Research Article

A cross-sectional survey of knowledge of malaria prevention among mobile and migrant populations in Cambodia

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Abstract

Background: Malaria elimination campaigns are making huge strides in Cambodia with a target of elimination by 2025. However, pockets of transmission remain. Predominately in border forested areas in Western Cambodia populations are often part of Mobile and Migrant Populations (MMPs).

Methods: The Cambodian Mobile and Migrant Population Survey aimed to gain further insight into MMPs. The cross-sectional survey was carried out across ten malaria endemic health districts in 2017. Separation of MMPs into four main occupational subgroups; construction workers, seasonal workers, forest goers and security personnel, was used for analysis.

Results: All MMPs questioned knew what malaria was and most MMPs knew mosquito bites caused malaria. However, there were other misconceptions about how it could be transmitted. Only 6% could correctly name three preventative measures. Overall net ownership was found to be 95% although high it remains lower than the national level. Furthermore, insecticide treated net (ITN) ownership 58%. MMPs reported to sleep under a mosquito net last night was 87% but only 37% of them did use effective ITN. Variation in subgroups was found regarding demographics of MMPs, and mobility.

Conclusion: MMPs are not a homogenous group and malaria interventions should focus on specific subgroups. This information should inform and improve effectiveness of future interventions to allow Cambodia to move closer to the 2025 elimination goal.

Introduction

In the last decade, malaria control efforts in Cambodia were very successful, reducing malaria cases by 50% between 2004 and 2014 [1]. The national strategy now focuses on elimination with a target of malaria elimination by 2025 [1]. The implementation of an infrastructure of village malaria workers is part of the national strategy and was instrumental to improving health in rural areas. These workers are members of the community who are trained in recognizing symptoms, diagnosing and treating malaria cases as well as providing protective measures such as insecticide treated nets in their local village [2]. Diagnosis is carried out with Rapid Diagnostic Tests (RDTs), which improve the speed of diagnosis. The use of Artemisinin-Based Combination Therapy (ACT) for treatment is vital to control efforts for successful treatment of malaria infections, however resistance to ACTs was first described in 2009 and is on the rise [3,4]. ACT resistance threatens the success of treatment which could result in unnecessary deaths. The spread of artemisinin resistance is a huge concern, there would be devastating consequences if it spread further afield to Africa where the majority of the worlds malaria cases occur [5]. Therefore, it is more important than ever for the success of the malaria elimination goals.

While Cambodia is nearing malaria elimination, hotspots remain and malaria is still a major public health concern [6]. In 2016 it was estimated that 48% of the population lived in a high transmission area with >1 case per 1000 people [7]. The overall prevalence of *Plasmodium falciparum* by polymerase chain reaction (PCR) was estimated to be 4.4% in 2016 [8]. Infection rates appear to be highest in the Western border regions of the country, where malaria burden is concentrated in Mobile and Migrant Populations (MMPs). MMPs on the Thailand-Cambodian border were identified to have higher rates of malaria and are three times more likely to experience a clinical malaria episode than the general population [9,10]. These populations are particularly at risk of malaria [11] due to their lifestyle, occupation and reduced access to resources such as health facilities [6]. The occupations MMPs undertake often involve work in the forest as well as living in close proximity, this increases their risk due to additional contact with malaria vectors [12,13]. Additionally, their high levels of mobility make it difficult to reach them with public health messages and interventions. High levels of mobility also poses a threat to malaria elimination, as it means that malaria can be easily spread between endemic and non-endemic areas, as well as across borders [14,15].

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Although general characteristics of MMPS are known, little data exists about their malaria knowledge and prevention activities associated within specific subgroups; subsequently they are targeted by non-specific interventions. Recent studies have indicated that there is much more heterogeneity within MMPs regarding health behaviour and utilization of health care than previously thought. In order to address this need for more specific information, the Cambodian Mobile and Migrant Survey 2017 (CMMS) was carried out to gather information on characteristics and behaviours of MMPs to help produce more specific strategies to target malaria interventions to these groups.

