A SURVEY ON MALARIA IN MOBILE CAMBODIANS IN ARANYAPRATHET, SA KAEO PROVINCE, THAILAND

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Abstract. A cross-sectional survey of the malaria prevalence among mobile Cambodians in Aranyaprathet, at the Thai-Cambodia border, was conducted in November 2000. A total of 666 asymptomatic, mobile Cambodians who worked as traders and laborers were studied. The overall prevalence rate was 2.4%, with 93.75% of the infections being due to *Plasmodium vivax* and 6.25% due to *Plasmodium falciparum*. Almost all cases had low level of parasitemia (1+) and no sexual stages were found. Factors associated with malaria infection included being male, being in the 10-59 year age group, having a lower level of education and frequent trans-border crossing. Both groups of migrant workers (traders and laborers) had an equal chance of infection.

INTRODUCTION

Malaria continues to be the major communicable disease problem in Thailand, particularly in the border areas where multi-resistant strains of *Plasmodium falciparum* exist (Nosten *et al*, 1991; Thimasarn *et al*, 1995). In 2000, up to 80.68% of the total malaria cases were reported from the provinces along the Thai-Myanmar (52,512 cases; 58.6%), Thai-Cambodia (17,846 cases; 19.46%), Thai-Lao (3,799 cases; 3.6%) and Thai-Malaysia (1,570 cases; 3.4%) borders (Malaria Division, 2001). The overall Annual Parasite Incidence (API) in Thailand was 1.6 per 1,000 and the mortality rate was 1.2 per 100,000 in 2000 (Malaria Division, 2001).

Among the 4 species of malaria parasites that infect humans, *P. falciparum* and *P. vivax* are most prevalent in the world today. *P. falciparum* causes high levels of mortality and is becoming increasingly difficult to treat due to widespread resistance to antimalarials. However, malaria due to *P. vivax* also places a large burden of disease on the affected populations. Although it is associated with a lower risk of mortality, the disease has a long, relapsing course and affects a large sections of the human population. In addition, the transmission of *P. vivax* can be particularly problematic because the infections remain asymptomatic for longer periods and therefore may remain untreated. By the time, the clinical threshold is reached and antimalarials are taken, gametocytes may have already been transmitted through mosquitos. (Peiris *et al*, 1988; Ranawaka *et al*, 1988; Naotunne *et al*, 1990).

Of the numerous mosquito species in Thailand, only 3 *Anopheles* species are important malaria vectors: *Anopheles dirus*, *An. minimus* and *An. maculatus* (Pinichpongse and Bullner, 1967; Chareonviriyaphap *et al*, 1999).

One border area that has seen an increase in malaria cases is Aranyaprathet on the Thai-Cambodia border. Since 1995, there has been an official border crossing at Aranyaprathet in Sa Kaeo on the Thai-Cambodia border, resulting in an increase in the movement of traders and laborers from Cambodia to Thailand. This

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has been associated with an increase in the number of reported malaria cases in the province. A review of the data from the vector-borne disease control center 52 Sa Kaeo shows that during period 1988-1995 the API rate decreased from 13.87 to 0.76, but after 1995 it increased to 5.17 (Ketkaew *et al*, 1998). Imported cases from abroad represented more than 15-19% of foreign people during 1995-2000 (Malaria Division, 2001).

It has been suggested the prevalence of malaria infections may be due higher on the Cambodian side of the border than on the Thai side and that mobile populations may act as focal reservoirs of malaria parasites, leading to pockets of transmission in the local non-immune population in Sa Kaeo Province. Unfortunately, this mobile group of Cambodian workers are relatively inaccessible to malaria control efforts. If they do indeed have a high prevalence of malaria, then a targeted approach to the problem may be necessary otherwise the local population in Sa Kaeo will continue to be at risk (Peiris *et al*, 1988; Ranawaka *et al*, 1988; Naotunne *et al*, 1990).

