Malaria Journal

RESEARCH

Open Access

Assessment of knowledge, attitude, and practices toward malaria in the Lunglei district, Mizoram, North-East India

C Vanlalhriata[1†], Lalpianpuii[1†], Phibahunlang T Wankhar[1], Pooja T Prakash[1], Christiana Amarthaluri[1], Lalfakzuala Pautu[2,3], Vanramliana[2], Pachuau Lalmalsawma[3], Prakash Babu Kodali[1], Karuppusamy Balasubramani[4] and Praveen Balabaskaran Nina[1*]

Abstract

Background The western districts of Mizoram (Lunglei, Mamit, and Lawngtlai) are malaria hotspots. Understanding the knowledge, attitude, and practices of the tribal communities in Mizoram's western districts will aid the development of specific interventions.

Methods An explanatory sequential mixed-method study was conducted from April to November 2023 in the Lunglei district. In a community-based cross-sectional survey of 353 participants, the knowledge, attitude, practices, and care-seeking behaviour toward malaria were assessed using a semi-structured questionnaire. Data was analysed using SPSS version 29 software; univariate variables were presented in percentage, and bivariate and multivariate variables were analysed using the chi-square test and logistic regression, respectively. This was followed by in-depth telephonic interviews of twelve participants, and the data was analysed using NVivo.

Results Out of the 353 respondents, 77.9%, 82.7%, 55.5%, and 63.2% of the participants had good knowledge, attitude, practices, and care-seeking behaviour, respectively. The in-depth qualitative interviews highlighted the villagers' good knowledge of the various aspects of malaria transmission, treatment, and prevention practices (indoor residual spraying and use of insecticide-treated nets).

Conclusion High disease endemicity, awareness programmes and vector control interventions might be contributing to the overall good knowledge, attitude, and practices toward malaria among the villagers. In addition to vector control measures, active parasite surveillance is key to malaria control in this region.

Keywords Mizoram, Malaria, Lunglei district, KAP study

[†]C Vanlalhriata and Lalpianpuii equal contribution.

*Correspondence:
Praveen Balabaskaran Nina
praveen.nina@cukerala.ac.in
Full list of author information is available at the end of the article

Background

Malaria remains a serious public health problem in 85 endemic countries worldwide; compared to 2021, the cases increased by 5 million to ~ 249 million in 2022 [1]. India is the major contributor to malaria cases and deaths in the South-East Asia Region, with about 3.4 million cases and about 5,500 deaths reported in 2022 [1]. In the last two decades, India has made huge strides in reducing malaria mortality and morbidity. Compared to 2015, malaria cases and deaths in India have steeply decreased by 84.90% and 78.39%, respectively, in 2022 [2, 3]. The majority of India's population (~ 95%) reside in malaria-endemic areas, and 80% of malaria is reported from hard-to-access tribal and hilly regions that constitute 20% of the population [4].

Even though malaria cases have steeply declined across India in the last two decades, there are a few endemic regions where the cases have not declined. The North-Eastern (NE) state of Mizoram is one such endemic region where malaria cases and deaths have not declined or plateaued in the last fifteen years; in fact, compared to 2007, the cases and deaths were higher in 2022. Remarkably, the small state of Mizoram, with an estimated population of just 1.25 million, contributed to 6.31% of India's malaria cases in 2022 [3, 5].

Mizoram shares its international borders with Myanmar and Bangladesh to its east and west, respectively. Malaria is highly endemic in the western districts (Mamit, Lunglei, and Lawngtlai) of Mizoram [6]. These three districts share their border with the Rangamati district in the Chittagong Hill Tracts (CHT) of Bangladesh; the CHT is the major contributor to the malaria disease burden in Bangladesh [7]. The international borders between Mizoram's western districts and Bangladesh present a formidable challenge to malaria control in this region.

Studies have shown local beliefs and culture can greatly influence a community's behaviour toward malaria prevention and control [8]. For malaria control strategies to be effective, understanding the locals' knowledge of malaria is critical, especially in Mizoram's western districts, which are populated by different tribes. In addition to Mizos (the dominant ethnic tribe), these western districts also have members of the Chakma and Bru tribes [9, 10]. Understanding the malaria knowledge of the villagers will help formulate effective intervention strategies tailor-made for a particular community/tribe. Even though malaria is endemic in Mizoram's western districts, literature on knowledge, attitude, practices, and perceptions about malaria among the different tribes living in this region is sparse. Given the background, a mixed-method study was carried out to understand the villagers' knowledge levels on malaria to guide malaria control efforts in this region.

Methods

Study site

The study was conducted in the Lunglei district, a western district of Mizoram. Lunglei district lies between 22.8671° N and 92.7655° E, covering an area of 4536 sq. km, of which 88.6% is under forest and tree cover [11]. The population density is 36/sq. km with a sex ratio of 947 females per 1000 males [12]. The majority of the population in Lunglei belong to Schedule Tribe. The average annual rainfall is 2566 mm, and the temperature ranges from 8–24 °C to 18–32 °C in winter and summer, respectively [12]. The houses in these study sites are mostly of semi-pucca "Assam-type"—a construction made of wood, tiles, and metal sheets (rangva). Some of these houses are also built with bamboo and hay. A few of the respondents lived near the bank of the river. The major occupation of these villagers is cultivation; the major agricultural products are rice, cabbage, eggplant, bitter tomato, and maize. In addition, some of them have their own small shops, and a few others work as daily wage labourers.

Study design

An explanatory sequential mixed-method approach was employed to assess the knowledge, attitude, practices, and care-seeking behaviour of the people in the community setting of the Lunglei district [13]. Initially, a cross-sectional quantitative study was conducted during April and May 2023, followed by a qualitative study (in-depth interviews) from September to November 2023.

Data collection

For the quantitative study, 353 respondents from 5 villages (Lunglei Town, Phairuangkai, Tlabung, Tuichawng, and Zawlpui) were selected through convenient sampling—due to multiple hamlets, some were located in hard-to-reach hilly terrains and barriers in communication in the Chakma language. The survey was conducted through face-to-face interviews using a validated semi-structured questionnaire from previous studies, and minor changes were made based on the study setting and population [14, 15]. The questionnaire has four major parts—A) Sociodemographic characteristics of the participants, B) Knowledge of the participants on malaria causes, symptoms, and prevention, C) Attitude of the participants toward malaria, and D) Prevention and care-seeking practices of the participants in case of fever and chills. The majority of the interviews were done during the daytime, and the respondents keenly participated in the survey. Even if they had chores to attend to, they

were willing to spare half an hour of their time for the interview.

