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The Variation of Malaria Prevention Measures Knowledge and their Associated Factors in Rural East Nusa Tenggara Province, Indonesia

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Abstract

BACKGROUND: Malaria is one of the major public health problems in African and Southeast Asian countries including Indonesia. However, knowledge of malaria prevention measures (MPM) is not well studied, particularly in Indonesia.

AIM: This study aimed to investigate the level of MPM knowledge and associated factors among rural adults in high, moderate, and low endemic settings of East Nusa Tenggara Province (ENTP), Indonesia.

MATERIALS AND METHODS: A community-based cross-sectional study was conducted among a randomly selected 1495 households at rural ENTP. Multistage sampling technique was employed to recruit participants. Univariate and multivariable logistic regression model was used to assess factors affecting knowledge of MPM.

RESULTS: The MPM knowledge in long-lasting insecticide-treated net was the highest in high endemic settings (76.8%), while MPM knowledge on keeping the surrounding house clean was the highest in low-endemic settings (71.9%). The level of MPM knowledge in low, moderate, and high endemic settings differs significantly with the highest in low settings (57%, 95% CI: 50.5–63.5) and the lowest in high settings (19.3%, 95% CI: 11.1–27.5). In all settings, good level of MPM knowledge was significantly higher for adults with high socioeconomic status (SES) (adjusted odds ratio [AOR] = 2.52, 95% CI: 1.20–5.30; AOR = 20.5, 95% CI: 4.64–90.8, AOR = 3.31, 95% CI: 1.34–8.15, respectively) compared to those having low SES. In high and moderate settings, the likelihood of good MPM knowledge was considerately higher for adults with at least secondary (AOR = 2.35, 95% CI = 1.29–4.36, AOR = 2.66, 95% CI = 1.32–5.39, respectively) than those with primary or no education level.

CONCLUSION: The good level of MPM knowledge was very low in three different malaria endemic settings. Higher level of education and high SES were significantly associated with the good level. Therefore, health education promotion on MPM knowledge is critical to support malaria elimination program in the province.

Introduction

Malaria is a communicable disease spreading across 84 countries globally [1]. The World Health Organization (WHO) projected that the number of malaria cases was about 247 million in 2021 worldwide with 95% of the cases was contributed by African region [1]. In South East Asia, the number of malaria cases was predicted about 5,383,185 in 2021, of which 79% were from India and 15% were from Indonesia [1]. The number of malaria cases in Indonesia shows that an increasing trend with the highest burden of malaria was in the Eastern part of the country [2]. Most of the districts in the Western part of Indonesia have been classified as malaria elimination area while it was limited in the Eastern part of the country [2].

East Nusa Tenggara Province (ENTP) which is one of the lag provinces in the Eastern part of Indonesia [3] was the third-highest contributor to the malaria burden of the nation in 2021 [2]. The province has 22 districts of which 13.6% of the total number of district were classified as high malaria-endemic setting (MES), 63.6% was low MES, and 22.7% was malaria-free zone [2]. Under the partnership with the National Malaria Control Program of Indonesia government, local authority of ENTP has applied various efforts to reduce the burden of malaria in this region. This includes ensuring the availability of artemisinin-based combination therapies (ACTs) for malaria treatment in all local health facilities [2], increasing coverage of ACT from 55% in 2013 [4] to 99.8% in 2021 [2], conducting indoor residual spraying (IRS) to respond outbreak, larva control, and environmental management [5], [6], increasing coverage of mass distribution of insecticide-treated mosquito nets from 9 districts in 2010 [6] to 15 districts in 2017 [7]. However, the number of malaria cases is still high with the total number of cases in 2021 being 9419 cases [2]. This implies that these approaches might not be enough and the

implementation of those measures might depend on the community behavior which is less documented in the study area. To progress to malaria elimination, active participation of community is critical [8] and to do that the community should have malaria awareness including knowledge in malaria prevention measures (MPM). Having a high level of MPM knowledge leads to high practice of MPM [9] and high participation in various malaria elimination programs which in turn to speed up malaria elimination [10].

There are many types of MPM including long-lasting insecticide-treated nets (LLINs), non-LLINs, IRS [11], house screening [12], and mosquito repellents [13]. Studies on these types of MPM at the global level indicated that the knowledge of MPM was significantly associated with the education level of participants [14], [15], [16]. A recent systematic review on MPM in the society of Southeast Asia nations implies that the studies of MPM and its associated factors were restricted in the zone [17]. To boost malaria elimination, local knowledge of MPM should be measurable and the level of malaria prevention knowledge of the local population should be integrated in designing malaria elimination programs [17].