Materials and Methods

Study design

The Cambodia Mobile and Migrant Survey 2017 was a cross-sectional non-probability sampling survey used to gather information on MMP knowledge and access to malaria prevention methods. The survey covered ten malaria endemic Operational Districts (ODs) in the provinces of Pursat, Battambang, Oddar Meanchey, Stung Treng and Rattanak Kiri, between March and April 2017 (Figure 1). This area was chosen as it has high levels of malaria transmission, ACT resistance and MMPs [16,17]. The MMP sample size was estimated by key individuals on the ground such as VMWs, the OD director, the OD malaria supervisor and village chiefs. Inclusion criteria included that participants must be over the age of 18. People were described as migrants if they were a resident for a period of between six and twelve months and mobile if they were a resident for less than six months [6].

Sampling and data collection

Desired study participants are by definition hard to reach and therefore a selective sampling technique was used. A sample size of 1200 was calculated for each MMP subgroup with even sampling across geographical areas. Initially a field assessment was undertaken to identify potential survey sites as well as estimate the number of MMPs in each site. This led to the creation of a provisional list of survey sites by OD and province. Participants were selected evenly across the 10 ODs in 5 provinces to try and ensure an even geographical distribution. An estimated sample size of 1,200 MMPs from each MMP subgroup was selected. A structured questionnaire was created to obtain information on various factors including; socio-demographic characteristics, recent mobility, high-risk forest going behaviour and preventative behaviour. Questionnaires were carried out by trained health surveyors in Khmer after written consent was given.

Ethical considerations

This survey was approved by the National Ethics Committee for Health in Research in Cambodia (ref: 065NECHR). Prior to participating in the study, written consent was obtained from each participant, ensuring they fully understood the nature of the survey and that is was confidential.

Data management and analysis

The data collected was entered into a database by a trained data processor. The dataset was cleaned and collated in a standardized
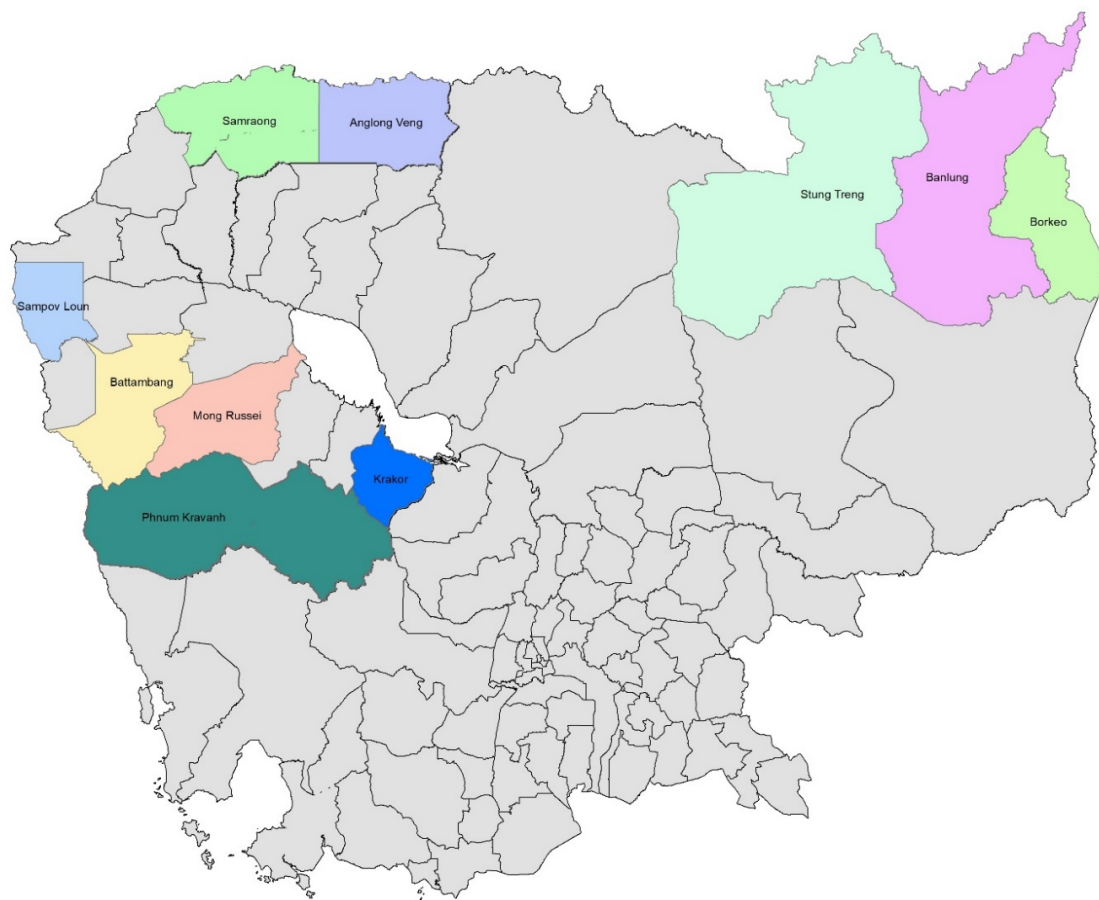

