

CHARACTERISTICS AND MALARIA PREVALENCE OF MIGRANT POPULATIONS IN MALARIA-ENDEMIC AREAS ALONG THE THAI-CAMBODIAN BORDER

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Abstract. The rise of artemisinin resistant *Plasmodium falciparum* along the Thai-Cambodian border is an urgent public health threat. We conducted an employer-based survey of migrant workers in two provinces in Thailand along the Thai-Cambodian border to explore socio-economic conditions, bednet ownership, and parasite prevalence among migrant workers. Five thousand three hundred seventy-one migrant workers were enrolled in this study; 56.9% were male. Cambodians comprised 69.0%, migrants from Myanmar comprised 20.7% and Mon and Laotian comprised 10.3%. Short term (<6 months) Cambodian migrants, primarily located in Chanthaburi Province, typically work in orchards or on cassava farms. The majority did not speak Thai and bednet ownership was low. The only cases of malaria, all *P. vivax*, were found in Chanthaburi. Migrants in Trat Province were primarily long-term residents (>6 months) from Cambodia and Myanmar and were engaged in rubber tapping, fisheries and domestic work. Bednet ownership and oral Thai fluency were higher, though Thai literacy remained low. Migrants from Myanmar had higher mother tongue literacy than migrants from Cambodia. The low oral Thai fluency and literacy rates suggest a Behavior Change Communication (BCC) package for Cambodian migrants should be developed in the Cambodian language. The low parasite prevalence and absence of *P. falciparum* in this study are encouraging signs in the fight against artemisinin resistance in eastern Thailand.

Keywords: malaria, migrant workers, mass screening, endemic area

INTRODUCTION

Malaria has been a serious health threat in Thailand for many years. Due to aggressive malaria control measures, transmission has decreased dramatically,

and is now principally found along the borders of Thailand, especially in the provinces bordering Myanmar and Cambodia. In 2006, there were 30,338 malaria cases (0.49 cases per 1,000) found among native Thais, and 36,313 malaria cases found among foreigners living in Thailand (Bureau of Vector Borne Disease, 2006). There is now increasing evidence of emerging resistance of *Plasmodium falciparum* to artemisinin containing combinations along the Thai-Cambodian border (Wongsrichannalai *et al*, 1999; Bureau of

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Vector Borne Disease, 2009; Dondorp *et al*, 2009; Rogers *et al*, 2009). Population movements may play a key factor in the development of artemisinin resistance, and may contribute to its spread within Thailand and to neighboring countries. Strategies to combat the development and spread of artemisinin resistance have been developed; targeting migratory populations is a key component of these strategies (Dondorp *et al*, 2010).

The root causes of population movements within the Greater Mekong subregion are poverty, high population growth rates, unemployment and political oppression (Dondorp *et al*, 2009). The rapid economic development of Thailand has stimulated migration to Thailand by foreigners in search of work, particularly in the sectors of agriculture, garment production, construction, fisheries, factories and domestic work (International Organization for Migration, 2009). In 2004 there were 838,943 registered migrant workers, this number increased to 913,853 in 2005 then decreased to 460,014 in 2006. The exact numbers of temporary and migrant populations are unknown since there are many unregistered migrants. Migration is suspected to be increasing due to economic recession and subsequent job loss in urban areas. Migration across the Thai-Cambodian border is comparatively easy, both through official and unofficial border crossings, and provides a channel for permanent and temporary immigration into the country.

Some studies of migrant health care access (Isarabhakdi, 2004) and malaria risk factors have been carried out, such as poverty, international migration, forest work and lack of access to preventive measures (including bednets) in western Thailand and along the Thai-Myanmar border (Chaveepojnkamjorn and Pi-

chainarong, 2004, 2005; Pichainarong and Chaveepojnkamjorn, 2004).