In Indonesia, limited research on the community-level MPM has been performed [18], [19], [20]. A study of malaria prevention knowledge of rural adults in Purworejo district of Central Java showed that about half of the participants had knowledge of mosquito nets and covering ventilation for preventing malaria, and the usage of these measures was considerably associated with the education of participants [18]. A study on 50 villages in Central Java shows that more than half of 1000 rural communities kept their house clean and applied indoor residual spray to prevent malaria [19]. However, all of these investigations were carried out in the Western part of Indonesia, which most of the districts in this area have been classified as malaria-free zone. The recent study in the Eastern part of Indonesia, including in ENTP, indicated that the practice of various types of MPM differs among provinces [20].

Some studies on MPM had been conducted in the context of rural ENTP [21], [22], [23], [24], [25] A study on knowledge of LLINs and non-LLINs for rural community in this province indicated that rural adults in low endemic settings were knowledgeable with non-LLINs, while it was LLINs in high endemic settings [21]. Another study on Tetun ethnicity in Timor Island indicated that most of community in that group had knowledge on the traditional plants for preventing malaria [22]. Other studies recruiting 1503 participants rural adults from 49 villages in ENTP reveal that the level of knowledge in some kinds of MPM of rural population was poor [23], [24], [25], however, the disparity of MPM knowledge among different MES has not been investigated in those studies. Moreover, the discrepancy in the level of MPM knowledge among different settings and its associated factors have not been explored in this study area. The local community should be able to identify various kinds of MPM and their knowledge of MPM should be considered in planning and implementing malaria elimination programs to succeed the program [17]. The high level of knowledge of MPM leads to a high level of practice of MPM in their daily life [9], and the combination of some kinds of MPM tailored to the local population would boost malaria elimination [26], [27], [28]. Furthermore, understanding the knowledge of MPM in the local community and identifying which groups are the most vulnerable in the population will help local authorities design sustainable malaria programs to accelerate malaria elimination. Therefore, this study investigated the discrepancy in MPM knowledge among different MES and its associated factors. It is anticipated that these findings will enhance the expectation of ENTP and the Indonesian government to achieve a malaria elimination zone by 2030 [29].

Materials and Methods

Study design and settings

This community-based cross-sectional study was performed in 3 out of 22 districts in the province from October to December 2019. First, East Sumba district which is 52.3% population of the district working in agricultural sector was classified as high MES [30], [31]. The area of the district is 7,000.50 km^2, with a population density of 35 people per square kilometer [32]. Second, Belu district which is 37.7% population of the district working in agricultural sector was classified as moderate MES [30], [31]. The area of the district is 1,284.94 km^2, with a population density of 177 people per square kilometer [33]. Finally, East Manggarai district with 78.8% population of the district working in agricultural sector was classified as low MES [30], [31]. The area of the district is 2,401.39 km^2, with a population density of 111 people per square kilometer [34].

Participants

Participants for this study were recruited by multistage sampling procedure. First, three districts were selected based on their level of malaria burden. In each selected district, three subdistricts were selected randomly. The number of villages was chosen in each subdistrict considering their population size. In each selected village, a systematic sampling procedure was applied to recruit one participant from each household. Any resident over than 18 years old was included as the potential participants for this study. Since the study wanted to explore the MPM knowledge of rural adults,

any participant <18 years of age was excluded from this study.

Study size

The initial sample (n_o) for this study was computed by following the formula of dichotomous variables for prevalence study [35]:

$$n_0 = \frac{Z^2 p(1-p)}{d^2}$$

Where p represents malaria prevalence study in ENTP =1.99 [36], Z means the standard value on interval confidence 95% = 1.96, and d denotes relative precision = 0.01125. Therefore, the initial sample becomes 592. By considering the coefficient of intraclass correlation (ρ = 0.04) in studying MPM in Indonesia [13] and the number of adult per village (n_1 = 30 people), the design effect (DEFF) was expressed following the WHO guidance [37]:

$DEFF = [1 + (n_1 - 1)\, p] = 2.16$

The adjusted sample size (n_2) becomes

$n_2 = n_0 * DEFF = 592 * 2.16 = 1278$

Following the WHO guideline, the final sample size (n) was calculated by considering the participation rate of participants (y = 85%).

$$n = \frac{n_2}{y} = \frac{1278}{0.85} = 1503$$

The comprehensive computation of sample size was reported on the previous article of the authors [38].

