THAILAND MMP SURVEY 2017

Evaluation of Utilization of Malaria Preventive Measures and Access to Malaria Case Management among Non-Thai Mobile Migrant Population in Malaria Transmission Areas in Thailand

malaria consortium
disease control, better health

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Cover Photo Credit: Mr. Arpan Kama
Photo taken on a boat in Ban Nang Sata, Yala province in Southern Thailand on a rainy day, while transporting tribal migrants for an interview.

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Glossary of terms

Term/Acronym	Operational Definition
Access	The percentage of MMP in the risk areas with fever in the last 3 months utilizing parasite-based diagnosis and treatment
ACT	Artemisinin-based Combination Therapy
Active foci area	A defined and circumscribed area where local acquired case(s) have been detected within the current calendar year
BVBD	Bureau of Vector Borne Disease
Coverage of ITN	The percentage of non-Thai MMP with possession of an insecticide treated net
CSO	Civil Society Organization
Forest goer	Someone who has spent time between 6 PM to 6 AM in the forest/ plantation/ garden/ farm at least once in the previous 6 months
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Nets defined as LLIN or LLIHN < 3 years old or a conventional net dipped in insecticide in the last 12 months.
LLIHN	Long-Lasting Insecticidal Hammock Nets
LLIN	Long-Lasting Insecticidal Nets
M1	Migrants who are in Thailand for more than six months.
M2	Migrants who stay in Thailand for less than six months are mobile migrant
Malaria Case Management	Diagnosis of Malaria using tools such as rapid diagnostic test (RDT) and blood microscopy (slide); and antimalarial drug therapy according to National guidelines of Thailand Ministry of Public Health.
Malaria Preventive Measures	ITN and other preventive measures like Indoor Residual Spray and personal protection (repellent, spray, covering clothes etc.)
Malaria Transmission Area	Malarious area in borders of Thailand that contains the epidemiological and ecological factors necessary for malaria transmission in this fiscal year.
MMP	Mobile Migrant Population (Non-Thai migrants who are either M1 or M2 according to Thailand Ministry of Public Health criteria)
MoPH	Ministry of Public Health
PHO	Provincial Health Office
PR-DDC	Principal Recipient –Department of Disease Control
RAI	Regional Artemisinin-Resistance Initiative
RDT	Rapid Diagnostic Test
Utilization of ITN	The percentage of non-Thai MMP using an ITN the last time they slept in the transmission area
VBDU	Vector Borne Disease Unit

EXECUTIVE SUMMARY

The Thailand MMP Survey was conducted in the months of November and December 2017 through a partnership of the PR-DDC and Malaria Consortium. This large scale cross-sectional study was conducted to evaluate the utilization of malaria preventive measures and access to malaria case management among non-Thai mobile migrant population in malaria transmission areas in Thailand.

The majority of MMP in the survey were of working age (between 25-64 years) with a median age of 35 years. The survey participants were predominantly M1 migrants- likely a consequence of the fact that many had settled in their current location in Thailand for > 5 years, making them easier to identify through the mapping process with key informants. That there were fewer M2 migrants included in the survey may be due to the fact that many of these individuals are likely to be undocumented and frequently mobile, and therefore more difficult to capture in large numbers at any one time.

Insecticide Treated Net (ITN) was the main malaria preventive measure, and long lasting insecticidal nets (LLIN) or long lasting hammock insecticidal nets (LLIHN) of less than 3 years age, or a conventional net dipped in insecticide in the last 12 months were considered to be an ITN. Utilization of ITN was defined as the percentage of non-Thai MMP using an ITN every night in the last week, including last night, prior to the survey. Treatment-seeking among MMP with fever in last three months was taken as a marker of access to malaria case management. Attitudes related to malaria and ITN were assessed using the Health Belief Model;[1] and satisfaction with access to malaria case management was measured in term of "5A" dimensions of access by Penchansky and Thomas.[2] This survey focused on MMP living in 21 provinces of four border regions with ongoing malaria transmission (A1- perennial transmission and A2- periodic transmission) and utilized a stratified cluster sampling design. A total of 3356 MMP participants were interviewed in 70 clusters.

ITN coverage (i.e. percentage of non-Thai MMP with possession of an ITN) was found to be low at 39%. Utilization of ITN was around 37%. In comparison to other three regions, ITN coverage and utilization were particularly lower in Thai-Malaysia border region at 16.8% and 15.8% respectively. Ownership of any type of mosquito nets was high at 94%, but, only 42% of those nets were effective ITN. One-third of nets owned were conventional nets bought from the private sector market. While there was an ownership gap of ITN, the behavioral or usage gap (MMP not sleeping under an available ITN) was reported to be much smaller at less than 5%, and similar across the four border regions. Considering high ownership and usage of any type of nets, treating the existing nets with an insecticidal solution could be an appropriate strategy to boost ITN coverage, in addition to free LLIN distribution.

MMP's attitude towards malaria and ITN, physical condition of net, and social determinants such as gender, religion, mobility, documentation status, and

[1] Rosenstock IM. The health belief model and preventive health behavior. Health education monographs. 1974;2(4):354-86.

[2] Penchansky R, Thomas JW. The concept of access: definition and relationship to consumer satisfaction. Medical care. 1981:127-40.

location of accommodation, were found to be significant barriers/determinants of ITN utilization at the border regions. MMP of Thai-Myanmar border region were more likely to sleep under an ITN if they were less mobile, had high perceptions of benefits and barriers of ITN use, and if their nets were in good condition. In contrast, MMP in Thai-Malaysia border region were more likely to do so if they were forest workers, and travelled back to their home country more frequently. Religion and perceptions of barriers of using ITN were also significant determinants of ITN use in this region. In Thai-Cambodia border region, MMP were more likely to sleep under an ITN if they were Laotians, undocumented, lived in village, had high perceptions of severity of malaria, had heard health messages, and perceived the net to be in good condition. In the Thai-Laos border region, males, above 65 years of age, earning more than 6000 THB a month, and having a high perception of benefits of ITN were more likely to use ITN. The barriers identified should be considered while devising and implementing malaria elimination strategies for MMP at the respective border regions.

A little above half of the MMP with fever in the last three months sought treatment (52.5%). Considering this figure, treatment-seeking within 24 hours of fever occurrence was relatively high (41.3%). Long-term resident MMP (>5 years) and those who had heard health messages were more likely to seek treatment, while religious minority and low knowledge of malaria were significant barriers to seeking treatment. Strategies that improve MMP's health literacy with interactive cognitive and social skills are needed to improve their ability to access malaria case management.

It is encouraging that most MMP healthcare seekers visited public sector services, and the proportion visiting the private sector was quite low (<10%), making most of the cases to be included in the national surveillance system. Among those who sought treatment for fever, 50.9% had a blood test for malaria; 15.1% were malaria positive; and all of them received antimalarial drugs. Public hospitals were the first choice of healthcare provider for most of the MMP due to convenience and/or ease of accessibility. There were some differences in satisfaction with different dimensions of access amongst the border regions. Satisfaction with accessibility to malaria care services was reported highest in Thai-Laos region, but lowest in Thai-Cambodia region. Similarly, MMP in Thai-Myanmar region reported higher awareness, availability, and affordability of malaria case management while those in Thai-Malaysia border reported lower availability and awareness. Healthcare providers in respective border region need to target the gaps in these reported dimensions of access to improve MMP's access to malaria case management. Outreach activities such as mobile clinics and having a migrant health worker at worksite may increase accessibility and availability, while concerns regarding affordability of malaria services could be alleviated by increasing awareness of free malaria diagnosis and treatment services and encouraging coverage of migrant health insurance.

Finally, almost one-third of the sample were forest-goers, but only 8% of them used an ITN (including LLIHN) in the forest. Using nets are not feasible for rubber tappers and other MMP sub-groups who go into forest to work all night. An appropriate alternative tool that suits the purposes of rubber tappers may be insecticide treated clothing. However, any intervention for forest goer MMP needs to be planned with gender-sensitivity as nearly half of them are females, and consider the variations in frequency of travel, duration

of stay and activities in the forest among different sub-groups of forest goers.

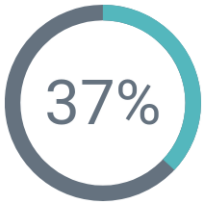
In conclusion, this Thailand MMP survey has provided data on key indicators that would help assist the NMCP in targeting this vulnerable group for malaria elimination. This survey has highlighted the impact of existing strategies and also the challenges in improving coverage of key malaria prevention interventions among MMP in Thailand. Novel approaches to behaviour change and strong community engagement are needed among the MMP in the border region to continue progress in malaria elimination.

Thailand MMP Survey Results

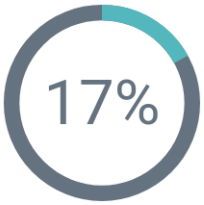
Malaria Preventive Mesaures

Own a bed net

ITN coverage



Use ITN every night



Protected by IRS

Forest Goers

32%

MMP going to forest

8%

Forest goer MMP use ITN in the forest

Access to Malaria Case Management

52.5% of MMP who had fever in last three months sought treatment

51% of MMP seeking treatment for fever got malaria blood test

100% of MMP with positive malaria test received anti-malarial drugs

INTRODUCTION

Thailand plans to eliminate malaria by 2024[1] and is steadily making progress in reducing malaria transmission with the incidence of malaria decreasing from 0.54 per 1000 population in 2012 to 0.13 per 1000 population in 2017.[2] The national strategic plan for the elimination of malaria was based on the findings of three consecutive household surveys conducted with the support of Malaria Consortium to monitor key performance indicators related to malaria prevention and control: the Thailand Malaria Survey (TMS) 2012,[3] the Knowledge, Attitudes and Practices (KAP) Survey 2015,[4] and the End-line Survey 2016.[5] Monitoring indicators of utilization of malaria preventive measures and access to malaria care services is important in order to inform the National Malaria Control Program (NMCP) on gaps and challenges that future interventions and behavior change initiatives may need to target if the country is to achieve its malaria elimination targets.

Whilst the prior household surveys that have been conducted have provided useful evidence to guide elimination strategies across the country, a key weakness has been their inability to capture hidden groups within the population, particularly the mobile migrant population (MMP). Despite being of relatively large scale, the three surveys did not capture many migrants.[3-5] Of these, a large proportion of those missing were non-Thai migrants who have resided in Thailand for less than six months, and are often mobile individuals who stay in the country for shorter periods of time or may come and go frequently from more malarious countries. In fact, over 96 percent of people surveyed in 2016 were Thai nationals, and the number of non-Thai individuals captured was low: M1 migrants (non-Thai nationals who have resided in the country for more than 6 months) only totalled 1.9 - 3.6 percent, and M2 migrants (those that have resided in the country for less than 6 months) totalled just 0.1 - 0.7 percent.[5] This is important because MMP are considered a high-risk group for malaria infection, given high vulnerability due to their migrant status and high mobility, and reduced access to malaria prevention measures and treatment services. In fact, in 2015, non-Thai cases accounted for nearly half of the total malaria cases in Thailand.[1] Therefore, a more in-depth analysis of their experiences related to access, understanding, and knowledge of malaria prevention and control tools and services is required to guide the implementation of targeted interventions.

An alternative sampling method is thus warranted to the conventional cross-sectional household design in order to reach these mobile/migrant groups.[6] Based on time and resource constraints and limited information available, we chose targeted sampling to survey MMPs in border areas of Thailand. Targeted sampling involves the selection of locations where the population of interest is known to congregate, and is applicable even when available data does not allow comprehensive mapping of all sites.[7] This method is also beneficial if there are specific sub-groups within the population to be investigated – for example, different types of migrants, or sites at different distances from health facilities. Targeted sampling has been previously used in malaria research in Ethiopia to enrol and study the experiences and perceptions of migrants to facilitate the design of targeted malaria

prevention strategies.[8] This method can, however, result in some selection bias and has limitations in its ability to be representative of the wider population as a whole.

We conducted a cross-sectional survey in November and December 2017, specifically designed to target migrant groups in four geographical regions bordering Thailand and its neighbouring countries: Myanmar, Laos, Cambodia and Malaysia. In this report, we present the key findings of the survey related to MMPs' knowledge and attitudes towards malaria transmission and risk and use of vector control tools, particularly ITNs; their forest-going and healthcare seeking behaviour; and access to malaria health services and case management. As the Thai government responds to the broader health and social needs of up to four million migrants from Myanmar, Cambodia and Laos living in Thailand,[9] - providing free primary education, enrolling migrant workers in a Social Security Fund and providing better access to healthcare - the findings of this survey provide baseline data and key insights for the NCMP on the best approaches to target MMPs in Thailand to support and better coordinate malaria elimination efforts.

Objectives of the study

Primary
1. To evaluate the utilization of malaria preventive measures among Non-Thai Mobile Migrant Population in Malaria Transmission Areas in Thailand
2. To evaluate access to malaria case management among Non-Thai Mobile Migrant Population in Malaria Transmission Areas in Thailand
Secondary
1. To estimate the percentage of non-Thai mobile migrant population in the risk areas with fever in the last 3 months accessing parasite-based diagnosis and treatment,
2. To estimate the percentage of non-Thai mobile migrant population that used an insecticide treated net the last time they slept in the transmission area,
3. To assess the proportion of forest-goers (defined as someone who has spent time between 6 pm to 6 am in the forest/ plantation/ garden/ farm at least once in the previous 6 months) among mobile populations, and of those, the percentage that used an insecticide treated net or long lasting hammock net the last time they slept in the forest.
4. To compare the determinants influencing non-Thai mobile migrant population's access to malaria services between the 4 border regions in Thailand
5. To compare the barriers preventing migrants from using insecticide treated nets between the 4 border regions in Thailand a. Barriers to use of insecticide treated nets and long lasting insecticide treated net b. Barriers to use of insecticide treated nets or long lasting insecticide treated hammock nets among the forest goers.

METHODOLOGY

Study design and approach

We utilized a cross-sectional survey design with a stratified two-stage cluster sampling with MMP sites (sub-districts with villages having more than two active foci areas) serving as clusters or primary sampling units, and MMP individuals as secondary sampling units. The study design was informed by a workshop which gathered information about current MMP situation in the border areas of Thailand from key informants from PR-DDC, BVBD and related CSOs.

A systematic random sampling with probability proportional to size was used to select sub-districts in the four geographic regions, followed by targeted sampling in these sub-districts to enrol MMP individuals from identified MMP subgroups. In each MMP site, a local level mapping process was conducted with key informants to determine the details of MMPs residing within the sub-district. When there was less information available from the key informants, snowballing was used to detect hidden MMPs.

Study sites

The primary sampling frame consisted of sub-districts from the following 21 malaria endemic provinces of Thailand along the border areas in four geographical locations (Table 1).

Study population

Although there are many types of MMPs living in Thailand - including internal migrants- for the purpose of this survey, MMPs were classified as:

MMP: Non-Thai migrants who are either M1 or M2 according to Thai MoPH definition.[1]

Table 1. Malaria endemic provinces along Thai borders

Thai-Myanmar	Thai-Cambodia	Thai-Lao	Thai-Malaysia
1. Chiang Rai	1. Srisaket	1. Ubonratchanthani	1. Songkhla
2. Chiang Mai	2. Surin	2. Mukdahan	2. Yala
3. Mae Hong Son	3. Burirum		3. Narathiwat
4. Tak	4. Sakew		
5. Kanchanaburi	5. Chanthaburi		
6. Ratchaburi	6. Trat		
7. Petchaburi			
8. Prachuab KhiriKhan			
9. Chumpon			

10. Ranong			
Total: 21 provinces			

M1: **Migrants** who are in Thailand for more than six months.
[Majority of whom are presumed to have registered with the Ministry of Labour, registration gives them the right to remain in Thailand for a prescribed period of time (typically 1-2 years) and enables them to access the formal Thai healthcare system][1,10]

M2: Migrants who stay in Thailand for less than six months are **mobile** migrants.
[Usually not registered with the Ministry of Labour; this means that they are residing in Thailand illegally, they do not have any claim to utilize the Thai health-care system (other than the services provided for malaria) and they could be arrested and deported at any time][1,10]

The survey also sought information about forest-going activities. From the previous surveys, forest-goers were found to be most at risk of malaria infection.[3-5] For the purposes of this survey, forest-goers were defined as:

Forest-goer: An MMP individual who has spent time in the forest/ plantation/ garden/ farm between the hours of 6 pm – 6 am at least once in the previous 6 months.

Sample size

Sample size calculation was based on the proportions of MMP who either used an ITN the previous night; or had fever in previous two weeks; or sought treatment for fever. Values were predicted using results from the previous KAP survey[5] assuming 3.5% prevalence of fever, 95% confidence interval, a margin of error of 1.75%, a design effect of 2.0 (considering the cluster sampling design), and a non-response rate of 10%. The sample size calculated was **941**, which had 86.6% power to detect small effect size of 0.1 at 5% significance level in chi-square analysis.
The initial sample size was then multiplied by four to reach a final sample size of **3764** MMP to account for comparison between the four different geographical regions of study. Expecting 50 MMPs to be enrolled in each cluster, the sample size and number of MMP sites for each region was calculated by proportional allocation and rounded up (Table 2).

Sampling strategy

MMPs were recruited in the study using a stratified two-stage cluster sampling:

1. Selection of clusters or "MMP sites":
Malaria endemic border areas of Thailand were stratified into four geographical regions: Thai-Myanmar (10 provinces), Thai-Laos (2 provinces), Thai-Cambodia (6 provinces), and Thai-Malaysia (3 provinces). Clusters were designated as MMP sites, defined as sub-districts with villages having more than two active malaria foci areas, based on the data from BVBD from the enlisted provinces. A primary sampling frame consisting of all MMP sites was prepared for each border region, from which required number of MMP sites were chosen by a systematic random sampling with probability proportional to size (PPS) of malaria transmission (i.e. number of villages/sub villages with more than 2 active foci of malaria in each sub-district). Cumulative total method of PPS[11] was used to select 75 MMP sites from the four regions.

Out of the 75 MMP sites selected, some clusters were inaccessible due to security reasons or unavailability of MMPs in the site. Replacement sites were chosen from an extended loop of the original PPS series in the primary sampling frame.

Table 2. Allocation of MMP sites

Region/Domain	No. of malaria endemic sub-districts	Proportional allocation	Sample size	Number of MMP Sites
Thai-Myanmar	109	50.9%	1917	**38**
Thai-Cambodia	40	19.6%	739	**15**
Thai-Laos	14	6.5%	246	**5**
Thai-Malaysia	49	22.9%	862	**17**
Total	**212**	**100%**	**3764**	**75**

Full details of the sampling size calculation are in Annex 1.

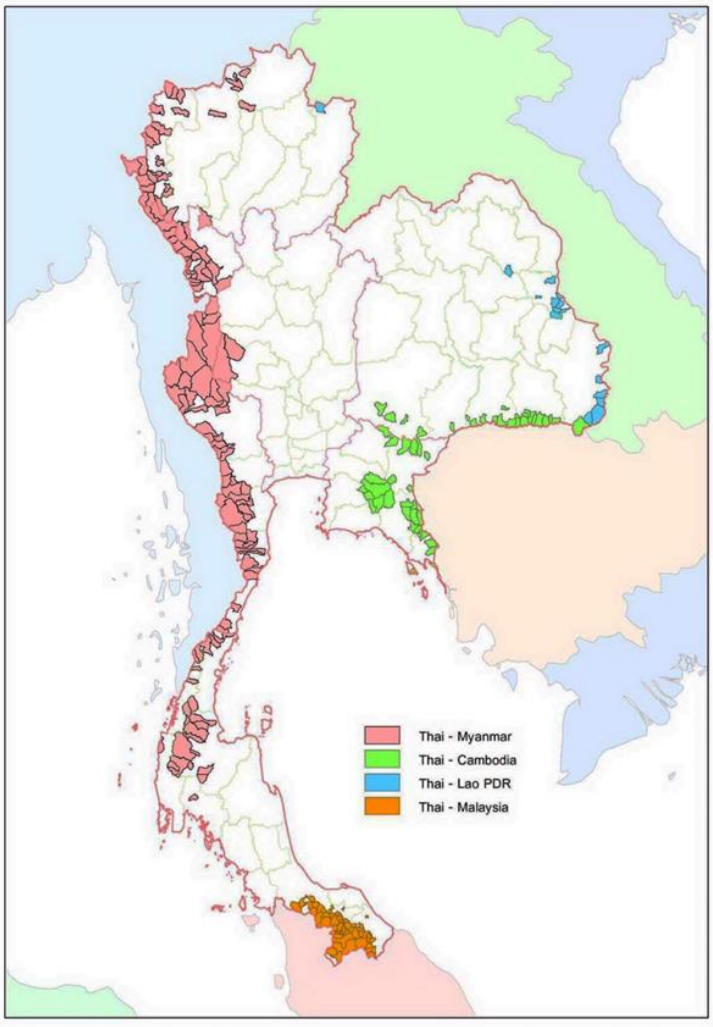


Figure 1. Geographical distribution of MMP sites

2. Selection of MMP Individuals:

In each of the MMP sites, a local mapping process was conducted before data collection in collaboration with local authorities from Thailand vector-borne disease unit (VBDU), provincial health offices (PHOs), Civil Society organizations (CSOs), and community leaders, who provided their inputs and updated knowledge of working with the migrants. MMPs were mapped according to the number and details of available sub-groups of MMPs at the site by location, occupation, and ethnicity. Hard to reach MMP sub-groups were prioritized to be enrolled in the survey, such as undocumented migrants, forest goers or people who spend their nights in the forest, daily border-crossers, highly mobile population in the malarious area (moving more than 2 times per year), and MMP who indulge in illegal work like woodcutting, sex work, drugs selling

Targeted sampling was then employed to enrol 50 MMP individuals at each site. The number of identified MMP sub-groups were used to divide the total sample needed at the site (i.e. 50) to ascertain the required quota for each sub-group. Within each sub-group, required number of MMP were selected purposively such that it reflected different age groups and gender. If certain MMP sub-groups were known to exist at the site but no information was available about their location and number, then snowball methodology was utilized to detect and enrol the hidden population till required sample size was met.

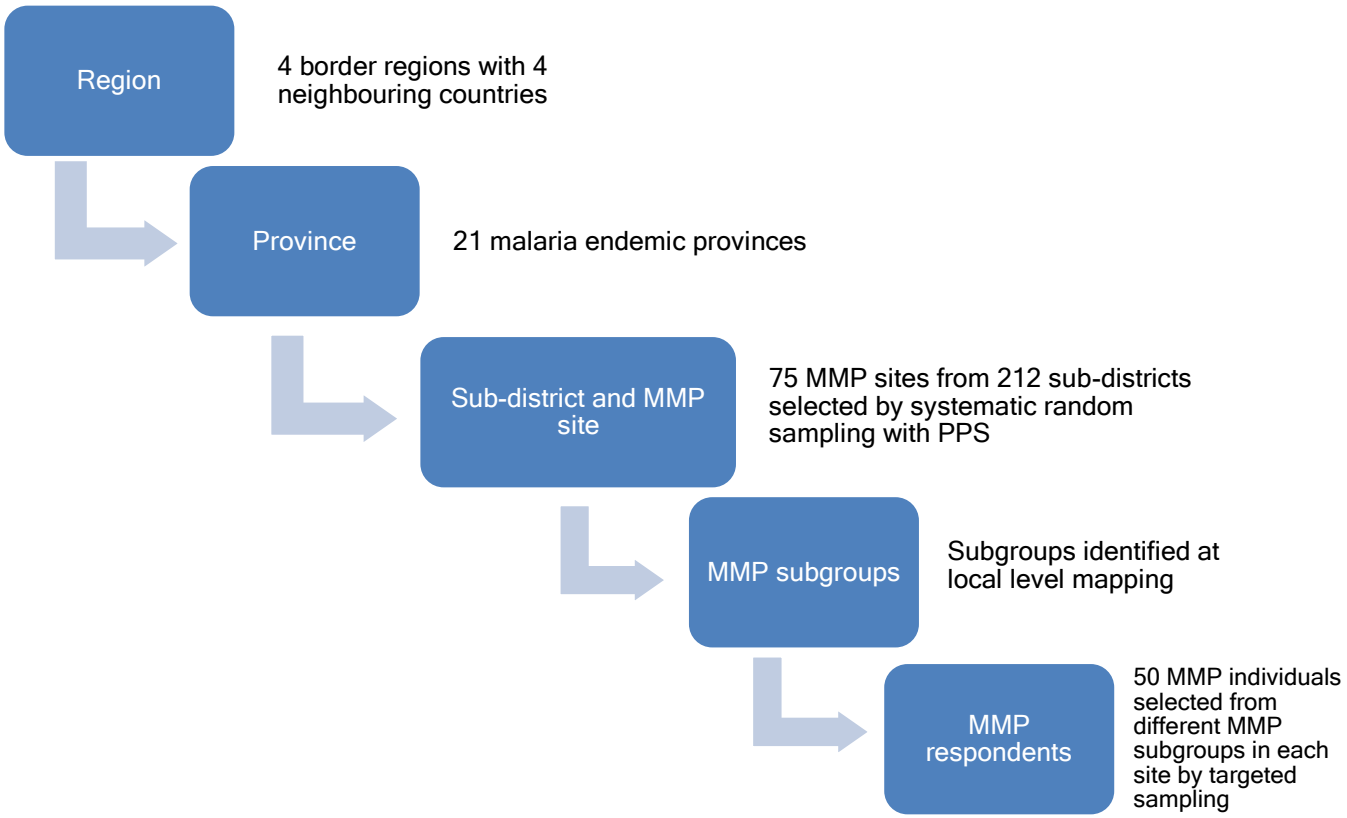


Figure 2. Flow-chart of Sampling of MMP Survey 2017

Inclusion and exclusion criteria

Respondents for the survey had to meet the following inclusion and exclusion criteria.

Inclusion:

1. Non-Thai citizen
2. Male and female MMP
3. Age 15 years of age or older
4. Ability to provide informed consent or assent to participate in the survey
5. Residing or spending time in active foci area between 6pm-6am within a radius of 3 kilometres.

Exclusion:

1. Individuals who are mentally ill or with limitations to communication (drunk, disability etc.)
2. Those who cannot speak or understand any of the common local languages, but can only speak very peculiar ethnic language beyond the scope of the skilled interviewer and translator.

Participants could discontinue their participation in the survey if: 1) the participants could not spend time to complete the questionnaire, and 2) the participant withdrew consent to participate in the interview. During the interview process, if any local situation or conditions occurred that might harm the participant and/or the interviewer, the interview could be stopped for the safety purposes of participant and/or interviewer.

Data Collection

Survey data were collected by field teams in the months of November and December 2017. A standard questionnaire was developed in English based on standard WHO questionnaires for difficult to reach population and a previous Malaria Consortium MMP survey conducted in Cambodia in 2017.[12] The questionnaire was structured to gather information on demographics, movement and living conditions, knowledge, attitudes and practices related to malaria and its prevention, and access to malaria case management. Questions related to attitudes towards malaria and ITN were based on the Health Belief Model (HBM) which includes five constructs that influence health behaviors, namely perceptions of susceptibility, severity, barriers, benefits, and cues to action.[13] The HBM posits that people are likely to exhibit disease prevention behaviors (such as sleeping under ITN) if they perceive that they are susceptible to the disease, the disease is severe, the behavior is beneficial, and barriers are minimal.[13] In addition, external cues to action, such as health messages or recommendations of healthcare workers, family or friends or other influential people can affect behaviors.

Reaching the hard to reach MMP by targeted sampling

Questions pertaining to access to malaria services were based on “5A” dimensions of access by

Penchansky and Thomas[14] who conceptualize access to healthcare is affected by **availability** - the extent to which the health facility has the requisite resources, such as personnel and technology, to meet the needs of the patients; **accessibility** - the geographic accessibility of the facility in terms of time and distance; **accommodation** - the extent to which health facility's operations are organized in ways that meet the constraints and preferences of the patients; **affordability** – the financial and incidental costs; and **acceptability** - the extent to which the patient is comfortable with the more immutable characteristics of the provider, and vice versa. A sixth dimension of **awareness** of availability of services was added recognizing that effective communication about the service is particularly important for MMP in rural and remote communities.[15]

The questionnaire was then translated into Thai by certified translators and pre-tested for validity and reliability in a cluster not selected for the survey. The questionnaire was converted into an Open Data Kit (ODK) software template for electronic data collection. The ODK tool had data quality checks in place to ensure all fields were filled in correctly before moving to the next question. The survey team members each had an electronic tablet with the questionnaire and were trained on its use and the data quality checks in place. Team supervisors checked each electronic submission at the end of the day before submitting to the online server, from which further checks were made on completeness of the data.