There are information gaps in malaria epidemiology among migrant populations along the Thai-Cambodian border that need to be filled in order to design strategies to combat the spread of artemisinin resistance (Delacollette *et al*, 2009). Migratory populations are, for many reasons, hidden and difficult to study; surveys of these populations have limitations. There is little information about the characteristics of migrants, such as literacy, predominant occupations and bednet use, that could be used in designing interventions to reach migrants for malaria control and behavior change. We explored socio-economic characteristics and malaria prevalence among migrant populations in malaria-endemic areas along the Thai-Cambodian border.

MATERIALS AND METHODS

Study site

We conducted a survey during June-August 2009 in malaria endemic villages of selected provinces in eastern Thailand along the border with Cambodia. Selected provinces and districts within the provinces, were chosen based on high malaria incidence on routine surveillance. The provinces and districts selected were Soi Dao and Pong Nam Ron Districts in Chanthaburi Province and Bo Rai, Mueang, Khlong Yai and Laem Ngop Districts in Trat Province. The survey was timed to coincide with the major fruit harvest season when the greatest numbers of migrant workers were present.

Sampling methods

We conducted a variant of a household survey in which we visited employers and requested permission to interview

Table 1
Numbers and percentages of employers and subjects in 6 districts.

District	No. of sub-districts	No. of villages	No. of employers (%)	No. of subjects (%)
Soi Dao	6	28	168 (29.9)	1,629 (30.3)
Pong Nam Ron	9	21	127 (22.6)	1,099 (20.5)
Bo Rai	6	24	47 (8.4)	443 (8.1)
Mueang	17	27	189 (33.6)	1,612 (30.0)
Khlong Yai	3	15	10 (1.8)	455 (8.5)
Laem Ngop	6	6	21 (3.7)	132 (2.5)
Total	47	121	562	5,371

their migrant employees. We obtained a list of major employers of migrants in the selected districts. We visited all major employers, and interviewed all consenting migrant laborers who were present. There were no age or gender inclusion or exclusion criteria.

Questionnaire

We conducted the survey among both registered and undocumented migrants who worked in agricultural and urban sectors. Individuals were eligible for inclusion if they were not originally from Thailand, but currently resided in Thailand for either short or long term work. Informed verbal consent was obtained from each participant. Each participant responded to a questionnaire with 12 questions covering general information, main occupation, length of residence in Thailand, mother tongue and Thai language literacy.

Blood examination

Participants who reported staying in forests or orchards over night also had a finger stick to obtain a thick smear for malaria. Slides were stained using 10% Giemsa and examined at the Vector Borne Disease Unit (VBDO). Patients with positive slides were treated per national

guidelines (*P. falciparum*: artesunate + mefloquine + primaquine; *P. vivax*: chloroquine + primaquine). Ten percent of slides were double-checked for quality control.

Data analysis

Data about each employer were entered into the program Microsoft Excel. Since we did not have a representative sampling frame, we used descriptive statistics only, and analyzed the results in terms of proportions.

RESULTS

The survey was carried out in 121 villages, 47 sub-districts in Chanthaburi and Trat Provinces. 5,371 subjects were selected for the study (Table 1).

In the 6 districts, there were 562 employers. The greatest number of employers was found in Mueang District in Trat Province (33.6%), followed by Soi Dao District (29.9%), and Pong Nam Ron District (22.6%) in Chanthaburi Province (Table 1). The greatest numbers of migrants were found in Soi Dao and Mueang Districts with 30% of the total study population from each district (Table 1).

Of the 5,371 migrants surveyed, 56.9% were male. Most migrants were at least 15

Table 2
Gender and ages of study subjects.

