Original article

Malaria knowledge, prevention practices, and insecticide-treated net ownership and use among foreign migrants: A survey in four malaria transmission districts of Yala Province, Southern Thailand

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Background: Increased malaria caseload is a public health threat to malaria elimination in Southern Thailand. Yala Province has the second highest malaria caseload in the country. Cross-border migration may be an underlying reason for the malaria outbreaks in Yala.
Objectives: In this study, we aimed to assess the malaria knowledge, prevention practices, and insecticide-treated net (ITN) ownership and use among migrants in four malaria transmission districts of Yala Province.
Methods: We conducted a cross-sectional survey with two-stage cluster sampling recruiting 414 migrants. We identified migrants' locations with the help of key informants. Migrants aged 18 years and older were interviewed face-to-face to collect information using a structured questionnaire by trained volunteers.
Results: Mean age was 29.9 ± 7.2 years and 71.5% were men. Of the surveyed population, 72.1% had heard of malaria and 47.9% knew about malaria prevention methods. Among the four districts, perceived susceptibility to malaria was highest in Yaha District; perceived severity of malaria and benefits of using ITNs were highest in Than To and perceived barriers to ITN use were highest in Bannang Sata District. Sixty-two point nine percent of migrants possessed a net and 40.7% owned an ITN, but only 14.1% used an ITN every night. ITN use more than 5 days a week and every night was significantly different among districts with the most migrants in Kabang District (44.8%, $P = 0.015$) and Yaha District (17.8%, $P = 0.046$) respectively.
Conclusions: This survey provides data to assist with malaria elimination in Thailand. ITN coverage should be improved among migrant populations in Yala. Behavioural change communication messages targeting migrant populations should focus on the benefits of sleeping under an ITN.

Keywords: Migrants, malaria, knowledge, insecticide-treated nets, Thailand.

There are multiple factors behind the social phenomenon of transnational migration, such as poverty, conflict and war, policies of structural adjustment, and globalization.[1] The impacts of migration are greater in developing countries.[2] Migrant workers in the Mekong Region cross borders through labour migration seeking work as a means to escape poverty and to acquire skills.[3, 4] However, being a migrant can make a person more vulnerable to negative influences on health.[5]

The poor living conditions of migrants who are employed as daily labourers can worsen problems caused by infectious and vector-borne diseases, including malaria.[6, 7] Temporary migrant workers could bring parasites into malaria-free areas[7] and subsequent local transmission can readily become established if personal protection and vector control measures are not properly implemented.[8] If sporadic epidemics occur, these can affect large numbers of local people, especially in previously malaria-free areas as the local population would generally be non-immune.[9]

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Southern Thailand has an international border with a heavy volume of transborder migration. Malaria cases in southern provinces of Thailand accounted for 30.3% of the country's caseload in 2019, and 83.3% of cases in the southern region were in Yala Province.[10, 11] This province had the highest malaria caseload in Thailand during 2016 and has had the second highest number of malaria cases since 2017.[12] The southern region was the fastest-growing area for migration, with the migrant population more than doubling during 2014 – 2017.[6]

Primary malaria vectors in Thailand are the *Anopheles dirus* complex and *Anopheles minimus* group.[10] As effective vector control contributes to the interruption of malaria transmission, it is essential to apply vector control measures based on the epidemiology, entomology, demography, and socioeconomic status of each area.[13] Vector control through application of indoor residual spraying is not readily accepted by the population.[11] Previous surveys in Thailand have revealed that using insecticide-treated nets (ITNs) is an effective means of preventing malaria among at-risk populations.[13, 14] The term ITN was reintroduced by the Global Malaria Programme as an umbrella term for all nets treated with an insecticide, insect-growth regulator, and/or synergist.[15]

Studies among migrants along the Thai–Cambodia and Thai–Myanmar borders have concluded that unregistered or undocumented people who do not access malaria services or adopt protective measures could be the origin of unidentified active malaria.[8, 16] It is crucial to develop innovative strategies related to malaria elimination among migrants and mobile populations who could harbour the largest reservoir of malaria infection.[11] To understand the underlying reasons for the increased malaria caseloads in Southern Thailand, especially in Yala Province where malaria outbreaks have been ongoing, data are needed regarding perceptions about malaria and prevention practices among migrant populations.[11] As yet, no studies have been conducted in Yala Province among a representative sample of migrants to address this information gap. Migrant health status and health issues are important for communicable disease control and malaria elimination.[17] In the present study, we assessed knowledge and practices regarding malaria prevention measures, perceived benefits and barriers to ITN use, and ITN ownership and use among migrants in Yala Province.