The field teams enrolled MMP individuals according to the plan developed during the mapping process for various subtypes of MMPs congregating at the site in their workplaces or accommodation. Interviews were conducted with participants who met the eligibility criteria and gave consent for the interview. Local translators were utilized when the interviewers and respondents faced a language barrier. Once all available MMPs were surveyed in the allotted time, the field teams moved to the next study site. Information collected included demographic characteristics, net ownership and usage, fever cases within the previous three months and healthcare seeking behaviour, malaria knowledge and attitudes, and practices of forest-goers.

Data management and analysis

Raw data from ODK was imported to excel and responses in Thai were translated to English. STATA software version 14.2 (StataCorp LP, College Station, TX, USA) was used to clean and analyse the data. Correct responses to six questions related to knowledge of malaria and its prevention were identified. Bloom's original cut off points (60 and 80%)[16] were used to classify MMP's knowledge into three categories, such that 5-6 correct answers was considered as "high", 3-4 correct answers as "fair" and less than 3 correct answers as "low". Responses to questions pertaining to each HBM construct and dimensions of access were summed into scores, and then dichotomized as low and high based on the median value. The summary scores of access dimensions were also converted into a scale of 0-1 to facilitate comparison.

Descriptive statistics included calculation of frequencies, percentage and proportions of demographic variables and specific indicators. The point estimate and their 95% confidence intervals (CI) were calculated using the SURVEY (SVY) command in STATA to account for clustering by MMP site and stratification by border regions. Rao-Scott chi-square tests were used, considering the sampling design to

compare categorical variables among MMPs from different geographic regions. The level of significance was kept at $p<0.05$.

A generalized estimating equations (GEE) model with a binomial distribution and logit link was used to estimate odds ratio (OR) and 95% CIs for determinants of ITN use and access to malaria case management, adjusting for clustering by MMP sites using an exchangeable correlation structure.[17] The multivariable logistic regression models were fitted with all the variables that showed at least some evidence of association (Type III p values <0.1 in the univariable analysis).

Ethical considerations

The consent forms and information sheet were translated to local languages of MMPs such as Karen, Khmer, Shan, Laos, Burmese and Yawi. Before each interviewee was requested to provide consent, the interviewer gave a brief description of the study's objectives and expected benefits, the data collection procedure, and the voluntary nature of participation at all stages of the interview. Written informed consent was sought from all respondents before the interviews were conducted. For minors aged 15-18 years, their assent and the permission of their parents/guardians or suitable adults were obtained. Consent from participants who were illiterate were indicated by their thumbprint on the consent form. Data was kept anonymous (no names were collected) and stored securely during and after data entry. The study protocol and documents were approved by the Ethics Committee for Research in Human Subjects, Department of Disease Control, Ministry of Public Health (FWA 00013622) on 27 October 2017 (DDC-EC Ethics Submission code 11/60-048 (MMP Survey 2017) version 1.2 dated 5 October 2017).

Obtaining informed consent from a literate and an illiterate MMP individual in Thai-Myanmar border region

RESULTS

A total of 3,356 MMPs participated in the study, recruited from Thai-Myanmar (1740; 52%), Thai-Cambodia (734; 22%), Thai-Malaysia (632; 19%) and Thai-Laos (250; 7%) border regions. Before presenting the detailed findings, we shall discuss some of the challenges faced during data collection in this survey.

Challenges faced

Two of the main challenges encountered by field data collection team while conducting this survey were:

1. Difficulty of finding MMP

In some of the clusters selected, the data collectors found it difficult to enrol the required number of participants:

- There were either very few or no migrants at all in 18 clusters (11 in Thai-Malaysia, 5 in Thai-Cambodia, 2 in Thai-Laos border region) (Annex-2).
- In three clusters of Thai-Myanmar border, most of the migrants had recently obtained Thai ID cards, making them ineligible for inclusion in this study.
- In one of the clusters in Thai-Cambodia border, the data collectors could not find enough participants as most of the seasonal worker migrants had returned back to their country since the data collection period was at the end of their harvest season.
- Due to limited time for data collection at each cluster, it was difficult for field interviewers to locate and enrol enough highly mobile and hidden migrants by snowballing.

2. Restricted access

There were 5 clusters that had limited access for the data collectors. Among them,

- 3 clusters at the border with Cambodia were completely inaccessible due to security reasons such as presence of mines or wildlife conservation areas.
- In two clusters in the Thai-Myanmar border, some of the migrant locations were not reachable due to extreme geographic remoteness and difficult terrain to travel.

Heavy rains in Thai-Malaysia border region made transportation to MMP sites challenging

Replacement clusters were chosen to enrol more participants. Despite adverse weather and transportation, the final sample collected was above 90% of the calculated sample size in each border region, except for Thai-Malaysia region, where the final sample size was around 75%. A detailed list of MMP sites where the final sample size was less than 50 individuals is provided in Annex-2.

A summary of key findings pertaining to the study objectives is presented in the following Table 3.

Table 3. Summary of Key indicators

Objective	Output	Indicator	N	%
Primary				
1	**Utilization of malaria preventive measures**	% of MMP having ITN (ITN coverage)	1305	38.88
		% of MMP using ITN every night in the last week, including last night (Utilization of ITN)	1246	37.12
		% of MMP having Indoor spraying within 12 months	574	17.1
		% of MMP having wire screens on doors and windows	26	0.77
		% of MMP using at least one of other strategies	2569	76.55
2	**Access to malaria case management**	% of MMP with fever in the last three months who sought treatment	259	52.54
		% of MMP with fever in the last three months who had a malaria test	132	50.97
		% of MMP with positive malaria test who received anti-malarial drugs	20	100
		% of MMP with positive malaria test who did not receive appropriate treatment	0	0.00
		% of MMP with fever in the last three months who sought treatment in the non-government/informal health provider	3	0.61
Secondary				
1	**Percentage of non-Thai mobile migrant population in the risk areas with fever in the last 3 months accessing parasite-based diagnosis and treatment**	% of MMP with fever in the last three months who sought treatment (ever, within 24, within 48 hours)	259	52.54
2	**Percentage of non-Thai mobile migrant population that used an insecticide treated net the last time they slept in the transmission area**	% of MMP using ITN every night	1246	37.12
3	**Proportion of forest-goer MMP**	% of MMP who are forest-goers	1082	32.24
	Utilization of LLIHN or ITN by forest-goers	% of forest-goers using ITN or long lasting hammock net in the forest	87	8.04

Sample Characteristics

Demographic Characteristics

The majority of participants were middle aged (25-64 years) (n=2506, 75%) with a median age of 35 years (IQR 26-47), female (n=1898, 57%), Myanmar nationals, (n=1716, 51%), and Buddhists (n=2876, 86%) (Table 4). More than 92% of the participants belonged to either of Karen, Burmese, Khmer, Mon or Lao ethnicity, with Karen (n=1094, 33%) being the most represented ethnic group. Around 44% of sampled MMPs had never attended school. Only 934 (28%) could speak Thai language, and 354 (11%) were able to read Thai. Among the MMP, 3042 (91%) were M1 and 314 (9%) were M2; a majority were undocumented (n=2000; 60%); and nearly 30% earned 3000 THB or less in a month (equivalent to national poverty line of $3.2 per day). The differences in sample characteristics of MMP residing in four border region are presented in Annex-3.

Table 4. Demographic Characteristics (n=3356)

Characteristic	N	%
Age (years)		
Median: 35, Interquartile range (26-47)		
Age groups:		
1) 15-24 years (young)	**693**	**20.65**
15-19	246	7.33
20-24	447	13.32
2) 25-64 (Middle)	**2506**	**74.67**
25-29	456	13.59
30-34	469	13.97
35-39	409	12.19
40-44	347	10.34
45-49	293	8.73
50-54	234	6.97
55-59	161	4.80
60-64	137	4.08
3) ≥ 65 (Elderly)	**157**	**4.68**
Sex		
Male	1458	43.44
Female	1898	56.56
Geographical region (Border)		
Thai-Myanmar	1740	51.00
Thai-Cambodia	734	21.87
Thai-Laos	250	7.45
Thai-Malaysia	632	18.83
Nationality		

Characteristic	N	%
Myanmar	1716	51.13
Lao	341	10.16
Cambodia	597	17.79
Malaysia	19	0.57
No citizenship	661	19.70
Others*	7	0.21
Do not know	15	0.45
*Others: Indonesia (3), Pakistan (3), South Africa (1)		
Ethnicity		
Karen	1094	32.60
Burmese	676	20.14
Khmer	590	17.58
Mon	395	11.77
Lao	346	10.31
Shan	87	2.59
Maniq	80	2.38
Malaysian	22	0.66
Lahu	15	0.45
Rohingya	8	0.24
Akha	4	0.12
Hmong	2	0.06
Chinese	1	0.03
Do not know	2	0.06
others*	13	0.39
*Indonesian (3) Pakistan (3) South Africa (1) Thai (5) India (1)		
Religion		
Buddhism	2876	85.70
Christian	299	8.91
Islam	87	2.59
No religion	79	2.35
Chinese traditional	8	0.24
Ancestor worship/spirit	6	0.18
Both Buddhism and Christian	1	0.03
Educational level		
Never attend school	1471	43.83
Till Primary school	1411	42.44
Secondary school or above	464	13.83
No answer/ Do not know	10	0.30

Characteristic	N	%
Thai language skill		
Can speak	934	27.83
Can read	354	10.55
Occupation		
Wage laborer	1,189	35.43
Seasonal worker	938	27.95
Forest worker	727	21.66
Jobless	202	6.02
Construction worker	180	5.36
Visitor/others	102	3.04
Security guard	18	0.54
Classification of migrants		
M1	3041	90.61
M2	315	9.39
Documented	1315	39.18
Undocumented	2000	59.59
No answer / Do not know	41	1.23
Monthly Income (Baht) n=3138		
≤3000	877	27.95
3001-6000	977	31.13
6001-10000	739	23.55
>10000	509	16.22
no answer	36	1.15

Movement Characteristics

Most of the participants had stayed in Thailand for more than 5 years (n=2887; 86%), with the average length of stay being 15 years (S.D. 14.02 years) (Table 5). More than two-thirds had lived in their current location for more than 5 years (n=2588; 77%) with the average being 13.31 years (S.D. 13.63 years). While 55% of the MMP migrated to their current location from outside of Thailand, around 36% had resided somewhere else in Thailand before moving to the current location, with most looking for work opportunities (n=1948; 58%). About 40% of MMP had crossed the border through a river or a forest unofficially. Nearly 80% of MMP supported their travel to Thailand either by themselves or through help of their family members. More than half of the MMP reported never visiting their home country, while nearly one quarters travelled back and forth at least once a year. Few (6%) participants had plans to relocate in the next six months, with one-third of them (70/217) planning to return back to their homes, mostly for seasonal work.

Table 5. Movement Characteristics

Characteristic	N	%
Length of stay in Thailand (Years)		
Mean:15.95 , S.D.:14.02, Median:13, Range:0-85		
<6 months	314	9.36
6 months to 5 years	155	4.62
> 5 years	2887	86.03
Length of stay at the current location		
Mean:13.31, S.D.:13.63, Median:10 , Range:0-85		
<6 months	506	15.08
6 months to 5 years	262	7.81
> 5 years	2,588	77.12
Residence prior to the current location		
Within this district	384	11.44
Within this province	262	7.81
Other province	569	16.95
Abroad	1842	54.89
No answer	299	8.91
Reasons for migration to the current location		
Work opportunity	1948	58.05
Family reason	774	23.06
Political reason	313	9.33
Born in this area	193	5.75
No answer / Do not know	72	2.14
Better life	45	1.34
Religion purpose	26	0.77
Others*	11	0.33
Leisure	8	0.24
Health care	5	0.15
In transit	2	0.06
**conflict with friend (1), follow leader (7), live in Cambodia (1) no document (1) and study (1)*		
Crossed the border by		
Temporary checkpoint	1582	47.14
Unofficial crossing point (river/forest)	1327	39.54
Born in Thailand	382	11.38
No answer/ Do not know	46	1.37
Helicopter	15	0.45

Characteristic	N	%
Checkpoint at airport	4	0.12
Migration to current location was supported by		
Family member	1690	50.36
Myself	959	28.58
Friends	271	8.08
Agency	114	3.40
Employer	88	2.62
No answer / Do not know	47	1.40
Community leader	25	0.74
Others (monk 2, police1,war1)	4	0.12
Local organization	2	0.06
Last travel to your country or outside of Thailand		
Never	1778	53.25
Yesterday	96	2.86
Last week	76	2.26
Last month	83	2.47
Last 3 months	69	2.06
Last 6 months	112	3.34
Once per year	472	14.06
< Once a year	557	16.6
No answer / Not sure	105	3.10
Frequency of visit to home country		
Never	1778	52.98
Daily	82	2.44
Weekly	51	1.52
Every 2 Weeks	5	0.15
Monthly	28	0.83
Every 2-3 months	30	0.89
Twice per year	67	2.00
Once per year	554	16.51
< Once a year	638	19.01
No answer / not sure	123	3.67
Most important reason to visit home country		
Never	1205	35.91
Family and friend reason	1167	34.77
No answer / Do not know	432	12.87
Leisure	342	10.19
Work opportunity	134	3.99

Characteristic	N	%
Religion purpose	32	0.95
Registration/documentation	19	0.57
Political reason	16	0.48
Health care	6	0.18
Better life	2	0.06
In transit	1	0.03
Have plans to relocate in next 6 months		
Yes	208	6.20
No	2921	87.04
No answer / Not sure	227	6.76
Next planned migration location (n=217)		
Back home	70	32.26
To another area in the same province	38	17.51
Where I can work	32	14.75
To another province	31	14.49
Do not know / No answer	23	10.60
To another area in the same district	19	8.76
To another country	5	2.30
Reason for relocating (n=217)		
Seasonal work	92	42.40
No job here/find new job	36	16.59
Going home (origin)	22	10.14
Better salary	21	9.68
Better work condition	18	8.29
No reason / No answer / Do not know	15	6.91
Work assignment	8	3.69
Visiting family	4	1.84
Study	4	0.12

Living Conditions

A majority of MMP reported living with family (n=2954; 88%), in single house (n=2130; 63%), in a village (n=2443; 73%), had piped water in the house (n=2004; 60%), and had a toilet that contained a pit latrine with a slab (n=2726; 81%) (Table 6).

Table 6. Living Characteristics

Characteristic	N	%
Living with		
Live with my family	2954	88.02
Live alone	218	6.50
Live with others but not family	184	5.48
Type of accommodation		
Single house	2130	63.47
Farm shelter	563	16.78
Dormitory	560	16.69
Tent	71	2.12
Rafting/floating house	16	0.48
Temple	6	0.18
Plastic sheet	4	0.12
Outdoors	2	0.06
Construction site	2	0.06
Do not know	2	0.06
Location of accommodation		
Village	2443	72.79
Paddy fields	559	16.66
Corn farm	77	2.29
Forest (wild)	60	1.79
Fruit Farm	56	1.67
Plantation (rubber, teak)	48	1.43
Factory	45	1.34
Cassava Farm	28	0.83
In town	19	0.57
Dam	16	0.48
Others *(worksite 1, Cambodia 7, Prawn farm 5)*	13	0.39
No fixed location	10	0.3
Construction site	7	0.21
No answer	1	0.03
Source of water		
Piped water into dwelling	2004	59.71
Bottle water	509	15.17
Protected well	227	6.76
Tube well or borehole	209	6.23
Unprotected well	208	6.20
Public tap/stand pipe	181	5.39
Tanker truck	135	4.02

Characteristic	N	%
Surface water	123	3.67
Cart	6	0.18
Do not know / no answer	4	0.12
Rain water	1	0.03
Type of toilet		
Pit latrine with slab	2726	81.28
No facility/bush/field	315	9.39
Pit latrine without slab	187	5.57
Flush or pour flush toilet	92	2.74
Hanging toilet	36	1.07

Knowledge, attitude and practice of malaria prevention measures

Knowledge of Malaria among MMP

Around 27% of the participants had never heard of malaria. More than half of the total participants knew that malaria was transmitted by mosquito bites (n=1977; 59%); identified at least one of its prevention methods (n=1911; 57%), at least one sign and symptom of malaria (n=1788; 53%), knew where to get tested for malaria in Thailand (n=1893; 56%); and what kind of malaria testing is done (n=1728; 51%) (Table 7). However, only two fifths of participants knew at least one sign or symptom of severe malaria (n=1333; 40%). Overall, 40% of the total participants had good knowledge, while 13% had fair, and 47% had low knowledge of malaria. MMP in Thai-Malaysia border region were more likely to have less knowledge about malaria than other three regions (Annex-3).

Table 7. Correct responses for knowledge of Malaria and its prevention (n=3356)

Knowledge	N	%
1. Malaria Transmission		
Mosquito/ Anopheles bites	1,977	58.91
2. Malaria Prevention Methods (any one of the following)		
Sleep under a mosquito net /ITN/ LLIN/, use repellent, insecticide spray, make smoke, wear covered clothes	1911	56.94
3. Malaria sign and symptoms (any one of the following)		
Fever, Chills, headache, fatigue, nausea, poor appetite	1788	52.98
4. Sign and symptoms of severe malaria (any one of the following)		
Unconscious, Convulsions, Fast breathing, High fever/high body temperature, Pale skin, Frequent vomiting, Shivering, Digestive system (Nausea, poor appetite), Cerebral malaria	1333	39.72
5. Malaria testing in Thailand (any one of the following)		
Village health Volunteer, Malaria Clinic, MP/BMP, Public Hospital, Private Clinic /hospital, Non-profit organization, Military health service	1893	56.41
6. Malaria testing is done by		
Blood slide and/or Rapid diagnostic test	1728	51.49
Overall Knowledge		
High (5-6 correct answers)	1578	39.93
Fair (3-4 correct answers)	438	13.05
Low (0-2 correct answers)	1340	47.02

MMP attitudes towards malaria prevention

Of the 2457 participants who had heard of malaria, 2056 (84%) responded to questions about their attitudes to malaria and its prevention (Table 8). Whilst almost 75% of participants believed that people in the area in which they worked/resided could get sick from malaria (n=1,537), only 40% of participants perceived themselves to be at risk of the disease (n=814). A majority of respondents perceived that staying overnight increased risk of getting malaria infection (n=1674; 81%), almost 90% perceived that malaria can be severe to cause death, and 83% believed that malaria warranted treatment. Around two-thirds thought that insecticide treated nets are better at preventing malaria than conventional net/non ITNs (n=1515; 74%), but a quarter of them believed that sleeping under LLINs might cause allergy and rash (n=511; 25%). Less than half of the MMP reported hearing/seeing any health message regarding malaria in the last 6 months in Thailand (n=856; 42%), mostly from healthcare workers (n=482; 23%).

Table 8. Perceptions of MMP related to Malaria and its prevention (n=2056)

Health belief model construct	Item	Agree response	
		N	%
Perceived Susceptibility	Do you think you could become sick from malaria?	814	39.50
	Do you think people in this area could become sick from malaria?	1,537	74.76
	People who stay overnight in the forest have high risk of malaria infection	1674	81.42
Perceived Severity	Severe malaria can lead to death	1,822	88.62
	Malaria infected patients need treatment as it is not a self-cured disease	1,711	83.22
Perceived Benefits	ITNs/LLINs can prevent malaria better than conventional net/non ITN	1515	73.69
Perceived Barriers	Sleeping under LLINs might cause allergy and rash	511	24.85
Cues to action	Heard/seen any health message regarding malaria in the last 6 months in Thailand	856	41.63
	Heard from healthcare workers	482	23.44
	Heard from Religious leaders and employers	143	6.96
	Media (leaflet, radio, public announcement, etc.)	87	4.23
	Heard from CSO members	40	1.95
	Family/friends/neighbors/community people	17	0.83

The differences in knowledge and attitude towards malaria prevention among MMP residing in four border region are presented in Annex-3. MMP in Thai- Malaysia border region were found to have lower perceptions about susceptibility to malaria infection, its severity, and benefits of sleeping under an ITN. In comparison, MMP in Thai-Myanmar and Thai-Cambodia had more perceptions of barriers of ITN use; and MMP in Thai-Laos were more likely to have external to cues to action (Annex-3).

Practices of malaria prevention measures

Using mosquito nets was the most frequently reported primary preventive action against mosquito bites by the MMP (n=1148, 34%). This was followed by doing nothing (n=708, 21%) (Table 9). Almost all MMP individuals reported not having wire screens on doors (n=3337, 99%) or windows (n=3334, 99%), and most had not been benefitted by indoor residual spray (IRS) (n=2640, 79%).

Table 9. MMP Malaria prevention practices

Characteristic	N	%
Primary action taken to prevent mosquito bites		
Use mosquito net	1,148	34.21
Nothing	708	21.09
Mosquito coil	558	16.63
Swatter/electric swatter	337	10.04
Insecticide spray	286	8.52
Herb (spray, burn, eat)	200	5.96
Wear covered clothes	25	0.74
Make smoke	20	0.60
Packet traditional medicine	18	0.54
Do not know/ No answer	16	0.48
Wear treated clothes	14	0.42
Mosquito repellent	10	0.30
Using electric fan/fan	7	0.21
Smash mosquito	5	0.15
Stay out of the forest	2	0.06
Others (Use abate sand, drink alcohol)	2	0.06
Interior walls of accommodation was sprayed against mosquitoes in the past 12 months		
Yes	574	17.1
No	2,640	78.67
Don't know	142	4.23
Accommodation has a mosquito wire screen		
Doors		
No screen on doors	3,337	99.43
Yes, screens on all doors	12	0.36
Yes, screens on some doors	7	0.21
Windows		
No screens on windows	3,334	99.34
Yes, screens on all windows	16	0.48
Yes, screens on some windows	6	0.18

Utilization of mosquito nets

Most of the MMPs owned a mosquito net (n=3139; 94%). ITN (defined as LLINs/LLIHNs aged 3 years or those aged more than 3 years but treated within the last year and/or conventional nets treated within the last year) were reported to be owned by only 39% of the participant (n=1305) (Table 10). Most of the nets were either received for free from governmental public health officials (n=1392; 44%) or purchased by the MMPs (n=1209; 39%). Nearly two-thirds of the nets were received within the last year (n=1974; 63%). A majority of the nets were already treated with an insecticide (n=1657; 52%), washed once a month or more frequently (n=1972; 63%), and in a good condition (n=2544; 81%). Most of the MMP reported using the net every night in the last week prior to the survey (2993; 95%), and having enough nets for the family (n=2450; 83%).

Table 10. Ownership and utilization of ITN (n=3356)

Characteristic	N	%
Own a mosquito net	3,139	93.53
Own an ITN (ITN coverage)	1,305	38.88
LLINs obtained in 3yrs/treated in 1 year	1,133	86.82
LLIHNs obtained in 3yrs/treated in 1 year	165	12.64
Conventional & treated in 1 year	7	0.54
Type of net owned (n=3,139)		
LLINs brand		
Permanet	553	17.62
Yorkool	512	16.31
Olyset	294	9.37
DawaPlus	223	7.10
Don’t know LLINs brand	105	3.35
Royal Sentry	28	0.89
Hammock net brand		
Yorkool	118	3.76
Olyset	58	1.85
DawaPlus	43	1.37
Don’t know hammock	14	0.45
Net protect	3	0.10
Conventional net	1,089	34.69
Don't know	98	3.12
Source of Net (n=3,139)		
Free from public health staff	1392	44.34
Purchased From Shops/Market/roaming seller	1209	38.51
Free from CSOs	381	12.14

Characteristic	N	%
Free from employer, relatives, community leader	111	4.00
Do not know/cannot remember	46	1.47
Duration of receipt of net (n=3,139)		
<6 months	1,054	33.58
6 months to 1 year	920	29.31
>1 year to 2 years	707	22.52
> 2 year to 3 years	290	9.24
> 3 years	130	4.14
No answer/ do not know	38	1.21
The net was already treated with an insecticide (n=3,139)		
Yes	1,657	52.79
No	1,109	35.33
Not sure/no answer	373	11.88
Time since the net was last soaked or dipped in a liquid (n=3,139)		
Not soaked since receipt	2,772	89.74
Don't remember	276	8.93
<12 months	41	1.30
Frequency of washing the net (n=3,139)		
Once a month or more	1972	62.82
Every 2-3 months	491	15.64
Twice per year or less	212	6.75
Never	442	14.08
Don't know/ no answer	22	0.70
Current Condition of net (n=3,139)		
Good	2,544	81.05
Bad	565	17.99
Not sure	30	0.96
Frequency of net use (n=3,139)		
Every night in the last week (including last night)	2,993	95.35
1-2 days in the last week	50	1.59
3-4 days in the last week	47	1.50
>5 days in the last week	4	0.13
Never	45	1.45
Frequency of ITN use among all MMP (n=3356)		
Every night in the last week (including last night)	1246	37.13
1-2 days in the last week	22	0.66

Characteristic	N	%
3-4 days in the last week	18	0.54
Never	2070	61.68
Frequency of ITN use among MMP having nets (n=3,139)		
Every night in the last week (including last night)	1246	39.69
1-2 days in the last week	22	0.70
3-4 days in the last week	18	0.57
Never	1853	59.03
Frequency of ITN use among MMP having ITN (n=1,305)		
Every night in the last week (including last night)	1246	95.48
1-2 days in the last week	22	1.69
3-4 days in the last week	18	1.38
Never	19	1.46
Enough nets for all family members to sleep under (n=3,139)		
yes	2,450	82.94
no	504	17.06

The top reason for not owning a net was non-use or dislike for using nets (n=88; 41%) (Table 11). About one-third of the respondents who did not use net daily, felt that sleeping under a mosquito net was hot and uncomfortable (47/146). Almost all MMP who used nets, said that they do so to stop mosquito bites (n=2,989; 96.61%); and 43% of those who didn't have enough nets for the family cited that they had too many family members.

Table 11. Reasons for net practices

Reasons	N	%
For not owning a net (n= 217)		
Not use net or don't like to use a net	88	40.55
Use other prevention (fan, make smoke etc.)	26	11.98
Expensive/no money	25	11.52
Did not bring or buy net	23	10.6
No answer	15	6.91
Use tent/ wire-screen	10	4.61
Not easy to hang (place ,device, type)	8	3.69
Just arrive Thailand	6	2.76
Net not in good condition	6	2.76
No reason/no net	4	1.84
Work at night	3	1.38
No mosquito	2	0.92
Do not know where to buy	1	0.46
For not using nets every night (n= 146)		

Reasons	N	%
Feeling hot & uncomfortable	47	32.19
No answer / Do not know	27	18.49
Work at night	17	11.64
No mosquitoes	14	9.59
Use other methods (tent, wire screen, coil)	14	9.59
Not easy to hang (place ,device, type)	12	8.22
Did not use for sleeping	6	4.11
Net not in good condition	6	4.08
Time/effort to set up net	4	2.74
Saving for visitors or future use	3	2.05
Others (drunk, forget)	3	2.04
Net is too small	2	1.37
Do not like chemical smell	2	1.37
Net not available	1	0.68
Net is too big	1	0.68
Rash/irritation/burning pain	1	0.68
For using nets (n=3094)		
Stop mosquito bites	2,989	96.61
Kill other insects	256	8.27
Repel mosquitoes	179	5.79
Privacy	168	5.43
Prevent malaria	138	4.46
Kill mosquitoes	58	1.87
No reason / No answer/ Do not know	28	0.90
Others (good sleep, warm, protection from dust (2),healthy)	8	0.26
Use for small children	7	0.23
Prevent other diseases such as Dengue fever (3), Malaria (1)	4	0.13
For not enough nets for family members (n=504)		
Too many family members	219	43.45
No free distribution of net	64	12.7
No money to buy net/too expensive	45	8.93
Net is too small/size is not proper	45	8.93
Net is not in good condition	41	8.13
No answer / Do not know	33	6.55
Dislike and not use	24	4.76
No net	16	3.17
Do not know where to buy/how to use	10	1.98
Other (no mosquito, no space to use, make smoke, keep to use in rainy season)	4	0.79
Gave to other family	3	0.60

Comparison by border region

MMP in Thai-Malaysia border region had comparatively less coverage and utilization of ITN than in other three border regions (p<0.005) (Figure 3 and Table 12). However, there was no significant difference in behavioral gap of ITN use (MMP not sleeping under available ITN) among the four regions (p=0.519). While 25% of MMP in Thai-Myanmar border region reported being protected by IRS, far fewer MMP reported of having benefited from IRS in the other three regions (p<0.001). Conversely, more MMP reported using at least one of other recommended strategies than ITN in the other three regions than Thai-Myanmar border region (p<0.001).