For the qualitative study, purposive sampling with maximum variation was used to select the participants from the quantitative study. Twelve telephonic In-Depth Interviews (IDIs) were conducted by the first author (CV) in the Mizo language using a semi-structured in-depth interview guide. Of the 12 respondents, five Mizos (Tlabung-2, Phairuangkai-2, and Zawlpui-1) were randomly selected from the quantitative study. To get the perspective of the Chakma tribe, we interviewed five members of the Chakma community from the villages of Tuichawng (3) and Diblibagh (2) who could understand and speak Mizo fluently. In addition, two Mizos from the Chakma-dominated Tuichawng village were interviewed to understand the community's perspectives on malaria. The interviewer introduced himself and explained the study to the participants and consent was obtained before the start of the interview. Each interview lasted ~ 25–30 min. Interviews were stopped when the data was saturated [16].

Data analysis

All the responses from the questionnaire were manually entered in an MS Excel sheet, and the analysis was carried out in SPSS software (v. 29.0). Descriptive statistics were performed; for continuous variables, mean and standard deviation were calculated, and frequencies were given for categorical variables. The four independent variables used for bivariate and multivariate analysis are as follows: (1) Knowledge score: The knowledge score was calculated using seven variables from the questionnaire related to malaria transmission, symptoms, and prevention. Participants were given a score of 1 for correctly identifying the cause (mosquito bite), time of bite (during nights/dusk to dawn), and main symptoms of malaria (fever, headache, body ache, chills, abdominal pain, nausea, vomiting, and vertigo). They were also assigned a score of 1 if they answered correctly to questions on breeding sites and malaria prevention. (2) Attitude score: Six variables related to risk, prevention, and treatment were used. The responses in Likert scale were scored 3, 2, and 1 for agree, undecided/neutral, and disagree, respectively. All the variables followed the same scoring pattern, except for "malaria can be cured without medical treatment", for which the scoring was reversed. The reliability was tested in the initial pilot phase, where 10% of the sample was tested for Cronbach's Alpha. A score of 0.795 indicated an acceptable internal consistency of the questionnaire to assess the attitude. (3) Prevention: Respondents who own an insecticide-treated bed net (ITN) and always use it and those using Indoor Residual Sprays (IRS) were considered to have good prevention practices for malaria control. (4) Care-seeking practice: those who sought care at a health facility (including public and private facilities) on the same day or the next day after the onset of fever were considered to have good care-seeking practice. For all the dependent variables, the scores for each question were summed up, and the median was taken as a cut-off. Participants with a total score equal to or above the median were categorized as "Good"; those who scored below the median were categorized as "Bad". The chi-square test was carried out for bivariate analysis, and multinomial logistic regression was carried out for multivariate analysis. Variables that were significant at $p \leq 0.25$ in the bivariate analysis were considered for multivariate analysis. With a confidence interval (CI) of 95%, adjusted odds ratios were calculated [14]. An alpha level of below 0.05 was considered statistically significant. The study area and spatial distribution of respondents were mapped using a dot method in ArcGIS software (v. 10.4).

For the qualitative study, audio recordings of the IDIs were transcribed verbatim in Mizo and translated into English. Inductive thematic analyses were conducted using Braun and Clarke's method [17]. The transcripts were thoroughly read and coded using NVivo version 11.

Results

Quantitative analysis

Socio-demographic characteristics

Three hundred and fifty-three respondents—males [147 (41.6%)] and females [206 (58.4%)], aged 13–89 years [Mean (SD): 35.8 (13.3)] from 5 villages of Lunglei district participated in the study (Table 1, Fig. 1). The majority of them were Christians [320 (90.7%)] and belonged to the Mizo tribe [259 (73.4%)]. Most of them [336 (95.2%)] knew how to read, and only 20 (5.7%) participants had no formal education. More than half of the participants [225 (66%)] had secondary-level education or above (diploma/higher education). More than a quarter of the participants [96 (27.2%)] were running small businesses or self-employed; 73 (20.7%) of them were students (Table 1).

Knowledge of study participants on malaria transmission, clinical features, and prevention

Of the 353 participants interviewed, 352 (99.7%) had heard of malaria before. More than half of the respondents who were affected by malaria were also able to recall the type of infection [*Plasmodium falciparum* [152 (43.1%)], *Plasmodium vivax* [37 (10.8%)], mixed-[11 (3.1%)]. Mosquito bite as the mode of transmission was answered by 331 (~ 94%) participants, while 3 (~ 1%) and 7 (~ 2%) respondents answered transmission was due to unclean surroundings and drinking water, respectively. Many of the participants were also aware of the time of mosquito bite and its breeding

Table 1 Sociodemographic characteristics of study participants in the Lunglei district of Mizoram

Variables	Category	n (%)
Age	Below 20 years	18 (5.1)
	20–39 years	226 (64.0)
	40–59 years	83 (23.5)
	60 years and above	26 (7.4)
Sex	Male	147 (41.6)
	Female	206 (58.4)
Village	Lunglei town	116 (32.9)
	Phairuangkai	49 (13.9)
	Tlabung	54 (15.3)
	Tuichawng	40 (11.3)
	Zawlpui	94 (26.6)
Religion	Christian	320 (90.7)
	Others	33 (9.3)
Tribe	Mizo	259 (73.4)
	Chakma	52 (14.7)
	Bru	24 (6.8)
	Others	18 (5.1)
Ability to read	Able to read	336 (95.2)
	Unable to read	17 (4.8)
Level of education	No formal education	20 (5.7)
	Primary	98 (27.8)
	Secondary	109 (30.9)
	Diploma	13 (3.7)
	Higher studies	113 (32.0)
Occupation	Agricultural workers	57(16.1)
	Daily wage workers	47 (13.3)
	Small business and self-employed	96 (27.2)
	Government jobs	30 (8.5)
	Students	73(20.7)
	Non-working	34(9.6)
	Other service sector works (Private jobs, teachers, HCW)	16 (4.5)

site; 253 (71.7%) said malaria mosquito bites during the night, and 213 (60.3%), 67 (19.0%), and 40 (11.3%), respectively, answered draining stagnant water, cleaning surroundings, or practicing both as means of preventing breeding sites. Many [243 (68.8%)] correctly said infants, children, and pregnant women were more susceptible to malaria. Of the 353 respondents, 308 (87.3%) were familiar with the malaria symptoms. Nearly one-third [113 (32%)] of the participants said insecticide-treated bed nets (ITNs) were the best means to prevent malaria, followed by environmental management [84 (23.8%)]. Overall, 77.9% (n = 275) of the respondents had good knowledge about malaria (Table 2).