Data collection procedure

Data collection tools were adapted from validated questionnaire [39] with some modifications. Originally, the questionnaire was prepared in English. Then, the local language expert and the main author of this study translated the questionnaire into local language (Indonesian). They then combined the translation version of the questionnaire. The combined version of the questionnaire was used as a final tool to collect data. Nine enumerators having background in nursing school and working experience in the local public health centers were employed and educated about the aim of the study including overview of MPM knowledge, how to approach participants and obtain their written consent, and how to complete the questionnaire. Data collection was supervised strictly by the main author of this study. The completeness of the questionnaire was monitored on daily basis and the incomplete questionnaire was returned to enumerators on the following day for correction by revisiting the household.

Study variables and operational definitions

The dependent variable of the study was the good level of MPM knowledge in each MES. The good level of MPM knowledge was defined based on the response of participant to six questions. It includes questions related to sleeping under LLINs, sleeping under non-LLINs, keeping surrounding house clean, using mosquito coil, wearing long-sleeved clothes when going outdoors at night, and using IRS. Each of questions has option yes or no, with yes obtaining of score one. Therefore, the total score of each participant ranged from zero to six. Participants who could answer correctly at least three question-related knowledge of MPM were categorized as having a good knowledge of MPM, while participants answering zero to two questions were categorized as having a poor knowledge of MPM [15].

The independent variables of the study were gender, age group, education level, occupation, family size, socioeconomic status (SES), household income, the nearest health facilities, the distance to the nearest health facilities, and the location of household. In this study, gender was categorized as male and female, age group was classified as <30 years old, 30–39 years, 40–49 years, 50–59 years, 60 years, or above. The education level was classified into two categories: Primary school or less and secondary school or above, and the main occupation was classified into four groups: Farmer, housewife, office staff, and others. The location of household was categorized as coastal, hills, and other areas. The SES group of participants was classified as low, average, and high.

Data analyses

Sociodemographic data of participants were described by descriptive statistics. The proportion of participants answering correctly for each question of MPM and its 95% confidence interval (CI) was computed in each MES. The percentage of good knowledge for each MES was calculated with its 95% CI. To investigate the potential factors affecting good knowledge of MPM, a univariate and multivariate binary logistic regression analysis was applied. Adjusted odds ratio (AOR) with 95% CI and p < 5% was employed to confirm the significance of each variable applying the statistical Package for the Social Sciences version 16.

Ethics approval and consent to participate

This study was accepted by the Human Ethics Committee of the Swinburne University of Technology (reference number 20191428-1490) and the Indonesian Ministry of Health (reference letter: 164 LB.02.01/2/KE.418/2019). Permission letter was further obtained

from the governor of ENTP; head of East Sumba, Belu, and East Manggarai district; nine head of sub-districts; and forty-nine village leaders in this region. Information related to the purposes, risk, and advantage of the study was provided to all participants before data collection. Participation in this study was fully voluntary and written consent was attained from each participant.

Results

Distribution of participants having awareness that malaria could be prevented by sociodemographic characteristics

The participation rate of the respondent was high at 99.5% (1495/1503). The total number of participants included in the initial analysis was 1495. The distribution of participants having awareness that malaria could be prevented is shown in Table 1. Most of participants in high MES (94.1%) had awareness that malaria could be prevented, whereas it was only 77.6% and 72.4% in low- and moderate-endemic settings, respectively. In all MES, the awareness that malaria could be prevented differs significantly between education level ($p < 0.001$) and there was a trend that malaria awareness was in line with the increase education level of participants. In terms of SES of participants, the highest proportion of participants having awareness about malaria that could be prevented was from the high SES group both for rural adults in moderate and high MES with 98.4% and 96.6%, respectively, while it was from low SES group in low-endemic settings. In moderate- and low-endemic settings, malaria awareness differs statistically between different distances from the nearest health center ($p < 0.001$).

Knowledge of MPM of participants

The variation of knowledge of malaria prevention methods of rural adults in different MES is presented in Table 2. Overall, a discrepancy of good level of MPM

Table 1: Distribution of participants having awareness that malaria could be prevented by sociodemographic factors in each malaria-endemic setting (n=1495)