Materials and methods

The study was set in Yala Province, Southern Thailand. Yala is one of three provinces within the conflict zone of Southern Thailand. Major migrant sites in Yala were initially identified with the help of key informants from the migrant population who were well acquainted with the migrant population and could provide information on the occupations in which migrants were working, migrants' places of work and residence, the approximate population size, and migrants' lifestyles.

Sample size was calculated to provide an estimated prevalence (95% confidence interval) of the proportion of migrants that had used an ITN the previous night (5.7%)[14] and the proportion that had fever in the previous 2 weeks (3.5%).[14] Taking the largest estimate to ensure all target variables could be calculated, the initial sample size was 848, assuming a design effect of two (for variation between the clusters). After adjustment applying the finite population correction, the minimum sample size required for the study was 412.

We conducted a cross-sectional survey among migrant workers aged 18 years and above in four malaria transmission districts of Yala Province. Qualitative information was collected in focus group discussions with migrants, to aid in constructing the questionnaire and interpreting the quantitative data. Questions related to attitudes about malaria and ITNs were based on the Health Belief Model.[18] The questionnaire was pre-tested to ascertain comprehensibility and revisions were made.

Two-stage cluster sampling was used in this study. Districts with the highest malaria caseloads and malaria transmission foci served as clusters or primary sampling units and malaria foci with migrant sites as secondary sampling units. Of eight districts in Yala, we selected four districts with the most malaria transmission foci. The sample quota was calculated based on the required sample size, according to the proportion of malaria transmission foci (villages/hamlets) in each district. Malaria foci were then listed in each selected district and the required number of hamlets were randomly selected from the list by applying the sampling interval (total foci divided by required foci). A preliminary mapping of migrant sites was done in the selected hamlets, followed by targeted sampling in those areas, based on the established quotas. Targeted sampling is useful when the available data do not allow for comprehensive mapping of all sites.[19]

The research proposal and associated documents, such as translated information sheets and consent forms in migrants' languages (Thai, Yawee, Myanmar, Karen, and Shan) were approved by the ethical review committee, Institutional Review Board (IRB), Faculty of Medicine, Chulalongkorn University, on 18 July 2019 (Certificate of Approval no. 777/2019). Full confidentiality regarding information in the records and anonymity of migrants' workplaces was strictly maintained and the right to refuse participation was guaranteed.

Data collection

Data collection was undertaken during August to September 2019. Face-to-face interviews were conducted in the migrants' own languages by trained interviewers using a structured questionnaire. Information was sought on demography, preventive measure practices, perceived knowledge of ITN usage, and ITN ownership and utilization among migrant workers. The answers did not need to be mutually exclusive. Migrants' reasons for using or not using ITNs were also investigated, to understand their perceptions.

Statistical analysis

Data were entered into Open Data Kit open-source software (https://getodk.org) and imported into Microsoft Excel 2016 (MicrosoftCorp, Redmond, WA). Stata version 13.0 (StataCorp LLC, College Station, TX, USA) was used to clean and analyse the data. Descriptive statistics included calculation of proportion, mean, and standard deviation (SD) for demographic variables and variables of interest. Cross-tabulations were done to examine how responses differed among the four districts. The proportions were weighted for clustering by district and migrant site using survey analysis. Considering the sampling design, Rao–Scott chi-square tests were used to compare categorical variables.[20] The level of significance was set at $P < 0.05$.