District	Gender and age							
	Male No. (%)	Female No. (%)	1-5 yrs No. (%)	6-10 yrs No. (%)	11-15 yrs No. (%)	16-20 yrs No. (%)	21-60 yrs No. (%)	61+ yrs No. (%)
Soi Dao	921 (56.5)	708 (43.5)	84 (5.2)	54 (3.3)	47 (2.9)	342 (21.0)	1,102 (67.6)	0 (0)
Pong Nam Ron	656 (59.6)	443 (40.3)	68 (6.2)	64 (5.8)	36 (3.3)	218 (19.8)	704 (64.1)	9 (0.8)
Bo Rai	235 (53.0)	208 (46.9)	39 (8.8)	17 (3.8)	21 (4.7)	56 (12.6)	298 (67.3)	12 (2.7)
Mueang	914 (56.7)	698 (43.3)	141 (8.7)	117 (7.3)	120 (7.4)	270 (16.7)	951 (59.0)	13 (0.8)
Khlong Yai	258 (56.7)	197 (43.3)	46 (10.1)	47 (10.3)	19 (4.2)	32 (7.0)	305 (67.0)	6 (1.3)
Laem Ngop	72 (53.8)	61 (46.2)	10 (7.5)	7 (5.3)	14 (10.5)	16 (12.0)	85 (63.9)	1 (0.8)
Total	3,056 (56.9)	2,315 (43.1)	388 (8.4)	306 (6.8)	563 (5.4)	934 (21.0)	3,438 (57.7)	33 (0.7)

Table 3
Occupations of study subjects.

District	Fruit orchard workers No. (%)	Cassava farm workers No. (%)	Rice farm workers No. (%)	Rubber tappers No. (%)	Other No. (%)
Soi Dao	915 (48.8)	462 (100)	0 (0)	9 (0.9)	0 (0)
Pong Nam Ron	897 (47.8)	0 (0)	102 (100)	43 (4.5)	46 (7.7)
Bo Rai	44 (2.3)	0 (0)	0 (0)	158 (16.6)	54 (9.1)
Mueang	18 (0.9)	0 (0)	0 (0)	631 (66.5)	159 (26.8)
Khlong Yai	0 (0)	0 (0)	0 (0)	6 (0.6)	331 (55.8)
Laem Ngop	0 (0)	0 (0)	0 (0)	101 (10.6)	3 (0.5)
Total (<i>n</i> = 3,979)	1,874 (47.1)	462 (11.6)	102 (2.6)	948 (23.8)	593 (14.9)

years old; 57.7% were aged 21-60 years, and 21.0% were aged 16-20 years (Table 2).

Of the 5,371 subjects, 3,979 had a documented source of employment. The predominant occupation was orchard workers (47.1%), followed by rubber tapping (23.8%), housekeeping and fisheries (combined in Table 3 as "other") (14.9%), cassava farming (11.6%) and rice farming (2.6%). Most migrants in Soi Dao and Pong Nam Ron Districts were employees of orchards, while most rubber tapping was done in Mueang District (Table 3).

Orchards were typically fruit trees, including mangosteen, durian, and longan.

Sixty-nine percent of subjects were Cambodian, 20.7% were Myanmar. Nine point four percent were Mon and 0.9% were Laotian (Table 4). Cambodian migrants were predominantly found in Klong Yai, Soi Dao and Pong Nam Ron Districts making up 99.8, 98.1, and 94.9% of study subjects, respectively. Myanmar migrants were found primarily in Laem Ngop, Bo Rai and Mueang Districts at 69.9, 63.9, and 43.3% of study subjects, respectively.

Table 4
Ethnic distribution of study subjects.

District	Myanmar No. (row %)	Mon No. (row %)	Cambodian No. (row %)	Laotian
Soi Dao	31 (1.9)	0 (0)	1,598 (98.1)	0 (0)
Pong Nam Ron	1 (0.1)	21 (1.9)	1,044 (94.9)	33 (3.0)
Bo Rai	286 (64.6)	48 (10.8)	109 (24.6)	0 (0)
Mueang	698 (43.3)	433 (26.9)	466 (28.9)	15 (0.9)
Khlong Yai	1 (0.2)	0 (0)	454 (99.8)	0 (0)
Laem Ngop	93 (69.9)	4 (3.0)	36 (27.0)	0 (0)
Total	1,110 (20.7)	506 (9.4)	3,707 (69.0)	48 (0.9)

Table 5
Duration of subject residence in Thailand.