Characteristics	ENTP		Malaria-endemic settings					
	Yes, n (%)	Total	High		Moderate		Low	
			Yes, n (%)	Total	Yes, n (%)	Total	Yes, n (%)	Total
Overall	1216 (81.3)	1495	466 (94.1)	495	362 (72.4)	500	388 (77.6)	500
Gender								
Male	614 (84.5)	727	216 (93.5)	231	190 (81.5)	233	208 (79.1)	263
Female	602 (78.4)	768	250 (94.7)	264	172 (64.4)	267	180 (75.9)	237
p	0.003		0.574		<0.001		0.401	
Age group								
<30	177 (86.3)	205	75 (94.9)	79	54 (84.4)	64	48 (77.4)	62
30–39	362 (86.6)	418	134 (97.8)	137	93 (86.1)	108	135 (78.0)	173
40–49	313 (84.4)	371	133 (96.4)	138	93 (75.6)	123	87 (79.1)	110
50–59	221 (74.9)	295	66 (95.7)	69	79 (61.2)	129	76 (78.4)	97
>60	143 (69.4)	206	58 (80.6)	72	43 (56.6)	76	42 (72.4)	58
p	<0.001		<0.001		<0.001		0.896	
Level of education								
Primary school or less	731 (76.2)	959	351 (92.9)	378	182 (61.1)	298	198 (70.0)	283
Secondary school or above	485 (90.5)	536	115 (98.3)	117	180 (89.1)	202	190 (87.6)	217
p	<0.001		0.029		<0.001		< 0.001	
Main occupation								
Farmer	690 (83.0)	831	321 (94.4)	340	115 (70.1)	164	254 (77.7)	327
Housewife	284 (70.5)	403	80 (90.9)	88	151 (63.7)	237	53 (67.9)	78
Other	102 (92.7)	110	48 (98.0)	49	43 (97.7)	44	11 (64.7)	17
Office staff	140 (92.7)	151	17 (94.4)	18	53 (96.4)	55	70 (89.7)	78
p	<0.001		0.390		<0.001		0.006	
Socioeconomic status								
Low	336 (74.8)	449	139 (92.1)	151	41 (39.0)	105	156 (80.8)	193
Average	710 (82.6)	860	271 (94.8)	286	258 (77.9)	331	181 (74.5)	243
High	170 (91.4)	186	56 (96.6)	58	63 (98.4)	64	51 (79.7)	64
p	<0.001		0.368		<0.001		0.263	
Family size								
≤4	633 (78.8)	803	190 (91.3)	208	260 (72.4)	359	183 (77.5)	236
>4	583 (84.2)	692	276 (96.2)	287	102 (72.3)	141	205 (77.7)	264
p	0.007		0.024		0.985		0.977	
The nearest health service								
Village maternity posts	310 (80.3)	386	131 (89.1)	147	166 (74.8)	222	13 (76.5)	17
Village health post	217 (71.9)	302	34 (100.0)	34	56 (53.8)	104	127 (77.4)	164
Subsidiary public health centers	290 (85.8)	338	168 (97.1)	173	35 (64.8)	54	87 (78.4)	111
Public health centers	399 (85.1)	469	133 (94.3)	141	105 (87.5)	120	161 (77.4)	208
p	<0.001		0.009		<0.001		0.996	
Distance to the nearest health service (km)								
<1	460 (79.6)	578	165 (94.8)	174	177 (65.3)	271	118 (88.7)	133
1–2	328 (82.0)	400	84 (96.6)	87	121 (81.2)	149	123 (75.0)	164
≥3	428 (82.8)	517	217 (92.7)	234	64 (80.0)	80	147 (72.4)	203
p	0.368		0.386		0.001		0.001	
HH income in relation to PMW								
<PMW	1082 (80.6)	1342	431 (93.9)	459	327 (71.7)	456	324 (75.9)	427
≥PMW	134 (87.6)	153	35 (97.2)	36	35 (79.5)	44	64 (87.7)	73
p	0.036		0.414		0.267		0.026	
Location of household								
Coastal area	186 (91.6)	203	85 (97.7)	87	78 (97.5)	80	23 (63.9)	36
Others	251 (82.0)	306	123 (94.6)	130	43 (62.3)	69	85 (79.4)	107
Hills	779 (79.0)	986	258 (92.8)	278	241 (68.7)	351	280 (78.4)	357
p	<0.001		0.229		<0.001		0.120	

ENTP: East Nusa Tenggara Province.