Attitude of study participants toward malaria

Almost all of the respondents [346 (98%)] believed anyone could get malaria, it is a deadly disease, and it could be prevented. Similarly, 97.7% (n = 345) and 94.6% (n = 334) were aware of the necessity to be tested for malaria before treatment and the importance of completing the treatment regimen, respectively. Only < 2% (n = 5) said malaria could be cured without treatment. Overall, 82.7% (n = 292) of the study participants showed a positive attitude toward malaria (Table 2).

Practices of study participants to prevent malaria

More than half of the study participants [217 (61.5%)] or their households reported ITN usage. Over 40% (n = 150) reported daily ITN usage, whereas 20.4% (n = 72) used it seasonally or infrequently. Furthermore, the public health practice of indoor residual spraying as a preventive measure was seen in 78.8% (n = 278) of the households. Participants also reported the usage of mosquito coils [221 (62.6%)], electric liquid vaporizers [41 (11.6%)], and topical creams [18 (5.1%)] as alternate protective measures from mosquito bites. Overall, 55.5% (n = 196) of the respondents followed good preventive practices (Table 2).

Care-seeking behaviour of study participants

Of the 353 participants, 328 (92.9%) said medical intervention is required for malaria treatment. More than 60% of the respondents (n = 231) would seek medical care within 24–48 h after the onset of symptoms, while 26.4% (n = 93) would do after 48 h. Healthcare facilities were the care-seeking points for most of the respondents [333 (94.3%)]. The condition of the patient [284 (80.5%)], followed by the cost [31 (8.8%)], were the deciding factors for care-seeking. Overall, 63.2% (n = 223) of participants reported good care-seeking behaviour (Table 2).

The association of sociodemographic variables with binary levels of knowledge, attitude, practices, and care-seeking behaviour of malaria is given in Supplementary Table 1. The variables significant at alpha level ≤ 0.25 were considered for multivariate analysis and are presented in Table 3.

Factors associated with knowledge, attitude, practices and care-seeking behaviour of malaria

Among the study variables, age and place of residence (village) were significantly associated with the knowledge level of participants ($p < 0.05$). Compared with older adults (60 years and above), the odds of good knowledge were lower among adolescents (under 20 years of age) [OR: 0.071, $p < 0.05$]. The likelihood of good knowledge was high among the residents of