District	Myanmar subjects			Cambodian subjects		
	<6 months No. (%)	≥6 months No. (%)	Total	<6 months No. (%)	≥6 months No. (%)	Total No.
Soi Dao	22 (70.9)	9 (29.0)	31	1,449 (90.7)	149 (9.2)	1,598
Pong Nam Ron	0 (0)	1 (100)	1	712 (68.2)	332 (31.8)	1,044
Bo Rai	17 (5.9)	269 (94.0)	286	0 (0)	109 (100)	16
Mueang	29 (4.1)	669 (95.8)	698	0 (0)	466 (100)	305
Khlong Yai	0 (0)	1 (100)	1	0 (0)	454 (100)	454
Laem Ngop	0 (0)	93 (100)	93	0 (0)	36 (100)	35
Total	68 (6.1)	1,042 (93.9)	1,110	2,161 (58.3)	1,546 (41.7)	3,707

There were 1,110 Myanmar migrants in the study 93.9% of whom had stayed longer than 6 months in Thailand, and they were found primarily in Bo Rai and Mueang Districts. There were 3,707 Cambodian migrants, 58.3% had resided in Thailand for <6 months; these were found primarily in Soi Dao and Pong Nam Ron Districts. Those who had resided in Thailand ≥ 6 months were more likely to be found in Bo Rai, Mueang, Klong Yai and Laem Ngop Districts (Table 5).

The abilities to read and write Thai among Myanmar immigrants were 86.7%

and 79.8%, respectively (Table 6), and among Cambodian immigrants were 68.9% and 62.0%, respectively (Table 8). Of the total study subjects 55.6% could speak Thai and 9.6% could read Thai. The greatest proportions of those who could speak Thai were found in Klong Yai (94.3%) and Laem Ngop (84.1%). The smallest proportions of these who could read Thai were in Soi Dao (1.2%), Pong Nam Ron (5.1%), Mueang (8.7%) and Laem Ngop (9.1%).

Twenty-six percent of study subjects owned a bednet. Bednet ownership was high in Laem Ngop 58.3% and Klong Yai

Table 6
Mother-tongue literacy and Thai literacy of Myanmar and Cambodian subjects.

District	Myanmar subjects		Cambodian subjects		All	
	Read No. (%)	Write No. (%)	Read No. (%)	Write No. (%)	Thai oral fluency	Thai literacy
Soi Dao	13 (41.9)	13 (41.9)	1,039 (65.8)	880 (55.8)	648 (39.8)	19 (1.2)
Pong Nam Ron	1 (100)	1 (100)	632 (60.5)	578 (55.4)	555 (50.5)	56 (5.1)
Bo Rai	191 (84.1)	191 (84.1)	0 (0)	0 (0)	191 (43.1)	209 (47.2)
Mueang	432 (81.4)	424 (79.8)	305 (100)	305 (100)	859 (53.3)	141 (8.7)
Khlong Yai	1 (100)	1 (100)	342 (75.3)	320 (70.5)	429 (94.3)	78 (17.1)
Laem Ngop	76 (81.7)	75 (80.6)	35 (100)	35 (100)	111 (84.1)	12 (9.1)
Total	766 (86.7)	705 (79.8)	2,353 (68.9)	2,118 (62.0)	2,984 (55.6)	515 (9.6)

Table 7
Bednet ownership and results of blood examination for malaria parasites.

District	Bednet ownership (<i>n</i> = 5,371)			Blood smear results (<i>n</i> = 2,792)		
	Total migrants	No. owning bednets	% owning bednets	<i>P. falciparum</i>	<i>P. vivax</i>	Negative
Soi Dao	1,629	442	27.1	0	2	1,317
Pong Nam Ron	1,099	113	10.3	0	6	1,154
Bo Rai	443	22	4.9	0	0	266
Mueang	1,612	484	30.0	0	0	47
Khlong Yai	455	242	53.2	0	0	0
Laem Ngop	132	77	58.3	0	0	0
Total	5,371	1,380	25.7	0	8 (0.3%)	2,784

53.2% and lower in Pong Nam Ron (10.3%) and Bo Rai (4.9%) (Table 7). Two thousand seven hundred ninety-two subjects (51.8%) underwent a blood examination for malaria. There were 8 positive slides, all were *P. vivax*, found in villages Nos. 4, 5, and 10 in Nong Ta Khong sub-district, Pong Nam Ron District and villages Nos. 2 and 8 in Sai Khao sub-district, Soi Dao District, Chanthaburi Province. The prevalence of malaria in study subjects was 0.28.