Table 2: Variation of knowledge of malaria prevention measures of rural adults who have awareness that malaria could be prevented in the ENTP, Indonesia (n=1216)

Knowledge of MPM	Malaria endemic settings						Total (n=1216)		p
	High (n=466)		Moderate (n=362)		Low (n=388)				
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI	
Sleeping under LLINs	358 (76.8)	72.4–81.2	210 (58)	51.3–64.7	184 (47.4)	40.2–54.6	752 (61.8)	58.3–65.3	<0.001
Keeping surrounding house clean	123 (26.4)	18.6–34.2	137 (37.8)	29.7–45.9	279 (71.9)	66.6–77.2	539 (44.3)	40.1–48.5	<0.001
Burning mosquito coil	113 (24.2)	16.3–32.1	120 (33.1)	24.7–41.5	111 (28.6)	20.2–37.0	344 (28.3)	23.5–33.1	0.018
Sleeping under non-LLINs	26 (5.60)	0.00–14.4	55 (15.2)	5.71–24.7	268 (69.1)	63.6–74.6	349 (28.7)	24.0–33.4	<0.001
Using IRS	170 (36.5)	29.3–43.7	41 (11.3)	1.61–21.0	33 (8.50)	0.00–18.0	244 (20.1)	15.1–25.1	<0.001
Wearing long-sleeved clothes when going outdoors at night	47 (10.1)	1.49–18.7	47 (13.0)	3.39–22.6	106 (27.3)	18.8–35.8	200 (16.4)	11.3–21.5	<0.001
Good level of MPM	90 (19.3)	11.1–27.5	76 (21.0)	11.8–30.2	221 (57.0)	50.5–63.5	387 (31.8)	27.2–36.4	<0.001

LLINs: Long-lasting insecticide-treated nets, MPM: Malaria prevention measure, CI: Confidence interval, IRS: Indoor residual spraying, ENTP: East Nusa Tenggara Province.

knowledge in these settings with the highest level was in low MES at 57.0% with 95% CI: 50.5–63.5, whereas the lowest level of good knowledge of MPM was in high MES at 19.3% with 95% CI: 11.1–27.5.

More than three-quarter of participants (76.8%, 95% CI: 72.4–81.2) in high MES had knowledge on sleeping under LLINs to prevent malaria. Meanwhile, it was about under half of participants in low MES (45.4%, 95% CI: 40.2–54.6). The highest percentage of participants having knowledge on applying non-LLINs to prevent malaria was in low MES at 69.1% with 95% CI: 63.6–74.6, whereas it was the lowest in high MES at only 5.6% with 95% CI: 0.00–14.4. The proportion of participants having knowledge on keeping surrounding house clean to prevent malaria in low MES (71.9%, 95% CI: 66.6–77.2) was the highest of other settings. The proportion of participants who had knowledge on burning mosquito coil to prevent malaria in low and moderate MES was almost comparable, 28.6% with 95% CI: 20.2–37.0 and 33.1% with 95% CI: 24.7–41.5 respectively. Meanwhile, it was 24.2% with 95% CI: 16.3–32.1 in high MES.

Variation of good level MPM knowledge in different MES

The variation of good level of malaria prevention methods knowledge among rural adults in different MES is presented in Table 3. The proportion of good level of MPM knowledge between male and female groups was not different significantly in all MES. There was a significant difference in good level of MPM knowledge based on the education level of participants in high ($p < 0.001$) and moderate ($p < 0.001$) MES. In all MES, the good level of MPM knowledge was statistically different among participants with different SES and there was a trend that the improvement of good level of malaria prevention knowledge was in line with the increase level of SES of participants. Regarding the occupation of participants, the highest proportion of good level of MPM knowledge was from office workers group with 65.7%, 47.1%, and 41.5% in low-, high-, and moderate-endemic settings, respectively.

Factors associated with good level of knowledge of MPM

Factors associated with good level of MPM knowledge are presented in Table 4. After controlling all potential confounding variables in multivariate analysis, it was found that in high MES, secondary school or above education level (AOR = 2.37, 95% CI: 1.29–4.36); living with high of SES (AOR = 3.31, 95% CI: 1.34–8.15); living closed to subsidiary public health center (AOR = 0.09, 95% CI: 0.04–0.22); and living closed to village health post (AOR = 0.14, 95% CI: 0.03–0.64) were significantly associated with good level of malaria prevention measure knowledge. Accordingly, the odds of good malaria prevention knowledge for rural adults in high MES were more 2 times higher among rural adults with secondary or above education level as compared to those with primary or no education level (AOR) = 2.37, 95% CI: 1.29–4.36). Rural adults living with high of SES had 3 times higher more likely to have good malaria prevention knowledge than those living in low SES (AOR = 3.31, 95% CI: 1.34–8.15).