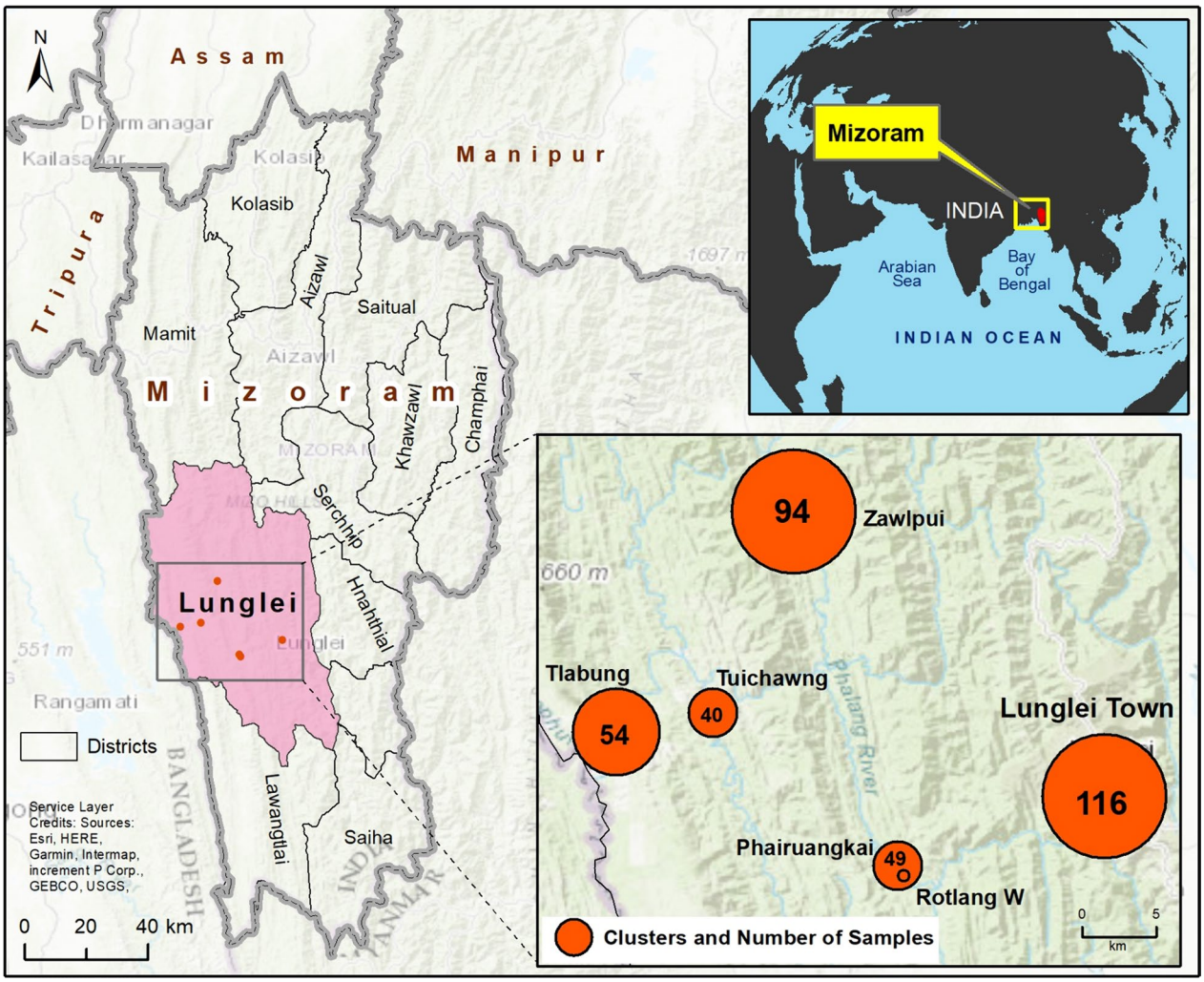

Fig. 1 Map of the Lunglei district showing the clusters and number of samples collected for the study. The district map of Lunglei is shown in pink. The study locations (villages) from which the participants were enrolled are represented as orange dots and circles. The size of the circle in the inset map indicates the proportion of the sample from that village. The background base map represents topography

Lunglei Town [OR: 2.646; marginally significant], while the residents of Phairuangkai were ~ 69% less likely to have good knowledge [OR: 0.309, $p < 0.05$] (Table 3).

The odds of positive attitude were five times higher among Christians [OR: 5.504, $p < 0.05$]. The residents of Tlabung had ~ 73% less likelihood to have a positive attitude toward malaria [OR: 0.271, $p < 0.05$] (Table 3). Females had ~ 2 times higher odds of observing good prevention practices when compared with males [OR: 1.871, $p < 0.05$] (Table 3).

The care-seeking behaviour of young adults (20–39 years) and middle-aged individuals (40–59 years) was found to be poor when compared with the elderly (60 years and above); the chances of young adults seeking care is ~ 84% less likely [OR: 0.163; $p < 0.05$], while it is ~ 80% less among the middle-aged [OR: 0.197; $p < 0.05$] (Table 3). The odds of good care-seeking are high among private officers, private school teachers, and healthcare workers [OR: 5.557, $p < 0.05$], followed by those engaged in agricultural activities [OR: 4.102; $p < 0.05$] (Table 3).

Qualitative analysis

Twelve in-depth interviews were conducted with respondents residing in Tlabung, Zawlpui, Tuichawng, Diblibagh and, Phairuangkai villages to understand their perceptions and practices toward malaria. Analysis of the transcripts in NVivo revealed a strong overall KAP on malaria prevention and control, similar to the quantitative analysis (Supplementary File 1).

Table 2 Key questions on knowledge, attitude, practices and care seeking behaviour toward malaria

Knowledge	n	%
Have you heard of malaria?		
No	1	0.3
Yes	352	99.7
Did you or any member of your family had malaria?		
P. falciparum	152	43.1
P. vivax	37	10.5
P. falciparum + *P. vivax*	11	3.1
No	153	43.3
What causes malaria?		
Bite of mosquito	331	93.77
Dirty drinking water	7	1.98
Unclean surroundings	3	0.85
Don't know	12	3.40
Do you know when malaria causing mosquito bite?		
During night	253	71.7
During the day	9	2.5
Anytime	63	17.8
Don't know	28	7.9
Do you know ways to prevent mosquito breeding?		
Drainage of stagnant water	213	60.3
Cleaning household surroundings	67	19.0
Both	40	11.3
Don't know	33	9.3
Do you know the symptoms of malaria?		
Major symptoms	308	87.25
Others	3	0.85
Don't know	42	11.90
Who do you think are more susceptible to malaria?		
Infants, children (aged 1–18) and pregnant women	243	68.83
Old aged	7	1.98
Adults	67	18.9
Don't know/No answer	36	10.20
How can malaria be prevented?		
ITN*	113	32.0
IRS*	5	1.4
EM*	84	23.8
ITN + EM	2	.6
IRS + EM	74	21.0
ITN + IRS	14	4.0
All the above	29	8.2
Don't know	32	9.1
Knowledge Score		
Good	275	77.9
Bad	78	22.1
Attitude		
Everybody can have malaria		
Agree	346	98.0
Neutral	7	2.0
Disagree	0	0

Table 2 (continued)

Knowledge	n	%
Malaria is deadly		
Agree	337	95.5
Neutral	14	4.0
Disagree	2	0.6
Malaria can be cured without treatment		
Agree	5	1.4
Neutral	35	9.9
Disagree	313	88.7
Malaria can be prevented		
Agree	339	96.0
Neutral	6	1.7
Disagree	8	2.3
It is important to be tested before malaria treatment		
Agree	345	97.7
Neutral	6	1.7
Disagree	2	0.6
It is important to finish taking malaria treatment		
Agree	334	94.6
Neutral	16	4.5
Disagree	3	0.9
Attitude Score		
Positive attitude	292	82.7
Negative attitude	61	17.3
Prevention practices		
Do you use insecticide treated bed nets?		
No	136	38.5
Yes	217	61.5
Insecticide-treated bed nets are used by?		
Entire family	178	50.4
Only children	29	8.2
Only adults	10	2.8
No Answer	136	38.6
How often does your family use insecticide-treated bed nets?		
Always	150	42.5
During season only	61	17.3
Infrequently	11	3.1
No Answer	136	38.5
How often do you re-treat the nets with insecticides?		
Once in 6 months	16	4.5
Yearly	29	8.2
Once in 2 or 3 years	18	5.2
Never	154	43.6
No Answer	136	38.5
Has your house been sprayed with insecticide repellent spray within the last one year?		
Yes	278	78.8
No	64	18.1
Don't know	11	3.1
What are other preventive measures do you use to protect yourself from mosquito bite?		
Burn materials and coils	221	62.6

Table 2 (continued)