Results

Sociodemographic characteristics

In total, 414 migrants were enrolled in the study. Sociodemographic characteristics of respondents were compared according to district (Table 1). The proportion of male migrants was significantly different among the districts ($P = 0.031$); the highest proportion was 89.6% in Yaha District (YH) followed by 70.1% in Bannang Sata District (BS), 59.7% in Than To District (TT), and 57.3% in Kabang District (KB). Mean age within districts was between 27.9 ± 7.2 and 32.9 ± 11.6 years. Seventy point eight percent of migrants could speak Thai in KB, followed by 53.2% in TT, 51.8% in BS, and 34.8% in YH. Rubber tappers (forest goers) were most common in KB (47.9%); the proportion of forest goers was 13.6%, 20.0%, and 25.9% in BS, YH, and TT, respectively. Regarding mobility, migrants in YH were more mobile, with 71.9% having lived in Thailand for less than 6 months; YH was followed by BS (30.1%), KB (27.1%), and TT (14.2%). As for insurance status, 30.2% of migrants in KB did not have any health insurance, followed by YH (21.5%), BS (20.6%) and TT (16.4%).

Knowledge about malaria and malaria prevention measures

The proportions of migrants who could correctly answer malaria knowledge questions were compared among the four districts (Table 2). TT had the most migrants who had heard about malaria (87.0%), followed by KB (81.3%), BS (68.9%), and YH (60.0%) ($P = 0.004$). Among the four districts, migrants in TT could correctly answer the most malaria-related knowledge questions regarding the mode of malaria transmission (45.8%, $P = 0.038$); 74.1% ($P = 0.032$) gave correct answers regarding malaria prevention measures such as sleeping under a mosquito net, using insecticide spray and mosquito repellents, and so on. As for malaria signs and symptoms, 78.6% ($P = 0.037$) of migrants in TT answered correctly regarding fever, chills, headache, fatigue, and so on; 81.1% ($P = 0.023$) responded correctly with respect to high fever, rapid breathing, unconsciousness, convulsions, and other symptoms and signs.

Perceptions of migrants related to malaria and prevention methods

Of all subjects, 37.2% had received malaria-related health education from health workers or volunteers. Among those having received health education, migrants in different districts differed in their perceptions about malaria and its prevention methods (Table 3). In terms of perceived susceptibility, migrants in YH had the highest scores for knowing that they could get sick from malaria (83.3%, $P = 0.19$) and being aware that people staying overnight in the forest had a high risk of contracting malaria (62.5%, $P = 0.005$). Migrants in TT had the highest scores for the perception that severe malaria

could lead to death (69.8%, $P = 0.034$) and that malaria definitely requires treatment (64.2%, $P = 0.663$). Migrants in TT also had the highest scores for the perceived benefit of using an ITN over conventional nets to prevent malaria (55.2%, $P = 0.096$); the highest proportion of migrants responding that sleeping under an ITN could cause skin allergies was in BS (42.3%, $P = 0.03$).

Table 1. Key socio-demographic characteristics of respondents by district (n = 414).

Variables	BS (n = 165) n (%)	YH (n = 69) n (%)	KB (n = 96) n (%)	TT (n = 84) n (%)	*P* - value[#]
Age (year)					0.168
Mean ± SD	29.8 ± 8.4	27.9 ± 7.2	31.3 ± 9.2	32.9 ± 11.6	
Sex					0.031
Male	115 (70.1)	58 (89.6)	55 (57.3)	50 (59.7)	
Female	50 (29.9)	11 (10.4)	41 (42.7)	34 (40.1)	
Ethnicity					0.138
Myanmar	70 (35.6)	25 (34.1)	57 (59.4)	31 (36.6)	
Shan	45 (23.0)	15 (11.1)	19 (19.8)	5 (5.7)	
Karen	24 (21.9)	8 (5.9)	20 (20.8)	0 (0.0)	
Malaysian	18 (10.7)	15 (44.4)	0 (0.0)	14 (16.6)	
Sakai	8 (8.8)	6 (4.4)	0 (0.0)	34 (41.1)	
Thai language skill					
Can speak Thai	84 (51.8)	35 (34.8)	68 (70.8)	45 (53.2)	0.149
Can read Thai	43 (22.9)	23 (19.3)	46 (47.9)	26 (30.5)	0.212
Occupation					0.078
Laborer	49 (37.3)	12 (24.4)	9 (9.4)	35 (41.7)	
Paddy farmer	8 (3.9)	0 (0.0)	6 (6.3)	1 (1.1)	
Construction worker	67 (33.2)	14 (10.4)	31 (32.3)	16 (19.0)	
Rubber tapper	21(13.6)	27 (20.0)	46 (47.9)	22 (25.9)	
Others	20 (12.0)	16 (45.2)	4 (4.2)	10 (12.2)	
Migration status					0.053
< 6 months	51 (30.1)	37 (71.9)	26 (27.1)	12 (14.2)	
≥ 6 months	114 (69.9)	32 (28.2)	70 (72.9)	72 (85.8)	
Health insurance status					0.280
No health insurance	36 (20.6)	17 (21.5)	29 (30.2)	14 (16.4)	
Migrant health insurance/HICS	109 (62.3)	31 (29.6)	67 (69.8)	48 (57.0)	
HIS-PCP	8 (8.8)	6 (4.4)	0 (0.0)	22 (26.7)	
Passport	12 (8.3)	15 (44.4)	0 (0.0)	0 (0.0)	