Furthermore, in moderate MES, variables that considerably associated with good level of malaria prevention measure knowledge were secondary school or above education level (AOR = 2.66, 95% CI: 1.32–5.39); living with high of SES (AOR = 20.5, 95% CI: 4.64–90.8); living closed to subsidiary public health center (AOR = 8.35, 95% CI: 3.14–22.2); and living more than 2 km from the nearest health facilities (AOR = 3.85, 95% CI: 1.71–8.63). Accordingly, the odds of good malaria prevention knowledge for rural adults in moderate MES were more 2 times higher among rural adults with secondary or above education level as compared to those with primary or no education level (AOR = 2.66, 95% CI: 1.32–5.39); Rural adults living with high of SES had 20 times higher more likely to have good malaria prevention knowledge than those living in low SES (AOR = 20.5, 95% CI: 4.64–90.8). The odds of good level malaria prevention knowledge for participants living close to subsidiary public health center (AOR = 8.35, 95% CI: 3.14–22.2) were 8 times higher than those living close to village maternity post.

Whilst, in low MES, factors such as high SES, having family size <4, living in coastal area, and living closed to the nearest health service were statistically associated with a good level of MPM knowledge. Participants living with high SES (AOR = 2.52, 95% CI: 1.20–5.30) were nearly 3 times higher to have good level of malaria prevention measure knowledge than those in low SES. Rural adults living between 1 and 2 km from the nearest health service (AOR = 0.42, 95% CI: 0.23–0.77) and living more than 2 km

Table 3: Variation of good level malaria prevention measures knowledge among rural adults in different malaria-endemic settings by sociodemographic and environmental factors

Characteristics	Malaria endemic settings					
	High		Moderate		Low	
	Number at risk	n (%)	Number at risk	n (%)	Number at risk	n (%)
Overall	466	90 (19.3)	362	76 (21.0)	388	221 (57.0)
Gender						
Male	216	48 (22.2)	190	45 (23.7)	208	111 (53.4)
Female	250	42 (16.8)	172	31 (18.0)	180	110 (61.1)
p		0.139		0.187		0.124
Age group						
<30	75	13 (17.3)	54	15 (27.8)	48	24 (50.0)
30–39	134	25 (18.7)	93	26 (28.0)	135	87 (64.4)
40–49	133	29 (21.8)	93	14 (15.1)	87	56 (64.4)
50–59	66	17 (25.8)	79	13 (16.5)	76	37 (48.7)
>60	58	6 (10.3)	43	8 (18.6)	42	17 (40.5)
p		0.239		0.12		0.013
Level of education						
Primary school or less	351	55 (15.7)	182	23 (12.6)	198	104 (52.5)
Secondary school or above	115	35 (30.4)	180	53 (29.4)	190	117 (61.6)
p		<0.001		<0.001		0.072
Main occupation						
Farmer	321	52 (16.2)	115	16 (13.9)	254	145 (57.1)
Housewife	80	19 (23.8)	151	25 (16.6)	53	23 (43.4)
Other	48	11 (22.9)	43	13 (30.2)	11	7 (63.6)
Office staff	17	8 (47.1)	53	22 (41.5)	70	46 (65.7)
p		0.008		<0.001		0.095
Socioeconomic status						
Low	139	11 (7.9)	41	3 (7.30)	156	76 (48.7)
Average	271	55 (20.3)	258	45 (17.4)	181	114 (63.0)
High	56	24 (42.9)	63	28 (44.4)	51	31 (60.8)
p		<0.001		<0.001		0.026
Family size						
≤4	190	41 (21.6)	260	55 (21.2)	183	92 (50.3)
>4	276	49 (17.8)	102	21 (20.6)	205	129 (62.9)
p		0.304		0.905		0.012
The nearest health service						
Village maternity posts	131	45 (34.4)	166	26 (15.7)	13	6 (46.2)
Village health post	34	2 (5.90)	56	12 (21.4)	127	85 (66.9)
Subsidiary public health centers	168	7 (4.20)	35	18 (51.4)	87	45 (51.7)
Public health centers	133	36 (27.1)	105	20 (19.0)	161	85 (52.8)
p		<0.001		<0.001		0.049
Distance to the nearest health service (km)						
<1	165	30 (18.2)	177	31 (17.5)	118	80 (67.8)
1–2	84	16 (19.0)	121	21 (17.4)	123	63 (51.2)
>2	217	44 (20.3)	64	24 (37.5)	147	78 (53.1)
p		0.874		0.002		0.016
HH income in relation to PMW						
<PMW	431	72 (16.7)	327	65 (19.9)	324	178 (54.9)
≥PMW	35	18 (51.4)	35	11 (31.4)	64	43 (67.2)
p		<0.001		0.111		0.071
Location of household						
Coastal area	85	20 (23.5)	78	18 (23.1)	23	4 (17.4)
Others	123	24 (19.5)	43	7 (16.3)	85	35 (41.2)
Hills	258	46 (17.8)	241	51 (21.2)	280	182 (65.0)
p		0.512		0.676		<0.001

from the nearest health service (AOR = 0.49, 95% CI: 0.27–0.86) were less likely to have a good level of malaria prevention knowledge than those living <1 km from the nearest health service. Participants living in the coastal area (AOR = 0.07, 95% CI: 0.02–0.22) were less likely to have a good level of malaria prevention knowledge than those living in hills area.