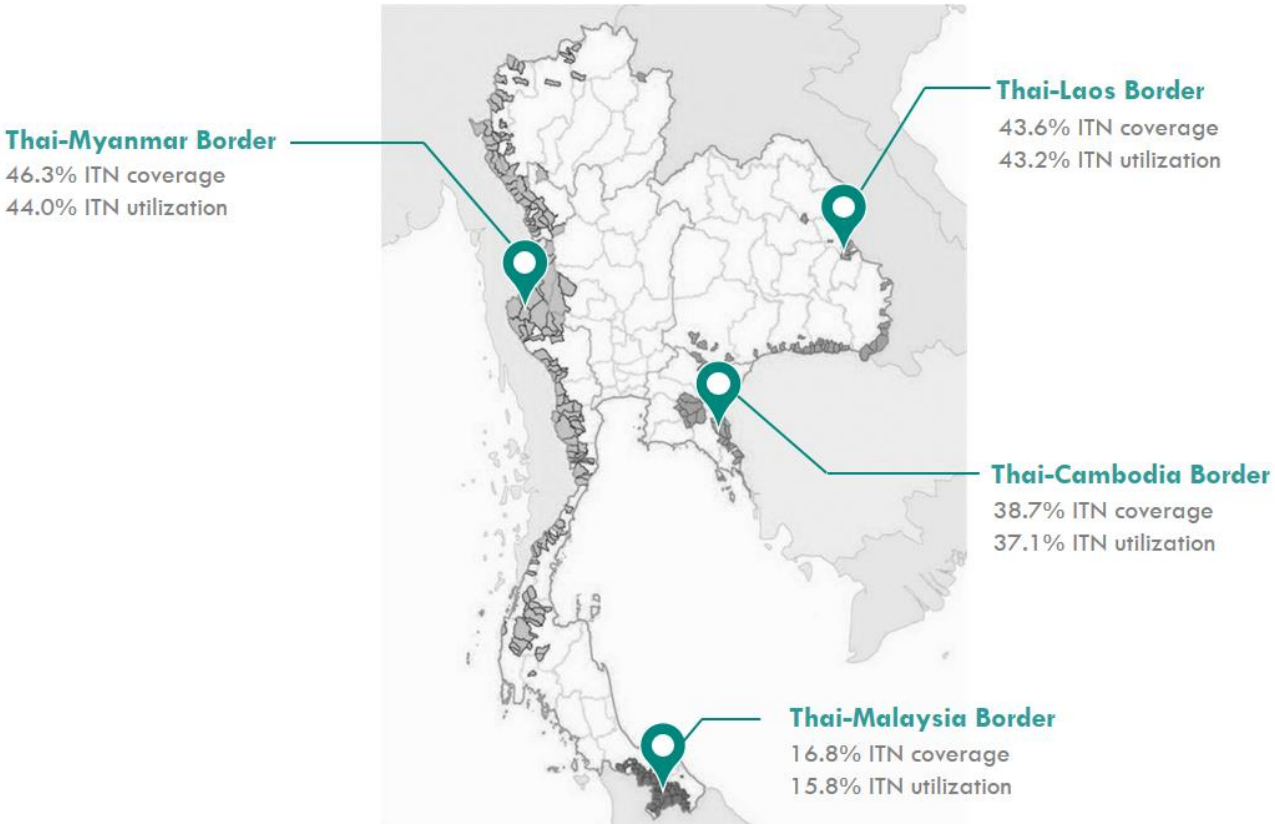


Figure 3. ITN coverage and use in four border regions

Table 12. Differences in MMP's use of malaria preventive measures by border regions

Indicator	Thai-Myanmar			Thai-Cambodia			Thai-Laos			Thai-Malaysia			p-value*
	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI	
MMP owning ITN	806	46.3	38.8-54.0	284	38.7	25.9-53.3	109	43.6	23.7-65.8	106	16.8	13.9-20.1	**0.002**
MMP using ITN every night	766	44.0	37.0-52.3	272	37.1	24.7-51.3	108	43.2	23.5-65.3	100	15.8	13.2-18.9	**0.003**
MMP not sleeping under available ITN (Behavioral gap)	40	5	3.6-6.7	12	4.2	1.4-12.2	1	0.9	0.1-9.5	6	5.7	2.5-12.2	0.519
MMP protected by IRS	461	26.5	21.1-32.7	31	4.2	0.9-18.2	0	-	-	82	13.0	8.6-19.2	**<0.001**
MMP having wire screens on doors and windows	11	0.6	0.3-1.5	5	0.7	0.3-1.8	6	2.4	0.7-7.8	4	0.6	0.1-3.0	0.203
MMP using other recommended malaria preventive strategies	1132	65.1	56.3-72.9	654	89.1	84.0-92.7	220	88	80.9-92.7	563	89.1	84.3-92.6	**<0.001**

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

Forest goer characteristics

About one-third of the sample were forest goers (1082; 32%), of whom 56% were male (n=611). The average age of forest goers was 33.41 years (S.D. 11.44). A high proportion of forest goers worked in the rubber plantation (721; 67%); went to forest every night (635; 61%); and never used a mosquito net in the forest (924; 85%) (Table 13). The top reason for not using the net in the forest was working for the whole duration of the night (630; 67%). The three most used alternative measures to prevent malaria were mosquito coils (526; 49%), wearing long sleeves/trousers (409; 38%) and repellents (289; 27%).

Significantly more proportion of MMP in Thai -Cambodia region were forest goers compared to Thai-Myanmar region (p<0.01), but the use of ITN in the forest was consistently low in all border regions (Table 14). The differences in demographics, movement and living condition characteristics of forest goer MMP residing in four border region are presented in Annex-4.

FOREST GOERS

Findings from forest going MMPs

1082

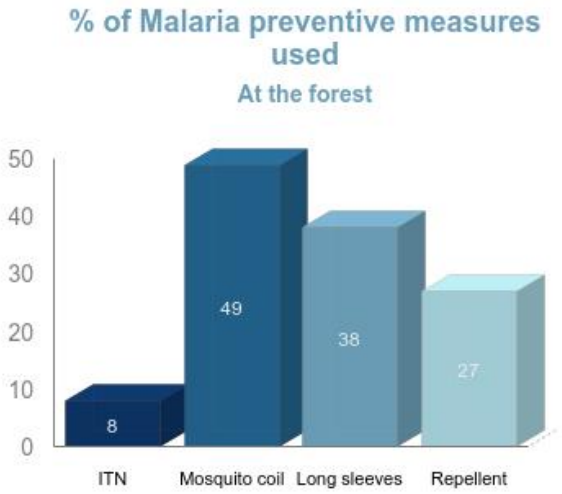
Total Number of Forest going MMP enrolled

56% Male
44% Female

67%
Rubber tappers

60%
Go to forest everyday

Number of forest goer MMPs enrolled at different regions



67%

Work all night

Most common reason for not using net in the forest

Table 13. Key findings among Forest goers (n=1082)

Characteristic	N	%
Geographical region (Border)		
Thai-Myanmar	361	33.36
Thai-Cambodia	394	36.42
Thai-Laos	51	4.71
Thai-Malaysia	276	25.51
Reasons for going to the forest/plantation/garden/farm and staying overnight		
Rubber planting/tapper	721	66.70
Picking forest products/hunting	139	12.86
Accommodation is in the forest	138	12.77
Gardening/farming	63	5.83
Fishing	47	4.35
Hunting	22	2.04
Logging	16	1.48
Other employment	12	1.11
Soldier/ranger	9	0.83
For holiday	9	0.83
Travel through	5	0.46
Cowman	5	0.46
Fruit farming	4	0.37
Toilet	2	0.19
Frequency of going to the forest at night		
Every day	635	60.63
Every week	310	28.65
Every month	66	6.10
< once/month	45	4.16
No answer	5	0.46
Use of net in the forest at night		
Every time/night	142	13.12
Sometimes	14	1.42
Never	924	85.4
No answer	2	0.18
Type of net used in the forest (n=156)		
LLINs brand		
Yorkool	38	24.36
Olyset	18	11.54
Permanet	11	7.05
Don’t know LLINs brand	6	3.85

DawaPlus	5	3.21
Hammock brand		
Don't know hammock	6	3.85
Yorkool	4	2.56
DawaPlus	2	1.28
Olyset	1	0.64
Conventional net	59	37.82
Tent	1	0.64
Do not know	5	3.21
Use of ITN in the forest at night among all forest goer (n=1082)		
Every time/night	87	8.04
Sometimes	3	0.28
Never	992	91.68
Frequency of using ITN in the forest among those who have ITN (n=432)		
Every night	87	20.14
Sometimes	3	0.69
Never	342	79.17
Frequency of using LLIHN in the forest among those having8 LLIHN (n=100)		
Every night	12	12.00
Sometimes	1	1.00
Never	87	87.00
Duration of net ownership (n=156)		
<6 months	67	42.95
6 months to 1 year	38	24.36
>1 year to 2 years	33	21.15
> 2 year to 3 years	10	6.41
> 3 years	5	3.21
Do not know	3	1.92
Time since the net was last soaked in a liquid (n=156)		
<6 months	1	0.64
Don't remember	148	94.87
Not soaked since receipt	7	4.49
Reasons for using net in the forest (n=156)		
Repel mosquitoes	108	69.23
Prevent malaria	17	10.90
Kill other insects	9	5.77
Kill mosquitoes	7	4.49

No answer / Do not know	7	4.49
Privacy	3	1.92
Protect family member	3	1.92
Others (convenient, stay in forest)	2	1.28
Reasons for not using nets in forest (n=940)		
Work all night	630	67.02
Net not available	92	9.77
Came back to sleep at home	67	7.11
Not easy to hang (place ,device, type)	57	6.05
No answer / Do not know	34	3.62
Did not use for sleeping	26	2.76
Use other prevention methods (coil, repellant, tent)	16	1.70
Saving for visitors or future use	9	0.96
Others (don't like, never use, rarely go to forest)	3	0.32
Feeling hot & uncomfortable	2	0.21
No mosquitoes	2	0.21
Time/effort to set up net	2	0.21
Net is too small	1	0.11
Net not in good condition	1	0.11
Other preventive measures used		
Mosquito coil	526	48.66
Wore long sleeves/long trousers	409	37.84
Repellent	289	26.73
Made smoke	174	16.10
None	81	7.49
Repellent insecticide impregnated clothing	9	0.83
Others (net (2), hammock (1) , fan (3) smash(1)	8	0.74
Do not know / No answer	4	0.37

Table 14. Differences in forest goer MMP's use of malaria preventive by border regions

Indicator	Thai-Myanmar			Thai-Cambodia			Thai-Laos			Thai-Malaysia			p-value*
	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI	
MMP who are forest-goers	361	20.7	14.9-28.1	394	53.7	30.0-75.8	51	20.4	8.6-41.2	276	43.7	26.5-62.5	**0.007**
Forest-goers using ITN or long lasting hammock net in the forest	25	6.9	3.8-12.1	42	10.6	4.2-24.3	5	9.8	3.8-22.7	18	6.5	1.6-23.0	0.301

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

Malaria case management

Fever and care-seeking behavior

Fever was reported by 15% of the participants (n=493) in the last three months, of whom 32 recalled having malaria (6.5%) (Table 15). More than half of those having fever sought treatment (259; 52.5%), primarily at a public hospital (187; 72%), mostly due to convenience (95; 37%). Most of the MMP who did not seek treatment at a medical facility, self-treated themselves (167; 71%). For the most frequently visited health facility, respondents reported a median distance of 3 km, a median travel time of 20 minutes, average travel cost of 97 THB (S.D. 193.29), and median waiting time of 30 minutes. Only 41% of those who went to health facility, sought treatment within 24 hours of fever.

Table 15. Fever and care-seeking behavior among MMP (n=493)

Characteristic	N	%
Type of fever		
Normal fever	258	52.33
Common cold/URI	174	35.29
Malaria (local terms)	32	6.49
Chronic disease	15	3.04
Influenza	14	2.84
Dyspepsia	9	1.83
Tonsillitis	8	1.62
Dengue fever	7	1.42
Other non-infectious disease	7	1.42
Bone/Joints pain	6	1.22
Don't know	6	1.22
Pneumonia/TB	2	0.41
Sought treatment for fever	259	52.54
Reasons/barriers for not getting treatment (n=234)		
Self-treated	167	71.37
Not severe	80	34.19
Waiting for self-cure	66	28.21
No money	11	4.70
No time	9	3.85
Treat with local traditional medicine	8	3.42
No health insurance	8	3.42
Health care facilities is too far	7	2.99
Do not know	7	2.99
Difficult to travel	5	2.14
No Vehicle	2	0.85
Need to work/no sick leave	2	0.85

Characteristic	N	%
Don't know where to go	1	0.43
First healthcare provider of choice for fever (n=259)		
Public hospital	187	72.20
Private clinic/hospital	23	8.88
MP/BMP	14	5.41
Malaria clinic	13	5.02
VHV/VMW	7	2.70
Health facility outside Thailand	7	2.70
Community health center	4	1.54
Vendor/market/shop	2	0.77
Drug store with license pharmacist	1	0.39
Home visit	1	0.39
Reasons for choosing the first healthcare provider (n=259)		
Convenience	95	36.68
The nearest place	77	29.73
Having insurance	22	8.49
Trust	16	6.18
Free/no insurance	9	3.47
Cheap	8	3.09
Good quality of drugs	7	2.70
Do not know other places	6	2.32
No need to wait	5	1.93
Suggested by others	3	1.16
Other (provide malaria test (1), staff for home visit(2))	3	1.16
Open longer hours (holiday/evening)	2	0.77
Variety of drugs	2	0.77
Taken their by employer	2	0.77
Staff speak same language	1	0.39
No answer	1	0.39
Health facility visited the most:		
Distance to health facility (in km)		
Mean: 11.26, S.D.: 22.,2, Median: 3, Range: 0-200		
Travel time taken (in minutes)		
Mean: 33.71, S.D.: 36.76, Median: 20, Range: 0-240		
Average Travel cost (in baht)		
Mean: 97.04, S.D.: 193.29, Median:40; Range: 0-1,100		
Average Waiting time at the health facility (min)		

Characteristic	N	%
Mean:52.12, S.D.: 65.28, Median: 30, Range: 0-480		
Interval of seeking care after fever occurrence		
Within 24 hours	107	41.31
Within 48 hours	87	33.59
Three or more days	58	22.39
Don't know	7	2.70

Malaria testing and treatment among MMP who had fever

Half of the MMP members who sought treatment for fever got a blood test for malaria (132; 51%), mostly a rapid diagnostic test (RDT) (110; 83%), at a public hospital (79; 60%) (Table 16). Only 15% of those that were tested (20/132) were reported to be positive for malaria infection, though the majority of respondents did not report on the type of malaria they had (14, 70%). All malaria positive cases were treated with anti-malarial drugs. Most of the MMP respondents who were treated for malaria received anti-malarial drugs three or more days after the start of fever (12; 57%) and within 24 hours of malaria blood testing (15; 71%). Most of them took full dose of prescribed drugs (17; 81%) and more than half of them went for all follow-up visits (12; 57%). Five of the MMP had to pay an average of 108 THB (S.D. 119.45) for malaria services.

Table 16. Malaria testing and treatment among MMP who had fever (n=259)

Characteristic	N	%
Had a blood test for malaria	132	50.97
Type of malaria test done		
RDT	110	83.33
Slide	15	11.36
Cannot remember	7	5.30
Facility where malaria test was done		
Public hospital	79	59.85
Malaria clinic	18	13.64
MP/BMP	18	13.64
Private clinic/hospital	7	5.30
Health facility outside Thailand	4	3.03
VHV/VMW	3	2.27
Mobile clinic by public health staff	2	1.52
Don't know	1	0.76
Result of malaria test		
Negative	109	82.58

Characteristic	N	%
Positive	20	15.15
Don’t know	3	2.27
Type of malaria reported (n=20)		
No answer	14	70.00
Not told species	2	10.00
Falciparum	2	10.00
Vivax	1	5.00
Mix (F&V)	1	5.00
Received treatment		
No	230	88.80
Yes	21	8.11
No answer / Do not know	8	3.09
Drug prescribed for malaria		
Can’t remember antimalarial drug	19	90.48
Not sure / Don't know	2	9.52
Received anti-malarial drugs at		
Public hospital	8	38.10
Malaria clinic	4	19.05
MP/BMP	4	19.05
Health facility (abroad)	3	14.29
VHV	1	4.76
Don’t know	1	4.76
Time interval of getting drugs from the start of fever		
Within 24 hours	4	19.05
Within 48 hours	5	23.81
Three or more days	12	57.14
Time interval of getting drugs after malaria blood testing		
Within 24 hours	15	71.43
Within 48 hours	3	14.29
Three or more days	2	9.52
Don’t know	1	4.76
Took all dose of the prescribed drugs		
Yes	17	80.95
No / Cannot remember	3	14.28
Still taking drug	1	4.76

Characteristic	N	%
Took drugs under DOT		
Some doses	12	57.14
Don't know / Cannot remember	4	19.05
No	3	14.29
All doses	2	9.52
Follow-up appointment		
Went to all follow up visit	12	57.14
Did not go to any follow up visit	5	23.81
Went for some follow up visits	3	14.29
Cannot remember	1	4.76
Reasons for not attending follow-up visits		
No appointment date/resolved	2	22.22
Waiting for self-cure	1	11.11
Self-treated	1	11.11
No money	1	11.11
Not severe	1	11.11
No time	1	11.11
Need to work/no sick leave	1	11.11
Travel to home country	1	11.11
Payment for malaria services		
Malaria testing and treatment were free	16	76.19
Had to pay for treatment only	2	9.52
Had to pay for both testing and treatment	2	9.52
Had to pay but covered by insurance or employer	1	4.76
Amount paid (baht)		
Mean 108: S.D. 119.45: Median 40: Range: 20-300		
Second healthcare provider sought		
Public hospital	22	84.62
Private clinic/hospital/drug store/vendor	2	7.69
Malaria clinic	1	3.85
MP/BMP	1	3.85
Reasons for going to second provider		
Not getting better	6	23.08
Getting additional medicine	6	23.08
Symptoms getting worse	5	19.23

Characteristic	N	%
Other (for underlying disease, get free test, health facility is too far, staff complained for coming many times)	4	15.38
Wanting to change medicine	2	7.69
Confirm diagnosis	2	7.69
Do not know	1	3.85

Access to malaria case management

Nearly 93% (n=3121) of the MMP had experience of using healthcare services in Thailand, and 90% of them (n=2795) were satisfied with the overall health and malaria services they were receiving. Health facilities that provided malaria services were found to be accessible in terms of distance by 60% of MMPs (n=1873) and in terms of travel duration by 58% (n=1803) (Table 17). Most of the MMP were satisfied with the ease with which they could avail the services (2515; 81%); 65% were satisfied with the availability of malaria tests and drugs (n=2036); but only 38% were happy with the waiting time at the facility (n=1191). Around 60% of the MMP were satisfied with the cost of testing, drugs and travel to the health facility; and 85% found the health facilities acceptable in terms of religion, culture or gender. About 83-92% were happy with the opening hours of the facility, medical ability of the healthcare workers, quality of care, and interpersonal care they receive from the healthcare workers at the facility. Only 65% (n=1345) were aware that malaria testing and treatment were provided free of charge for them in Thailand. The averaged summary scores of dimensions of access of MMP to malaria case management are presented in figure 4.

Construct	Perceived Satisfaction with	Satisfied		Neutral		Unsatisfied	
		n	%	n	%	n	%
Accessibility	Travel distance to health facility	1873	60.01	250	8.01	998	31.98
	Travel time to reach health facility	1803	57.77	312	10.00	1006	32.23
Availability	Ease to get service	2515	80.58	254	8.14	352	11.28
	Malaria testing and drugs availability	2036	65.24	837	26.82	248	7.95
	Waiting time at health facility	1191	38.16	849	27.20	1081	34.64
Affordability	Cost of malaria testing	1892	60.62	882	28.26	347	11.12
	Anti-malarial drugs cost	1849	59.24	910	29.16	362	11.60
	Travel cost to health facility	1957	62.70	591	18.94	573	18.36
Acceptability	Religious/Cultural concerns	2652	84.97	376	12.05	93	2.98
	Gender preference of HCW	2672	85.61	336	10.77	113	3.62
Accommodation	Opening hours of health facility	2599	83.27	307	9.84	215	6.89
	Medical ability of HCW	2873	92.05	118	6.02	60	1.92

	Quality of care	2848	91.25	217	6.95	56	1.79
	Interpersonal treatment from HCW	2831	90.71	221	7.08	69	2.21
Awareness	Provision of free malaria testing and treatment in Thailand	1345	64.94	308	14.87	418	20.18
Overall	Overall satisfaction towards existing health and malaria care services	2795	89.55	280	8.97	46	1.47

Table 17. Dimensions of Access to healthcare among MMP

**HCW: Healthcare workers*

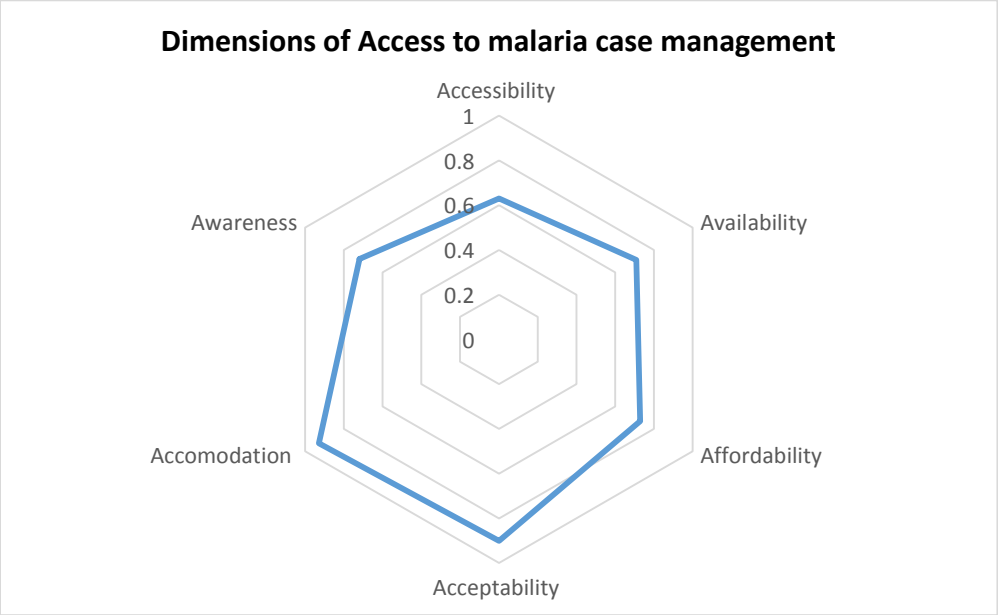


Figure 4. Summary score chart for dimensions of access to malaria case management

Improvements needed for increasing access to malaria case management

The MMPs suggested a number factors that might improve their access to malaria case management in Thailand (Table 18). The most frequent suggestions were to provide the services by a mobile clinic (1019; 30%) and make the services cheaper or free (855; 25%).

Table 18. Suggestions by MMP for improving access to malaria case management

Factor	N	%
Mobile clinic	1,019	30.36
Free/cheaper	855	25.48
Provide health insurance/documentation /social security	533	15.88
Having migrant health workers at worksite	329	9.80
Improve quality service	323	9.62
Transportation support	296	8.82
Longer opening hours	288	8.58
High wages	100	2.98
More health care provider (number, quality, friendly)	95	2.83
Special treatments and medicines	73	2.18
Worksite health provisions	53	1.58
Translation service	34	1.01
More medical devices and equipment	26	0.77
Having sick leave	20	0.60
Provide prevention intervention (IRS, Net)	14	0.42
Provide health education (sanitation, malaria, access to care)	12	0.36

Comparison by border region

Proportions of MMP seeking treatment for fever in last three months were not different among the four regions, however, MMP in Thai-Myanmar region were more likely to get a blood test for malaria than in Thai-Cambodia or Thai-Laos border regions (Table 19). All MMP with positive malaria tests received anti-malarial drugs (8 in Thai-Myanmar, 6 in Thai-Cambodia, and 7 in Thai-Malaysia).

Table 19. Differences in MMP's access to malaria case management by border regions

Indicator	Thai-Myanmar			Thai-Cambodia			Thai-Laos			Thai-Malaysia			p-value*
	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI	
MMP with fever in the last three months who sought treatment	131	60.1	51.9-67.8	67	46.9	36.8-57.2	18	48.6	37.8-59.7	43	45.3	33.7-57.4	0.060
MMP with fever in the last three months who had a malaria test	84	64.1	53.7-73.4	24	35.8	22.1-52.4	4	22.2	11.4-38.9	20	46.5	30.7-63.1	**0.001**

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

In terms of dimensions of access, MMP in Thai-Myanmar region reported higher awareness, availability, and affordability of malaria case management (Figure 6). Accessibility to malaria care services was reported highest in Thai-Laos region and lowest in Thai-Cambodia region. MMP in Thai-Malaysia border reported lower availability and awareness. Scores for accommodation and acceptability were similar in all four regions.

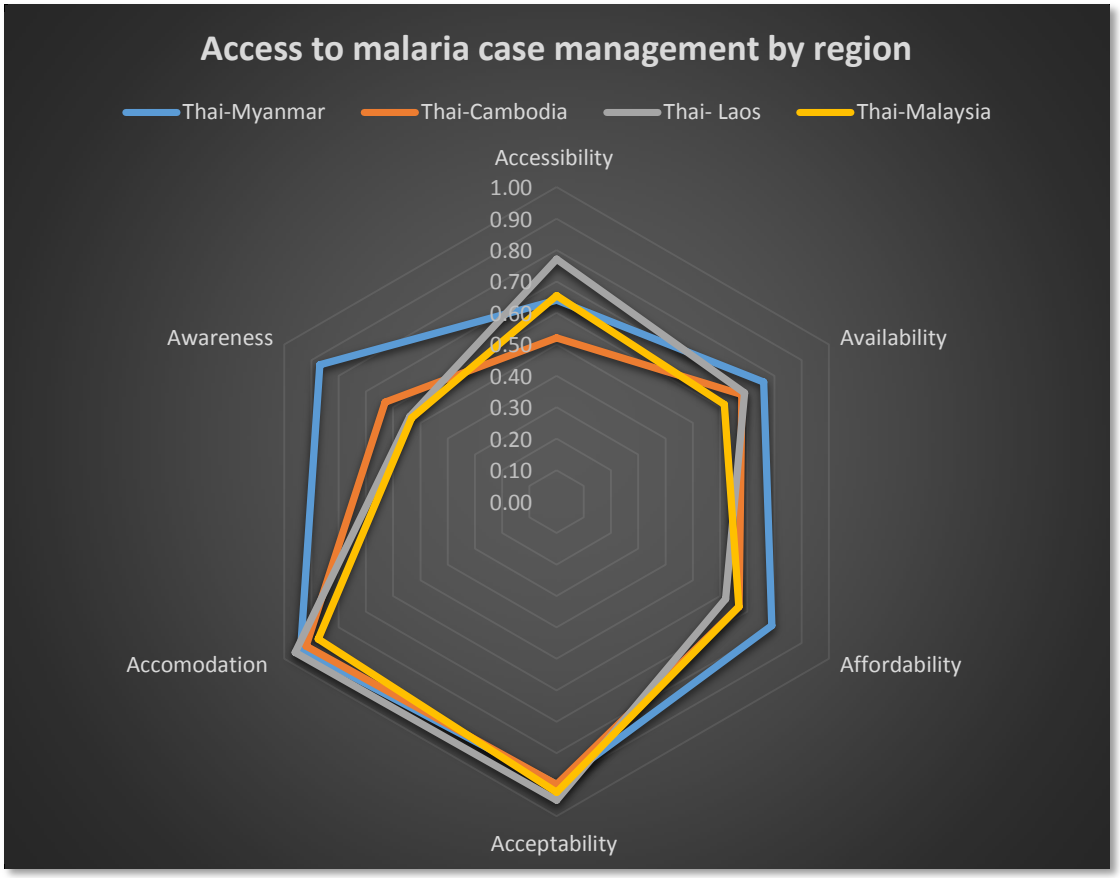


Figure 5. Dimensions of access of malaria case management by region

Key Indicators by gender

When disaggregated by gender, there were some differences seen in the key indicators of the study (Table 20). Males were more likely to have attended school, work more as construction and security workers, and earn relatively higher than females. On the other hand, female MMP were more likely to be living with their families, have health insurance, have better attitudes towards malaria prevention, own more ITN, and seek treatment for fever at a health center. Male MMP were more likely to be tested for malaria and be diagnosed with malaria.