However, until now there has been no study to examine the actual prevalence rate of asymptomatic infection in this group of workers. We therefore undertook this survey including demographic characteristics and some risk factors in order to document the current situation. In addition, a preliminary survey on microfilariae was undertaken opportunistically.

MATERIALS AND METHODS

Study area

The study was conducted in Amphoe Aranyaprathet, an Amphoe (district) which lies on the Thai-Cambodia border in Sa Kaeo Province, 236 km east of Bangkok. Within this Amphoe, the survey was undertaken in two neighboring sites: one was at the border market, Ban Khlong Luk, which is located some 200 m from the border crossing, and the second site was at the border crossing checkpoint itself.

Study design

A cross-sectional malaria survey was carried out during 7-8 November 2000. We based our sample-size estimation on the previous studies (Malaria Division, 2000) done in the border area, which showed that the proportion of persons with infection from aboard, attributes for our study was expected to be 20%, the standard error and equal 0.05. Using the formula of Supanvanich and Podhipak (1992), we calculated that the required sample size was 246 persons.

Study population

Two groups of asymptomatic mobile Cambodians were studied. Group1 comprised of the population who worked in Ban Khlong Luk market (trader group) and Group 2 comprised of the population who passed the immigration checkpoint (laborer group). Convenience or volunteer sampling was used.

Data collection

A questionnaire was designed to obtain information on demographic characteristics (age, sex, level of education, and occupation), frequency of travel into Thailand, use of antimalarials and past history of malaria. The questionnaires were used by trained staff with assistance from the malaria center teams from the Aranyaprathet Malaria Unit.

Blood collections

All participants agreed to have their blood taken as part of the study. Blood samples from finger-prick were collected from each subject and thick and thin smeared prepared for microscopic examination. In addition a second blood film and micro-capillary tube were prepared for a parallel study of microfilarial infection (WHO, 1987; Zamman and Keong, 1994).

The thick and thin blood films were stained with 3% Giemsa in phosphate buffer (pH 7.2), following the standard WHO procedure (1991) and examined under an oil-immersion lens. The specific species of *Plasmodium*, stage of parasite and parasite densities were recorded.

Blood films were reported as negative if no parasites were seen in 100 high-power fields.

The trial was conducted in cooperation with Rangsit University, the Aranyaprathet Malaria Unit, and Sa Kaeo Public Health Center. All participants found to be infected with malaria were contacted and provided with standard curative treatment from Sa Kaeo Public Health Center.

Data analysis

Data were interpreted by descriptive statistics and expressed as percentage (%) for comparison between infected groups, demographic characteristics factors and formal interviews.

RESULTS

A total of 666 blood samples were collected: 386 from the trader group and 280 from the laborer group. Overall, 16 people were malaria parasite-positive, giving an overall prevalence rate of 2.4%. Both groups were equally affected with 9 cases in the trader group and 7 cases in the laborer group, giving prevalence rates of 2.3 % and 2.5%, respectively.

Plasmodium vivax accounted for nearly all of the cases (15/16 cases; 93.75%) with only one case being infected with *P. falciparum* (1/16 cases, 6.25%). All positive cases were infected with only trophozoites (asexual stage) and all the densities of infection were classified as 1+ (1-10 parasites per 100 oil-immersion field).

The demographic characteristics of the participants are summarized in Table 1. A high prevalence was found in the 10-19 and 50-59 years age groups. No cases were found in the 0-9 or 50-59 years age group but the sample size was small. A higher proportion of males than females were infected (2.1:1) Malaria was found to affect those who had the education lower than graduation from school.

The results from the structured interviews are shown in Table 2. All the 16 people who were found to be malaria parasite-positive reported passing into Thailand more than once a week. Almost all of mobile people who had a high frequency of crossing into Thailand also had a high chance of contracting malaria. Although 186 (27.9%) of the participants reported having had malaria in the past, only 121 (18.2%) reported having received antimalarials. Neither a past history of malaria, nor the prior use of antimalarials appeared to be associated with whether the participant was infected or not.