Discussion

To our knowledge, this is the first study to investigate the good level of knowledge of MPM and their associated factors among rural adults in different MES of ENTP, Indonesia. This study shows that there was a statistical difference in good level of knowledge of MPM among rural adults in high, moderate, and low MES with the lowest being in high MES. This implies that the knowledge related to MPM should be scaled up to progress to malaria elimination by 2030. The main factors significantly associated with the good level of MPM knowledge for rural adults in high and moderate settings were the high level of education, and high SES. While, in low MES, it was high SES, distance to the nearest health centers, and location of household.

The present study shows that the prevalence of good knowledge of malaria preventative measures in low, moderate, and high MES was very low, with 57%, 21%, and 19.3%, respectively. These findings were lower than reported in rural settings of other nations such as Cameroon [14] and Northwest Ethiopia [15]. The low level of malaria prevention method knowledge of participants in this study might be contributed to the lack of health promotion actions, especially related to malaria preventions with the fact that the number of health promotion workers at the level of public health centers in this region was low and their distribution was uneven among health centers [40]. In addition, nurses and midwifes, beside their main tasks to provide service at health centers, have to work extra hours without well compensation to educate local people on the significance of MPM particularly related to how to

Table 4: Factors associated with the good level malaria prevention measures knowledge among rural adults in different malaria-endemic settings

Characteristics	Malaria-endemic settings (AOR)		
	High	Moderate	Low
Gender			
Male	1.14 (0.68–1.91)	1.46 (0.78–2.73)	0.76 (0.48–1.21)
Female	1.00	1.00	1.00
Age group			
<30	1.23 (0.39–3.91)	1.29 (0.37–4.46)	1.82 (0.70–4.70)
30–39	2.43 (0.88–6.76)	1.03 (0.34–3.08)	2.85 (1.28–6.32)
40–49	2.42 (0.88–6.65)	0.70 (0.23–2.10)	2.61 (1.14–5.98)
50–59	2.55 (0.86–7.63)	1.03 (0.34–3.10)	1.37 (0.59–3.15)
>60	1.00	1.00	1.00
Level of education			
Primary school or less	1.00	1.00	1.00
Secondary school or above	2.37 (1.29–4.36)	2.66 (1.32–5.39)	1.1 (0.67–1.81)
Main occupation			
Farmer	1.00	1.00	
Housewife	1.65 (0.78–3.50)	1.35 (0.38–4.86)	
Other	0.92 (0.38–2.19)	1.76 (0.66–4.71)	
Office staff	2.28 (0.71–7.31)	2.42 (0.94–6.26)	
Socioeconomic status			
Low	1.00	1.00	1.00
Average	1.92 (0.92–4.00)	4.46 (1.13–17.7)	1.87 (1.14–3.06)
High	3.31 (1.34–8.15)	20.5 (4.64–90.8)	2.52 (1.20–5.30)
Family size			
≤4			0.51 (0.32–0.81)
>4			1.00
The nearest health service			
Village maternity posts	1.00	1.00	
Village health post	0.14 (0.03–0.64)	1.43 (0.59–3.47)	
Subsidiary public health centers	0.09 (0.04–0.22)	8.35 (3.14–22.2)	
Public health centers	0.64 (0.37–1.12)	0.90 (0.44–1.86)	
Distance to the nearest health service (km)			
<1	1.00	1.00	1.00
1–2		0.94 (0.46–1.94)	0.42 (0.23–0.77)
≥3		3.85 (1.71–8.63)	0.49 (0.27–0.86)
HH income in relation to PMW			
<PMW	1.00		
≥PMW	2.12 (0.91–4.95)		
Location of household			
Coastal area			0.07 (0.02–0.22)
Others			0.32 (0.19–0.56)
Hills			1.00

AOR: Adjusted odds ratio.

apply LLINs appropriately for preventing malaria [41]. Furthermore, this study shows that there was a discrepancy of MPM knowledge among MES with the lowest in high MES. This might be related with the low level of education for rural population in high MES. Literature indicated that the proportion of population having no education in high MES was higher than those in low-endemic settings [32], [34], [42]. Health promotion activities to improve MPM knowledge for local community in high and moderate MES are essential to boost malaria elimination effort in this region.