Table 20. Key differences by gender

Factor	Male (n=1458)		Female (n=1898)		p-value*
	n (%)	95% CI	n (%)	95% CI	
Education					**<0.001**
never attend school	569 (39.0)	34.0, 44.3	945 (49.8)	44.3, 55.3	
till primary school	672 (46.1)	41.7, 50.5	739 (38.9)	34.4, 43.6	
secondary school	217 (14.9)	12.0, 18.3	214 (11.3)	9.5, 13.3	
Occupation					**<0.001**
Wage laborer	526 (36.1)	28.7, 44.2	663 (34.9)	27.7, 42.9	
Jobless	29 (2.0)	1.2, 3.3	173 (9.1)	6.2, 13.3	
Visitor/household worker	30 (2.1)	1.1, 3.9	72 (3.8)	1.9, 7.6	
Security	18 (1.2)	0.2, 7.7	0	0	
Construction	123 (8.4)	5.0, 13.9	57(3.0)	1.9, 4.7	
Seasonal worker	341 (23.4)	16.9, 31.5	597 (31.5)	24.5, 39.4	
Forest worker	391 (26.8)	18.4, 37.4	336 (17.7)	11.5, 26.3	
Income/month					**<0.001**
1-3000 THB	253 (18.0)	13.3, 23.9	624 (36.8)	30.6, 43.4	
3001-6000 THB	384 (27.3)	22.2, 33.0	593 (35.0)	30.0, 40.2	
6001-10000 THB	405 (28.8)	23.9, 34.3	334 (19.7)	15.4, 24.9	
> 10000 THB	364 (25.9)	19.2, 33.9	145 (8.5)	5.7, 12.5	
Have health insurance					**<0.001**
Yes	651 (44.7)	38.5, 51.0	998 (52.6)	45.7, 59.4	
No	807 (55.3)	49.0, 61.5	900 (47.4)	40.6, 54.3	
Living with					**<0.001**
Live alone	161 (11.0)	8.5, 14.3	57 (3.0)	2.2, 4.1	
Live with others but not family	149 (10.2)	7.0, 14.7	35 (1.8)	1.2, 2.7	
Live with family	1148 (78.7)	73.5, 83.2	1806 (95.2)	93.7, 96.3	
Overall Malaria Knowledge					0.065
Low	616 (42.2)	37.2, 47.4	724 (38.1)	33.7, 42.8	
Fair	192 (13.2)	11.6, 14.9	242 (12.8)	11.0, 14.8	

Factor	Male (n=1458)		Female (n=1898)		p-value*
	n (%)	95% CI	n (%)	95% CI	
High	650 (44.6)	39.5, 49.8	932 (49.1)	44.5, 53.7	
Perceived Susceptibility					**0.006**
Low	253 (29.3)	24.6, 34.5	267 (22.4)	18.7, 26.5	
High	611 (70.7)	65.5, 75.4	925 (77.6)	73.5, 81.3	
Perceived Severity					**0.002**
Low	196 (22.7)	19.3, 26.5	202 (16.9)	14.4, 19.8	
High	668 (77.3)	73.5, 80.7	990 (83.1)	80.2, 85.6	
Perceived Benefits					**<0.001**
Low	271 (31.6)	26.3, 37.4	268 (22.5)	18.2, 27.4	
High	591 (68.4)	62.6, 73.7	924 (77.5)	72.6, 81.8	
Perceived Barriers					0.411
Low	659 (76.3)	72.0, 80.1	886 (74.3)	69.9, 78.3	
High	205 (23.7)	19.9, 28.0	306 (25.7)	21.7, 30.1	
Cues to action					**0.204**
Low	1108 (76.0)	71.1, 80.3	1392 (73.3)	69.5, 76.8	
High	350 (24.0)	19.7, 28.9	506 (26.7)	23.2, 30.5	
Have ITN (including LLIHN)					**0.007**
yes	508 (34.8)	29.0, 41.1	797 (42.0)	36.2, 48.0	
no	950 (65.2)	58.9, 71.0	1101 (58.0)	52.0, 63.8	
Use ITN					**0.001**
Every night	477 (32.7)	27.4, 38.6	769 (40.5)	35.0, 46.3	
No/ not every night	981 (67.3)	61.4, 72.6	1129 (59.5)	53.7, 65.0	
Use of ITN among those who own ITN					0.061
yes	477 (93.9)	90.4, 96.2	769 (96.5)	94.7, 97.7	
no	31 (6.1)	3.8, 9.6	28 (3.5)	2.3, 5.3	

Factor	Male (n=1458)		Female (n=1898)		p-value*
	n (%)	95% CI	n (%)	95% CI	
Forest goer					**<0.001**
yes	611 (41.9)	33.7, 50.6	471 (24.8)	18.3, 32.7	
no	847 (58.1)	49.4, 66.3	1427 (75.2)	67.3, 81.7	
Use ITN/LLIHN in forest (n=1082)					0.798
yes	52 (8.5)	4.8, 14.8	38 (8.1)	4.6, 13.7	
no	559 (91.5)	85.2, 95.2	433 (91.9)	86.3, 95.4	
MMP with fever in the last three months who sought treatment (n=493)					**0.018**
No	109 (54.0)	46.9, 60.9	125 (43.0)	36.6, 49.5	
Yes	93 (46.0)	39.1, 53.1	166 (57.0)	50.5, 63.4	
MMP with fever in the last three months who had a malaria test (n=259)					**0.049**
No	38 (40.9)	30.7, 51.8	89 (53.6)	44.0, 62.9	
Yes	55 (59.1)	48.2, 69.3	77 (46.4)	37.1, 56.0	
MMP with fever in the last three months who had a positive malaria test (n=132)					**0.026**
Negative	40 (72.7)	58.1, 83.7	69 (89.6)	79.4, 95.1	
Positive	14 (25.5)	14.8, 40.1	6 (7.8)	2.9, 19.1	
Don't know	1 (1.8)	0.2, 13.0	2 (2.6)	0.6, 10.0	

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

Differences between M1 and M2 migrants

Compared to M1, M2 migrants were more likely to be undocumented and highly mobile (more frequent travel to home country (Table 21). M2 migrants were also more likely to be younger (15-24 years); male; have school education; living alone; own ITN; have received ITN from CSOs; have higher perceived barriers of sleeping under ITN; and report lower satisfaction with affordability, accommodation, and less awareness of malaria care services than M1 migrants.

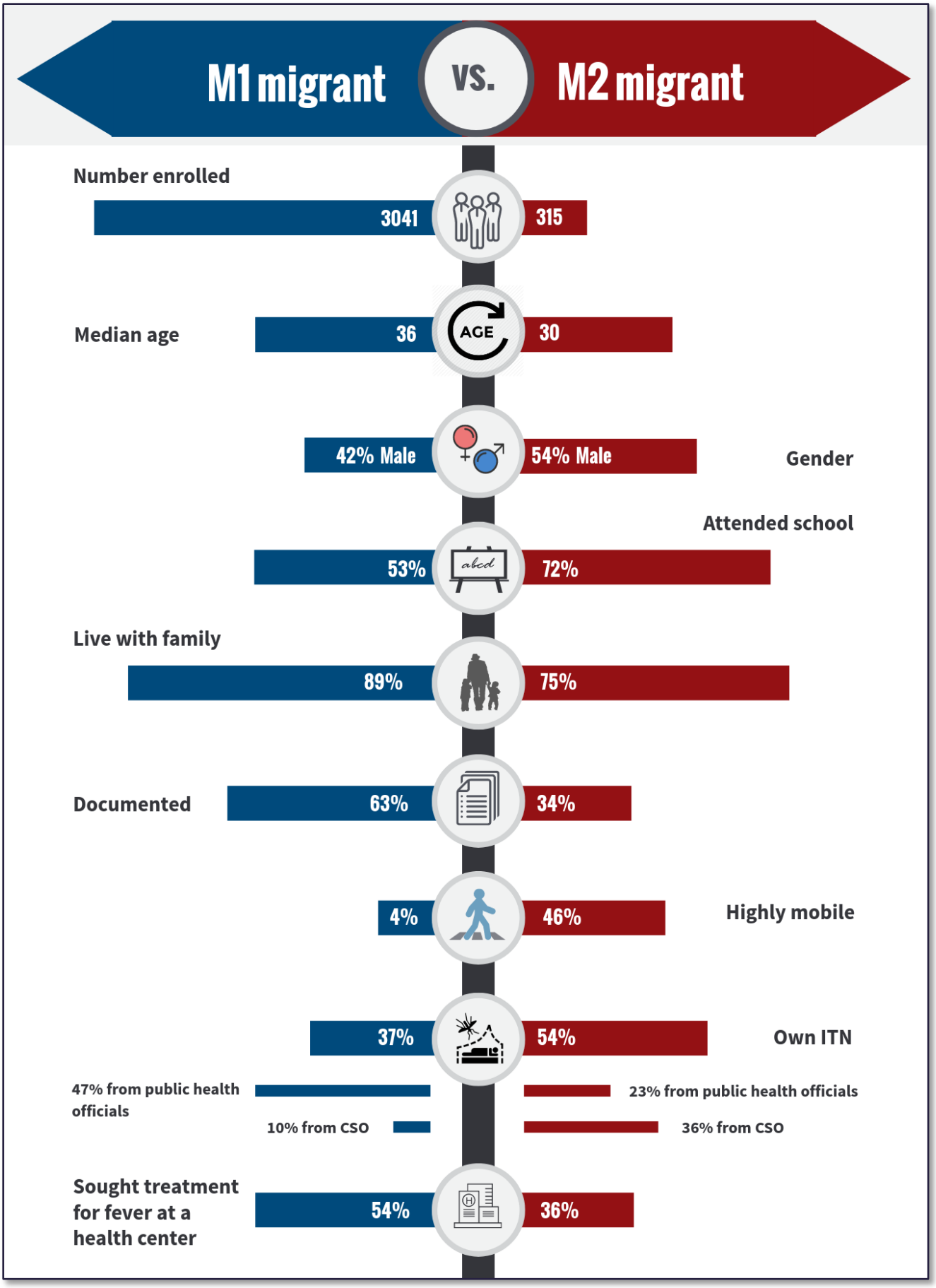

M1 migrant
VS.
M2 migrant
Number enrolled
3041
315
Median age
36
AGE
30
42% Male
54% Male
Gender
Attended school
53%
abcd
72%
Live with family
89%
75%
Documented
63%
34%
4%
46%
Highly mobile
37%
54%
Own ITN
47% from public health officials
23% from public health officials
10% from CSO
36% from CSO
Sought treatment for fever at a health center
54%
36%

Table 21. Differences between M1 and M2 migrants

Factor	Migrant classification				p-value*
	M1		M2		
	n (%)	95% CI	n (%)	95% CI	
Age group					**0.013**
15 - 24 years	598 (19.66)	17.52, 22.00	95 (30.16)	21.22, 40.91	
25-64 years	2291 (75.34)	73.23, 77.42	215 (68.25)	58.05, 76.96	
>65 years	152 (5)	3.78, 6.59	5 (1.59)	0.53, 4.68	
Sex					**0.002**
Male	1288 (42.35)	38.60, 46.19	170 (53.97)	46.57, 61.19	
Female	1753 (57.65)	53.81, 61.40	145 (46.03)	38.81, 53.43	
Geographical region (Border)					0.229
Thai-Myanmar	1598 (52.55)	42.46, 61.44	134 (42.54)	19.73, 69.04	
Thai-Cambodia	614 (20.19)	13.38, 29.29	120 (38.10)	16.79, 65.24	
Thai-Laos	245 (8.06)	4.48, 14.07	5 (1.59)	0.31, 7.64	
Thai-Malaysia	548 (19.20)	13.83, 26.03	48 (15.24)	5.39, 36.19	
Nationality					**0.001**
Myanmar	1582 (52.02)	42.16, 61.44	134 (42.54)	19.73, 69.04	
Lao	331 (10.88)	6.71, 17.18	10 (3.17)	0.99, 9.68	
Cambodia	472 (15.52)	9.00, 25.45	125 (39.68)	17.69, 66.82	
Malaysia	2 (0.07)	0.02, 0.27	17 (5.40)	0.71, 31.25	
No citizenship	654 (21.51)	14.97, 29.89	29 (9.21)	2.87, 25.80	
Religion					0.643
Buddhism	2599 (85.47)	78.63, 90.38	277 (87.94)	67.87, 96.18	
Islam	71 (2.33)	1.46, 3.71	16 (5.08)	0.76, 27.10	
Christian	277 (9.11)	5.47, 14.78	22 (6.98)	2.20, 20.06	
Others	94 (3.09)	1.12, 8.24	0	0	
Education					**<0.001**
never attend school	1427 (46.93)	41.84, 52.07	87 (27.62)	19.52, 37.52	
till primary school	1250 (41.10)	36.89, 45.46	161 (51.11)	43.43, 58.74	
secondary school	364 (11.97)	10.50, 13.62	67 (21.27)	14.16, 30.67	
Occupation					**0.003**
Wage laborer	1098 (36.11)	29.07, 43.80	91 (28.89)	16.68, 45.19	
Jobless	193 (6.35)	4.34, 9.42	9 (2.86)	1.07, 7.38	
Visitor/household worker	89 (2.93)	1.69, 5.04	13 (4.13)	0.73, 20.07	
Security	0	0	18 (5.71)	0.85, 30.04	
Construction	173 (5.69)	3.50, 9.13	7(2.22)	0.59, 8.01	

Factor	Migrant classification				p-value*
	M1		M2		
	n (%)	95% CI	n (%)	95% CI	
Seasonal worker	841 (27.0)	21.01, 33.95	117 (37.14)	17.67, 61.93	
Forest worker	667 (21.93)	14.61, 31.56	60 (19.05)	9.87, 33.58	
Income/month					0.465
1-3000 THB	819 (29.09)	23.46, 35.45	61 (20.54)	12.72, 31.43	
3001-6000 THB	874 (31.16)	26.46, 36.28	103 (34.68)	27.21, 42.99	
6001-10000 THB	661 (23.57)	19.08, 28.73	78 (26.26)	18.49, 35.87	
> 10000 THB	454 (16.19)	11.71, 21.95	55 (18.52)	8.47, 35.81	
Documentation Status					**0.016**
Documented	1894 (63.07)	55.73, 69.85	106 (33.67)	16.08, 58.01	
Undocumented	1109 (36.93)	30.15, 44.27	206 (66.03)	41.99, 83.92	
Thai language skill					0.081
can speak or read	932 (30.65)	24.95, 37.00	61 (19.37)	11.11, 31.58	
can't speak or read	2109 (69.35)	63.00, 75.05	254 (80.63)	68.42, 88.89	
Forest goer					0.559
Yes	964 (31.70)	24.30, 40.16	118 (37.46)	20.56, 58.09	
No	2077 (68.30)	59.84, 75.70	197 (62.54)	41.91, 79.44	
Have health insurance					0.321
Yes	1517 (49.88)	43.40, 56.37	132 (41.90)	27.33, 58.05	
No	1524 (50.12)	43.63, 56.60	183 (58.10)	41.95, 72.67	
Frequency of visit to home country					**<0.001**
Never	1626 (53.47)	48.47, 58.40	152 (48.25)	28.12, 68.97	
More frequent (at least once in 6 months)	117 (3.85)	2.68, 5.49	146 (46.35)	25.27, 68.81	
Less frequent (less than once in 6 months)	1298 (42.68)	38.03, 47.47	17 (5.40)	2.68, 10.58	
Living with					**0.003**
Live alone	177 (5.82)	4.64, 7.29	41 (13.02)	7.81, 20.90	
Live with others but not family	146 (4.8)	3.64, 6.30	38 (12.06)	4.84, 26.99	
Live with family	2718 (89.38)	87.18, 91.23	236 (74.92)	62.40, 84.32	
Family with pregnant woman					0.706
No	2921 (96.83)	95.54, 97.11	305 (96.83)	94.07, 98.32	
Yes	109 (3.60)	2.89, 4.46	10 (3.17)	1.68, 5.93	

Factor	Migrant classification				p-value*
	M1		M2		
	n (%)	95% CI	n (%)	95% CI	
Family with children age < 5 years					0.091
No	1957 (64.65)	61.65, 67.62	231 (73.57)	62.62, 82.22	
Yes	1070 (35.35)	32.38, 38.44	83 (26.43)	17.78 ,37.38	
Overall Malaria Knowledge					0.774
Low	1221 (40.15)	35.99, 44.46	119 (37.78)	24.39, 53.33	
Fair	387 (12.73)	11.20, 14.43	47 (14.92)	10.50, 20.77	
High	1433 (47.12)	42.94, 51.35	149 (47.30)	33.64, 61.38	
Perceived Susceptibility					0.112
Low	485 (26.15)	22.57, 30.07	35 (17.41)	10.01, 28.56	
High	1370 (73.85)	69.93, 77.43	166 (82.59)	71.44, 89.99	
Perceived Severity					0.784
Low	357 (19.25)	16.63, 22.16	41 (20.40)	13.50, 29.62	
High	1498 (89.75)	77.84, 83.37	160 (79.60)	70.38, 86.50	
Perceived Benefits					0.218
Low	500 (26.95)	22.48, 31.95	41 (20.40)	12.35, 31.80	
High	1355 (73.05)	68.05, 77.52	160 (79.60)	68.20, 87.65	
Perceived Barriers					**<0.001**
Low	1431 (77.14)	74.03, 79.98	114 (56.72)	44.24, 68.39	
High	424 (22.86)	20.02, 25.97	87 (43.28)	31.61, 55.76	
Cues to action					0.280
Low	2281 (75.01)	71.33, 78.36	219 (69.52)	57.57, 79.32	
High	760 (24.99)	21.64, 28.67	96 (30.48)	20.68, 42.43	
Have ITN (including LLIHN)					**0.043**
yes	1135 (37.32)	32.21, 42.74	170 (53.97)	37.58, 69.55	
no	1906 (62.68)	57.26, 67.79	145 (46.03)	30.45, 62.42	
Use ITN					0.066
Every night	1086 (35.71)	30.87, 40.86	160 (50.79)	34.53, 66.89	
No/ not every night	1955 (64.29)	59.14, 69.13	155 (49.21)	33.11, 65.47	
Source of Net					**<0.001**
Free from public health staff	1327 (47.21)	41.27, 53.23	65 (23.05)	13.12, 37.27	
Free by CSOs	280 (9.96)	6.23, 15.54	101 (35.82)	18.17, 58.37	

Factor	Migrant classification				p-value*
	M1		M2		
	n (%)	95% CI	n (%)	95% CI	
Received from community people	101 (3.59)	2.10, 6.08	10 (3.55)	1.33, 9.10	
Purchased	1103 (39.24)	32.63, 46.26	106 (37.59)	24.22, 53.16	
Duration of receipt of net					**<0.001**
< 1 Year	1710 (60.68)	56.20, 64.99	264 (93.29)	88.99, 95.98	
1 year to 2 years	695 (24.66)	22.13, 27.39	12 (4.24)	2.17, 8.13	
2 years to 3 years	284 (10.08)	8.06, 12.53	6 (2.12)	0.96, 4.63	
> 3 years	129 (4.58)	3.42, 6.10	1 (0.35)	0.05, 2.69	
Enough net in Household					0.355
No	459 (16.89)	14.22, 19.94	45 (19.07)	15.11, 23.77	
Yes	2259 (83.11)	80.06, 85.78	191 (80.93)	76.23, 84.89	
Net condition					0.067
Not good	526 (18.65)	15.98, 21.65	39 (13.49)	9.31, 19.17	
Good	2294 (81.35)	78.35, 84.02	250 (86.51)	80.83, 90.69	
MMP with fever in the last three months who sought treatment					0.056
No	206 (45.88)	40.46, 51.39	28 (63.64)	46.01, 78.23	
Yes	243 (54.12)	48.61, 59.54	16 (36.36)	21.77, 53.99	
MMP with fever in the last three months who had a malaria test					0.623
No	120 (49.38)	41.08, 57.72	7 (43.75)	24.38, 65.23	
Yes	9 (56.25)	34.77, 75.62	123 (50.62)	42.28, 58.92	
Accessibility					0.165
Low	1295 (45.15)	39.95, 50.47	130 (51.38)	42.44, 60.24	
High	1573 (54.85)	49.53, 60.05	123 (48.62)	39.76, 57.56	
Availability					0.144
Low	896 (31.24)	27.77, 34.93	90 (35.57)	30.14, 41.44	
High	1972 (68.76)	65.07, 72.23	163 (64.43)	58.56, 69.89	
Affordability					**0.026**
Low	1116 (38.91)	35.31, 42.64	125 (49.41)	40.20, 58.66	
High	1752 (61.09)	57.36, 64.69	128 (50.59)	41,43, 59.80	
Acceptability					0.212
Low	516 (17.99)	15.28, 21.06	56 (22.13)	15.78, 30,13	

Factor	Migrant classification				p-value*
	M1		M2		
	n (%)	95% CI	n (%)	95% CI	
High	2352 (82.01)	78.94, 84.72	197 (77.87)	68.87, 84.22	
Accommodation					**<0.001**
Low	661 (23.05)	20.58, 25.71	91 (35.97)	29.23, 43.31	
High	2207 (76.95)	74.29, 79.42	162 (64.03)	56.69, 70.77	
Awareness					**<0.001**
Low	630 (33.71)	29.37, 38.33	96 (47.52)	40.65, 54.49	
High	1239 (66.29)	61.67, 70.63	106 (52.48)	45.51, 59.35	

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

Case study – Maniq Tribe

One of the highlights of this survey is the inclusion of different ethnic minority MMP groups who have not been previously studied in malaria prevention research, such as the tribal Maniq people. Maniq are physically and culturally different group of people than Thai and other MMP in Thailand. They are an indigenous, Negrito, nomadic, mostly forest-dwelling tribe living in remote areas near the Thai-Malaysia border - some accessible only by a boat. While most Thai people refer to them as "Sakai", the term often had derogatory connotations of inferiority and slavery in the past, and therefore these tribal people do not like to be called as Sakai. The Maniqs who lived deep in the forest were still hunter-gatherers, but the ones who lived closer to the mainland had found it more acceptable to work with the local farmers for small wages. Eighty Maniq people were enrolled in the study from different clusters of Narathiwat and Yala province. All of them were M1 migrants, without documentation.

Most of the Maniq MMP were born in Thailand (n=75, 94%); had no formal religion, but worshipped their ancestral spirits (n=72, 90%), had never attended school (n=79, 99%), lived in temporary forest shelters (n=78, 98%), did not speak Thai language (n=57, 71%), worked as wage laborers (n=73, 91%), earned less than 3000 THB per month (n=46, 58%), and had no insurance (n=66, 83%).

Ten Maniq individuals reported of fever in the last three months. One sought treatment at malaria clinic and two with VHV. All 3 got tested for malaria: 2 were positive and both received anti-malarial drugs.

Inside the forest shelter of a Maniq tribal family

Characteristic	n	%
Age group		
15-24 years	47	58.75
25-64 years	33	41.25
Sex		
Male	41	51.25
Female	39	48.75
Religion		
Buddhism	6	7.50
Islam	2	2.50
No formal religion	72	90.00
Occupation		
Wage laborer	73	91.25
Seasonal worker	2	2.50
Forest worker	5	6.25
Income		
1-3000 THB	46	57.50
3001-6000 THB	12	15.00
6001-10000 THB	5	6.25
>10000 THB	4	5.00
No answer	13	16.25
Knowledge of malaria		
Low	49	61.25
Fair	11	13.75
High	20	25.00
ITN Use	8	10.00
Fever in last 3 months	10	12.50
Sought treatment	3	30.00

ITN was used by only 8 of them. When asked about ITN use, a Maniq headman explained that when they sleep, they place their heads outside the shelter such that in case of an attack by a wild animal at night, their heads would be bitten off first – they would rather be dead than alive with a disability that impairs their normal livelihood. And if someone in the tribe died, the whole community would migrate to another location leaving the dead body behind without cremation.

Traditionally, Maniq used to wear minimal clothing in the forest. But some have now accepted the clothes handed down to them and wear mostly t-shirt and shorts/pants. Maniq people were noticeably shy and avoided strangers from outside their tribe. The eldest male, the headman, was responsible for most of the communication with Thai authorities and outsiders.

A typical Maniq female with short curly hair, dark skin, short stature and shy nature

Young Maniq boys finding it exciting to see themselves on a tablet device screen

Maniq Tribe

MMP sub-group in focus

Maniq are small groups of Negrito hunter-gatherers

99% of the sampled Maniq MMP have never gone to school

60% earn below the national poverty line of $3.2 per day

Living in the forests near the Thai-Malaysia Border

Hard to reach

No access by road, needed to take a boat to reach the forest they were living in

Determinants of ITN use

While nearly 94% of the total sample owned mosquito nets, the coverage of ITN was only about 39%. Those who had an ITN were likely to use it as indicated by the low behavioral gap. When ITN use was considered among the MMP who owned any type of mosquito nets, the determinants of ITN use (apart from having an ITN) were identified using a multivariable logistic regression model in each of the border region and also among the forest goers. The univariable analyses used for screening factors related to ITN use (demographic, mobility, living conditions, knowledge of malaria, HBM constructs for attitude towards malaria prevention and net details) are provided in the Annex-5. Findings from the multivariable models are presented below:

Thai-Myanmar Border region

MMP of Thai-Myanmar border region were less likely to sleep under an ITN if they were highly mobile (travel to home country more frequently) (Adjusted Odds Ratio [aOR] 0.29, 95% CI 0.14-0.59). Significant determinants of ITN use included high perceptions of benefits of ITN (aOR 1.85, 95% CI 1.29-2.65), high perceptions of barriers (aOR 1.43, 95% CI 1.05-1.94), and perceiving the net to be in good condition (aOR 3.11, 95% CI 1.91-5.07) (Table 22).

Table 22. Determinants of Utilization of ITN in Thai-Myanmar Border region among MMP having nets

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Demographic	**Nationality**			
	Myanmar	ref		
	No citizenship	0.79	0.55, 1.14	0.202
	Others	1.10	0.48, 2.53	0.815
	Education			
	never attend school	ref		
	till primary school	1.26	0.96, 1.63	0.089
	secondary school	1.32	0.81, 2.14	0.268
	Documentation Status			
	Documented	ref		
	Undocumented	0.97	0.69, 1.38	0.882
	Forest goer			
	yes	1.15	0.84, 1.56	0.382
	no	ref		
	Frequency of visit to home country			
	Never	ref		
	More frequent (at least once in 6 months)	0.29	0.14, 0.59	**0.001**

	Less frequent (less than once in 6 months)	0.82	0.57, 1.17	0.278
Living condition	**Type of accommodation**			
	Dormitory	1.02	0.52, 1.97	0.961
	Farm shelter	0.67	0.44, 1.05	0.081
	Single house	ref		
	Temporary accommodation (outdoors, plastic sheet, tent, temple, construction site etc.)	0.71	0.16, 3.14	0.650
	Living with			
	Live alone	0.58	0.33, 1.02	0.060
	Live with family	ref		
	Family with children age < 5 years			
	No	ref		
	Yes	1.05	0.81, 1.36	0.705
Malaria Knowledge	**Overall Malaria Knowledge**			
	Low	ref		
	Fair	2.66	0.54, 13.06	0.229
	High	3.75	0.72, 19.32	0.114
Attitude related to malaria prevention	**Perceived Susceptibility**			
	Low	ref		
	High	1.15	0.83, 1.61	0.399
	Perceived Benefits			
	Low	ref		
	High	1.85	1.29, 2.65	**0.001**
	Perceived Barriers			
	Low	ref		
	High	1.43	1.05, 1.94	**0.024**
	Cues to action			
	Low	ref		
	High	1.01	0.78, 1.29	0.950
Net details	**Net condition**			
	Not good	ref		
	Good	3.11	1.91, 5.07	**<0.001**

**Multivariable model includes all variables related to ITN use with p<0.1 in univariable analyses, except for variables which were collinear and those with a high degree of separation.*

*** P-values are Type III Wald Statistics from GEE model and bold font indicate significance at p<0.05*

Thai-Cambodia Border region

MMP in Thai-Cambodia border region were more likely to sleep under an ITN if they were Laotians (aOR 2.22, 95% CI 1.04-4.68), undocumented (aOR 2.09, 95% CI 1.14-3.86), lived in village (aOR 2.41, 95%CI 1.34-4.31), had high perceptions of severity of malaria (aOR 1.60, 95% CI 1.02-2.51), had external cues to action from health messages (aOR 1.49, 95% CI 1.07-2.07) and perceived the net to be in good condition (aOR 4.05, 95% CI 2.33-7.04) (Table 23).