Knowledge	n	%
Topical creams	18	5.1
Closing doors, windows and Fan	5	1.5
Electric liquid vaporizer	41	11.6
Any of the above measures in combination	34	9.6
Do not use	34	9.6
How often do you clean your surroundings?		
Daily	176	49.9
Weekly	130	36.8
Monthly	35	9.9
Rarely	12	3.4
Prevention score		
Good	196	55.5
Bad	159	44.5
Care seeking		
According to you, what is the best treatment available for malaria?		
Medical intervention	328	92.9
Self-treatment	18	5.1
Medical intervention + Self-treatment	4	1.2
Traditional healer	2	0.6
Don't know	1	0.3
When do you seek treatment from hospital for fever, chills, and head and body ache?		
I do not go to hospital for fevers	29	8.2
After 48 h	93	26.4
Within 24–48 h	231	65.4
If showed signs and symptoms of malaria, where would you seek treatment first?		
Health facilities	333	94.3
Others	20	5.7
What is the deciding factor for seeking care?		
Availability of health provider	16	4.5
Condition of the patient	284	80.5
Cost	31	8.8
Time availability	10	2.8
Condition of the patient and Cost	11	3.1
Don't know	1	0.3
Care seeking Score		
Good	223	63.2
Bad	130	36.8

* ITN: Insecticide-treated bed Nets; IRS: Indoor Residual Spray; EM: Environmental Management

Knowledge about malaria

Most of the respondents perceived stagnant water as the source of mosquito breeding.

> *"There is a stream at the back side of our house; when we go there, the mosquitoes surround us because there is stagnant water, which is a suitable place for mosquito breeding." IDI 10*

Headache, followed by fever and shivering, were the major malaria symptoms reported by the respondents, and most of them considered malaria as a dangerous disease.

> *"Then, about 6–12 days after biting, the symptoms start appearing. If we are infected with malaria, we have fever and headache. If we do not take treatment immediately, it may cause other diseases as well, like jaundice, liver enlargement, etc. So, if we have a fever, we must go for testing blood immediately to rule out whether we were infected with malaria or not. If infected, it is safe to start treatment immediately." IDI 02*

Table 3 Factors associated with knowledge, attitude, prevention and care- seeking practices of malaria

Variables	Knowledge		Attitude		Prevention		Care-seeking	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Age								
Below 20 years	0.071 (0.011–0.465)	**0.006***					0.199 (0.028–1.403)	0.105
20–39 years	0.323 (0.080–1.309)	0.113					0.163 (0.041–0.654)	**0.011***
40–59 years	0.530 (0.142–1.978)	0.345					0.197 (0.049–0.791)	**0.022***
60 years and above	**Ref**						**Ref**	
Sex								
Female					1.871 (1.083–3.233)	**0.025***		
Male					**Ref**			
Village								
Lunglei town	2.646 (0.969–7.227)	0.058	1.643 (0.558–4.837)	0.367				
Phairuangkai	0.309 (0.133–0.719)	**0.006***	1.510 (0.481–4.736)	0.480				
Tlabung	0.468 (0.196–1.121)	0.088	0.271 (0.110–0.667)	**0.005***				
Tuichawng	1.394 (0.435–4.466)	0.576	1.060 (0.225–4.997)	0.942				
Zawlpui	**Ref**		**Ref**					
Religion								
Christian			5.504 (1.062–28.51)	**0.042***				
Others			**Ref**					
Occupation								
Agricultural workers							4.102 (1.280- 13.141)	**0.017***
Daily wage workers							0.907 (0.326- 2.522)	0.852
Small business/self employed							1.636 (0.670- 3.998)	0.280
Government jobs							1.177 (0.382- 3.629)	0.776
Other service sector works †							5.557 (1.026- 30.085)	**0.047***
Students							0.942 (0.362- 2.448)	0.902
Non-working							**Ref**	

* significant ($p < 0.05$)

† Private officers, Teachers, Health care workers

One of the respondents was aware of malaria relapse.

"I think we usually get infected in the months of June, July and August. In my case, if the parasite does not die out from our body, it will reappear in its subsequent year at the same time." IDI 04

Attitude toward malaria

Most of the respondents perceived malaria as a fatal disease if not treated on time and would seek immediate treatment from the healthcare facility as they had experienced or witnessed the complications of malaria.

"We must approach them as soon as possible, because one of my siblings had already passed away due to malaria Pf and the malaria had reached up to his brain." IDI 04
"Yes, because if malaria cause high fever and enter to brain, there is a chance to turn fatal." IDI 07
"I regard it as a very fatal disease. If they do not seek treatment immediately, for them it is very dangerous. But, for us who have frequently got infected, it may have effect only like a flu, but if neglected it is still fatal, so I think neglecting or paying importance can really make a difference." IDI 10
"I regard it as a very dangerous disease. If treated early, it can be cured easily, but if treated late, it could cause death easily." IDI 11

Malaria prevention practices

The respondents were aware that the IRS and the use of insecticide-treated bed nets are key strategies in the prevention and control of malaria. IRS was sprayed inside most of the houses, usually twice a year. Similarly, the respondents also had a good opinion on the effectiveness of ITNs and used them regularly. However, complaints about ITN causing skin irritation when touched

were reported. Burning coils, agarbatti, and rice bags are the other main protective strategies employed by the villagers.

"We use mosquito net for the whole year, even during rainy or dry season." IDI 03
"When we come in touch with the net, it used to be itchy, and we have a rash. Yes, but now we do not experience anything. We faced the problem at the beginning when we newly took it out from the packet. We had washed once without soap, and we let it dry without keeping under the sun." IDI 04
"I think it's good, but there used to be a skin problem when touched." IDI 09

Health seeking behaviour and treatment adherence

Good health-seeking behaviour was observed among the respondents once they suspected fever and other malaria symptoms. Accessibility for malaria diagnosis and treatment was easier as they could either go to a health facility or community health workers when they suspected malaria. This strengthens the result of the quantitative survey, where 65.4% of respondents sought medical care within 1–2 days.

"We approach doctor, nurse, health worker and ASHA, and from them we got the medicine." IDI 06
"These days our sub-centre is very reliable, even the ASHA's are well supplied with the test kit." IDI 09
"That is the time when I used to have a stock of test kit, soon after the night I was having fever, on the next morning I said "last night I was having a high fever, let me test myself as I may have malaria," so after the test, I came to know that I was having malaria. Then, I started taking the drug which we have it for malaria Pv, that is primaquine and quinine, so I start a treatment for myself." IDI 03

Respondents in the in-depth interviews had previously been infected with malaria or had family members who had suffered from it. The respondents were aware of the drug names and had completed the treatment regimen. The respondents were even aware of the species of the *Plasmodium* that they or their children were infected with. One of the respondents, whose son was infected with malaria, mentioned the drug name and regimen for both kinds of malaria infections.