This study demonstrated that the proportion of rural adults having knowledge in various methods to prevent malaria was very poor and the discrepancy among MES was significant. The proportion of rural adults having knowledge in LLINs to prevent malaria was only common in high MES, while in low-endemic setting, it was common with keeping house clean to prevent malaria. The high level of knowledge in LLINs for rural community in high-endemic setting might be attributed to long-term exposure with many malaria programs, as the distribution of LLINs in the country was prioritized in high-endemic settings [5]. LLINs are the best prevention measures among other methods [11] and at present, Indonesia government has applied this method for preventing malaria in this nation [29], therefore, the distribution of LLINs should be implemented for all MES. Furthermore, keeping house clean is the cheapest method to prevent malaria as people do not spend money to have this method, it just needs community awareness to keep house cleaning and their surroundings. Improving housing condition reduced the density of mosquito in house [43], while other methods of MPM including wearing long-sleeved clothes when going outdoors at night, IRS, and burning mosquito coil were less knowledgeable by rural adults of ENTP. To boost malaria elimination efforts, integrated various strategies of MPM tailored with local condition were more advantage than single method [26], [27], [28]. Having a good understanding of MPM knowledge leads to a greater willingness to practice MPM [9].

This study further indicates that in all MES, good knowledge of MPM was significantly associated with SES level of participant. The higher the level of SES participants, the higher the level of good knowledge of MPM of participants. This finding was in line with study in Southern Ethiopia [15] and Equatorial Guinea [44] indicating that there was a positive correlation between good level of malaria prevention knowledge and SES groups. This might be due to the fact that people from low SES had limited access to multiple sources of information [45] including poor access on the internet for health information [46] and they had lower sureness in gaining health information [47]. Therefore, local authority should provide health promotion to improve the MPM knowledge of local community, particularly for those with lower SES.

This study further shows that good level of MPM knowledge was significantly associated with education level of participants. This finding was consistent with similar study in other countries such as Malawi [48], Equatorial Guinea [44], and Cameroon [14], indicating that the increasing of malaria prevention knowledge was in line with the improvement of education level of participants. This study discovered that in moderate MES, malaria prevention knowledge of rural adults with secondary or above education level was almost 3 times higher than those have primary or no education level, while, in high MES, rural adults with secondary school or above education level had more than 2 times higher more likely to have good malaria prevention knowledge than those had primary or no education level. The reason for this might be that educated people tend to be exposed with multiple sources of information, permitting them to advance their knowledge on MPM [49]. These results imply that it is imperative to choose different health communication strategies for educating the targeted population about malaria prevention methods tailored to their education background.

The results of this study corroborate with studies in other rural settings to emphasize the power of SES and education in supporting good knowledge of MPM [15], [48]. As a consequence of good understanding of MPM, the behavior of rural adults might change, leading to increasing good practice of malaria prevention methods in their life. This research provides indication for the low level of good knowledge of MPM in three different MES of rural ENTP. Improving knowledge of MPM is critical to reduce the burden of malaria and to progress to malaria elimination. The WHO suggests that each nation should persist effort to prevent malaria while taking approach to prevent the huge impact of COVID-19. The interruption in delivering malaria prevention tools including insecticide-treated nets leads to surge the burden of malaria worldwide [50] and in Indonesia, there was an increasing trend of the total number of malaria patients during the COVID-19 pandemic [2]. Therefore, well-designed and sustainable approach to expand knowledge of MPM of rural communities would enhance malaria elimination development in this province.

This study has been advantaged by high participation rate of participants in different MES permitting writers to capture the estimation of prevalence of knowledge malaria prevention methods accurately in different settings of rural ENTP. Moreover, data were gathered by visiting household allowing authors to notice the environmental condition including the cleanliness and the usage of mosquito nets in home of participants. However, the authors note some limitations of this study including knowledge of MPM based on the self-reported of study participants. It might be diverse if the outcome variables were gained through observation intensively in their daily life. Likewise, the community-based cross-sectional study approach was unable authors to infer causal relationship between knowledge of MPM and independent variables of the study.

Conclusion

The good level of MPM knowledge in different MES of rural ENTP was very low and the disparity among different settings was significant statistically. Higher SES and education level were considerably associated with a good level of MPM knowledge. Therefore, improving MPM knowledge for rural community in moderate and high MES is critical to boost malaria elimination in ENTP. Having high knowledge of MPM would encourage the community to participate in various malaria elimination programs. Targeting the intervention to the low SES and low education level is crucial to boost malaria elimination progress in ENTP Indonesia.

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