Table 23. Determinants of Utilization of ITN in Thai-Cambodia Border region among MMP having nets

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Demographic	**Nationality**			
	Cambodia	0.69	0.38, 1.29	0.256
	Myanmar	ref		
	Laos	2.22	1.04, 4.68	**0.037**
	Documentation Status			
	Documented	ref		
	Undocumented	2.09	1.14, 3.86	**0.018**
Living condition	**Location of accommodation**			
	Village	2.41	1.34, 4.31	**0.003**
	Farm (fruit, cassava, corn, paddy fields)	ref		
Malaria knowledge	**Overall Malaria Knowledge**			
	Low	ref		
	Fair	0.35	0.01, 9.00	0.525
	High	0.73	0.03, 17.88	0.847
Attitude towards malaria prevention	**Perceived Severity**			
	Low	ref		
	High	1.60	1.02, 2.51	**0.042**
	Perceived Benefits			
	Low	ref		
	High	1.36	0.69, 8.10	0.174
	Cues to action			
	Low	ref		
	High	1.49	1.07, 2.07	**0.017**
Net details	**Enough net in Household**			
	No	ref		
	Yes	0.84	0.44, 1.59	0.597

	Net condition			
	Not good	ref		
	Good	4.05	2.33, 7.04	**<0.001**

**Multivariable model includes all variables related to ITN use with p<0.1 in univariable analyses, except for variables which were collinear and those with a high degree of separation.*
*** P-values are Type III Wald Statistics from GEE model and bold font indicate significance at p<0.05*

Thai-Laos Border region

MMP in Thai-Laos border region were less likely to sleep under an ITN if they were female (aOR 0.56, 95% CI 0.38-0.84), but more likely to do so if they were above 65 years of age (aOR 2.70, 95% CI 1.27-5.76), earned more than 6000 THB per month (aOR 2.16, 95%CI 1.42-3.29), and had high perceptions of benefits of using ITN (aOR 2.73, 95% CI 1.22-6.11) (Table 24).

Table 24. Determinants of Utilization of ITN in Thai-Laos Border region among MMP having nets

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Demographic	**Age group**			
	15 - 24 years	ref		
	25-64 years	1.08	0.45, 2.62	0.861
	>65 years	2.70	1.27, 5.76	**0.010**
	Sex			
	Male	ref		
	Female	0.56	0.38, 0.84	**0.005**
	Occupation			
	Wage laborer	1.07	0.59, 1.93	0.833
	Jobless/household worker	ref		
	Seasonal worker	0.74	0.20, 2.75	0.651
	Forest worker	1.10	0.29, 4.24	0.885
	Income/month			
	1-3000 THB	ref		
	3001-6000 THB	1.41	0.40, 5.01	0.598
	> 6001 THB	2.16	1.42, 3.29	**<0.001**
	Thai language skill			
	can speak or read	ref		
	can't speak or read	2.22	0.82, 5.99	0.116
Attitude related to malaria prevention	**Perceived Benefits**			
	Low	ref		
	High	2.73	1.22, 6.11	**0.014**

**Multivariable model includes all variables related to ITN use with p<0.1 in univariable analyses, except for variables which were collinear and those with a high degree of separation.*

*** P-values are Type III Wald Statistics from GEE model and bold font indicate significance at p<0.05*

Thai-Malaysia Border region

MMP in Thai-Malaysia border region were less likely to sleep under an ITN if they were Buddhists (aOR 0.19, 95% CI 0.08-0.41), but more likely to do so if they were forest workers (aOR 3.46, 95% CI 1.49-7.99), travelled back to their home country more frequently (aOR 3.00, 95%CI 1.27-7.09), and had high perceptions of barriers of using ITN (aOR 2.10, 95% CI 1.18-3.72) (Table 25).

Table 25. Determinants of Utilization of ITN in Thai-Malaysia Border region among MMP having nets

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Demographic	**Religion**			
	Buddhism	0.19	0.08, 0.41	**<0.001**
	Islam	ref		
	Others	4.16	0.28, 62.09	0.302
	Education			
	never attend school	ref		
	till primary school	1.79	0.91, 3.53	0.090
	secondary school	1.34	0.42, 4.22	0.622
	Occupation			
	Wage laborer	ref		
	Seasonal worker	1.32	0.68, 2.98	0.509
	Forest worker	3.46	1.49, 7.99	**0.004**
Mobility	**Length of stay at current location**			
	<6 months	1.58	0.72, 3.45	0.250
	6 months to 5 years	0.15	0.02, 1.04	0.054
	> 5 years	ref		
	Frequency of visit to home country			
	Never			
	More frequent (at least once in 6 months)	3.00	1.27, 7.09	**0.012**
	Less frequent (less than once in 6 months)	0.59	0.33, 1.05	0.073
Living conditions	**Type of accommodation**			
	Dormitory	0.77	0.30, 1.97	0.590
	Farm shelter	0.11	0.01, 2.10	0.143
	Single house	ref		
Malaria Knowledge	**Overall Malaria Knowledge**			
	Low	ref		
	Fair	1.74	0.22, 13.65	0.598
	High	2.27	0.21, 24.08	0.497

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Attitude related to malaria prevention	**Perceived Susceptibility**			
	Low	ref		
	High	1.20	0.72, 2.02	0.481
	Perceived Severity			
	Low	ref		
	High	1.34	0.84, 2.14	0.215
	Perceived Benefits			
	Low	ref		
	High	1.04	0.62, 1.75	0.872
	Perceived Barriers			
	Low	ref		
	High	2.10	1.18, 3.72	**0.011**
	Cues to action			
	High	ref		
	Low	1.86	0.83, 4.17	0.131

**Multivariable model includes all variables related to ITN use with p<0.1 in univariable analyses, except for variables which were collinear and those with a high degree of separation.*

*** P-values are Type III Wald Statistics from GEE model and bold font indicate significance at p<0.05*

Forest goers

Forest going MMP were more likely to use an ITN (including LLIHN) in the forest if they had high knowledge of malaria and its prevention (aOR 2.08, 95% CI 1.02-4.26) and if there were enough nets in the household (aOR 2.70, 95% CI 1.26-5.77). However, forest workers (aOR 0.18, 95% CI 0.06-0.53) and those earning between 6000-10,000 THB (aOR 0.43, 95% CI 0.18-0.99) were less likely to do so (Table 26).

Table 26. Determinants of Utilization of ITN among forest-going MMP having nets

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Demographic	**Religion**			
	Buddhism	ref		
	Islam	2.98	0.80, 11.04	0.102
	Christian	0.50	0.14, 1.80	0.286
	Others	0.81	0.37, 1.76	0.598
	Income/month			
	1-3000 THB	ref		
	3001-6000 THB	1.66	0.77, 3.57	0.192
	6001-10000 THB	0.43	0.18, 0.99	**0.048**

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
	> 10000 THB	0.41	0.12, 1.41	0.157
	Occupation			
	Other/jobless	ref		
	Seasonal farmers	1.76	0.81, 3.82	0.154
	Forest worker	0.18	0.06, 0.53	**0.002**
Mobility	**Frequency of going to the forest at night**			
	Every day	1.73	0.69, 4.34	0.238
	Every week	0.46	0.16, 1.33	0.154
	Once a month or less	ref		
Malaria Knowledge	**Overall Malaria Knowledge**			
	Low	ref		
	Fair	0.97	0.27, 3.45	0.957
	High	2.08	1.02, 4.26	**0.045**
Attitude related to malaria prevention	**Cues to action**			
	Low	ref		
	High	1.39	0.61, 3.18	0.433
Net details	**Enough net in Household**			
	No	ref		
	Yes	2.70	1.26, 5.77	**0.010**

**Multivariable model includes all variables related to ITN use with p<0.1 in univariable analyses, except for variables which were collinear and those with a high degree of separation.*

*** P-values are Type III Wald Statistics from GEE model and bold font indicate significance at p<0.05*

Determinants of Access to malaria case management

Out of 493 MMP having fever in the last three months, 259 (52.5%) sought treatment at a health centre. Factors related to access of malaria case management (demographics, mobility, living conditions, knowledge and attitude towards malaria, and dimensions of access) were screened using univariable logistic regression (Annex-6) and then fitted into a multivariable model. MMP less likely to access malaria services were those who followed Islam or other minority religions (aOR 0.14, 95% CI 0.04-0.46), those who had lived in the current location for less than 6 months (aOR 0.26, 95% CI 0.07-0.87) or between 6 months to 5-years (aOR 0.35, 95% CI 0.15-0.87), those having low knowledge of malaria (aOR 0.14, 95% CI 0.04-0.47), and those with a high perception of accessibility to health centres (aOR 0.37, 95% CI 0.19-0.71). Having heard of health messages as cues to action was a significant determinant (aOR 2.67, 95% CI 1.38-5.16) (Table 27).

Table 27. Determinants of Access to malaria case management among MMP having fever in last three months

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
Demographic	**Sex**			
	Male	ref		
	Female	1.07	0.59, 1.93	0.825
	Geographical region (Border)			
	Thai-Myanmar	ref		
	Thai-Cambodia	1.45	0.49, 4.28	0.497
	Thai-Laos	1.42	0.15, 13.53	0.762
	Thai-Malaysia	0.88	0.29, 2.73	0.830
	Nationality			
	Myanmar	ref		
	Lao	0.69	0.08, 6.07	0.737
	Cambodia	0.67	0.27, 1.67	0.387
	Malaysia	4.96	0.70, 35.21	0.109
	No citizenship	2.58	0.99, 6.67	0.051
	Religion			
	Buddhism	ref		
	Christian	1.44	0.42, 4.94	0.563
	Islam/others	0.14	0.04, 0.46	**0.001**
	Income/month			
	1-3000 THB	ref		
	3001-6000 THB	0.96	0.47, 1.98	0.913
	6001-10000 THB	0.67	0.28, 1.60	0.364
	> 10000 THB	1.50	0.53, 4.27	0.447
	Migrant classification			
	M1	ref		

Characteristic	Factor	Multivariable model*		
		Adjusted OR	95% CI	p-value**
	M2	1.14	0.25, 5.23	0.867
Mobility	**Length of stay at current location**			
	<6 months	0.26	0.07, 0.87	**0.029**
	6 months to 5 years	0.35	0.15, 0.87	**0.024**
	> 5 years	ref		
Living conditions	**Living with**			
	Live alone	1.78	0.29, 10.83	0.533
	Live with others but not family	ref		
	Live with family	1.15	0.26, 5.14	0.855
	Family with children age < 5 years			
	No	ref		
	Yes	1.36	0.78, 2.37	0.285
Malaria Knowledge	**Overall Malaria Knowledge**			
	Low	0.14	0.04, 0.47	**0.002**
	Fair	0.56	0.30, 1.08	0.072
	High	ref		
Attitude towards malaria	**Perceived Susceptibility**			
	Low	ref		
	High	1.00	0.48, 2.08	0.997
	Cues to action			
	Low	ref		
	High	2.67	1.38, 5.16	**0.004**
Dimensions of Access	**Accessibility**			
	Low	ref		
	High	0.37	0.19, 0.71	**0.003**
	Affordability			
	Low	ref		
	High	1.48	0.77, 2.84	0.237
	Acceptability			
	Low	ref		
	High	2.05	1.00, 4.23	0.051
	Awareness			
	Low	ref		
	High	0.91	0.51, 1.62	0.753

**Multivariable model includes all variables related to ITN use with p<0.1 in univariable analyses, except for variables which were collinear and those with a high degree of separation.*

*** P-values are Type III Wald Statistics from GEE model and bold font indicate significance at p<0.05*

DISCUSSION

Key findings

This was the first national level survey in Thailand focusing exclusively on non-Thai mobile migrant populations and their practices related to malaria prevention. Our study was aimed to generate population-averaged estimates using many clusters and a large sample size. It has helped to understand the prevailing situation of MMP in different border regions of Thailand where malaria transmission is high, and provides a baseline data of MMP on key indicators targeted by NMCP for malaria elimination. Some areas of improvement and gaps to focus on during implementation of the National Strategic Plan (NSP) have been highlighted by the study findings.

MMP characteristics

Most of the MMP in our survey were in the working age group of 25-64 years, with a median age of 35 years. The survey participants were predominantly M1 migrants, probably because most of these migrants had settled in their current location in Thailand for more than 5 years which made them easier to locate via key informants in the local mapping process. In comparison to M1, M2 migrants were more likely to be undocumented and frequently mobile – in line with the official MOPH definition of M1 and M2 migrants.[1]

MMP participants in all border regions were more likely to be female; wage labourers and seasonal workers; and belong to ethnic groups from respective neighbouring countries, except for in the Thai-Malaysia border region, where there were more male; forest and construction workers; and Mon ethnic people from Myanmar. MMP in Thai-Cambodia border were comparatively more likely to cross borders frequently. While more MMP travelled to their current location in Thai-Myanmar and Thai-Laos border region from their home country, MMP in Thai-Cambodia and Thai-Malaysia border regions tended to reside in other places of Thailand first before moving to their current location. A similar finding was seen in a previous qualitative study which had found that migrants along the Thai-Cambodia border were more inclined to move within the same district or province because there were enough jobs in economic farming such as fruit orchard and rubber plantation for the MMP to be able to rotate jobs.[18] These variations in MMP characteristics reflect the socio-cultural differences, economic opportunities and mobility patterns of MMP at the four border regions.

Malaria preventive measures

ITN coverage

Overall ITN coverage was estimated at 39%, which is well below the targeted coverage of 90% among people living in malaria transmission areas of Thailand.[1] Similar to the findings among Thai population in malaria endemic areas in 2016,[5] the ownership of mosquito nets was high among the MMP at 94%, but less than half of those nets could be considered as effective ITN. This ownership gap could be attributed to the gaps in free LLIN distribution among MMP and that the majority of nets purchased by MMP were conventional nets which do not qualify as an ITN, especially in Thai-Malaysia region where the ITN coverage was particularly low at 16%. ITN coverage was found higher among M2 migrants, compared to M1 migrants. This may be due to the Thai NMCP strategically targeting M2 migrants attending

public health facilities and CSO health facilities for ITN promotion. While targeting M2 migrants seem to be working, our findings may be limited by low number of M2 migrants in the survey. Nevertheless, since the overall ITN coverage in low, both M1 and M2 migrants living in the high malaria transmission areas should be given equal priority.

Although access to these groups is challenging, more concerted efforts are needed to improve the ITN coverage among MMP. Screening migrants at border crossings and providing them with a free net may be effective to target highly mobile migrants, especially at the Thai-Cambodia border where MMP are known to cross more frequently. For long-term settled migrants, free LLIN distribution needs to be continued to systematically increase ITN coverage. In addition to distributing new LLINs, treating existing nets with an insecticide solution may be a viable way to increase coverage of ITN among MMP as more than 80% of MMP already own a net of age less than 2 years and perceive them to be in good condition. Although treating plain nets with insecticides annually is in the strategic plan of NMCP,[1] only 1.3% of MMP reported their nets being soaked in insecticidal liquid in the last 12 months. This is indicative of an implementation gap and calls for an urgent attention to carry out the proposed strategy. A specific guideline of timing and location of re-treatment of nets should be developed to facilitate maximum of MMP nets to be treated by insecticidal solution.

Furthermore, BCC and health education messages around ITN should focus on benefits of sleeping under an ITN and on reducing concerns of allergies or other negative perceptions to ITN. Information on recommended number/timing of washing of treated nets should also be emphasized as there was some evidence that MMP washed their nets too frequently which can reduce the effective lifespan of the insecticide. The WHO recommends that conventionally treated ITNs are retreated with non-binder insecticide after every three washes, while LLINs and ITNs treated with WHO Pesticide Evaluation Scheme (WHOPES) approved kits remain effective for up to 20 washes.[19]

ITN utilization

ITN utilization was around 38%, less than the target of 55% by 2018.[1] However, unlike the Thai population in malaria endemic areas who had a behavioural gap of 52% in 2016,[5] MMP in this survey reported of much smaller behavioural gap of less than 5%, which was consistent across all four border regions. This indicates that MMP are likely to sleep under an ITN if they had an ITN. This is highly encouraging and provides support to the current NMCP strategy of scaling up ITN promotion among MMP.

Other determinants/barriers of ITN use were found to be different in different border regions. MMP of Thai-Myanmar border region were more likely to sleep under an ITN if they were less mobile, had high perceptions of benefits and barriers of ITN use, and if their nets were in good condition. A strong preference for LLIN among M1 migrants has been noted previously in a province in Thai-Myanmar border region.[20] Long-term settlers in this region who travel less may benefit from being available during the health promotion activities of government health workers and CSOs which gives them higher chances of developing better attitudes regarding use of ITN and receiving more free nets. In contrast, MMP in Thai-Malaysia border region were more likely to sleep under an ITN if they were forest workers, and travelled back to their home country more frequently. Religion and

perceptions of barriers of using ITN were also significant determinants of ITN use in this region. While majority of MMP in both regions are from Myanmar, these results reflect the contextual differences and diverse approaches needed to target MMP in these regions for promotion of ITN use.

In Thai-Cambodia border region, MMP were more likely to sleep under an ITN if they were Laotians, undocumented, lived in village, had high perceptions of severity of malaria, had heard health messages, and perceived the net to be in good condition. More undocumented, Thai speaking Laotian MMP were found to be living in villages in this region, who might have received more ITN and understood more health messages regarding malaria from the health promotion activities of Thai-government than the Cambodian MMP who were mostly M2 and living in the farms/forest. These findings are in line with a previous study which also showed that short-term Cambodian migrants were less likely to have received health messages from healthcare workers in the Thai-Cambodia border region.[21]

Determinants of ITN use in the Thai-Laos border region were male gender, above 65 years of age, earning more than 6000 THB a month, and having a high perception of benefits of ITN. Since 98% of MMP in this region are long-term M1 migrants, this signifies socio-economic and gender disparity in access to an ITN, when other factors such as mobility, length of stay and location of accommodation were not significant. These results suggest the need for more targeted, gender-sensitive, and effective promotion of ITN in migrant communities in this region.

Other vector control measures

Aside from nets, other household vector control measures were infrequently used. Less than 1% of all MMP reported having wire screens on any windows or doors in their house. Considering nearly half of the MMP living in temporary settings, wire screens may not be a feasible strategy for them. Only 17% of MMP had benefited from IRS in the previous 12 months, reflecting the NMCP strategy to move away from IRS and only use it in new foci.

Forest goers

Almost one-third of the sample were forest-goers, but only 8% of them used an ITN (including LLIHN) in the forest. MMP who worked in the forest and earned between 6000-10,000 THB were particularly less likely to use an ITN, simply because they worked all night. Rubber tappers and other forest-goers who work at night are unable to use nets and thus need to be targeted with personal protection that can be worn while they work. Forest going MMP were found to use locally modified methods, such as mosquito coils tucked into a headband or belt buckle during night-time work. While mosquito coil's efficacy in preventing malaria infection is still not clear,[22] keeping the coil burning near the body surface for extended hours may pose health risks to the MMP. Some of this sub-group use repellent, but there is likely to be poor compliance to reapplying the repellent regularly enough for it to be effective.

A more tailored personal protective tool for rubber plantation can be insecticide treated clothing (ITC), which has been shown to reduce the risk of malaria infection by 50% in settings where ITN roll out is not possible by a recent Cochrane review.[22] ITC has been found to have high acceptability and non-inferiority among rubber tappers in Myanmar.[23] Likewise, ITC could be an appropriate strategy for forest going MMP in Thailand as they are already accustomed to wearing long sleeves/trousers while working in the forest.

However, more research is needed into the feasibility and protective efficacy of ITC before it can be considered for roll-out to all forest going MMP. Since nearly half of the rubber-tappers were female who were equally likely to work all night, ITC design should consider the needs of both sexes for function and fashion.

MMP were more likely to use an ITN in the forest if they had high knowledge of malaria and if there were enough nets in the household. This implies that for non-rubber tapper MMP who do not have to work all night, increasing knowledge of malaria and providing enough ITN may promote their use in the forest. Therefore, different strategies are needed to target different types of forest-going MMP for malaria prevention. Contrary to previous assumptions that forest goers were exclusively male, almost 45% of forest goers in our survey were female. Accordingly, strategies such as effective malaria messaging will be needed to tailor for both male and female forest-goers.

One of the strengths of this survey is the inclusion of ethnic minority groups such as the Maniq, who have not been captured in previous studies. Maniq are a primitive, hard to reach, socio-economically disadvantaged tribe living in remote forests near the Thai-Malaysia border. They may be at a higher risk of malaria given their forest-dwelling nature and non-use of ITN due to their traditional culture of hunting-gathering. As the Maniq who live closer to the mainland have accepted modern attire like t-shirts and pants, they may also find ITC acceptable. However, for those who hunt deep in the forest, the smell of the ITC may alert the animals to escape faster. Any intervention effort among this tribe, though, will require special coordination with local governmental officials who speak a common language and the tribe leader. The tribe leader should be consulted and involved in development and implementation of suitable and acceptable malaria protective strategies for this vulnerable group, giving due respect to their way of life.

Access to malaria case management

Treatment-seeking among MMP with fever cases was lower than that reported by the Thai population in border areas in 2016 (52.5% vs 67.5%).[5] However, treatment-seeking within 24 hours of fever occurrence was relatively higher among the MMP than Thai population in 2016 (41.3% vs 26.1%).[5] Long-term resident MMP (>5 years) and those with external cues to action (having heard health messages) were more likely to seek treatment, while religious minority and low knowledge of malaria were significant barriers to seeking treatment. However, since most MMP have limited school-education and Thai language skill, health education with printed BCC/IEC materials may not be suitable for inducing behavior change. In addition to low literacy approach such as theatre parties and verbal messaging through loud speakers, radio, and TV, strategies that empower the MMP with interactive cognitive and social skills are needed to improve their ability to obtain, process, and understand basic anti-malaria information and services needed to make appropriate health decisions.

One of such strategies can be increasing health literacy of MMP, which goes beyond a narrow concept of health education and individual behaviour-oriented communication, and addresses the environmental, political and social factors that determine health.[24] Health literacy can be improved by methods that stimulate interaction, participation and critical analysis, such as community engagement events, community dialogues, drama, role-plays, having peer educator,

and culturally-competent healthcare providers. Participatory drama has been shown to be feasible in promoting awareness and understanding of malaria in Cambodia,[25] and could also be considered as part of the community engagement for malaria elimination in Thailand. Improving Thai language literacy among migrants from Myanmar and Cambodia will also help in increasing their health literacy.

It is encouraging that most MMP healthcare seekers visited public sector services, and the proportion visiting the private sector was quite low (<10%), making most of the cases to be included in the national surveillance system. Public hospitals were the first choice of healthcare provider for most of the MMP due to convenience and/or accessibility. However, the average distance, time, and travel cost to healthcare provider reported by MMP had a wide variance, suggesting that different groups of MMP might have differential accessibility to healthcare provider. In fact, satisfaction with accessibility of malaria care services was reported highest in Thai-Laos region and lowest in Thai-Cambodia region. Similarly, MMP in Thai-Myanmar region reported higher awareness, availability, and affordability of malaria case management while those in Thai-Malaysia border reported lower availability and awareness. These variations in dimensions of access across different border regions point towards the respective gaps that may be targeted by healthcare providers to improve MMP's access to malaria case management. Provision of mobile clinics and having a migrant health worker at worksite may increase accessibility and promoting awareness of free malaria diagnosis and treatment services and increasing coverage of health insurance may reduce concerns of affordability. These strategies require close collaboration with and support from the employers. Employers could also be engaged during health promotion activities and distribution of nets to provide advice on health seeking.

The malaria test rate was relatively higher among MMP in this survey compared to Thai survey in 2016 (50.9% vs 18.8%),[5] but the malaria positivity rate were similar (15.1% vs 11.2%)[5] and all malaria positive cases received antimalarial drugs. Of all fever cases, 34% were self-treated, which is a concern as some of these may have been missed cases of malaria and there may be a potential misuse of drugs sold over the counter. No data was gathered on what drugs people used for self-treatment or whether any were antimalarial drugs. Self-treatment of fever among MMP and Thai population alike warrant a separate investigation to ascertain what kind of drugs people use to self-treat and examine whether there is misuse of antimalarial drugs that may contribute to artemisinin resistance.

Limitations

Despite the strengths of the study, there are some limitations that need to be considered. First, even though use of targeted sampling enabled enrolling many migrants, our sample could not capture many M2 migrants, especially those who may be participating in illegal activities such as wood lodging, hunting, and sex work at the border region. This was mainly due to a lack of information about these hidden groups and limited time for data collection in each MMP site for snowballing to be effective in locating enough of these MMP. Understanding of malaria risk among these types of MMP will require more qualitative and time-sensitive study designs that focus exclusively on these sub-groups such as prospective ethnographic research. Nevertheless, our study was able to include more undocumented migrants and provide reasonable estimates of MMP as a whole.

Second, since there was no sampling frame of MMP, we sampled clusters in the border region according to the size of malaria transmission in those areas as a proxy for malaria risk among MMP. The sampling procedure was informed by a national workshop of BVBD and CSO key informants. However, some of the clusters selected were found to have restricted access due to security concerns or contained no or very few MMP and needed to be replaced to maintain statistical power of the study. The replacement clusters were chosen from the extended loop of PPS which resulted in re-selection of few clusters. This might have created some selection bias as there may have been oversampling in these clusters. Nonetheless, the impact on the representativeness of border regions may be negligible as the sample size obtained were similar to the proportional allocation as planned. A valuable lesson learnt in this survey is to have an updated mapping of MMP in the border region to better utilize limited resources for future survey purposes. As location of MMP are affected by seasonal variation, economic opportunities, and security concerns, it is essential to conduct a mapping process before designing the sampling frame.

Third, the survey relied on interviews with the MMP, who may have given socially desirable answers due to their vulnerable status as migrants. There is also a possibility of recall bias, especially in fever cases as MMP might have had problems recollecting their history of last three months. Use of local translators who spoke the same language as the ethnic minority made their inclusion possible, but there is a possibility that the local translators might not have interpreted some of the questions correctly. This was minimized by giving a briefing to the translators before conducting the survey interview, and utilizing local VBDU and CSO staff who were experienced with malaria prevention as translators whenever possible.

Conclusion

In conclusion, the survey conducted was comprehensive, representative of the MMP and within each geographic region, and has provided data on key indicators that would help assist the NMCP in targeting this vulnerable group for malaria elimination. This survey has highlighted the impact of existing strategies and also the challenges in improving coverage of key malaria prevention interventions among MMP in Thailand. Rapid scaling up of ITN coverage, novel approaches to behaviour change and strong community engagement are needed among the MMP in the border region to continue progress in malaria elimination. ITN coverage could be increased by community-based re-dipping campaigns in addition to LLIN distribution. Culture and gender sensitive strategies that enable the MMP to improve their cognitive, social skills and critical thinking may improve their health-seeking behavior and access to malaria case management.

RECOMMENDATIONS

This MMP survey has highlighted some areas of improvement for implementation of NSP for targeting migrants in the border regions of Thailand. In the past, migrants have been assumed to be mainly male but this survey shows that female migrants are higher in number and there are different sex ratios in different border regions. It is thus evident that a one size fits all intervention will not be sufficient to target all groups and that ethnicity, language, and gender as well as mobility and place of origin will need to be taken into account.