"For Pf, he took primaquine for 1 day and artemether for 3 days and for Pv, he took primaquine for 3 days." IDI 07
"Also, what is that small tablet? Primaquine, I took that as well." IDI 04

Opinion toward local health and wellness centres

The residents of these communities faced intermittent shortages of rapid-diagnostic test kits, as a result of which they had to approach the drugstore for testing from out of their pocket.

"We are having shortage of test kit, and a lot of people get a test from private facility and from hospital, so cases are high for this year. If there is no test kit, we can buy it from private pharmacy, the pharmacy store also used to sell test kit, so we advise them to get a test from them and in case if they got infected with malaria, we ask them to come back with their test kit and provide malaria drug if available. If no test kit is available at all, we suggest them to approach Lungsen PHC or some other hospital." IDI 03

All the respondents strongly appreciated the work rendered by the workers at the health and wellness centres in their locality.

"Our health workers are working so hard that whenever we approach them, they try their best to help us out, sometimes we even approach and contact them at night in case of stomach-ache. They provide us with the best care." IDI 12
"They are working so hard, we feel pity for them as they had taken care of us during day and night, we are really grateful." IDI 05

Discussion

For this mixed method study, the Lunglei town, Tlabung, Phairuangkai, Tuichawng, and Zawlpui villages in the Lunglei district were chosen based on the malaria endemicity data obtained from the State Vector-Borne Disease Control Programme. These villages are located in the western part of the Lunglei district and share international boundaries with Bangladesh. Mizoram's western districts-Lunglei, Mamit, and Lawngtlai, are hyper-endemic for malaria, and they share a similar ecology with Bangladesh's Chittagong Hill Tracts (CHT) that borders these districts [6]. Understanding the knowledge, attitude, practices, and perceptions of malaria in these malaria-endemic villages is critical to devise specific malaria intervention strategies.

In India, depending on the site, malaria knowledge levels vary from good to poor and are influenced by various socioeconomic and demographic factors [14, 18–20]. In this study, the respondents had a very good knowledge of malaria and its prevention and control measures. Remarkably, more than half of the respondents (56.6%) had been infected with malaria before. In both

the quantitative and qualitative surveys, the respondents were able to identify the malaria infection at the species level—*P. falciparum* or *P. vivax.* Furthermore, a few of them were even aware of the drug used for the treatment of *P. falciparum* and *P. vivax*. On the contrary, malaria knowledge levels were less within the Chakma tribe, whose ancestry can be traced to Bangladesh [21]. In these settings, all malaria Information, Education, and Communication (IEC) materials are in Mizo and English, which might be hard for the Chakma tribe to understand and follow. A recent study from Bangladesh has reported good malaria knowledge in the Chakma tribe [22]; the lack of a language barrier might be a key contributing factor to the Chakma tribe's high awareness level in Bangladesh. Adapting malaria intervention strategies tailor-made for the Chakma community might help increase their awareness of malaria, especially on its prevention and control.

As seen with knowledge, the care-seeking behaviour of the elderly was relatively higher than the young and middle-aged individuals in the study. This is in contrast to the other studies where care-seeking was poor among the elderly, mainly due to accessibility and cost of treatment [23]. The high malaria morbidity in these hyper-endemic settings, and their past experience could be important drivers of the higher care-seeking behaviour in the older respondents.

The study findings showed that a majority of the respondents went to a health facility if their fever did not subside within 24–48 h and would complete the drug regimen; this indicates their high awareness of malaria complications if not treated early. The high treatment-seeking behaviour could be attributed to the community's improved access to health services, especially through the ASHA workers; this finding is consistent with other studies in malaria-endemic regions in Africa [24, 25]. Another reason could be the various interventions and awareness programs of the state vector-borne disease control programme, coupled with radio and television broadcasts. Even though the knowledge levels were high among the majority of the respondents, a few had misconceptions about malaria [26]. A few reported malaria is caused by unclean air or drinking dirty water and/ or is not fatal. Furthermore, some are still seeking treatment from traditional healers and mostly approach the health centre at the last stage of their suffering. Previous studies in Assam, Orissa, and Nepal have also reported similar findings [27–31]. The treatment-seeking behaviour in different regions could be influenced by deep rooted culture and customs of the community [32, 33], illness severity, economic status, accessibility to local health centres/ hospitals, opinions of patients and other household members, and perceived efficacy of the treatment [34, 35]. Malaria misconceptions lead to lack of implementation of health interventions, delayed diagnosis, and treatment. Educating and removing misconceptions about malaria in endemic pockets is critical to India's target of malaria elimination by 2030.

In the study site, every year, the IRS was carried out twice. Such consistent IRS use has not been reported in studies reported from other parts of India [18, 36]. Interestingly, at the time of the IRS, a few respondents obtained a few grams of the pesticide from the health workers for later reconstitution and use. The health authorities also provide ITNs to these communities. Here, the respondents were aware of the importance of ITNs in malaria prevention; the usage of ITNs is quite high (> 60%), and the nets were used throughout the year. The majority of the respondents were very satisfied with the services rendered by the health centre. The sense of community and togetherness is very high across Mizoram [37]. The village council and various NGOs actively participate in the health and welfare of the Mizo community [38]. Even though, Mizoram has limited resources, they have optimized the available resources for efficient health care of the community. During the current study, the strong bond among the various stakeholders in the community was witnessed firsthand; the villagers were very receptive to the messages and actively participated in the health camps organised by the health centres.

