to the main job of the patients, the prevalence of each

Table 2: Distribution of *Plasmodium* species by sociodemographic in Mangili Health Centre for a 4-year period from 2019 to 2022

Characteristics	<i>Plasmodium</i> types			Total
	Pf	Pv	Pmix	
Total	381	62	162	605
Gender				
Male	219 (57.5)	31 (50.0)	94 (58.0)	344 (56.9)
Female	162 (42.5)	31 (50.0)	68 (42.0)	261 (43.1)
p-value				0.512
Age group				
<5	54 (14.2)	11 (17.7)	32 (19.8)	97 (16.0)
5-9	83 (21.8)	16 (25.8)	35 (21.6)	134 (22.1)
10-14	74 (19.4)	10 (16.1)	39 (24.1)	123 (20.3)
≥15	170 (44.6)	25 (40.3)	56 (34.6)	251 (41.5)
p-value				0.29
Main Job				
Housewife	49 (12.9)	9 (14.5)	13 (8.02)	71 (11.74)
Office staff	6 (1.57)	1 (1.61)	3 (1.85)	10 (1.65)
Student	180 (47.2)	29 (46.8)	80 (49.4)	289 (47.8)
Farmer	75 (19.7)	9 (14.5)	25 (15.4)	109 (18.0)
No working	71 (18.6)	14 (22.6)	41 (25.3)	126 (20.8)
p-value				0.532
Pregnant status				
Yes	3 (0.79)	3 (4.84)	4 (2.47)	10 (1.65)
No working	378 (99.2)	59 (95.2)	158 (97.5)	595 (98.3)
p-value				0.043
Cases finding				
Health facilities	359 (94.2)	57 (91.9)	162 (100)	578 (95.5)
Visiting home	14 (3.67)	3 (4.84)	0 (0)	17 (2.81)
Contact survey	8 (2.1)	0 (0)	0 (0)	8 (1.32)
Mass blood survey	0 (0)	2 (3.23)	0 (0)	2 (0.33)
p-value				0.000

The data source: Mangili Public Health Centre and Health Department of East Sumba District, East Nusa Tenggara Province, Indonesia.

type of infection shows a difference among diverse occupation. The highest prevalence of single infection due to Pf, vivax, and mixed infection was in the group of students, accounting for 47.2%, 46.8%, and 49.4%, respectively, as shown in Table 2.

Discussion

To the best of our knowledge, this is the first study to investigate the trend of Pf and Pv using the

large database from the local health center in rural ENT Province Indonesia for the last 10 year. This study found that in Mangili Public Health Centre the prevalence of malaria was high in the past 10 years; however, the overall trend of malaria prevalence decreased significantly during the period under review. Furthermore, the prevalence of malaria falciparum was higher than malaria vivax and the number of malaria cases reached a peak in January and the lowest was in October. During the COVID-19 pandemic, the prevalence of single infection due to Pf rose significantly. Furthermore, the prevalence of malaria in male and student groups was higher than their counterparts.

This study demonstrates that the prevalence of malaria decreased over the past 10-year period. This great achievement might have been contributed by good management in treating malaria patients. The artemisinin-based combination therapy (ACT) as the main course to treat malaria has been introduced since 2004 throughout Indonesia by the national government and by 2012, the coverage of ACT has achieved more than 75% in high endemic settings [16]. In 2005, the national government introduced insecticide-treated nets in some parts of Indonesia to prevent malaria [16]. In 2017, the government provided mass distribution of the insecticide-treated nets massively to all high endemic settings in the eastern part of Indonesia [17]. These interventions are believed as also the main factor that has reduced the malaria cases in the study area.

This study showed that the prevalence of Pf was higher than Pv. This consistent with the national report of Indonesia government [5] and study in many parts of Indonesia [14], [18], [19], [20] and other countries including Ethiopia [21], North-west Ethiopia [22] Saudi Arabia [23], but this contrast with study in Mauritania [24] indicating the prevalence of malaria vivax was higher than falciparum. In this study, the prevalence of Pf shows a decreased trend from year to year; however, the number of cases was still high until the end of period under review. Stakeholders should provide much attention to tackle Pf, due to its clinical complications and drug-resistant threat in this archipelago [25]. Interestingly, the prevalence of single infection due Pv and the prevalence of mixed infection due to Pf dan Pv was high in the past 10 years. The high number of malaria vivax found in this study is a signal for the local authority that more attention should be paid for this situation as treatment of Pv needs higher awareness of local community to take the medication for 14 days to achieve to optimal result in curing the malaria vivax [26], [27], [28].