Some key recommendations stemming from the findings for the survey are:

1. Prioritize efforts to increase awareness of malaria among MMP in the border regions.

a) Since most of the MMP in the survey had low knowledge of malaria and its prevention, **improving awareness of malaria should be prioritized**, especially in the Thai-Malaysia border region where the knowledge among MMP was significantly lower than other border regions. Efforts should be made to identify preferred touch points/sources for acquiring information of malaria prevetion and treatment across each border region to facilitate this (eg. in Thai-Myanmar border, majority of MMP use public health sources to acquire nets, whereas in the Thai-Cambodia border, over half of MMP surveyed sourced and purchased nets from private market vendors).

b) Strategies to raise awareness of malaria prevention and case management should include **community engagement activities** which provide a socio-culturally acceptable environment for the MMP to build their **health literacy** by facilitating participation, interaction and critical thinking. Community outreach and events like community cleaning programs, dramas, and peer education are some of the examples of such community engagement that can be considered to be a part of malaria elimination strategy. In terms of Thai illiteracy, adult learning classes may be beneficial, especially for long term M1 migrants. These activities should be organized outside the work hours to allow inclusion of maximum number of MMP.

c) There might need to be different approaches to BCC particularly focusing on strategies to address youth, women, and the low literacy population such as verbal messaging through loud speakers, radio and TV. Particularly in the Thai-Myanmar and Thai-Cambodia border, the majority of the MMP sampled were female, and more likely to have a better attitude toward malaria prevention strategies as well as actively seek out help at health centres when experiencing fever: identifying strategies that could better engage this group in awareness campaigns could be particularly useful as an entry point to engage other high risk groups in these areas.

d) BCC efforts should be directed towards **improving interpersonal communication skills of healthcare providers, community/religious leaders and employers**, as most MMP reported hearing health messages from these sources. The skills of these influential group of people should be equipped with accurate malaria health messages, better understanding of cultural diversity of MMP, and enhanced ability to respond or communicate in a manner that considers each MMP's cultural and linguistic characteristics and unique values across all border settings.

2. Scale up insecticide treated nets coverage and utilization among MMP in the border regions

a) Implement a community-led annual programme of **re-dipping conventional nets and ITNs** that MMP already own. A specific guideline of timing and location of re-treatment of nets should be developed to facilitate maximum of MMP nets to be treated by insecticidal solution. This program may serve to foster community engagement and build community ownership of the program which can ensure sustainability. Local manufacture of re-treatment kits could take place and be available and promoted in retail outlets or in work place shops.

b) Continue **free LLIN/LLIHN distribution** among MMP (both M1 and M2) to replace old and worn out nets, and to ensure there are enough ITN with the MMP considering their family size, as well as distributing these with gender-sensitive considerations in mind.

c) Considering the **determinants of ITN utilization** in different border regions, promote and expand collaboration with CSO and faith based organizations to target LLIN distribution and awareness of ITN as an effective tool of malaria prevention among:

   i. Thai-Myanmar border: MMP who travel frequently to their home country
   ii. Thai-Cambodia border: Cambodian MMP living in the farms/forest
   iii. Thai-Laos border: Females, working age group and MMP with lesser income
   iv. Thai-Malaysia border: Ethnic and religious minority, long-term residents

d) Include messaging about benefits of ITN and **correct washing frequency** (and technique) for ITN and LLIN in the BCC efforts.

3. Facilitate MMP's access to malaria case management

a) Build MMP's ability to seek information and treatment by **raising awareness of availability and provision of free malaria diagnosis and treatment** in Thailand, specifically through community-based BCC interventions and engagement activities that are culturally-sensitive. Short-term resident MMP and those who belong to a religious minority need to be included in such activities as they were found to be less likely to seek treatment.

b) Screen the new and mobile migrants early by setting up **cross border posts/collaborating with partners who already manage existing posts** in areas where frequent border crossing takes place. As M2 migrants across all border regions are less aware of anti-malaria services and less likely to seek treatment, these border posts should be used to **actively screen cases** and distribute nets as well as language appropriate messages about where to seek care and what to expect when care is sought.

c) Improve malaria case management service quality by **strengthening clinical skills** and **developing cultural competence of healthcare providers** to provide prompt diagnosis and treatment.

d) Increase MMP's accessibility to malaria case management in remote areas where migrants are concentrated by strategies such as **mobile clinics** and having **a migrant health worker** at worksite, particularly in the Thai-Myanmar and Thai-Malaysia border regions. Coordination with employers to support coverage of health insurance may reduce MMP's concerns of affordability.

e) Conduct a formative assessment to **evaluate the self-treating behaviour** and use of over-the -counter drugs for fever among MMP in these border region, considering the threat of artemisinin resistance.

4. Increase forest goer MMP's utilization of malaria preventive measures

a) Assess the feasibility and protective efficacy of **insecticide treated clothing** as an appropriate personal protective tool for malaria prevention among both male and female forest going MMP who work at night, particularly in the Thai-Cambodia and Thai-Malaysia border regions where a high number of MMP sampled were forest-goers.

b) Target and tailor the BCC/IEC messages to better influence the attitudes of both **male and female** forest going MMP who do not work in the forest all night.

5. Update information of MMP for monitoring and evaluation

a) Use the findings of this survey as a **baseline data** to evaluate future progresses made in key indicators of malaria elimination among MMP in Thailand. Seasonal variations should be accommodated by conducting surveys at different times of year.

b) As migration is time sensitive, **periodically update the mapping** and health profiles of non-Thai MMP by close collaboration among the local health officials, CSO staff, community leaders and MMP gatekeepers such as employers. An updated MMP mapping will be crucial to ensure precise sampling and planning future study designs such as the targeted sampling used in this survey.

c) Conduct studies that utilize appropriate **qualitative designs** to gain a better understanding of malaria risk and preventive practices among **highly mobile and hidden migrants** who may participate in illegal activities such as wood lodging and sex work along the border region.

REFERENCES

1. Ministry of Public Health. National Malaria Elimination Strategy Thailand 2017-2026. Thailand; 2016.
2. Thailand Department of Disease Control. Malaria map. Bangkok, 2018 [10/04/2018]. Available from: http://mgis.ddc.moph.go.th/.
3. Zegers De Beyl C, Leslie G, Hamade P, Smith E, Meek S. Thailand Malaria Survey 2012. Thailand; 2013.
4. Malaria Consortium, Ministry of Public Health. Evaluation of coverage and usage of malaria prevention methods and associated malaria risk factors among populations in area with malaria transmission in Thailand. KAP survey. Thailand; 2015.
5. Malaria Consortium, Ministry of Public Health. Evaluation of coverage and usage of malaria prevention methods and associated malaria risk factors among populations in area with malaria transmission in Thailand. Endline Survey. Thailand; 2016.
6. Jacobson JO, Cueto C, Smith JL, Hwang J, Gosling R, Bennett A. Surveillance and response for high-risk populations: what can malaria elimination programmes learn from the experience of HIV? Malaria Journal. 2017;16(1):33.
7. Watters JK, Biernacki P. Targeted sampling: options for the study of hidden populations. Social problems. 1989;36(4):416-30.
8. Schicker RS, Hiruy N, Melak B, Gelaye W, Bezabih B, Stephenson R, et al. A Venue-Based Survey of Malaria, Anemia and Mobility Patterns among Migrant Farm Workers in Amhara Region, Ethiopia. PLOS ONE. 2015;10(11):e0143829.
9. United Nations Thematic Working Group on Migration in Thailand. Thailand Migration Report 2014. Thailand; 2014.
10. World Health Organization, Regional Office for South-East Asia. Mobile and migrant populations and malaria information systems. New Delhi; 2015.
11. Alam M, Sumy SA, Parh YA. Selection of the samples with probability proportional to size. Science Journal of Applied Mathematics and Statistics. 2015;3(5):230-3.
12. Kheang ST, Ir P. The Cambodia Mobile & Migrant Population Survey 2017. Cambodia; 2017.
13. Rosenstock IM. The health belief model and preventive health behavior. Health education monographs. 1974;2(4):354-86.
14. Penchansky R, Thomas JW. The concept of access: definition and relationship to consumer satisfaction. Medical care. 1981:127-40.
15. Saurman E. Improving access: modifying Penchansky and Thomas's Theory of Access. Journal of health services research & policy. 2016;21(1):36-9.
16. Bloom BS. Taxonomy of educational objectives. Vol. 1: Cognitive domain. New York: McKay. 1956:20-4.

17. Hubbard AE, Ahern J, Fleischer NL, Van der Laan M, Lippman SA, Jewell N, et al. To GEE or not to GEE: comparing population average and mixed models for estimating the associations between neighborhood risk factors and health. Epidemiology. 2010;21(4):467-74.
18. Jithhai N. Migration and malaria: knowledge, beliefs and practices among migrants in border provinces of Thailand. Bangkok: International organization for migration; 2012.
19. World Health Organization. Insecticide-treated mosquito nets: a WHO position statement. Global malaria programme. 2011.
20. Wangroongsarb P, Hwang J, Thwing J, Karuchit S, Kumpetch S, Rand A, et al. Using respondent driven sampling to identify malaria risks and occupational networks among migrant workers in Ranong, Thailand. PloS one. 2016;11(12):e0168371.
21. Wangroongsarb P, Satimai W, Khamsiriwatchara A, Thwing J, Eliades JM, Kaewkungwal J, et al. Respondent-driven sampling on the Thailand-Cambodia border. II. Knowledge, perception, practice and treatment-seeking behaviour of migrants in malaria endemic zones. Malaria journal. 2011;10(1):117.
22. Maia MF, Kliner M, Richardson M, Lengeler C, Moore SJ. Mosquito repellents for malaria prevention. The Cochrane Library. 2018.
23. Crawshaw AF, Maung TM, Shafique M, Sint N, Nicholas S, Li MS, et al. Acceptability of insecticide-treated clothing for malaria prevention among migrant rubber tappers in Myanmar: a cluster-randomized non-inferiority crossover trial. Malaria journal. 2017;16(1):92.
24. Castro-Sánchez E, Chang PW, Vila-Candel R, Escobedo AA, Holmes AH. Health literacy and infectious diseases: why does it matter? International Journal of Infectious Diseases. 2016;43:103-10.
25. Lim R, Tripura R, J Peto T, Sareth M, Sanann N, Davoeung C, et al. Drama as a community engagement strategy for malaria in rural Cambodia. Wellcome Open Research. 2017;2:95.

ANNEX

Annex 1. Sample size calculation

According to the previous national survey, the proportion of MMPs that did each of the following indicators was:

1) Used an ITN the previous night = 55.0% (M1) and 5.7% (M2)
2) Fever (in previous two weeks[3]) = 3.5%
3) Fever cases that had accessed treatment = 100%

Considering the above indicators, which are the key indicators to be estimated in the MMP survey, the following standard formula is used for calculating the minimum sample size.[4]

$$n = \frac{z^2\, p(1-p)}{d^2}$$

Here, p = proportion of the indicator of interest, z = 1.96 (95% confidence interval) and d (margin of error) =5% or half of the proportion if it is less than 10%. Conventionally, d as 5% or d=0.05 is considered a conservative precision which will give the width of 95% CI as 10% (e.g. 50% to 60%, or 60% to 70%). However, when the prevalence (p) of the statistic used is less than 10%, use of d=0.05 may result in irrelevant negative lower-bound values of CI. Therefore, to use a smaller margin of error, we have used d as a half of p when p is below 10% as recommended by Naing, Winn, and Rusli.[5]

The initial sample size is then estimated assuming a design effect of two (as we assume variation between the clusters) and a 10% inflation for non-response rate. The calculated initial sample size is then multiplied by four to account for comparison between the four different geographical regions of study. Using this methodology, the three indicators give the estimated sample sizes as:

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[3] The indicator required by the MMP survey is fever in previous three months, but this data has not been captured before. Therefore, use of two weeks is used as proxy. Since this should be a lower proportion than fever in three months, it should give a conservative estimate that is able to answer the proportion with fever in three months.

[4] Krejcie RV, Morgan DW. Determining sample size for research activities. Educational and psychological measurement. 1970;30(3):607-10.

[5] Naing L, Winn T, Rusli B. Practical issues in calculating the sample size for prevalence studies. Archives of orofacial Sciences. 2006;1:9-14.

Sample size estimation from each of the three indicators

Indicator	Prevalence	Margin of error	Design effect	Non-response rate	Initial sample size	Number of strata	Total sample size
1. For utilization of malaria preventive measures, Used ITN a) M1 b) M2	55% 5.7%	5% 2.85%	2	10%	a) 845 b) 565	4	a) 3380 b) 2260
2. For access to malaria case management, treatment, Fever (in previous two weeks)	3.5%	1.75%	2	10%	941	4	3764

Taking the largest estimate to ensure all indicators can be calculated, the estimated sample size is 3,764.

In addition, to ensure that the sample size chosen has adequate power to detect even small effect size[6] in the proposed data analysis plan, sample size estimation and power calculation are done using G*Power Version 3.0.10[7] as follows:

Sample size estimation for chi-square analysis

Effect size	Significance level	Power	Sample Size
0.1 (small)	5%	80%	**785**
0.3 (medium)	5%	80%	87
0.5 (large)	5%	80%	31
0.1 (small)	5%	**86.6%**	941

*Note: Sample size estimated for Chi-square test at degree of freedom =1, using G*Power Version 3.0.10 for effect sizes categorization of Cohen[6].*

The sample size needed to detect an effect size of 0.1 at 5% significance level, 80% power and df=1, is **785**. Our chosen final sample size (i.e. **941** in each group) has **86.6%** power to detect the true effect in chi-square analysis.

[6] Cohen J. Statistical power analysis for the behavioral sciences. Hilsdale. NJ: Lawrence Earlbaum Associates. 1988;2.
[7] Erdfelder E, Faul F, Buchner A. GPOWER: A general power analysis program. Behavior research methods, instruments, & computers. 1996;28(1):1-11.

Annex 2. MMP sites with final sample size less than 50 individuals

Region	Sub-district name	No. of MMP enrolled	Reason for inability to reach required sample size
Thai-Myanmar	Thasongyang, Tak	25	The sub-sites were too difficult to access with limited potential participants for data collection.
	Ma wa Laung, Thasongyang Tak	12	Most of the potential participants are registered and have recently obtained Thai IDs
	Yang Klad Nean, Nong Ya Plong , Phetchaburi	20	
	Mae Kong, Maesarieng, Mae Hong Son	33	Difficulty and risk to reach the sub-sites
	Mae Saud, Sob moei, Mae Hong Son	0	All of the participants in the areas are registered and have recently obtained Thai IDs.
Thai-Cambodia	Laem Klad, Muang , Trat	33	There are few potential participants, M1 and M2,
	Buk Dong, Khun Han,Srisaket	2	
	Hauy Chan, Khun Han, Srisaket	3	
	Dong Rak, Phusing, Srisaket	10	
	Dan, Kab Cheong, Surin	5	There are few potential participants, M1 and M2 (not harvest season)
	Charas, Bua chet , Suring	0	This is a high-risk area due to the presence of mines, the border with Cambodia, and wildlife conservation areas which had restricted access.
	Charas, Bua chet , Suring	0	
	Ta Tum, Sangkla, Surin	0	
	Kom pradit, Nam Yean, Ubon Ratchathatni	34	There are few potential participants, M1 and M2,
Thai-Laos	Parai, Don Tan, Mukdahan	9	There are few potential participants, M1 and M2,
	Nachalauw, Ubonratchanthani	26	
Thai-Malaysia	Kalong, Srisakorn, Narathiwat	0	There are few potential participants, M1 and M2,
	Srisakorn, Srisakorn, Narathiwat	12	
	Mamong, Sukirn, Narathiwat	5	
	Sa-ae, Krongpinang,Yala	15	
	Kabang, Kabang, Yala	14	
	Ban Rae, Than To, Yala	13	
	Banglang dam, Banangsata, Yala	13	
	Mae wad, Than To, Yala	43	
	Talingchan, Bangnangsata,Yala	28	
	Bachor, Bangnangsata, Yala	41	

	Aiyaweng, Ba tong, Yala	21	

Annex 3. Differences among MMP from four border regions

Factor	Thai-Myanmar (n=1740)			Thai-Cambodia (n=734)			Thai-Laos (n=250)			Thai- Malaysia (n=632)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
Age group													**<0.001**
15-24 year	18.6	323	[15.9,21.5]	21.4	157	[17.0,26.5]	8.8	22	[6.3,12.1]	30.2	191	[24.3,36.9]	
25-64 year	75.1	1307	[72.4,77.6]	76.4	561	[70.9,81.2]	80.4	201	[74.4,85.2]	69.1	437	[62.5,75.1]	
>65 year	6.3	110	[4.8,8.3]	2.2	16	[0.6,8.0]	10.8	27	[6.1,18.3]	0.6	4	[0.2,2.4]	
Sex													**<0.001**
Male	37.5	653	[32.9,42.4]	44.8	329	[37.8,52.0]	24.8	62	[18.9,31.9]	65.5	414	[58.5,71.9]	
Female	62.5	1087	[57.6,67.1]	55.2	405	[48.0,62.2]	75.2	188	[68.1,81.1]	34.5	218	[28.1,41.5]	
Nationality													**<0.001**
Myanmar	66.1	1150	[53.9,76.4]	12.9	95	[4.9,30.2]	0	0		74.5	471	[49.9,89.6]	
Laos	0.2	4	[0.0,1.7]	11.7	86	[4.1,29.3]	99.6	249	[97.9,99.9]	0.3	2	[0.0,2.0]	
Cambodia	1	18	[0.2,5.9]	75.2	552	[50.4,90.1]	0.4	1	[0.1,2.1]	4.1	26	[1.3,12.2]	
Malaysia	0	0		0	0		0	0		3	19	[0.5,16.4]	
no citizenship	32.6	568	[22.3,45.0]	0.1	1	[0.0,0.9]	0	0		18	114	[6.1,42.5]	
Ethnicity													**<0.001**
Burmese	26.8	466	[16.7,39.9]	5.9	43	[1.9,17.0]	0	0		26.4	167	[17.0,38.7]	
Karen	61.8	1075	[47.6,74.2]	0.3	2	[0.0,2.3]	0	0		2.7	17	[0.8,9.0]	
Khmer	1	18	[0.2,5.9]	74.7	548	[49.7,89.8]	0			3.8	24	[1.1,12.2]	
Lao	0.3	6	[0.1,1.4]	12	88	[4.2,29.8]	100	250		0.3	2	[0.0,2.0]	
Malaysia										3.5	22	[0.7,15.3]	
Mon	4	69	[1.6,9.4]	6.5	48	[2.6,15.3]	0			44	278	[27.7,61.6]	
Maniq										12.7	80	[3.2,38.9]	
Others	6.1	106	[1.6,20.7]	0.7	5	[0.2,2.6]	0			6.6	5	[2.4,17.2]	
Religion													**<0.001**
Buddhism	81.7	1421	[71.6,88.7]	98.6	724	[95.8,99.6]	99.2	248	[98.3,99.6]	76.4	483	[54.1,89.9]	
Islam	0.9	15	[0.2,3.4]	1	7	[0.2,5.0]	0	0	0	10.3	65	[5.0,19.9]	
Christian	16.7	290	[9.9,26.7]	0.3	2	[0.1,1.1]	0			1.1	7	[0.4,3.4]	
Others	0.8	14	[0.4,1.5]	0.1	1	[0.0,1.0]	0.8	2	[0.4,1.7]	12.2	77	[3.2,36.7]	
Education level													0.071
Never	49.5	862	[42.1,57.0]	40.1	294	[32.9,47.7]	49.6	124	[36.3,63.0]	35.4	224	[24.2,48.5]	

Factor	Thai-Myanmar (n=1740)			Thai-Cambodia (n=734)			Thai-Laos (n=250)			Thai- Malaysia (n=632)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
attend													
Primary school	40.1	697	[34.0,46.4]	43.6	320	[38.1,49.2]	41.6	104	[29.0,55.3]	45.9	290	[35.8,56.3]	
Secondary school	10.3	179	[8.3,12.7]	16.1	118	[12.9,19.8]	8.8	22	[6.0,12.8]	17.7	112	[12.6,24.4]	
Do not know	0.1	2	[0.0,0.5]	0.3	2	[0.1,1.1]	0	2	[0.5,1.9]	0.9	6	[0.5,1.9]	
Occupation													**<0.001**
wage laborer	37.8	658	[29.4,47.1]	41.3	303	[25.4,59.2]	38.8	97	[21.7,59.1]	20.7	131	[9.3,40.0]	
Jobless	6.7	117	[3.8,11.7]	5.2	38	[2.8,9.5]	16.8	42	[10.8,25.3]	0.8	5	[0.2,3.4]	
Visit/work in household	2.3	40	[1.4,3.7]	5.2	38	[1.0,23.5]	4.4	11	[1.6,11.2]	2.1	13	[0.8,5.3]	
Security	0			0.1	1	[0.0,0.9]	0			2.7	17	[0.4,17.6]	
construction	0.4	7	[0.2,1.1]	0.4	3	[0.2,1.0]	0.4	1	[0.1,2.1]	26.7	169	[14.9,43.2]	
Seasonal	41	714	[31.4,51.4]	8.2	60	[1.6,32.5]	30.4	76	[20.0,43.4]	13.9	88	[5.1,32.9]	
Forest worker	11.7	204	[6.3,20.9]	39.6	291	[19.1,64.7]	9.2	23	[3.1,24.3]	33.1	209	[15.1,57.8]	
Income													**<0.001**
1-3000 baht	34.1	546	[27.3,41.6]	21	143	[11.4,35.4]	64.3	133	[60.1,68.2]	9	55	[1.8,34.4]	
3001-6000 baht	45	720	[38.1,52.1]	27.4	187	[22.1,33.4]	21.7	45	[19.2,24.5]	4.1	25	[1.7,9.7]	
6001-10000 baht	17.4	278	[11.6,25.2]	37	252	[27.8,47.1]	11.1	23	[8.0,15.3]	30.4	186	[44.3,68.0]	
>10000 baht	3.6	57	[2.1,6.0]	14.7	100	[7.8,25.8]	2.9	6	[1.0,7.8]	56.5	346	[44.3,68.0]	
Migrant status													0.229
M1	91.8	1598	[82.7,96.4]	83.7	614	[63.9,93.7]	98.0	245	[90.5,99.6]	92.4	584	[82.5,96.9]	
M2	8.2	142	[3.6,17.3]	16.3	120	[6.3,36.1]	2.0	5	[0.4,9.5]	7.6	48	[3.1,17.5]	
Documentation													**0.044**
No/don't know	48.3	841	[39.4,57.4]	33.7	247	[20.1,50.5]	47.2	118	[35.5,59.2]	23.7	150	[11.1,43.7]	
Yes	51.7	899	[42.6,60.6]	66.3	487	[49.5,79.9]	52.8	132	[40.8,64.5]	76.3	482	[56.3,88.9]	
Thai language skill													**<0.001**
can speak or read	18.4	320	[14.2,23.5]	55.9	410	[46.7,64.6]	62.0	155	[29.4,86.5]	17.1	108	[9.5,28.9]	
can't speak or read	81.6	1420	[76.5,85.8]	44.1	324	[35.4,53.3]	38.0	95	[13.5,70.6]	82.9	524	[71.1,90.5]	
Length of stay in Thailand													0.183
<6 month	8.2	142	[3.6,17.3]	16.3	120	[6.3,36.1]	2	5	[0.4,9.5]	7.6	48	[3.1,17.5]	
6 month –5 year	3.8	66	[2.1,6.8]	6.4	47	[3.8,10.7]	1.6	4	[0.6,4.3]	6	38	[3.8,9.4]	

Factor	Thai-Myanmar (n=1740)			Thai-Cambodia (n=734)			Thai-Laos (n=250)			Thai- Malaysia (n=632)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
>5 years	88.0	1532	[79.3,93.4]	77.2	567	[61.9,87.7]	96.4	241	[93.3,98.1]	86.4	546	[77.2,92.3]	
Length of stay in this location													**<0.001**
<6 month	9.6	167	[4.9,17.9]	28.7	211	[16.3,45.4]	3.2	8	[1.3,7.5]	19	120	[12.5,27.8]	
6 month-5 year	4.9	85	[2.8,8.3]	10.6	78	[5.7,18.8]	2.4	6	[1.1,5.2]	14.7	93	[10.3,20.6]	
>5 years	85.5	1488	[77.2,91.1]	60.6	445	[44.5,74.7]	94.4	236	[91.6,96.3]	66.3	419	[54.2,76.6]	
Residence prior to the current location													**<0.001**
Within this district	13	209	[10.2,16.4]	10.9	71	[7.0,16.6]	7.9	18	[2.5,22.5]	15.2	86	[11.6,19.6]	
Within this province	8.6	96	[4.3,8.3]	12.4	81	[6.4,22.6]	6.6	15	[2.6,15.5]	12.3	70	[7.9,18.7]	
Other province	5.3	85	[3.4,8.2]	30.7	200	[18.8,45.8]	19.7	45	[9.7,36.1]	42.2	239	[32.9,51.9]	
Abroad	75.8	1220	[70.3,80.5]	46.0	300	[30.9,61.9]	65.8	150	[52.5,77.0]	30.3	172	[22.9,38.9]	
Frequency of visit to home country													**0.002**
Never	63.0	1096	[56.8,68.8]	32.4	238	[22.3,44.5]	46.0	115	[40.9,51.1]	52.1	329	[43.7,60.3]	
More frequent	6.4	111	[2.6,15.0]	16.2	119	[6.1,36.7]	5.6	14	[3.4,9.2]	3.0	19	[1.3,6.7]	
Less frequent	30.6	533	[26.0,35.7]	51.4	377	[36.4,66.1]	48.4	121	[44.2,52.6]	44.9	284	[37.1,53.1]	
Crossed the border by													**<0.001**
Official checkpoint	43.6	758	[36.4,51.0]	78.2	574	[60.2,89.5]	32.4	81	[21.3,45.9]	97.5	616	[94.0,98.9]	
Unofficially	56.4	982	[48.9,63.6]	21.8	160	[10.5,39.8]	67.6	169	[54.1,78.7]	2.5	16	[1.1,5.9]	
Type of accommodation													**<0.001**
Dormitory	6.7	117	[2.7,15.9]	13.5	99	[8.0,21.9]	0.4	1	[0.1,2.1]	54.3	343	[34.4,72.9]	
Farm shelter	15.4	268	[11.0,21.2]	24.4	179	[16.8,34.1]	6.8	17	[5.1,9.1]	15.7	99	[5.4,37.6]	
Single house	76.6	1332	[68.8,82.9]	51.6	379	[34.4,68.5]	92.8	232	[90.9,94.3]	29.6	187	[15.7,48.6]	
Temporary shelter	1.3	23	[0.3,5.2]	10.5	77	[3.6,27.0]	0			0.5	3	[0.1,1.9]	
Location of accommodation													**<0.001**
Town	0.2	4	[0.1,0.6]	0.8	6	[0.2,3.3]	0			1.3	8	[0.4,4.2]	
Village	84.5	1470	[76.4,90.2]	53.4	381	[28.3,76.9]	92	230	[86.5,95.4]	54.8	346	[41.1,67.8]	
Workplace	2.1	36	[0.9,4.7]	0.6	4	[0.1,2.4]	0			1.4	9	[0.6,3.3]	
Farm	12.1	211	[7.0,20.2]	44.2	315	[20.8,70.4]	8	20	[4.6,13.5]	26.8	169	[13.1,47.0]	
Forest	1	18	[0.2,5.9]	1	7	[0.4,2.2]	0			15.7	99	[7.7,29.4]	
Source of water													**<0.001**
Protected	93.5	1627	[90.4,95.7]	78.3	573	[63.6,88.1]	99.6	249	[97.9,99.9]	90.6	572	[80.5,95.8]	
Unprotected	6.5	113	[4.3,9.6]	21.7	159	[11.9,36.4]	0.4	1	[0.1,2.1]	9.4	59	[4.2,19.5]	