Figure 1. Operational districts covered by the survey.

database in Excel by a senior researcher. Analysis was carried out using Excel and SPSS. For analysis purposes, MMPs were characterized into four subgroups based on occupation, which was developed by Guyant *et al.* These were:

- Security personnel include military and the police, they have activities that include patrolling forested border areas.

- Forest goers are individuals that may be mobile or migrants but also local residents that engage in migration into forested areas.

- Seasonal workers are involved in agricultural activities and are usually located in foothills/plains/valleys.

- Construction workers whose occupation includes construction, mining, dam and demining activities.

Means and confidence intervals were calculated to give general characteristics of each group while chi-square testing was used to compare between the MMP subgroups for various variables. Significance was determined at the 5% level (*p<0.05*).

Results

Socio-demographic characteristics of MMPS

A total of 4,844 questionnaires were undertaken, representing 1,215 construction workers, 1,210 forest goers, 1,209 seasonal workers and 1,210 security personnel. Data was collected from 158 survey sites, either at MMP workplaces or villages, across ten malaria endemic ODs in five provinces. Representation from each province aimed to be even, although there is some variation, the lowest number of people questioned occurred in Stueng Treng (n=590), while the highest was in Oddar Meanchey (n=1,275) (Figure 2).

The majority of the MMPs interviewed were male (74%), although this distribution was not even amongst the different MMP subgroups. While almost all (99%) security personnel were males, just over half of the seasonal workers were female (51%). The age of the respondents interviewed ranged from 18 (which was set as the minimum age) to 83 years old, with a mean age of 35 years. The age distribution was similar across all four MMP subgroups. Seasonal workers worked farming plantations of mainly cassava, while the majority of construction workers were involved with road construction.

Over half of the MMPs reported living with their families (59%), while the remaining lived with co-workers (35%), alone (5%) or with friends (1%). Again, the distribution in each group varies by subgroup (Table 1). Among the MMPs that reported living with family members, on average they lived with 3 other family members per household (Mean=2.85, Std Dev=1.57).

By definition MMPs are highly mobile. However, the degree of mobility varies between MMP subgroup (Figure 3). Construction worker and seasonal worker subgroups had the highest proportion of people living in that area for less than 3 months, 71% for both subgroups. This contrasts with both forest goers and security personnel subgroups where only 5% and 6% of the groups, respectively, lived in the area for less than 3 months, while the majority (92% and 87%, respectively) lived in the area for more than 12 months. Few people from any of the subgroups were living in the area for between 3 and 12 months. The majority of MMPs who reported to have moved to the area in the last 3 months (n=1858) came from another province (66%).

Knowledge of prevention methods

Almost all MMPs interviewed in the Cambodian Mobile and Migrant Survey 2017 reported to have heard of a disease called malaria and 64% knew that transmission only occurs through mosquito bites. A further 11% believed that you could acquire malaria from mosquito bites and staying overnight/visiting the forest. While the remaining 25% gave at least one incorrect answer. The 4 subgroups performed similarly regarding knowledge of transmission; a range of 58-68% of people responded that only mosquito bites caused malaria (the lowest was found in seasonal workers).