[#]Wald statistic; Rao–Scott chi-squared test.
BS, Bannang Sata; YH, Yaha; KB, Kabang; TT, Than To.

Table 2. Correct responses for malaria-related knowledge and prevention measures by district (n = 414).

Knowledge factors	BS (n = 165) n (%)	YH (n = 69) n (%)	KB (n = 96) n (%)	TT (n = 84) n (%)	*P* - value[#]
Having heard of malaria	119 (68.9)	45 (60.0)	78 (81.3)	73 (87.0)	0.004
Mode of malaria transmission	44 (28.7)	23 (30.4)	26 (27.1)	38 (45.8)	0.038
Malaria preventive measures	67 (39.8)	31 (34.1)	54 (56.3)	62 (74.1)	0.032
Malaria signs and symptoms	102 (57.6)	41 (50.4)	69 (71.9)	66 (78.6)	0.037
Severe malaria signs and symptoms	92 (52.9)	41 (50.4)	66 (68.8)	68 (81.1)	0.023

[#]Wald statistic; Rao–Scott chi-squared test.
BS, Bannang Sata; YH, Yaha; KB, Kabang; TT, Than To; SD, standard deviation; HICS, health insurance card scheme; HIS-PCP, health insurance for people with citizenship problem

Table 3. Perceptions of migrants related to malaria and its prevention methods by district, among those who had received malaria-related knowledge (n = 133).

Health belief	BS (n = 59) n (%)	YH (n = 18) n (%)	KB (n = 36) n (%)	TT (n = 20) n (%)	*P* - value[#]
Perceived susceptibility					
Can get sick from malaria	39 (68.0)	14 (83.3)	28 (77.8)	15 (75.4)	0.190
People overnight in forest have high risk of malaria	21 (36.3)	12 (62.5)	16 (44.4)	11 (54.7)	0.005
Perceived severity					
Severe malaria can lead to death	27 (46.4)	13 (66.7)	19 (52.8)	14 (69.8)	0.034
Malaria not self-cured; needs treatment	35 (59.0)	12 (50.0)	19 (52.8)	13 (64.2)	0.663
Perceived benefits					
ITNs better to prevent malaria than convectional nets	13 (24.4)	7 (29.2)	10 (27.8)	11 (55.2)	0.096
Perceived barriers					
Sleeping under ITNs can cause skin allergies	25 (42.3)	4 (16.7)	8 (22.2)	3 (15.1)	0.030

[#]Wald statistic; Rao–Scott chi-squared test.
BS, Bannang Sata; YH, Yaha; KB, Kabang; TT, Than To; ITN, insecticide-treated nets.

Ownership and use of ITNs

Regarding ITN ownership among all migrants, 62.9% had at least one type of net (any kind of net, including ITNs) whereas only 40.7% owned an ITN. Among those who owned an ITN, 34.7% (14.1% of all migrants) used an ITN every night and 67.3% (27.4% of all migrants) slept under an ITN more than 5 days a week. Figure 1 shows the proportions of migrants that owned any net, an ITN, and that used an ITN, based on all surveyed migrants (100.0%).