DISCUSSION

The majority of migrants in this study were from Myanmar and Cambodia. Most of the female subjects and children were with their families.

The majority of Cambodian migrants were found in Soi Dao and Pong Nam Ron Districts, Chanthaburi Province and predominantly worked in orchards and cassava farms. Most were short term

(<6 months) migrants, returning to their homes when the harvest season was over. Only a minority could speak Thai, and very few could read it. Bednet ownership was low. The only cases of malaria were found among these workers. Cambodian subjects found in the four districts of Trat (primarily Mueang and Khlong Yai) had been in Thailand greater than 6 months, spoke Thai, and worked as rubber tappers or in fisheries. The majority of the migrants from Myanmar worked as rubber tappers, and were found primarily in Bo Rai and Mueang Districts. Most had been in Thailand greater than 6 months, and could speak Thai. In both groups, mother-tongue literacy was high. This is in contrast to Kanchanaburi Province, western Thailand, where migrants was mostly from Myanmar or were members of Karen or Mon tribes; none were from Cambodia. Most of these had no formal education, were agriculture workers, and did not speak Thai (Isarabkakdi, 2004).

There were few subjects in Klong Yai and Laem Ngop Districts. Most of the subjects in Klong Yai were long-term Cambodian workers, who had settled in Thailand, spoke Thai, worked in fisheries and owned bednets. In Laem Ngop Districts, the few subjects were from Myanmar or Cambodia, were long-term workers who spoke Thai, worked predominantly on rubber plantations and owned bednets.

The positive *P. vivax* cases were detected in Pong Nam Ron District and Soi Dao District, Chanthaburi Province. All were short-term Cambodian migrant workers with a low rate of bednet ownership. *P. falciparum* cases was not found in this survey, although routine surveillance was carried out. This is good news for the problem of *P. falciparum* artemisinin resistance containment. These findings are in

contrast to Chaing Rai Province in western Thailand where 45.8% were infected with *P. falciparum* or *P. vivax*. (Pichainarong, Chaveepojnkamjorn, 2004).

This study had a number of limitations. We did not have a complete list of migrants or employers, and thus were unable to develop a sampling frame for a probability sample, but the subjects in this study are likely to be representative of the other migrant workers.

Based on blood films primarily from subjects in Soi Dao and Pong Nam Ron Districts, it is difficult to draw conclusions about malaria prevalence in Trat. The data allowed us to compare some variables, such as ethnicity, occupation, length of residence in Thailand, Thai language fluency and bednet ownership. Further studies with a more robust sampling group are needed.

In Chanthaburi Province, study subjects were primarily highly mobile Cambodian orchard and farm workers, and were at risk for malaria infection, since many of them were forced to sleep in exposed access without sufficient mosquito protection. Because many did not speak Thai, it was very difficult to communicate health messages or to advise them about the availability of health services. The migrants in Trat were primarily longer term migrants who had learned to speak Thai and may have been able to receive health messages from conventional health information strategies. They were more likely to own bednets. This finding is similar to a previous study of Myanmar migrant workers in eastern Thailand where bednets were found in 98%. Most stayed long term (>6 months) in Thailand with no plans to move back to Myanmar and 77% understand spoken Thai (Piyaporn *et al*, 2011).

To decrease the risk of malaria among migrant workers, it is important to devise strategies to access these populations and to provide long-lasting insecticide treated nets (LLINs) and long-lasting hammock insecticide treated nets (LLHNs). This information is useful for those who plan Information Education Communication (IEC) and Behavior Change Communication (BCC) packages for Cambodian migrant workers, since these groups are least likely to be able to receive messages in Thai. Malaria treatment with artemisinin-based combination therapies (ACTs) free of charge should be carried out among these populations in order to stop the spread of resistant parasites.

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