In the in-depth interviews, a shortage of rapid diagnostic test (RDT) kits and drugs was a major complaint from villagers and community health workers. As microscopy is possible only at the Primary health centre (PHC)/ Sub-Divisional hospital, the availability of RDT kits for malaria diagnosis is critical. The patients with severe malaria are referred to the Lunglei district hospital; the poor roads and inadequate transportation facilities complicate malaria treatment [39]. Despite the excellent efforts of the health authorities, malaria cases continue to increase in Mizoram. Compared to 2018, the malaria cases and deaths in 2022 have increased steeply by 138.1% and 233%, respectively [5]. The malaria control in this region is mainly focused on vectors—IRS, ITNs, and IEC materials. Despite the high awareness of the need to use ITNs, it might not be feasible for all the respondents to use them daily due to frequent power outages. Also, several of these villagers depend on forests for their livelihood, which exposes them to continuous mosquito bites. Furthermore, the "Assam-type" houses they reside in are not mosquito-proof. Given the situation where they are continuously exposed to mosquitoes at home and at work, strategies focusing on parasite control, in addition to vectors, have to be implemented in these settings.

Limitations

The population in the villages of Tlabung, Phairuangkai, Tuichawng, and Zawlpui comprises members from the Chakma, Bru, and Mizo communities. The Chakma community residing in these western districts of Mizoram are natives of the Chittagong hill tracts of Bangladesh and are not fluent in the Mizo language [40]. For the quantitative part of the study, a pilot survey was carried out with a few individuals from the Chakma community. The study found that their replies were not accurate as they had a hard time understanding the questions asked in the Mizo language. Also, the language limitation meant they could not communicate the responses, even if they understood the question. Therefore, the interviews were conducted only with the villagers who spoke Mizo. The members of the Chakma community who could not speak in Mizo were excluded, and this is a major limitation of the study.

Conclusions

Despite the good knowledge, awareness, practices and care-seeking behaviour of the villagers, malaria continues to be a major public health problem in Mizoram**.** Even though the health facilities are performing well in awareness camps, distribution of ITNs, and IRS, they fall short in RDTs and antimalarials due to the high disease burden. As vector control is hard in these forested regions, active parasite surveillance should be a necessary control measure.

Abbreviations

CHT	Chittagong Hill Tracts
IDI	In-depth interviews
IRS	Indoor residual sprays
ITN	Insecticide-treated bed net
IEC	Information, education and communication
RDT	Rapid diagnostic test
PHC	Primary health centre
NE	North-East

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12936-024-05058-y.

Additional file 1. KAP Codebook.

Additional file 2: Table 1. Association of sociodemographic variables with binary levels of knowledge, attitude, prevention and care-seeking practices of malaria.

Acknowledgements

We greatly thank the healthcare staff at Lunglei district for facilitating the data collection.

Author contributions

PBN conceptualized, designed, and wrote the first draft of the manuscript. First authors, CV and L, equally contributed to the data collection. LP, V, PL and KB contributed to the literature search, review and editing of the manuscript. PTW, PTP, CA and PBK analysed the data and KB made the figure. All authors have read and agreed to the final version of the manuscript.

Funding

No funding was received for this study.

Availability of data and materials

The datasets used for the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The ethical approval was obtained from the Institutional Human Ethics Committee of the Central University of Kerala. Informed written consent was taken from each respondent before inclusion as a study participant. Oral consent was taken for telephonic interviews.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Public Health and Community Medicine, Central University of Kerala, Kasaragod, Kerala, India. [2]Department of Life Sciences, Pachhunga University College, Mizoram University, Mizoram, India. [3]Integrated Disease Surveillance Programme, Health & Family Welfare Department, Mizoram, India. [4]Department of Geography, School of Earth Sciences, Central University of Tamil Nadu, Thiruvarur, Tamil Nadu, India.

Received: 22 January 2024 Accepted: 27 July 2024
Published online: 07 August 2024

References

1. WHO. World malaria report. Geneva: World Health Organization; 2023.
2. Balasubramani K, Bharti PK, Amarthaluri C, Chellappan S, Behera SK, Mohanty AK, Sarma DK, Dash AP, Balabaskaran NP. Spatiotemporal epidemiology of malaria in India from 2007 to 2022. Am J Trop Med Hyg. 2024;111(1):26–34.
3. National Center for Vector Borne Diseases Control (NCVBDC), Ministry of Health and Family Welfare, Government of India. Malaria situation October 2019. https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/Malaria-Situation-Oct19.pdf. Accessed 18 Jan 2024.
4. National Vector Borne Disease Control Program. http://www.nvbdcp.gov.in/. Accessed 18 Jan 2024.
5. National Health Mission Mizoram. National Vector Borne Disease Control Programme. https://nhmmizoram.org/page/15. Accessed 18 Jan 2024.
6. Lalmalsawma P, Balasubramani K, James MM, Pautu L, Prasad KA, Sarma DK, et al. Malaria hotspots and climate change trends in the hyper-endemic malaria settings of Mizoram along the India-Bangladesh borders. Sci Rep. 2023;13:4538.
7. PLOS Speaking of Medicine and Health. Is Bangladesh entering the era of malaria elimination? PLOS Blogs. 2022. https://speakingofmedicine.plos.org/2022/04/25/is-bangladesh-entering-the-era-of-malaria-elimination/. Accessed 18 Jan 2024.
8. Bloland PB, Williams HA; National Research Council (US) Committee on Population; Program on Forced Migration and Health at the Mailman School of Public Health, Columbia University. Community Involvement in Malaria Control and Prevention. In: Malaria Control during Mass Population Movements and Natural Disasters. Washington (DC): National Academies Press (US); 2002. https://www.ncbi.nlm.nih.gov/books/NBK221155/. Accessed 18 Jan 2024.
9. Mamit District. History. Mamit District Website. https://mamit.nic.in/history/. Accessed 18 Jan 2024.
10. Mizoram Land Revenue & Settlement Department. Historical Evolution of Mizoram. https://landrevenue.mizoram.gov.in/uploads/files/historical-evolution-of-mizoram.pdf. Accessed 18 Jan 2024.