Factor	Thai-Myanmar (n=1740)			Thai-Cambodia (n=734)			Thai-Laos (n=250)			Thai- Malaysia (n=632)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
Type of toilet													0.318
Permanent	80.9	1408	[73.0,86.9]	84.5	620	[68.4,93.2]	98.8	247	[98.2,99.2]	85.9	543	[63.0,95.6]	
Temporary	19.1	332	[13.1,27.0]	15.5	114	[6.8,31.6]	1.2	3	[0.8,1.8]	14.1	89	[4.4,37.0]	
Living with													0.548
Live alone	7.2	125	[4.9,10.4]	4.9	36	[3.2,7.4]	4	10	[1.5,10.4]	7.4	47	[4.9,11.1]	
Line with other but not family	1.4	24	[0.8,2.3]	2.9	21	[1.1,7.5]	0.4	1	[0.1,2.1]	21.8	138	[15.5,29.8]	
Live with family	91.4	1591	[88.0,94.0]	92.2	677	[87.2,95.4]	95.6	239	[88.4,98.4]	70.7	447	[62.5,77.8]	
Family with pregnant woman													0.238
No	95.9	1665	[94.6,96.8]	97.8	717	[96.7,98.6]	97.2	241	[91.2,99.1]	96.2	603	[94.1,97.6]	
Yes	4.1	72	[3.2,5.4]	2.2	16	[1.4,3.3]	2.8	7	[0.9,8.8]	3.8	24	[2.4,5.9]	
Family with children age < 5 years													**0.001**
No	60.7	1055	[55.6,65.6]	70.4	517	[64.6,75.6]	66.3	165	[61.8,70.4]	72.6	451	[67.5,77.2]	
Yes	39.3	682	[34.4,44.4]	29.6	217	[24.4,35.4]	33.7	84	[29.6,38.2]	27.4	170	[22.8,32.5]	
Overall Malaria Knowledge													**<0.001**
Low	44.1	768	[39.0,49.4]	27.0	198	[16.9,40.1]	19.6	49	[9.0,37.6]	51.4	325	[42.5,60.3]	
Fair	7.7	134	[6.2,9.5]	20.3	149	[18.2,22.6]	17.6	44	[14.0,21.9]	16.9	107	[14.2,20.0]	
High	48.2	838	[43.0,53.4]	52.7	387	[41.0,64.1]	62.8	157	[45.0,77.7]	31.6	200	[24.1,40.3]	
Attitude related to malaria prevention													
Perceived Susceptibility													**<0.001**
Low	19.1	187	[14.4,25.0]	25.7	141	[19.4,33.2]	19	39	[12.0,28.8]	47.2	153	[41.3,53.3]	
High	80.9	792	[75.0,85.6]	74.3	407	[66.8,80.6]	81	166	[71.2,88.0]	52.8	171	[46.7,58.7]	
Perceived Severity													**<0.001**
Low	15.8	155	[12.4,20.0]	18.6	102	[15.4,22.3]	10.2	21	[4.8,20.6]	37	120	[30.8,43.7]	
High	84.2	824	[75.0,85.6]	81.4	446	[77.7,84.6]	89.8	184	[79.4,95.2]	63	204	[56.3,69.2]	
Perceived Benefits													**<0.001**
Low	25.7	252	[20.7,31.5]	12.6	69	[7.0,21.7]	11.7	24	[5.4,23.4]	60.5	196	[53.2,67.4]	
High	74.3	727	[68.5,79.3]	87.4	479	[78.3,93.0]	88.3	181	[71.2,88.0]	39.5	128	[32.6,46.8]	
Perceived Barriers													**0.002**

Factor	Thai-Myanmar (n=1740)			Thai-Cambodia (n=734)			Thai-Laos (n=250)			Thai- Malaysia (n=632)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
Low	71.3	698	[66.1,76.0]	72.4	397	[64.0,79.5]	87.8	180	[83.0,91.4]	83.3	270	[77.4,87.9]	
High	28.7	281	[24.0,33.9]	27.6	151	[20.5,36.0]	12.2	25	[8.6,17.0]	16.7	54	[12.1,22.6]	
Cues to action													**0.031**
Low	77.6	1350	[72.3,82.1]	68.4	502	[58.1,77.1]	61.6	154	[51.0,71.2]	78.2	494	[69.9,84.6]	
High	22.4	390	[17.9,27.7]	31.6	232	[22.9,41.9]	38.4	96	[28.8,49.0]	21.8	138	[15.4,30.1]	
Source of Net													**<0.001**
Public health officers	64.2	1074	[55.8,71.8]	27.2	190	[21.1,34.2]	15.2	37	[8.3,26.4]	19.0	91	[10.0,33.1]	
CSO	9.9	166	[5.2,18.0]	18.3	128	[7.2,39.1]	34.9	85	[11.1,69.8]	0.4	2	[0.1,2.9]	
Community/ employers	4.6	77	[2.2,9.3]	3.4	24	[2.0,5.8]	0.4	1	[0.1,2.1]	1.9	9	[0.9,3.9]	
Purchased at market	21.2	355	[15.7,27.9]	51.1	357	[36.5,65.4]	49.4	120	[23.9,75.2]	78.7	377	[65.4,87.8]	

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

Annex 4. Differences among forest goer MMP from four border regions

Factor	Thai-Myanmar (n=361)			Thai-Cambodia (n=394)			Thai-Laos (n=51)			Thai- Malaysia (n=276)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
Age group													0.250
15-24 year	19.1	69	[14.5,24.6]	21.4	95	[18.3,31.0]	15.7	8	[10.2,23.5]	34.1	94	[23.5,46.5]	
25-64 year	78.4	283	[73.1,82.8]	75.4	297	[68.2,81.4]	84.3	43	[76.5,89.9]	65.9	182	[53.5,76.5]	
>65 year	2.5	9	[1.2,5.3]	0.5	2	[0.1,2.4]	0	0	0	0	0	0	
Sex													**0.036**
Male	58.4	211	[50.1,66.3]	53.8	212	[50.9,56.6]	31.4	16	[14.8,54.6]	62.3	172	[52.8,70.9]	
Female	41.5	150	[33.7,49.8]	46.2	182	[43.3,49.1]	68.6	35	[45.4,85.2]	37.7	104	[29.1,47.1]	
Nationality													**<0.001**
Myanmar	64.3	232	[46.8.9,78.6]	20.1	79	[7.9,42.1]	0	0		66.7	184	[29.2,90.7]	
Laos	0.3	1	[0.0,2.1]	12.9	51	[4.0,34.55]	67.1	264	[36.9,87.6]	0	0		
Cambodia	1.1	4	[0.2,7.5]	67.0	264	[36.9,87.6]	0	0		1.1	3	[0.3,3.6]	
Malaysia	0	0		0	0		0	0		3.6	10	[0.4,25.5]	
no citizenship	34.3	124	[20.2,52.0]	0	0		0	0		28.6	79	[7.1,67.7]	
Ethnicity													**<0.001**
Burmese	35.5	128	[19.3,55.9]	9.9	39	[3.4,25.3]	0	0		6.5	18	[3.4,12.1]	
Karen	51.3	185	[31.4,70.7]	0.5	2	[0.1,4.2]	0	0		0.4	1	[0.0,3.1]	
Khmer	1	4	[0.2,7.5]	66.5	262	[36.1,87.5]	0	0		1.1	3	[0.3,3.7]	
Lao	0.5	2	[0.1,2.4]	13.2	52	[4.2,34.73]	100	51		0	0		
Malaysia										3.6	10	[0.4,25.5]	
Mon	10.2	37	[5.3,18.9]	9.1	36	[3.4,22.2]	0	0		59	164	[27.2,85.2]	
Maniq										27.5	76	[6.6,67.2]	
Others	1.4	5	[0.35,5.3]	0.7	3	[0.2,2.6]	0	0		1.45	4	[0.3,6.1]	
Religion													**0.004**
Buddhism	83.4	301	[71.6,90.9]	97.9	386	[92.7,99.5]	100	51		68.5	189	[31.4,91.2]	
Islam	0.55	2	[0.1,2.4]	1.78	7	[0.4,8.2]				5.43	15	[1.2,21.0]	
Christian	15.2	55	[7.9,27.4]	0.25	1	[0.0,1.5]				0.36	1	[0.0,2.98]	
Others	0.83	3	[0.3,2.4]							25.7	71	[5.9,65.5]	
Education level													0.431
Never attend	40.7	147	[29.1,53.5]	34.5	136	[29.7,39.6]	49.0	25.0	[25.2,73.3]	47.8	132	[26.2,70.2]	

Factor	Thai-Myanmar (n=361)			Thai-Cambodia (n=394)			Thai-Laos (n=51)			Thai- Malaysia (n=276)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
Primary school	48.2	174	[39.1,58.4]	48.5	191	[45.2,5.7]	39.2	20	[19.1,63.9]	36.9	102	[21.7,55.4]	
Secondary school	11.1	40.0	[7.1,16.9]	17.0	67	[13.5,21.3]	11.7	6	[9.7,14.2]	15.2	42	[9.18,24.2]	
Occupation													0.464
wage laborer	26.0	94	[16.8,38.0]	25.9	102	[12.7,45.6]	47.1	24	[19.4,76.6]	28.3	78.0	[7.7,65.2]	
Jobless	0.55	2	[0.13,2.36]	0.76	3	[0.3,1.8]							
Visit/work in household	0.83	3	[0.3,2.5]	0.51	2	[0.1,4.5]	0.25	1	[0.0,11.2]			[0.8,5.3]	
Security	0	0		0.25	1	[0.03,2.3]	0	0		3.62	10	[0.41,25.5]	
construction	0.28	1	[0.04,2.1]	0	0		0	0		6.16	17	[1.8,19.1]	
Seasonal	21.9	79	[13.2,34.0]	11.2	44	[1.5,50.7]	17.7	9	[6.4,40.0]	0.36	1	[0.05,2.4]	
Forest worker	50.4	182	[32.7,68]	61.4	242	[36.7,81.4]	33.3	17	[15.4,57.9]	61.6	170	[27.7,87.1]	
Income													**0.009**
1-3000 baht	21.2	76	[12.7,33,2]	12.0	46	[6.4,21.5]	45.1	23	[33.3,57.4]	17.1	45	[2.4,63.7]	
3001-6000 baht	36.9	132	[28.2,46.5]	24.3	93	[19.5,29.8]	35.3	18	[27.6,43.8]	4.9	13	[1.13,19.2]	
6001-10000 baht	32.7	117	[21.3,46.6]	43.6	167	[37.7,49.7]	11.8	6	[6.3,20.9]	27	71	[15.2,43.4]	
>10000 baht	9.2	33	[5.4,15.4]	20.1	77	[11.3,33.1]	7.84	4	[2.1,25.7]	51	134	[31.4,70.2]	
Migrant status													0.463
M1	88.9	321	[79.0,94.5]	84.3	332	[56.2,95.7]	90.2	46	[65.0,97.9]	96.0	265	[76.4,99.5]	
M2	11.1	40	[5.5,21.0]	15.7	62	[4.3,43.8]	9.8	5	[2.1,35.0]	4	11	[0.6,23.6]	
Documentation													0.292
No/don't know	45	161	[34.0,56.5]	25.8	101	[16.7,37.5]	52.9	27	[25.4,78.8]	30.3	80	[9.5,64.3]	
Yes	55.0	197	[43.5,66.1]	74.2	291	[62.5,83.3]	47.1	24	[21.2,74.6]	69.7	184	[35.7,90.5]	
Thai language skill													**0.001**
can speak or read	20.5	74	[12.2,32.3]	50.5	199	[36.5,64.4]	43.1	22	[23.7,64.9]	21.7	60	[11.2,38.0]	
can't speak or read	79.5	287	[67.7,87.8]	49.5	195	[35.6,63.5]	56.9	29	[35.1,76.3]	78.3	216	[62.0,88.8]	
Frequency return home country													**0.012**
Never	59.3	214	[51.1,67.0]	29.2	115	[20.2,40.2]	41.2	21	[24.5,60.2]	38.4	106	[29.0,48.8]	
More frequent (at least once in 6 months)	8.9	32	[4.4,17.0]	9.6	38	[2.9,27.8]	5.9	3	[3.8,9.0]	4.4	12	[1.9,9.7]	
Less frequent	31.9	115	[24.6,40.1]	61.2	241	[42.0,77.4]	52.9	27	[36.5,68.8]	57.3	158	[46.7,67.1]	

Factor	Thai-Myanmar (n=361)			Thai-Cambodia (n=394)			Thai-Laos (n=51)			Thai- Malaysia (n=276)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
(Less than once in 6 months)													
Length of stay in Thailand													0.312
<6 month	11.1	40	[5.5,21.0]	15.7	62	[4.3,43.8]	9.8	5	[2.1,35.0]	4	11	[0.55,23.6]	
6 month –5 year	3.6	13	[1.2,10.3]	9.6	38	[6.3,14.6]	2	1	[0.2,18.3]	4	11	[1.5,9.9]	
>5 years	85.3	308	[73.6,92.4]	74.6	294	[55.4,87.5]	88.2	45	[65.1,96.8]	92.0	254	[80.3,97.0]	
Length of stay in this location													**0.006**
<6 month	13.0	47	[7.1,22.7]	31.2	123	[16.8,50.5]	11.8	6	[3.9,30.4]	8.3	23	[2.1,27.9]	
6 month-5 year	5.3	19	[2.0,13.0]	15.7	62	[9.4,25.3]	2.0	1	[0.2,18.3]	11.2	31	[6.7,18.3]	
>5 years	81.7	295	[70.6,89.3]	53.1	209	[39.9,65.8]	86.3	44	[69.2,94.6]	80.4	222	[65.8,89.8]	
Residence prior to the current location													**0.007**
Within this district	12.7	46	[8.2,19.3]	7.4	29	[4.1,12.8]	5.9	3	[1.4,22.0]	13.0	36	[10.3,16.5]	
Within this province	5.8	21	[3.2,10.3]	9.9	39	[6.0,16.0]	5.9	3	[1.4,22.0]	12.3	34	[4.8,28.1]	
Other province	10.8	39	[6.0,18.7]	37.6	148	[26.4,50.2]	31.4	16	[17.1,50.3]	35.5	98	[19.1,56.2]	
Abroad	64.3	232	[53.0,74.2]	34.3	135	[20.0,52.1]	51	26	[31.3,70.4]	19.6	54	[9.6,35.8]	
Type of accommodation													**0.016**
Dormitory	16.3	59	[7.5,3.1]	15	59	[7.5,27.6]	0	0		26.1	72	[14.0,43.3]	
Farm shelter	12.5	45	[7.0,21.2]	33.5	132	[22.6,46.6]	11.8	6	[6.3,20.9]	30.8	85	[9.1,66.5]	
Single house	70.4	254	[58.1,80.3]	37.3	147	[24.1,52.7]	88.2	45	[79.1,93.7]	42.8	118	[21.2,67.4]	
Temporary shelter	0.83	3	[0.3,2.6]	14.2	56	[5.7,31.2]	0	0		0.36	1	[0.05,2.4]	
Location of accommodation													**0.007**
Town	0	0		0.5	2	[0.1,3.4]	0	0		0	0		
Village	63.7	230	[45.2,78.9]	29.7	117	[15.4,49.5]	84.3	43	[64.1,94.2]	40.6	112	[20.5,64.3]	
Workplace	2.8	10	[1.0,7.7]	0	0		0	0		2.5	7	[1.0,6.2]	
Farm	32.7	118	[17.3,53.0]	67.3	265	[48.4,81.9]	15.7	8	[5.8,35.9]	55.1	152	[32.0,76.1]	
Forest	0.55	2	[0.1,2.4]	1.0	4	[0.4,2.7]	0	0		1.5	4	[0.3,7.8]	
Source of water													**0.006**
Protected	94.2	340	[90.3,96.6]	69.5	274	[55.3,80.9]	100	51		85.9	237	[71.3,93.7]	
Unprotected	5.8	21	[3.5,9.7]	30.5	120	[19.2,44.7]	0	0		14.1	39	[6.3,28.7]	
Type of toilet													0.461

Factor	Thai-Myanmar (n=361)			Thai-Cambodia (n=394)			Thai-Laos (n=51)			Thai- Malaysia (n=276)			p-value*
	%	n	95% CI	%	n	95% CI	%	n	95% CI	%	n	95% CI	
Permanent	83.7	302	[72.4,90.9]	80	315	[63.1,90.3]	98	50	[86.0,99.8]	71.4	197	[33.8,92.4]	
Temporary	16.3	59	[9.1,27.6]	20.1	79	[9.7,37.0]	1.96	1	[0.24,14.0]	28.6	79	[7.6,66.2]	
Living with													**0.007**
Live alone	6.9	25	[3.5,13.3]	5.1	20	[3.2,8.0]	0	0		2.5	7	[1.3,5.0]	
Line with other but not family	1.7	6	[0.7,4.0]	3.6	14	[0.8,13.9]	0	0		18.8	52	[10.6,31,2]	
Live with family	91.4	330	[85.7,95.0]	91.4	360	[82.1,96.1]	100	51		78.6	217	[66.7,87.1]	
Family with pregnant woman													0.098
No	95.3	342	[92.7,96.4]	98	386	[95.1,99.2]	94.1	48	[91.0,96.2]	95.2	258	[92.5,97.0]	
Yes	4.7	17	[3.1,7.3]	2	8	[0.8,4.9]	5.9	3	[3.8,9.0]	4.8	13	[3.0,7.5]	
Family with children age < 5 years													**0.042**
No	65.9	238	[57.9,73.1]	75.6	298	[69.8,80.7]	60.8	31	[57.3,64.2]	69.1	183	[63.0,74.6]	
Yes	34.1	123	[26.9,42.1]	24.4	96	[19.3,30.2]	39.2	20	[35.8,42.8]	30.9	82	[25.4,37.1]	
Overall Malaria Knowledge													**0.042**
Low	42.4	153	[33.7,51.5]	33	130	[20.0,49.3]	11.8	6	[6.9,19.3]	40.6	112	[29.8,52.4]	
Fair	8.6	31	[5.5,13.2]	20.8	82	[18.0,24.0]	17.7	9	[15.0,20.6]	19.2	53	[16.4,22.4]	
High	49	177	[41.1,57.0]	46.2	182	[33.1,59.8]	70.6	36	[65.7,75.0]	40.2	111	[29.8,51.6]	

**P-value calculated from Rao-Scott chi-square tests and bold font indicate significance at p<0.05*

Annex 5. Factors associated with ITN use among MMP

a) In Thai-Myanmar border region:

Factor	Use ITN every night		Univariable model		
	Yes (n=766)	No (n=974)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Age group					0.436
15 - 24 years	144 (18.80)	179 (18.38)			
25-64 years	574(74.93)	733 (75.26)	0.89	0.72, 1.09	
>65 years	48 (6.27)	62 (6.37)	0.81	0.55, 1.19	
Sex					0.351
Male	275 (35.90)	378 (38.81)			
Female	491 (64.10)	596(61.19)	1.11	0.89, 1.38	
Nationality					0.085
Myanmar	490(63.97)	660(67.76)			
No citizenship	267(34.86)	301(30.90)	1.06	0.77, 1.46	
Others	9(1.17)	13(1.33)	0.54	0.31, 0.94	
Ethnicity					0.482
Karen	461(60.18)	614(63.18)	0.91	0.55, 1.52	
Burmese	203(26.50)	263(27.00)			
Mon	29(3.79)	40(4.11)	0.72	0.45, 1.16	
Shan	51(6.66)	33 (3.39)	1.15	0.63, 2.09	
Others	22(2.87)	24(2.46)	0.65	0.33, 1.31	
Religion					0.551
Buddhism	588(76.76)	833(85.52)			
Christian	8(1.04)	7(0.72	1.25	0.91, 1.72	
Islam	164(21.41)	126(12.94)	1.33	0.47, 3.78	
Others	6(0.78)	8(0.82)	0.79	0.31, 1.99	
Education					0.097
never attend school	351(45.82)	513(52.67)			
till primary school	321(41.91)	376(38.60)	1.19	0.99, 1.43	
secondary school	94(12.27)	85(8.73)	1.39	0.96, 2.03	

Factor	Use ITN every night		Univariable model		
	Yes (n=766)	No (n=974)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Occupation					0.493
Wage laborer	321(41.91)	337(34.60)	1.12	0.77, 1.62	
Jobless/household worker	64(8.36)	93(9.55)			
Seasonal worker	281(36.68)	440(45.17)	0.92	0.62, 1.37	
Forest worker	100(13.05)	104(10.68)	0.95	0.56, 1.61	
Income/month					0.613
1-3000 THB	242(34.28)	304(33.97)			
3001-6000 THB	308(43.63)	412(46.03)	1.12	0.84, 1.49	
6001-10000 THB	125(17.71)	153(17.09)	0.98	0.63, 1.53	
> 10000 THB	31(4.39)	26(2.91)	1.24	0.70, 2.22	
Migrant classification					0.550
M1	681(88.90)	917(94.15)			
M2	85(11.10)	57(5.85)	1.17	0.69, 1.98	
Documentation Status					0.012
Documented	425(55.77)	474(48.82)			
Undocumented	337(44.23)	497(51.18)	0.75	0.60, 0.94	
Thai language skill					0.137
can speak or read	158(20.63)	162(16.63)			
can't speak or read	608(79.37)	812(83.37)	0.79	0.59, 1.07	
Forest goer					0.095
yes	153(19.97)	208(21.36)	0.81	0.63, 1.04	
no	613(80.03)	766(78.64)			
Length of stay at current location					0.424
<6 months	91(11.88)	76(7.80)	1.00	0.65, 1.55	
6 months to 5 years	41(5.35)	44(4.52)	1.58	0.77, 3.23	
> 5 years	634(82.77)	854(87.68)			
Frequency of visit to home country					0.090
Never	498(65.01)	598(61.04)			
More frequent (at least once in 6 months)	64(8.36)	47(4.83)	0.59	0.33, 1.05	
Less frequent (less than once in 6 months)	204(26.63)	329(33.78)	0.85	0.69, 1.04	
Type of accommodation					0.001
Dormitory	53(6.92)	64(6.57)	1.03	0.60, 1.76	

Factor	Use ITN every night		Univariable model		
	Yes (n=766)	No (n=974)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Farm shelter	66(8.62)	202(20.74)	0.48	0.33, 0.70	
Single house	643(83.94)	689(70.74)			
Temporary accommodation (outdoors, plastic sheet, tent, temple, construction site etc.)	4(0.52)	19(1.95)	0.49	0.08, 2.96	
Location of accommodation					0.141
Town/village	673(87.86)	801(82.24)			
Workplace (Factory, construction site)	16(2.09)	20(2.05)	1.05	0.51, 2.19	
Farm (fruit, cassava, corn, paddy fields)	77(10.05)	153(15.71)	0.65	0.42, 0.99	
Source of water					0.217
Protected (piped, tube well, public tap etc)	712(92.95)	915(93.94)			
Unprotected (surface water, uncovered stored water)	54(7.05)	59(6.06)	1.25	0.88, 1.78	
Type of toilet					0.569
Permanent (Flush or pour flush toilet, pit latrine with slab)	640(83.55)	768(78.85)			
Temporary (Pit latrine without slab, hanging toilet, bush, field)	126(16.45)	206(21.15)	1.12	0.75, 1.69	
Living with					0.061
Live alone	40(5.22)	85(8.73)	1.96	0.75, 5.12	
Live with others but not family	4(0.52)	20(2.05)			
Live with family	722(94.26)	869(89.22)	2.70	1.02, 7.13	
Family with pregnant woman					0.631
No	731(95.56)	934(96.09)			
Yes	34(4.44)	38(3.91)	1.10	0.74, 1.63	
Family with children age < 5 years					0.003
No	422(55.09)	633(65.19)			
Yes	344(44.91)	338(34.81)	1.41	1.13, 1.77	
Overall Malaria Knowledge					<0.001
Low	282(36.81)	486(49.90)			
Fair	50(6.53)	84(8.62)	0.97	0.67, 1.40	
High	434(56.66)	404(41.48)	1.47	1.25, 1.73	

Factor	Use ITN every night		Univariable model		
	Yes (n=766)	No (n=974)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Perceived Susceptibility					0.091
Low	70(14.43)	117(23.68)			
High	415(85.57)	377(76.32)	1.29	0.96, 1.73	
Perceived Severity					0.840
Low	75(15.46)	80(16.19)			
High	410(49.76)	414(83.81)	0.97	0.69, 1.35	
Perceived Benefits					<0.001
Low	83(17.11)	169(34.21)			
High	402(82.89)	325(65.79)	2.07	1.53, 2.78	
Perceived Barriers					<0.001
Low	312(64.33)	386(78.14)			
High	173(35.67)	108(21.86)	1.71	1.36, 2.17	
Cues to action					0.006
Low	546(71.28)	804(82.55)			
High	220(56.41)	170(17.45)	1.34	1.09, 1.64	
Source of Net					<0.001
Free from public health staff	583(76.41)	491(54.02)	8.31	5.16, 13.37	
Free by CSOs	121(15.89)	45(4.59)	8.17	4.40, 15.17	
Received from community people (employer, leader, relatives, neighbor)	18(2.36)	59(6.49)	2.26	1.09, 4.68	
Purchased	41(5.37)	314(34.54)			
Duration of receipt of net					<0.001
< 1 year	756(98.69)	213(23.13)			
> 1 year	10(1.31)	708(76.87)	0.00	0.002, 0.009	
Enough net in Household					<0.001
No	84(11.63)	175(20.14)			
Yes	638(88.37)	694(79.86)	1.65	1.29, 2.09	
Net condition					<0.001
Not good	89(11.63)	282(30.36)			
Good	676(88.37)	647(69.64)	2.87	2.02, 4.07	

** P-values are Type III Wald Statistics from univariable logistic regression (GEE) model*

b) In Thai-Cambodia border region:

Factor	Use ITN every night		Univariable model		
	Yes (n=272)	No (n=462)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Age group					0.272
15 - 24 years	51(18.75)	106(22.94)			
25-64 years	213(78.31)	348(75.32)	1.14	0.63, 2.07	
>65 years	8(1.73)	8(2.94)	0.81	0.45, 1.43	
Sex					0.828
Male	111(40.81)	218(47.19)			
Female	161(59.19)	244(52.81)	1.03	0.80, 1.32	
Nationality					0.061
Cambodia	194(71.59)	358(77.49)	0.82	0.56, 1.21	
Myanmar	28(10.33)	67(14.50)			
Laos	49(18.08)	37(8.01)	1.93	1.09, 3.41	
Ethnicity					0.182
Burmese, Karen, Mon	28(10.29)	70(15.15)			
Khmer	195(71.69)	353(76.41)	0.92	0.61, 1.37	
Laos	49(18.01)	39(8.44)	1.86	0.42, 1.09	
Religion					0.002
Buddhism	266(97.79)	458(99.13)			
Others	6(2.21)	4(0.87)	4.25	1.71, 10.56	
Education					0.136
never attend school	126(46.32)	170(36.80)			
till primary school	102(37.50)	218(47.19)	0.85	0.72, 1.01	
secondary school	44(16.18)	74(16.02)	1.03	0.59, 1.77	
Occupation					0.173
Wage laborer	133(48.90)	170(36.80)	1.50	0.77, 2.92	
Jobless/household worker	35(12.87)	41(8.87)			
Seasonal worker	31(11.40)	33(7.14)	1.09	0.54, 2.20	
Forest worker	73(26.84)	218(47.19)	0.90	0.37, 2.21	

Factor	Use ITN every night		Univariable model		
	Yes (n=272)	No (n=462)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Income/month					0.474
1-3000 THB	75(30.12)	68(15.70)	1.00		
3001-6000 THB	70(28.11)	117(27.02)	0.78	0.57, 1.08	
6001-10000 THB	72(28.92)	180(41.57)	0.77	0.49, 1.22	
> 10000 THB	32(12.85)	68(15.70)	1.00	0.42, 2.38	
Migrant classification					0.626
M1	215(79.04)	399(86.36)			
M2	57(20.96)	63(13.64)	1.08	0.79, 1.49	
Documentation Status					0.042
Documented	148(54.41)	339(74.51)			
Undocumented	124(45.59)	116(25.49)	1.59	1.02, 2.48	
Thai language skill					0.814
can speak or read	124(45.59)	200(43.29)			
can't speak or read	148(54.41)	262(56.71)	0.96	0.67, 1.37	
Forest goer					0.207
yes	128(47.06)	266(57.58)			
no	144(52.94)	196(42.42)	1.23	0.89, 1.69	
Length of stay at current location					0.679
<6 months	75(27.57)	136(29.44)	0.87	0.65, 1.18	
6 months to 5 years	24(8.82)	54(11.69)	0.92	0.39, 2.20	
> 5 years	173(63.60)	272(58.87)			
Frequency of visit to home country					0.564
Never	95(34.93)	143(30.95)			
More frequent (at least once in 6 months)	59(21.69)	60(12.99)	1.18	0.84, 1.65	
Less frequent (less than once in 6 months)	118(43.38)	259(56.06)	1.01	0.67, 1.52	
Type of accommodation					0.489
Dormitory	22(8.09)	77(16.67)	0.65	0.31, 1.35	
Farm shelter	58(21.32)	121(26.19)	0.77	0.49, 1.21	
Single house	169(62.13)	210(45.45)			
Temporary accommodation (outdoors, plastic sheet, tent, temple, construction site etc.)	23(8.46)	54(11.69)	1.12	0.33, 3.83	
Location of accommodation					<0.001