Half of MMPs could name at least one correct preventative measure, however only 6% could name 3 correct malaria preventative measures without any incorrect answers. The most common preventative measures stated were "sleeping under a bed net", "sleeping under a hammock net" and "wearing long sleeved/covered up clothing". These responses accounted for 66.7% of all responses. However, 27.1% of responses were incorrect, including "burning leaves", "mosquito coil", "boiling water" and "insecticide spray".

Between MMP subgroups there was some variation in knowledge. Security personnel had the highest percentage of people who gave at
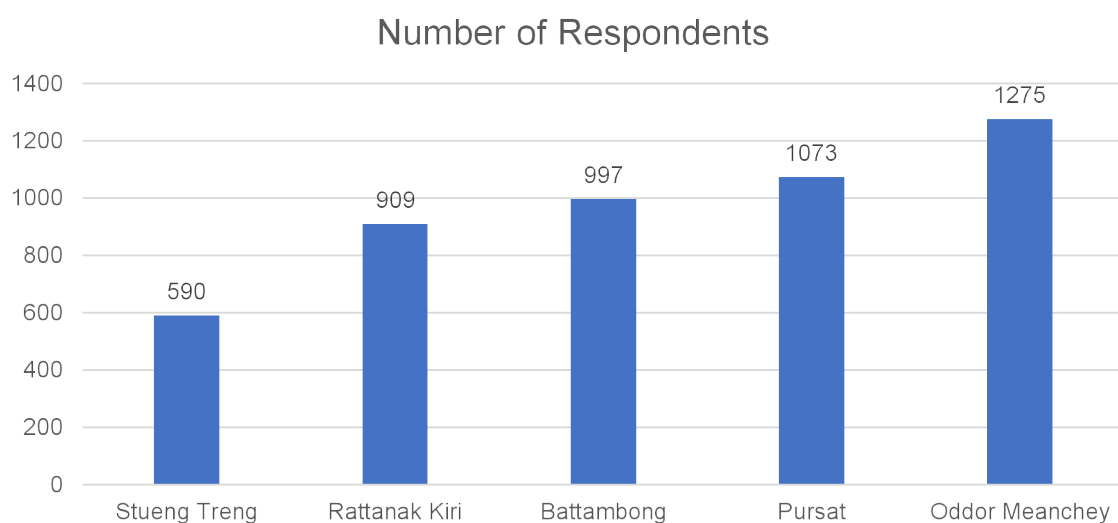
Number of Respondents

Figure 2. Number of questionnaire respondents by province

Table 1. Percentage of MMPs household living arrangement by MMP subgroup

Household	Seasonal Worker (n=1209)	Construction Worker (n=1215)	Forest Goers (n=1210)	Security Personnel (n=1210)	All MMPs (n=4844)
Living alone	4.6%	9.3%	1.2%	4.7%	5.0%
Living with family	78.4%	35.0%	95.1%	27.7%	59.0%
Living with friends	1.8%	2.2%	0.8%	0.7%	1.3%
Living with co-workers	15.2%	53.5%	2.9%	66.9%	34.7%
Total	**100%**	**100%**	**100%**	**100%**	**100%**
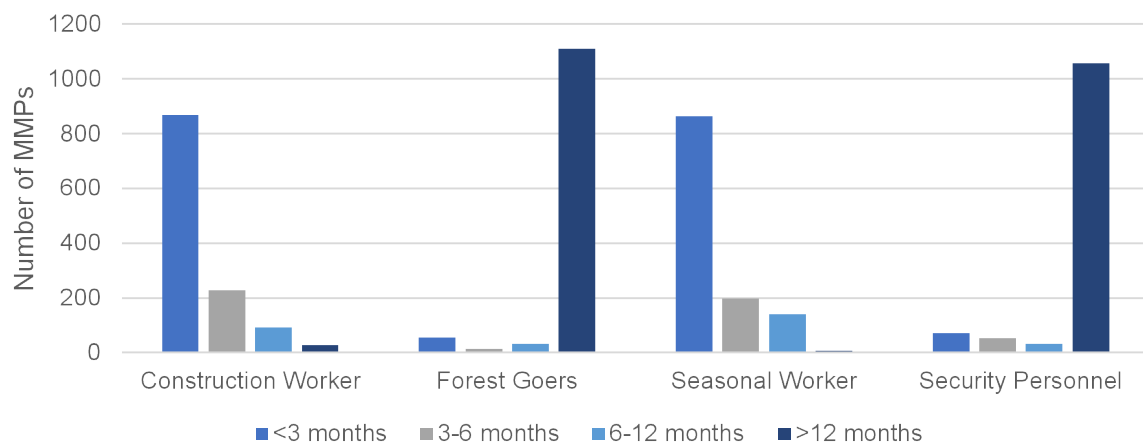
Figure 3. Length of time MMP has been at survey site by MMP subgroup