11. Forest Department, Mizoram. Vulnerability Assessment Report: Lunglei, IORA-MFD. https://forest.mizoram.gov.in/uploads/attachments/2022/02/ff44817501da591a86eccafb1ce025a6/vulnerability-assessmentreport-lunglei-iora-mfd.pdf. Accessed 18 Jan 2024.
12. Kendriya Vidyalaya Sangathan Lunglei. Lunglei District Profile. https://kvklunglei.mizoram.gov.in/page/lunglei-districtprofile. Accessed 18 Jan 2024.
13. Creswell JW, Clark VLP. Designing and conducting mixed methods research. Thousand Oaks: SAGE Publications; 2017.
14. Tairou F, Nawaz S, Tahita MC, Herrera S, Faye B, Tine RCK. Malaria prevention knowledge, attitudes, and practices (KAP) among adolescents living in an area of persistent transmission in Senegal: results from a cross-sectional study. PLoS ONE. 2022;17:e0274656.
15. Ahmed SM, Haque R, Haque U, Hossain A. Knowledge on the transmission, prevention and treatment of malaria among two endemic populations of Bangladesh and their health-seeking behaviour. Malar J. 2009;8:173.
16. Saunders B, Sim J, Kingstone T, Baker S, Waterfield J, Bartlam B, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. Qual Quant. 2018;52:1893–907.
17. Clarke V, Braun V. Thematic analysis. In: Teo T, editor. Encyclopedia of critical psychology. New York: Springer; 2014. p. 1947–52.
18. Rajvanshi H, Saha KB, Sharma RK, Bharti PK, Nisar S, Jayswar H, et al. Assessing community knowledge, attitude and practices to strengthen communication strategy for Malaria Elimination Demonstration Project in Mandla. Malar J. 2021;20:354.
19. Abdelwahab SI, Elhassan IM, Albasheer O, Taha MME, Ali NA, Al-Jabiri YS, et al. Knowledge, attitudes, and practices (KAP) during the malaria elimination phase: a household-based cross-sectional survey. Medicine (Baltimore). 2023;102:e33793.
20. Mohan I, Kodali NK, Chellappan S, Karuppusamy B, Behera SK, Natarajan G, et al. Socio-economic and household determinants of malaria in adults aged 45 and above: analysis of longitudinal ageing survey in India, 2017–2018. Malar J. 2021;20:306.
21. Das SRG& DM. Mapping of Chakma Tribes in Tripura. Tripura: Tribal Research and Cultural Institute; 2020.
22. Saha A, Sarker M, Kabir M, Lu G, Müller O. Knowledge, attitudes, and practices regarding malaria control among the slash and burn cultivators in Rangamati Hill tracts of Bangladesh. Malar J. 2019;18:216.
23. Barua K, Borah M, Deka C, Kakati R. Morbidity pattern and health-seeking behavior of elderly in urban slums: a cross-sectional study in Assam, India. J Family Med Prim Care. 2017;6:345–50.
24. Hasabo EA, Khalid RI, Mustafa GE, Taha RE, Abdalla RS, Mohammed RA, et al. Treatment-seeking behaviour, awareness and preventive practice toward malaria in Abu Ushar, Gezira state, Sudan: a household survey experience from a rural area. Malar J. 2022;21:182.
25. Hlongwana KW, Mabaso ML, Kunene S, Govender D, Maharaj R. Community knowledge, attitudes and practices (KAP) on malaria in Swaziland: a country earmarked for malaria elimination. Malar J. 2009;8:29.
26. Zomuanpuii R, Hmar CL, Lallawmzuala K, Hlimpuia L, Balabaskaran Nina P, Senthil KN. Epidemiology of malaria and chloroquine resistance in Mizoram, northeastern India, a malaria-endemic region bordering Myanmar. Malar J. 2020;19:95.
27. Borah PK, Dutta P, Phukan AC, Mahanta J. Health seeking behavior among the fever cases during an outbreak of malaria in Assam. J Hum Ecol. 2004;15:195–7.
28. Chaturvedi HK, Mahanta J, Pandey A. Treatment-seeking for febrile illness in north-east India: an epidemiological study in the malaria endemic zone. Malar J. 2009;8:301.
29. Borah DJ, Sarma PS. Treatment seeking behavior of people with malaria and households' expenditure incurred to it in a block in endemic area in Assam, North East India. BMC Infect Dis. 2012;12:P41.
30. Joshi AB, Banjara MR. Malaria related knowledge, practices and behaviour of people in Nepal. J Vector Borne Dis. 2008;45:45–50.
31. Vijayakumar KN, Gunasekaran K, Sahu SS, Jambulingam P. Knowledge, attitude and practice on malaria: a study in a tribal belt of Orissa state, India with reference to use of long-lasting treated mosquito nets. Acta Trop. 2009;112:137–42.
32. Ahmed SM, Adams AM, Chowdhury M, Bhuiya A. Gender, socioeconomic development and health-seeking behaviour in Bangladesh. Soc Sci Med. 2000;51:361–71.
33. Stevenson FA, Britten N, Barry CA, Bradley CP, Barber N. Self-treatment and its discussion in medical consultations: how is medical pluralism managed in practice? Soc Sci Med. 2003;57:513–27.
34. Adhikari B, Phommasone K, Pongvongsa T, Koummarasy P, Soundala X, Henriques G, et al. Treatment-seeking behaviour for febrile illnesses and its implications for malaria control and elimination in Savannakhet Province, Lao PDR (Laos): a mixed method study. BMC Health Serv Res. 2019;19:252.
35. Sydara K, Gneunphonsavath S, Wahlström R, Freudenthal S, Houamboun K, Tomson G, et al. Use of traditional medicine in Lao PDR. Complementary Ther Med. 2005;13:199–205.
36. Dhawan G, Joseph N, Pekow PS, Rogers CA, Poudel KC, Bulzacchelli MT. Malaria-related knowledge and prevention practices in four neighbourhoods in and around Mumbai, India: a cross-sectional study. Malar J. 2014;13:303.
37. Mizoram Government. People of Mizoram. https://mizoram.nic.in/about/people.htm. Accessed 18 Jan 2024.
38. Raj R. Mizoram - NGOs India: NGO Resources, NGO Registration and NGO Funding. 2019. https://ngosindia.com/mizoram/. Accessed 18 Jan 2024.
39. Sarma DK, Mohapatra PK, Bhattacharyya DR, Chellappan S, Karuppusamy B, Barman K, et al. Malaria in North-East India: importance and implications in the era of elimination. Microorganisms. 2019;7:673.
40. Chakma Autonomous District Council. The Chakma People. https://www.cadc.gov.in/the-chakma-people. Accessed 18 Jan 2024.

Publisher's Note