ITN coverage and use

Net ownership and utilization among migrants according to each surveyed district are shown in Table 4. Among all districts, KB had the highest proportion of migrants who owned an ITN (63.5%, $P = 0.110$) and that used an ITN more than 5 days a week (44.8%, $P = 0.015$) whereas the migrant population in YH had the highest ITN utilization every night, (17.8%, $P = 0.046$).

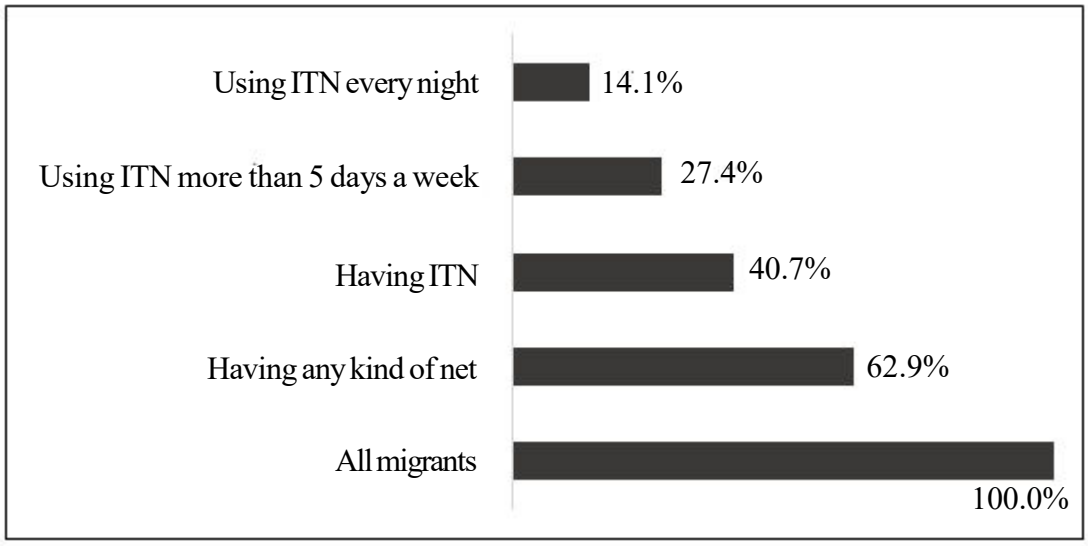

Figure 1. Insecticide-treated net ownership and utilization among all respondents (n = 414); Abbreviation: ITN, insecticide-treated net.

Table 4. Insecticide-treated net ownership and utilization of migrants by district (n = 414).

Variable	BS (n = 165) n (%)	YH (n = 69) n (%)	KB (n = 96) n (%)	TT (n = 84) n (%)	*P* - value[#]
Owning any ITNs	51 (32.2)	32 (34.8)	61 (63.5)	37 (43.2)	0.110
Using ITNs more than 5 days a week	46 (28.1)	25 (29.6)	43 (44.8)	7 (8.0)	0.015
Using ITNs every night	24 (14.8)	12 (17.8)	17 (17.7)	4 (4.6)	0.046

[#]Wald statistic; Rao–Scott chi-squared test.
BS, Bannang Sata; YH, Yaha; KB, Kabang; TT, Than To; ITN, insecticide-treated net.

Discussion

There have been no prior surveys conducted among foreign migrants in Yala Province assessing their malaria knowledge, prevention practices, or ITN ownership and utilization. This study aimed to generate population-averaged estimates in Yala using clusters. Our findings provide data that will be helpful in understanding the prevailing situation among migrants in different districts of Yala where malaria transmission is ongoing.