least 3 correct answers without any incorrect answers, however it was still only 12% of this population. Although the use of bed nets was reported highly by all subgroups, forest goers and seasonal workers had the highest proportion (94%), while for construction workers and security personnel it was lower, 89% and 87%, respectively. Fewer MMPs reported that hammock nets could be used as a preventative measure against malaria; this was higher for security personnel with 50% naming this as a preventative measure compared to 32% forest goers, 31% of construction workers and 17% of seasonal workers.

Net Ownership

A high level of net ownership was found in the survey, 95% reported that their family owned at least one net. 43.2% of MMPs owned both a hammock net and a bed net, a further 41.2% owned only a bed net and 10.1% owned only a hammock net. Ownership was heterogeneous between different MMP subgroups (Figure 4). Security personnel had the highest number of both hammock and bed net ownership at 69.7% compared to other subgroups. Construction workers had the lowest levels of hammock and bed net ownership (19%), although this group had the highest level of hammock only ownership (still only 24.3%). Construction workers also had the highest proportion of people that did not own a net.

Only 62% of all the reported hammock nets and 63% of all the reported bed nets were considered insecticide treated nets (ITNs). This makes the proportion of ownership of ITNs much lower than the ownership of all kinds of mosquito nets. Moreover, there were big differences in the proportion on MMPs in each subgroup who owned an ITN. While 71% of Security personnel and 67% of Forest Goers had an ITN, only 37% of Seasonal Workers an 19% of Construction Workers had an ITN. This ITN ownership was statistically significantly different at the 95% level (X^2=779.1, $p<0.00001$).

The majority of MMPs received their nets within the last 2 years, with 45% of MMPs having received their net in the last 6 months. This did not vary between MMP groups. 35% of the nets were reported to have holes. The majority of MMPs obtained their nets from shops or markets (45%), a further 17% obtained their nets from VMWs or migrant malaria workers (MMWs). The remaining MMPs stated they acquired their nets from "other government sources", "NGOs", "health centres", "itinerant sellers", "military institutions", their "employer" or as a "gift". Construction Workers and Seasonal Workers were much more likely to get their nets from markets, 76% and 55%, respectively, compared to other MMP subgroups. Forest goers on the other hand mainly obtained their nets from VMWs or MMWs (42%). The majority of Security Personnel acquired their nets from alternative government sources (42%). The difference between groups is significant at the 95% level (X^2=780.6, $p<0.00001$).