Factor	Use ITN every night		Univariable model		
	Yes (n=272)	No (n=462)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Village	183(69.06)	208(45.61)	1.63	1.24, 2.14	
Farm (fruit, cassava, corn, paddy fields)	82(30.94)	248(54.39)			
Source of water					0.267
Protected (piped, tube well, public tap etc.)	211(77.86)	362(78.52)			
Unprotected (surface water, uncovered stored water)	60(22.14)	99(21.48)	1.23	0.85, 1.77	
Type of toilet					0.051
Permanent	227(83.46)	393(85.06)			
Temporary	45(16.54)	69(14.94)	1.69	0.99, 2.88	
Living with					0.160
Live alone	7(2.57)	29(6.28)			
Live with others but not family	7(2.57)	14(3.03)	1.30	0.73, 2.32	
Live with family	258(94.85)	419(90.69)	1.98	0.97, 4.02	
Family with pregnant woman					0.951
No	266(97.79)	451(97.83)			
Yes	6(2.21)	10(2.17)	1.02	0.51, 2.04	
Family with children age < 5 years					0.356
No	182(66.91)	335(72.51)			
Yes	90(33.09)	127(27.49)	1.10	0.90, 1.33	
Overall Malaria Knowledge					<0.001
Low	57(20.96)	141(30.52)			
Fair	43(15.81)	106(22.94)	0.76	0.52, 1.11	
High	172(63.24)	215(46.54)	1.30	0.99, 1.69	
Perceived Susceptibility					0.736
Low	45(20.64)	96(29.09)			
High	173(79.36)	234(70.91)	1.11	0.60, 2.05	
Perceived Severity					0.006
Low	30(13.76)	72(21.82)			
High	188(86.14)	258(78.18)	1.45	1.11, 1.89	
Perceived Benefits					0.049
Low	11(5.05)	58(17.58)			

Factor	Use ITN every night		Univariable model		
	Yes (n=272)	No (n=462)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
High	207(94.95)	272(582.42)	2.25	1.00, 5.06	
Perceived Barriers					0.781
Low	154(70.64)	243(73.64)			
High	64(29.36)	87(26.36)	0.94	0.63, 1.42	
Cues to action					<0.001
Low	155(56.99)	347(75.11)			
High	117(50.43)	115(24.89)	1.63	1.24, 2.14	
Source of Net					<0.001
Free from public health staff	135(51.14)	55(12.64)	68.32	18.45, 253.05	
Free by CSOs	108(40.91)	20(4.60)	146.43	37.45, 572.53	
Received from community people (employer, leader, relatives, neighbor)	8(3.03)	16(3.68)	14.02	4.12, 47.67	
Purchased	13(4.92)	344(79.08)			
Duration of receipt of net					<0.001
< 1 year	270(99.26)	244(57.96)			
> 1 year	2(0.74)	177(42.04)	0.0429	0.019, 0.0947	
Enough net in Household					0.023
No	27(10.47)	67(15.99)			
Yes	231(89.53)	352(84.01)	1.77	1.08, 2.91	
Net condition					<0.001
Not good	21(7.81)	114(26.07)			
Good	248(92.19)	313(73.30)	3.32	2.48, 4.44	

** P-values are Type III Wald Statistics from univariable logistic regression (GEE) model*

c) In Thai-Laos border region:

Factor	Use ITN every night		Univariable model		
	Yes (n = 108)	No (n= 142)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Age group					0.002
15 - 24 years	6(5.56)	16(11.27)			
25-64 years	89(82.41)	112(78.87)	1.73	1.18, 2.53	
>65 years	13(12.04)	14(9.86)	1.87	1.11, 3.17	
Sex					0.059
Male	31(28.70)	31(21.83)			
Female	77(71.30)	111(78.17)	0.71	0.49, 1.01	
Nationality					
Laos	108(100.00)	141(99.29)			
Cambodia	0	1 (0.71)			
Ethnicity					
Lao	108(100)	142(100)			
Religion					
Buddhism	108(100)	140(98.59)			
Others	0	2(1.41)			
Education					0.276
never attend school	60(55.56)	64(45.07)			
till primary school	38(35.19)	66(46.48)	0.75	0.52, 1.08	
secondary school	10(9.26)	12(8.45)	1.07	0.51, 2.26	
Occupation					<0.001
Wage laborer	42(38.80)	55(38.73)	0.93	0.66, 1.33	
Jobless/household worker	20(18.52)	33(23.24)			
Seasonal worker	31(28.70)	46(32.39)	0.85	0.46, 1.58	
Forest worker	15(13.89)	8(5.63)	1.45	0.51, 4.11	
Income/month					0.022
1-3000 THB	54(59.34)	79(68.10)			
3001-6000 THB	21(23.08)	24(20.69)	1.40	0.51, 3.87	

Factor	Use ITN every night		Univariable model		
	Yes (n = 108)	No (n= 142)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
> 6001 THB	16(17.58)	13(11.21)	1.87	1.19, 2.94	
Migrant classification					0.416
M1	104(96.30)	141(99.30)			
M2	4(3.70)	1(0.7)	2.54	0.26,24.16	
Documentation Status					0.699
Documented	61(56.48)	71(50.00)			
Undocumented	47(43.52)	71(50.00)	0.94	0.67, 1.31	
Thai language skill					0.087
can speak or read	51(47.22)	104(73.24)			
can't speak or read	57(52.78)	38(26.76)	2.05	0.90, 4.67	
Forest goer					0.297
yes	27(25.00)	24(16.90)	1.21	0.85, 1.71	
no	81(75.00)	118(83.10)			
Length of stay at current location					0.607
<6 months	5(4.63)	3(2.11)	1.40	0.27, 7.21	
6 months to 5 years	1(0.93)	5(3.52)	0.47	0.11, 2.06	
> 5 years	102(94.40)	134(94.37)			
Frequency of visit to home country					0.113
Never	53(49.07)	62(43.66)			
More frequent (at least once in 6 months)	3(2.78)	11(7.75)	0.46	0.18, 1.15	
Less frequent (less than once in 6 months)	52(48.15)	69(48.59)	0.90	0.61, 1.35	
Type of accommodation					0.132
Farm shelter	12(11.11)	5(3.52)	3.40	0.69,16.76	
Single house	96(88.89)	137(96.48)			
Location of accommodation					0.342
Village	98(90.74)	132(92.96)	0.57	0.18, 1.82	
Farm (fruit, cassava, corn, paddy fields)	10(9.26)	10(7.04)			
Source of water					
Protected (piped, tube well, public tap etc.)	107(99.07)	142(100)			
Unprotected (surface water, uncovered stored water)	1(0.93)				

Factor	Use ITN every night		Univariable model		
	Yes (n = 108)	No (n= 142)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Type of toilet					0.642
Permanent (Flush or pour flush toilet, pit latrine with slab)	107(99.07)	140(98.59)			
Temporary (Pit latrine without slab, hanging toilet, bush, field)	1(0.93)	2(1.41)	0.62	0.08, 4.61	
Living with					0.710
Live alone	4(3.37)	6(4.23)			
Live with family/others	104(96.30)	136(95.77)	0.91	0.55, 1.50	
Family with pregnant woman					0.927
No	103(96.26)	138(97.87)			
Yes	4(3.74)	3(2.13)	1.09	0.15, 7.83	
Family with children age < 5 years					0.538
No	73(68.22)	92(64.79)			
Yes	34(31.78)	50(35.21)	0.84	0.48, 1.46	
Overall Malaria Knowledge					0.196
Low	15(13.89)	34(23.94)			
Fair	19(17.59)	25(17.61)	1.20	0.94, 1.54	
High	74(68.52)	83(58.45)	1.12	0.55, 2.28	
Perceived Susceptibility					0.289
Low	18(19.15)	21(18.92)			
High	76(80.85)	90(81.08)	1.28	0.81, 2.03	
Perceived Severity					0.563
Low	8(8.51)	13(11.71)			
High	86(91.49)	98(88.29)	1.26	0.57, 2.77	
Perceived Benefits					0.073
Low	5(5.32)	19(17.12)			
High	89(94.68)	92(82.88)	2.15	0.93, 4.97	
Perceived Barriers					0.287
Low	81(86.17)	99(89.19)			
High	13(13.83)	12(10.81)	1.30	0.80, 2.11	
Cues to action					0.360
Low	61(56.48)	93(65.49)			

Factor	Use ITN every night		Univariable model		
	Yes (n = 108)	No (n= 142)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
High	47(43.52)	49(34.51)	1.18	0.82, 1.71	
Source of Net					<0.001
Free from public health staff	35(33.02)	2(1.47)	725.27	102.78, 5117.7	
Free by CSOs	69(65.09)	16(11.76)	105.37	74.01, 150.02	
Purchased	2(1.67)	118(86.76)			
Duration of receipt of net					<0.001
< 1 year	107(99.07)	68(49.64)			
> 1 year	1(0.93)	69(50.36)	0.02	0.002, 0.19	
Enough net in Household					0.528
No	16(15.53)	18(13.24)			
Yes	87(84.47)	118(86.76)	0.89	0.62, 1.28	
Net condition					0.121
Not good	8(7.41)	19(13.87)			
Good	100(92.59)	118(86.13)	2.09	0.82, 5.26	

** P-values are Type III Wald Statistics from univariable logistic regression (GEE) model*

d) In Thai-Malaysia border region:

Factor	Use ITN every night		Univariable model		
	Yes (n=100)	No (n=532)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Age group					0.247
15 - 24 years	24(24.0)	167(31.39)			
25-64 years	75(75.0)	362(68.05)	1.43	0.93, 2.22	
>65 years	1(1.0)	3(0.56)	2.33	0.18, 30.74	
Sex					0.322
Male	60(60.0)	345(66.54)			
Female	40(40.0)	178(33.46)	1.32	0.76, 2.32	
Nationality					<0.001
Myanmar	69(69.0)	402(75.56)			
Laos/Cambodia	5(5.0)	23(4.32)	1.18	0.22, 6.20	
Malaysia	11(11.0)	8(1.50)	7.41	3.79, 14.48	
No citizenship	15(15.0)	99(18.61)	0.87	0.46, 1.65	
Ethnicity					0.024
Burmese	19(10.0	165(31.02)			
Khmer/Laos	4(4.0)	22(4.14)	1.40	0.23, 8.70	
Malaysia/others	21(21.0)	43(8.08)	4.02	1.70, 9.55	
Mon	48(48.0)	230(43.23)	1.84	1.03, 3.31	
Maniq	8(8.0)	72(13.53)	1.03	0.08, 2.71	
Religion					<0.001
Buddhism	66(66.0)	417(78.38)	0.25	0.12, 0.49	
Islam	25(25.0)	40(7.52)			
Others	9(9.0)	75(14.10)	0.76	0.10, 0.34	
Education					0.099
never attend school	28(280)	202(37.97)			
till primary school	48(48.0)	242(45.49)	1.42	0.95, 2.11	
secondary school	24(24.0)	88(16.54)	1.98	1.03, 3.79	

Factor	Use ITN every night		Univariable model		
	Yes (n=100)	No (n=532)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Occupation					0.085
Wage laborer	26(26.0)	140(26.32)			
Seasonal worker	31(31.0)	226(42.68)	0.72	0.29, 1.80	
Forest worker	43(43.0)	166(31.20)	1.34	0.65, 2.77	
Income/month					0.582
1-3000 THB	10(10.0)	45(8.77)			
3001-6000 THB	3(3.0)	22(4.29)	0.61	0.14, 2.54	
6001-10000 THB	22(22.0)	164(31.97)	0.60	0.24, 1.53	
> 10000 THB	64(64.0)	282(54.97)	1.02	0.56, 1.84	
Migrant classification					0.287
M1	86(86.0)	498(93.61)			
M2	14(14.0)	34(6.39)	2.43	0.47, 12.44	
Documentation Status					0.206
Documented	71(71.0)	411(81.07)	0.61	0.28, 1.31	
Undocumented	27(27.0)	96(18.93)			
Thai language skill					0.329
can speak or read	13(13.0)	95(17.86)			
can't speak or read	87(87.0)	437(82.14)	1.46	0.68, 3.11	
Forest goer					0.123
yes	53(53.0)	223(41.92)	1.57	0.88, 2.78	
no	47(47.0)	309(58.08)			
Length of stay at current location					0.064
<6 months	22(22.0)	98(18.42)	1.09	0.42, 2.84	
6 months to 5 years	6(6.0)	87(16.35)	0.34	0.13, 0.87	
> 5 years	72(72.0)	347(65.23)			
Frequency of visit to home country					0.002
Never	48(48.0)	281(52.82)			
More frequent (at least once in 6 months)	10(10.0)	9(1.69)	6.62	2.31, 18.94	
Less frequent (less than once in 6 months)	42(42.0)	242(45.49)	1.01	0.67, 1.54	
Type of accommodation					0.037
Dormitory	48(48.0)	295(55.45)	0.54	0.30, 0.96	

Factor	Use ITN every night		Univariable model		
	Yes (n=100)	No (n=532)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Farm shelter	9(9.0)	93(17.48)	0.32	0.12, 0.84	
Single house	43(43.0)	144(27.07)			
Location of accommodation					0.116
Town/village	54(54.0)	309(58.08)			
Farm (fruit, cassava, corn, paddy fields)	36(36.0)	133(25.0)	0.66	0.30, 1.45	
Forest (wild, rubber and teak plantation)	9(9.0)	90(16.92)	0.40	0.16, 0.95	
Source of water					0.667
Protected (piped, tube well, public tap etc.)	89(89.0)	483(90.96)			
Unprotected (surface water, uncovered stored water)	11(11.0)	48(9.04)	1.28	0.41, 3.95	
Type of toilet					0.148
Permanent (Flush or pour flush toilet, pit latrine with slab)	91(91.0	452(84.96)			
Temporary (Pit latrine without slab, hanging toilet, bush, field)	9(9.0)	80(15.04)	0.56	0.26, 1.23	
Living with					0.489
Live alone	4(4.0)	43(91.49)			
Live with others but not family	18(18.0)	120(22.56)	1.60	0.41, 6.26	
Live with family	78(78.0)	369(69.36)	2.27	0.58, 8.84	
Family with pregnant woman					0.099
No	93(93.0)	510(96.77)			
Yes	7(7.0)	17(3.23)	2.32	0.85, 6.29	
Family with children age < 5 years					0.342
No	68(68.0)	383(73.23)			
Yes	30(30.0)	140(26.77)	1.2	0.82, 1.77	
Overall Malaria Knowledge					0.007
Low	34(34.0)	291(54.70)			
Fair	17(17.0)	90(16.92)	1.63	0.97, 2.74	
High	49(49.0)	151(28.38)	2.76	1.44, 5.29	
Perceived Susceptibility					0.063
Low	27(40.30)	126(49.03)			
High	40(59.70)	131(50.97)	1.42	0.98, 2.06	

Factor	Use ITN every night		Univariable model		
	Yes (n=100)	No (n=532)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Perceived Severity					0.025
Low	19(19.0)	101(39.03)			
High	48(48.0)	156(60.70)	1.63	1.06, 2.51	
Perceived Benefits					0.011
Low	32(32.0)	164(63.81)			
High	35(35.0)	93(36.19)	1.94	1.16, 3.26	
Perceived Barriers					<0.001
Low	49(73.13)	221(85.99)			
High	18(26.87)	36(14.01)	2.25	1.44, 3.50	
Cues to action					0.002
High	36(36.0)	102(19.17)			
Low	64(64.0)	430(80.83)	2.45	1.39, 4.31	
Source of Net					<0.001
Free (public health staff/CSO/community)	55(55.0)	47(12.34)	9.08	4.26, 19.32	
Purchased	43(43.0)	344(87.66)			
Duration of receipt of net					<0.001
< 1 year	99(99.0)	217(57.71)			
> 1 year	1(1.0)	159(42.29)	0.01	0.002, 0.115	
Enough net in Household					<0.001
No	2(2.0)	115(31.17)			
Yes	76(76.0)	254(68.83)	18.6	4.08, 84.72	
Net condition					0.168
Not good	2(2.0)	30(8.02)			
Good	98(98.0)	344(91.98)	4.31	0.54, 34.39	

** P-values are Type III Wald Statistics from univariable logistic regression (GEE) model*

e) Among forest goers:

Factor	Use ITN every night at forest		Crude OR	95% CI	p-value*
	Yes (n=90)	No (n=992)			
	n (%)	n (%)			
Age group					0.607
15 - 24 years	24(8.66)	253(91.34)			
> 25 years old	66(8.20)	739(91.80)	0.88	0.54, 1.40	
Sex					0.980
Male	52(8.51)	559(91.49)			
Female	38(8.07)	433(91.93)	1.00	0.72, 1.39	
Geographical region (Border)					0.780
Thai-Myanmar	25(6.93)	336(93.07)			
Thai-Laos	42(10.66)	352(89.34)	1.27	0.39, 8.23	
Thai-Cambodia	5(9.80)	46(90.20)	1.80	0.45, 3.53	
Thai-Malaysia	18(6.52)	258(93.48)	0.71	0.15, 0.18	
Nationality					<0.001
Myanmar	23(4.65)	472(95.35)			
Lao	8(7.77)	95(92.23)	1.42	0.74, 2.70	
Cambodia	36(13.28)	235(86.72)	1.46	0.69, 3.04	
Malaysia	7(70.0)	3(30.0)	32.43	22.75, 46.21	
No citizenship	16(7.88)	187(92.12)	0.62	0.28, 1.36	
Religion					<0.001
Buddhism	62(6.69)	865(93.31)			
Islam	10(41.67)	14(58.33)	7.38	3.71, 14.65	
Christian	6(10.53)	51(89.47)	1.80	0.84, 3.94	
Others	12(16.22)	62(83.78)	2.03	0.72, 5.73	
Education					0.398
never attend school	49(11.14)	391(88.86)			
till primary school	30(6.16)	457(93.84)	0.73	0.46, 1.14	
secondary school	11(7.10)	144(92.90)	0.75	0.37, 1.48	
Income/month					0.014

Factor	Use ITN every night at forest		Crude OR	95% CI	p-value*
	Yes (n=90)	No (n=992)			
	n (%)	n (%)			
1-3000 THB	36(18.95)	154(81.05)			
3001-6000 THB	27(10.55)	229(89.45)	0.54	0.29, 1.01	
6001-10000 THB	12(3.32)	349(96.68)	0.21	0.83, 0.56	
> 10000 THB	11(4.44)	237(95.56)	0.34	0.13, 0.95	
Occupation					<0.001
Other/jobless	45(14.90)	257(85.10)			
Seasonal	29(20.14)	115(79.86)	1.16	0.511, 2.64	
Forest worker	12(1.97)	597(98.03)	0.16	0.066, 0.371	
Migrant classification					0.150
M1	46(5.55)	783(94.45)			
M2	44(17.39)	209(82.91)	1.87	0.79, 4.40	
Documentation Status					0.291
Documented	50(7.18)	646(92.82)			
Undocumented	38(10.30)	331(89.70)	1.29	0.80, 2.08	
Thai language skill					0.879
can speak or read	27(7.61)	328(92.39)	0.969	0.64, 1.45	
can't speak or read	63(8.67)	664(91.33)			
Length of stay at current location					0.448
<6 months	32(16.08)	167(83.92)	1.4	0.83, 2.40	
6 months to 5 years	5(4.42)	108(95.58)	0.98	0.51, 1.91	
> 5 years	53(6.88)	717(93.12)			
Frequency of visit to home country					0.595
Never	38(8.33)	418(91.67)			
More frequent (at least once in 6 months)	16(18.82)	69(81.18)	0.71	0.25, 1.98	
Less frequent (less than once in 6 months)	36(6.65)	505(93.35)	0.84	0.33, 2.13	
Frequency of going to the forest at night					0.012
Every day	66(10.06)	590(89.94)	0.94	0.45, 1.99	
Every week	10(3.23)	300(96.77)	0.35	0.15, 0.79	
Once a month or less	14(12.61)	97(87.39)	ref		
Overall Malaria Knowledge					0.046

Factor	Use ITN every night at forest		Crude OR	95% CI	p-value*
	Yes (n=90)	No (n=992)			
	n (%)	n (%)			
Low	21(5.24)	380(94.76)			
Fair	10(5.71)	165(94.29)	1.14	0.53, 2.44	
High	59(11.66)	447(88.34)	2.17	1.11, 4.26	
Perceived Susceptibility					0.076
Low	23(11.98)	169(88.02)			
High	46(9.06)	462(90.94)	1.308	0.97, 1.76	
Perceived Severity					0.363
Low	18(10.84)	148(89.16)			
High	51(9.55)	483(90.45)	1.2	0.81, 1.79	
Perceived Benefits					0.170
Low	14(7.04)	185(92.96)			
High	55(10.98)	446(89.03)	0.646	0.345, 1.20	
Perceived Barriers					0.526
Low	50(9.56)	473(90.44)			
High	19(10.73)	158(89.27)	0.87	0.58, 1.32	
Cues to action					0.080
High	50(6.29)	745(93.71)			
Low	40(13.94)	247(86.06)	1.823	0.93, 3.57	
Have ITN (including LLIHN)					
yes	90(100.00)	342(34.47)			
no	0	650(65.53)			
Duration of receipt of net					0.688
< 1 year	61(58.10)	44(41.90)			
>1 year	29(60.42)	19(39.58)	0.803	0.27, 2.34	
Enough net in Household					0.017
No	7(3.57)	189(96.43)			
Yes	62(8.14)	700(91.86)	2.11	1.14, 3.90	

** P-values are Type III Wald Statistics from univariable logistic regression (GEE) model*

Annex 6. Factors associated with Access to malaria case management among MMP with fever in last three months

Factor	Sought treatment for fever		Univariable model		
	Yes (n=259)	No (n=234)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Age group					0.694
15 - 24 years	42(16.22)	47(20.09)			
25-64 years	200(77.22)	174(74.36)	1.30	0.69, 2.42	
>65 years	17(6.56)	13(5.56)	1.38	0.52, 3.67	
Sex					0.022
Male	93(35.91)	109(46.58)			
Female	166(64.09)	125(53.42)	1.51	1.06, 2.15	
Geographical region (Border)					0.065
Thai-Myanmar	131(50.58)	87(37.18)			
Thai-Laos	67(25.87)	76(32.48)	0.64	0.38, 1.07	
Thai-Cambodia	18(6.95)	19(8.12)	0.56	0.33, 0.96	
Thai-Malaysia	43(16.60)	52(22.22)	0.54	0.31, 0.93	
Nationality					<0.001
Myanmar	120(46.33)	109(46.58)			
Lao	26(10.04)	23(9.83)	1.05	0.57, 1.92	
Cambodia	55(21.24)	72(30.77)	0.62	0.32, 1.18	
Malaysia	1(0.39)	4(1.71)	0.21	0.16, 0.27	
No citizenship	57(22.01)	26(11.11)	1.97	1.08, 3.58	
Religion					0.010
Buddhism	222(85.71)	205(87.61)			
Christian	27(10.42)	13(5.56)	1.77	1.01, 3.11	
Islam/others	10(3.86)	16(6.84)	0.58	0.30, 1.12	
Education					0.742
never attend school	117(45.17)	109(46.58)			
till primary school	109(42.08)	92(39.32)	1.10	0.72, 1.70	
secondary school	33(12.74)	33(14.10)	0.93	0.49, 1.70	

Factor	Sought treatment for fever		Univariable model		
	Yes (n=259)	No (n=234)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Occupation					0.198
Wage laborer	97(37.45)	78(33.33)	1.76	0.85, 3.67	
Jobless/household worker	28(10.81)	41(17.52)			
Seasonal worker	79(30.50)	59(25.21)	2.10	1.05, 4.17	
Forest worker	55(21.24)	56(23.93)	1.49	0.76, 2.90	
Income/month					0.001
1-3000 THB	81(33.47)	48(23.65)			
3001-6000 THB	75(30.99)	50(24.63)	0.88	0.52, 1.47	
6001-10000 THB	48(19.83)	63(31.03)	0.46	0.27, 0.76	
> 10000 THB	38(15.70)	42(20.49)	0.53	0.27, 1.07	
Migrant classification					0.044
M1	243(93.82)	206(88.03)			
M2	16(6.18)	28(11.97)	0.49	0.24, 0.98	
Documentation Status					0.341
Documented	160(62.02)	134(58.26)			
Undocumented	98(37.98)	96(41.74)	0.81	0.52, 1.25	
Thai language skill					0.791
can speak or read	80(30.89)	75(32.05)			
can't speak or read	179(69.11)	159(67.95)	1.05	0.73, 1.51	
Forest goer					0.434
Yes	78(30.12)	81(34.62)			
No	181(69.88)	153(65.38)	1.18	0.78, 1.80	
Have health insurance					0.410
Yes	138(53.28)	130(55.56)			
No	121(46.72)	104(44.44)	1.19	0.78, 1.80	
Length of stay at current location					<0.001
<6 months	26(10.04)	50(21.37)	0.38	0.22, 0.66	
6 months to 5 years	14(5.41)	27(11.54)	0.38	0.21, 0.69	
> 5 years	219(84.56)	157(67.09)			
Frequency of visit to home country					0.495

Factor	Sought treatment for fever		Univariable model		
	Yes (n=259)	No (n=234)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Never	124(47.88)	124(52.99)	0.81	0.45, 1.448	
More frequent (at least once in 6 months)	24(9.27)	19(8.12)			
Less frequent (less than once in 6 months)	111(42.86)	91(28.89)	1.01	0.57, 1.78	
Living with					0.043
Live alone	15(5.79)	19(8.12)	2.02	0.69, 5.98	
Live with others but not family	6(2.32)	15(6.41)			
Live with family	238(91.89)	200(85.47)	3.02	1.18, 7.73	
Family with pregnant woman					0.330
No	248(95.75)	227(97.42)			
Yes	11(4.25)	6(2.58)	1.73	0.57, 5.25	
Family with children age < 5 years					0.002
No	153(59.30)	167(71.67)			
Yes	105(40.70)	66(28.33)	1.69	1.21, 2.37	
Overall Malaria Knowledge					0.007
Low	84(32.43)	87(37.18)	0.72	0.49, 1.04	
Fair	26(10.04)	40(17.09)	0.49	0.30, 0.81	
High	149(57.53)	107(45.73)			
Perceived Susceptibility					0.085
Low	37 (21.02)	46 (30.07)			
High	139 (78.98)	107 (69.93)	1.57	0.94, 2.63	
Perceived Severity					0.739
Low	34 (19.32)	28 (18.30)			
High	142 (80.68)	125 (81.70)	0.89	0.48, 1.69	
Cues to action					<0.001
Low	160 (61.78)	183 (78.21)			
High	99 (38.22)	51 (21.79)	2.18	1.46, 3.26	
Accessibility					0.018
Low	138(53.28)	90(41.86)			
High	121(46.72)	125(58.14)	0.64	0.44, 0.93	
Availability					0.141
Low	64(24.71)	69(32.09)			
High	195(75.29)	146(67.91)	1.41	0.89, 2.21	

Factor	Sought treatment for fever		Univariable model		
	Yes (n=259)	No (n=234)	Crude OR	95% CI	p-value*
	n (%)	n (%)			
Affordability					0.001
Low	86(33.20)	103(47.91)			
High	173(66.80)	112(52.09)	1.93	1.32, 2.81	
Acceptability					0.019
Low	35(13.51)	42(19.53)			
High	224(86.49)	173(80.47)	1.63	1.08, 2.44	
Accommodation					0.552
Low	69(26.64)	51(23.72)			
High	190(73.36)	164(76.28)	0.88	0.57, 1.35	
Awareness					0.093
Low	58(32.58)	65(42.21)			
High	120(67.42)	89(57.79)	1.48	0.94, 2.38	

** P-values are Type III Wald Statistics from univariable logistic regression (GEE) model*

Established in 2003, Malaria Consortium is one of the world's leading non-profit organisations specialising in the prevention, control and treatment of malaria and other communicable diseases among vulnerable populations. Our mission is to improve lives in Africa and Asia through sustainable, evidence-based programmes that combat targeted diseases and promote child and maternal health.

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