Most migrants surveyed were in the working age group 25 – 64 years. Survey subjects were predominantly those living in Thailand for more than 6 months, probably because most of these migrants had been settled in their current location in Thailand for over 5 years, which made them easier to locate via key informants during the local mapping process. The sex ratio of 2:1 among migrants in this study was also in line with data from the Yala Provincial Labor Office.[21]

Ownership of at least one net among migrants was much lower than the findings of a 2016 household-based survey in which only 3.6% of subjects were migrants (62.9% vs. 90.8%); however, ownership of at least one ITN was not much different between the two surveys (40.7% vs. 52.3%).[14] More concerted efforts are needed to improve both conventional net and ITN coverage among migrants, although access to these groups is challenging. Screening migrants at border crossings (both official and unofficial) and providing them with a free ITN may be an effective way to target highly mobile migrants. Free long-lasting insecticide-treated net (LLIN) distribution, currently via Global Fund grants, must be continued to increase ITN coverage among long-term settled migrants. The term LLIN is only used for ITN classes for which physical and chemical durability have been comprehensively demonstrated against World Health Organization (WHO) thresholds of 20 washes and 3 years of use in the field.[15] In addition to distributing new LLINs, treating existing nets with an insecticide solution may be a viable way to increase ITN coverage among migrants; 63.0% of migrants in this study already owned a net. Treating plain nets with insecticides annually is included within the strategic plan of the Thai national malaria elimination program.[10] A specific guideline regarding timing and locations for the retreatment of nets should be developed, to facilitate treatment of a maximum number of nets with insecticidal solution.

Behavioural change communication and health education messages directed toward migrant populations should focus on the benefits of sleeping under an ITN and on reducing migrants' negative perceptions to ITNs. Twenty-two percent of migrants surveyed did not sleep under an ITN because of skin rashes, a burning sensation, or the chemical smell. Information on the number and timing of washes for treated nets should also be emphasized, according to recommendations of the WHO.[22]

Regarding ITN utilization, only 34.7% of migrants who owned an ITN slept under one every night, which indicates a behavioural gap. Although migrants in TT knew the most about malaria prevention measures and had the highest levels regarding perceived benefits of using an ITN, they used ITNs the least in comparison with migrants in other districts. Beyond improving knowledge, closing the behavioural gap is difficult to address and require novels and effective approaches to behaviour change.[23]

In this study, KB had the most migrants with health insurance and who owned an ITN among all districts, reflecting that registered migrants may benefit from greater access to health promotion activities.[24] This could provide migrants with a better chance of improving their attitudes regarding the use of ITNs; migrants in KB also used ITNs for more than 5 days a week (the most among all districts surveyed).

Having a migrant health worker at worksites can serve to improve awareness about malaria among non-registered migrants. This would require close collaboration with and support from employers. Employers can also become engaged in health promotion activities and distribution of nets.

In this study, 23.6% of migrants were rubber tappers. Migrants who work on rubber plantations less commonly use an ITN because they work all night.[25] Rubber tappers and other forest-goers who work at night are unable to use nets and therefore must be targeted for the use of personal protection that can be worn while working.[25, 26] A more tailored personal protective tool for forest-goers may be insecticide-treated clothing (ITC), such as an insecticide-treated net jacket, which has been shown in a recent Cochrane review to reduce the risk of malaria infection by 50.0% in settings where ITN roll out is not possible.[27] However, more research is needed into the feasibility and protective efficacy of ITC.

In this study, there are some limitations. Limited time was allowed for data collection at migrant sites in Yala Province owing to security reasons in the southern conflict zone, and we sampled clusters according to the size of malaria transmission as a proxy for malaria risk among migrants since there was no sampling frame of migrants in Yala Province. However, this survey was representative of the migrants within each district surveyed and provides data that will assist with malaria elimination in Thailand.

Conclusion

Rapid scaling up of ITN coverage, novel approaches to behaviour change, and strong community engagement are needed among migrants in Yala to continue progress toward malaria elimination. ITN coverage could be increased via community-based net re-dipping campaigns in addition to LLIN distribution. As migration is time sensitive, it would be beneficial for the healthcare system to periodically update the mapping and health profiles of migrants via close collaboration among local health officials, community leaders, civil society organization staff, and employers. Updated migrant mapping is crucial to ensure precise sampling and planning of future study designs. Studies that use appropriate qualitative designs should be conducted to gain a better understanding of the malaria risk and preventive practices among highly mobile and hidden migrants who may participate in illegal activities such as wood logging and sex work along the border region. It is hoped that this survey and recommendations stemming from the results will assist with malaria elimination in Thailand and the surrounding region.

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Conflict of interest

The authors hereby declare no conflict of interest.

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