Sleeping sites and net usage

Most of those interviewed slept at the survey site (workplace or village) the night before (91%), 8% slept elsewhere and only 1% of those slept in the forest. However, 58% of the survey sites were located within the forest. The majority reported having slept under a mosquito net the previous night (87%). This proportion varied significantly between MMP subgroups (X^2=33.1, $p<0.0001$), 82% of construction workers used a net the previous night, 88% of forest goers, 90% of seasonal workers and 88% of security personnel. Fortunately, a higher proportion of the MMP family members slept under a net the previous night (92%). Again, the proportion of family members protected varied between MMP subgroup. Construction workers had the lowest proportion of family members sleeping under a net the previous night at 87%, compared to 97% of security personnel, 90% of seasonal workers and 93% of forest goers. Based on what our interviewers could verify and what was reported by respondents, 35% of the used mosquito nets had holes but 21% were repaired. Interviewers ascertained that 37% of
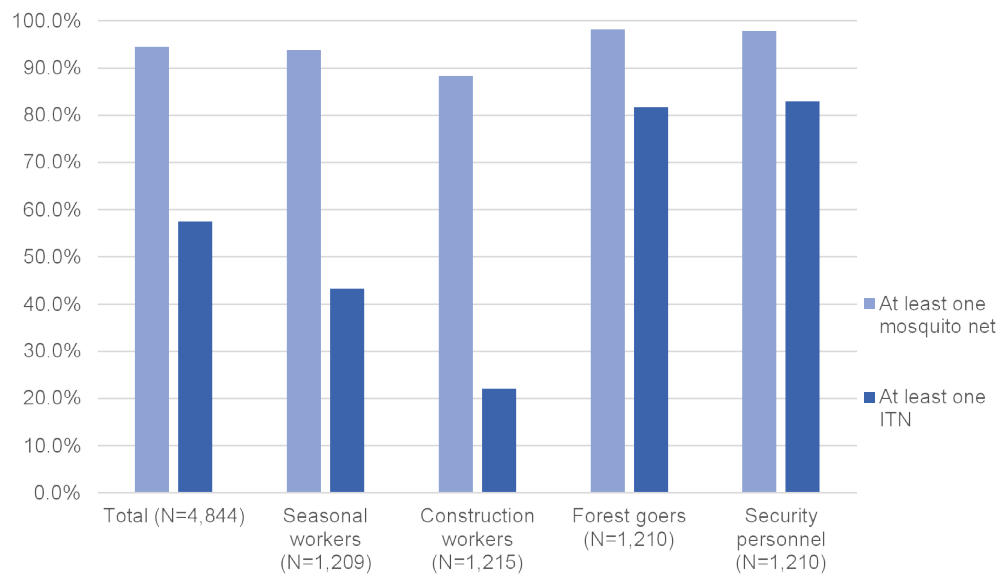
Figure 4. Net and ITN ownership disaggregated by MMP subgroup

the nets used were deemed ineffective due to criteria including age or holes. The main problem appears to be damage to the net as 98% were obtained within 3 years and 70% of those within the last year therefore insecticides present should still be effective. Of the 4,215 mosquito nets reportedly used by MMPs for sleeping the previous night, the data collectors could verify 48% of them.

Discussion

MMPs are identified as a group essential to target for the successful elimination of malaria in Cambodia [18]. The Cambodian Mobile and Migrant Survey successfully provided insight into these hard to reach populations, which will be beneficial to further inform malaria control elimination in Cambodia. Almost all MMPs knew malaria was caused by mosquito bites. There was good knowledge of preventative measures such as sleeping under a bed net or hammock net, although some misconceptions about other incorrect methods of malaria prevention were also reported. This suggests that the range of Behaviour Change Communication (BCC) activities implemented by the National Programme since 2009 were partially effective [19]. However, misconceptions may highlight the need for further education and awareness on the correct ways to prevent malaria. BCC is important to improve malaria control [20,21] and, subsequently, the BCC strategy is an integral component of the national strategy. Findings from the survey should help to inform revisions of the BCC strategy, as needed.

Although MMPs are identified as a population that is in need of additional interventions, MMPs have too often been treated as a homogenous risk group [22] and interventions targeted at this group are not always effective. For example, one study examining the effectiveness of MMWs as an intervention on seasonal workers found that 71% of seasonal workers were unaware that MMWs were available for malaria consultation due to the short length of time they were in the area [13]. The findings of the Cambodian Mobile and Migrant Survey 2017 identified a number of key differences found between MMP subgroups. These differences include demographic and behavioural variances and access to preventative measures. The majority of MMPs were male, however distribution varied between subgroups. Construction workers, forest goers and security personnel were all majority males however within seasonal workers the sex distribution was almost even with

slightly more female workers (51%). These sex differences may alter the type and how interventions are implemented.