This study shows that the number of malaria cases shows an increasing trend during COVID-19 pandemic. This finding was consistent the global trend of malaria due to this pandemic [29] and other findings in Saudi Arabia [23] and Zimbabwe [30]. This could be understood as during this pandemic time, access to health services was limited which might impact on

health-seeking behavior of the local community. Fear of infection to the COVID-19 leads to people do not seek treatment for their malaria on the health facilities, as a result malaria patient was not diagnosed and do not receive the proper treatment. This could lead to local transmission of malaria continue in the community contributing to increasing the number of malaria cases. However, it is worth to note that the increasing number of malaria cases in this region was not entirely due to the disruption during COVID-19. For instance, environmental factors such as temperature and rainfall might be contributed to the higher occurrence of malaria in the nation. The previous study has showed that the important role of environmental factors play in malaria transmission in Indonesia [31], [32]. To better understand the factors that trigger a high number of malaria cases during the pandemic, further investigation of the impact of COVID-19 to this region is needed.

This study further shown that in the study area, the number of malaria cases peaked in wet season and the lowest malaria cases was in the beginning of transition period from rainy to dry season in period of April to Mei. This finding corroborates with other result in other settings [33], [34], [35]. This could be understood as during the wet season from October to April, the habitat of mosquito might be extended [36] and there were many puddles which have the highest larva density among other breeding site of mosquitos [37]. This condition could provide an appropriate environment for Anopheles mosquito to breed and grow well. As a result, the transmission of malaria runs well to achieve the highest number of cases during this wet period. Therefore, it highly recommended to anticipate the high number of the cases during this season. This could be done by encouraging the local community to clean their surroundings, spraying disinfectant to reduce the proliferation of the mosquito. The local authority also could encourage rural community in the area to use mosquito net as literature indicated the used of mosquito net is effective to prevent mosquito bite [27]. While during dry season from April to September, the minor transmission period might occur as a result of low rainfall. Although malaria transmission is usually associated with rainy seasons, in this study, malaria cases were also significant in dry season, indicating that climatic and environmental factors other than rainfall could also determine the occurrence of malaria in this region.

This study further shown that the prevalence of malaria infection in male group was higher than in female and this trend is consistent in each year for the duration of period under review. This finding was consistent with other studies in Sumba Island [11], [14] and other parts of Indonesia [38] and other countries including Ethiopia [21] Malaysia [39] indicating that the likelihood to have malaria in the group of male was higher than their counterpart. This could be attributed by lifestyle and main occupation. Most of

the community around the study area was working in agricultural sector [40] and with the fact that males were mainly engaged in agricultural activities and other large projects. This enables male group was exposure more with malaria vector allowing them have the high risk to have malaria. Targeting intervention for this group is critical to enhance malaria elimination in the study area.

Furthermore, our study shows that prevalence of malaria in student was the highest of other occupation. This finding corroborates result in other settings indicated that the prevalence of malaria among school age group was higher than their counterpart [41]. The high number of malaria cases on the student group might be attributed by the low level of malaria awareness of rural adults in this region. The previous study shown that most of rural adult in ENT Province had poor malaria awareness indicating that rural adults could not have enough knowledge on how to prevent and treat malaria [26], [27], [42], [43], [44], [45]. As a result, rural adults could not act as a row model for their children on how to practice some measures to prevent malaria and to find appropriate treatment when their family members obtained the symptoms of the disease. This situation was worsen by the fact that the prevalence of out of school children in this province was high [46], [47]. Meanwhile, literature indicated that student in primary school in rural settings could become the best media to spread malaria information on basic malaria knowledge, prevention measures, and appropriate treatment-seeking behavior [48]. Therefore, the policy marker should provide special intervention to enhance malaria awareness of the student in this area to boost malaria elimination in this province.

The strength of the study lies on the fact that malaria data were collected by trained laboratory technician having experience in their field and working as full-time position at the Mangili Health Centre. Furthermore, some malaria data were extracted directly from the Electronic Malaria Surveillance Information System managed by Health Ministry of Indonesia government. However, this study has some limitations including the identification of malaria cases based on the microscopic examination which its sensitivity rate was lower than polymerase chain reaction to identify *Plasmodium* species in the health center. Then, the recorded data in malaria register book were incomplete; therefore, the demographic profile of the *Plasmodium* species was merely identified for four years. However, this study provided the baseline data on the malaria prevalence research to be carried out in the future in the Sumba Island of ENT Province Indonesia.

Conclusion

In this present study, the overall trends of the malaria prevalence decreased significantly in the past

10 years from 2013 to 2022; however, its prevalence was still high; therefore, malaria is still among the major public health problems in Mangili Public Health Centre. Single infection due to Pf is the dominant species in the study area, followed by mixed infection due to Pf and vivax. Scaling up malaria control and prevention activities and enhancing malaria campaign for improving malaria awareness of students are very crucial to significantly reduce the burden of malaria and to boost achieving of malaria elimination in the study area.

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