Another big difference found was in mobility, which as shown, varies between subgroups, with construction workers and seasonal workers having particularly high levels of mobility, probably due to their occupation. This information is key for organization of interventions, for example the WHO previously stated that they aimed to time interventions with seasonal mobility [15], these results indicate that it may not be as straightforward as that as there are multiple patterns of mobility. There were also differences in the demographics of the MMP subgroups.

Net ownership was demonstrated to be high at 95%, however this is still lower than the national ownership levels found by the Cambodia Malaria Survey (2013) (99.7%) suggesting that MMPs have reduced access to nets compared to the general population. Similar trends have been seen in other Greater Mekong Sub-region countries. For example, in Thailand in 2012 it was reported that the national ownership of nets in households was nearly 10% higher than in MMP populations [23]. However, national ownership has only recently reached this high level with previous levels of 52% in 2010 and 75% in 2013 [24]. The type of net is also important, the Cambodia Malaria Survey in 2013 reported ITN household ownership of 77.8% (CI; 69.7, 84.2), compared to 63% ITNs found in this survey population. This suggests that the type of nets MMPs can access is different from the general population. This may again reiterate how difficult it is to reach these populations with interventions such as mass distribution campaigns.

Significant differences between the MMP subgroups were found with regard to ITNs. Both forest goers and security personnel have much higher levels of ITN ownership compared to seasonal workers and construction workers. The differences between where MMP subgroups acquired their net may explain this. The majority of MMPs reported getting their nets from markets. Purchasing nets from public markets may mean that the nets are more likely to be untreated nets or conventionally treated nets that have a significantly shorter insecticidal efficacy. However, the majority of forest goers obtained their nets from VMWs, and the majority of security personnel obtained their nets from other government sources. This may suggest that VMWs and government sources are more likely to supply ITNs. This may indicate that VMWs and government sources need to try and reach out further

to reach seasonal workers and construction workers. The majority of nets were obtained within the last 3 years suggesting that the nets should be in good condition given the manufacturers usually give three years as a baseline for efficacy [25]. However, 37% of nets were deemed ineffective by the interviewer which suggest that the problem is holes in the net. These nets may be in worse condition than expected due to the mobility of the owners causing additional ware and tare.

Nearly all MMPs interviewed slept at the survey site, whether this was at their workplace or village, and the majority of these sites were located within a forested area. This means that although they may not be sleeping directly in the forest most MMPs are in very close proximity to it, which increases their risk of exposure to malaria vectors. Moreover, it needs to be understood that MMPs often live with their families and so it is essential to ensure they are not forgotten when it comes to malaria interventions in these communities as this undoubtedly puts them at higher risk of malaria [26]. Pregnant women and children under 5 are recognized as groups that are at higher risk of malaria. Pregnant women are three more time likely to develop severe disease compared to non-pregnant women, furthermore in 2015 69% of malaria deaths were in children under 5, therefore increased risk to these groups is unwelcomed [27,28]. Nearly all forest goers and the majority of seasonal workers lived with their families. Although 87% of MMPs reported sleeping under a net the previous night, it does appear that more of their family members are being protected. However, the least protected family member groups are construction workers and forest goers, the groups most likely to be accompanied with their family. Subsequently, these groups should receive interventions that focus on protection not only the workers but their families.

Conclusion

This study highlights aspects of MMP knowledge and their use of preventative measures. Clearly improvements in targeting this heterogeneous population with preventative measures are needed, with interventions specifically relevant for the characteristics of each MMP subgroup. As these populations are one of the last remaining reservoirs of transmission remaining in Cambodia, in order for Cambodia to successfully reach its 2025 elimination target, control of malaria in these populations should be prioritized. The Cambodian Mobile and Migrant Survey should provide useful information to enable effective interventions.

Funding

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