Table 1
Demographic characteristics of the mobile Cambodians in the study areas of Aranyaprathet, Sa Kaeo Province.

Demographic characteristics	No.	Number positive (%)
Age (in years)		
0-9	2	0
10-19	136	6 (4.4)
20-29	227	7 (3.1)
30-39	209	1 (0.5)
40-49	65	1 (1.5)
50-59	23	1 (4.3)
≥60	4	0
Sex		
Female	313	5 (1.6)
Male	353	11 (3.1)
Female: Male ratio	1: 2.08	
Level of education		
No formal education	199	6 (3.0)
Primary school (1-6)	290	6 (2.1)
Secondary school (7-12)	169	4 (2.4)
Higher than secondary school	8	0
Occupation		
Trader	386	9 (2.3)
Laborer	280	7 (2.5)

DISCUSSION

In 1998 and 1999, the reported API and mortality rates in Thailand were 2.27 and 1.60 per 1,000 and 1 and 1.2 per 100,000, respec-

Table 2
Structured interviews for the mobile Cambodians in the study areas of Aranyaprathet, Sa Kaeo Province.

Interview questions	No.	(%)	Number positive (%)
Frequency of passing through immigration			
> once / week	648	(97.3)	16 (2.5)
< once / week	18	(2.7)	0
Antimalarials used in the past			
Yes	121	(18.2)	3 (2.5)
No	517	(77.6)	13 (2.5)
Not sure	28	(4.2)	0
Past history of malaria before blood collection			
Yes	186	(27.9)	4 (2.2)
No	480	(72.1)	12 (2.5)

No microfilariae were found in this study.

tively; in 1999, *P. vivax* was reported to be the dominant species for the first time (Malaria Division, 2001). In this study, conducted in the peak season for malaria in Sa Kaeo, we found a prevalence rate of 2.4%, with 15 of the 16 cases caused by *P. vivax*. All these cases had parasite densities of 1+. These results are similar to those described previously in Sa Kaeo Province (Ketkaew *et al*, 1998). In the present study, all of the infected cases had low parasitemia and no sexual stage was found. Bouth and Giboda (1987) also reported that all patients had low parasitemia, although more asexual forms of *Plasmodium* per microliter were observed.

In this study, we were not able to confirm whether a group of patients with asymptomatic infection could act as a reservoir for malaria transmission.

It appears that the change of dominant malaria species from *P. falciparum* to *P. vivax* occurred in 1996 in Sa Kaeo Province (Ketkaew *et al*, 1998). Epidemics of *P. vivax* have been reported in some other provinces such as Surat Thani, Chumphon and Ranong. However, the most serious situation occurred in Sa Kaeo, where *P. vivax* cases increased from 763 cases in 1996 to 4,232 cases in 1997, reversing the *falciparum: vivax* ratio from 60: 40 to 15: 85 (Malaria Division, 1987-1997). There are several possible explanations for this phenomenon. Firstly, the impact of the new antimalarials (Artesunate) on falciparum malaria. In October 1995, the Thai malaria control program instituted a policy of an artesunate-mefloquine combination as the standard therapy for outpatients in malaria clinics in selected areas, designated as having high-levels of drug-resistance, mainly along the borders. The parasite mass is greatly reduced after this treatment and no clinical resistance has been reported so far (Kyle *et al*, 1998; White, 1998). Secondly, the sensitivity of *P. vivax* to chloroquine is decreasing since first reported in Papua New Guinea (Rieckman *et al*, 1989), followed by Indonesian New Guinea (Baird *et al*, 1996; Fryauff *et al*, 1998), Myanmar (Marlar-Than *et al*, 1995), and India (Garg *et al*, 1995). Although there has been no direct evidence of clinical chloroquine-resistant *P. vivax* in Thailand, it may be that sensitivity is now decreasing in Thailand as well. Thirdly, the reduced use of residual insecticide spraying and low coverage of the substitute measures (insecticide impregnated bed net) and less intensified efforts on disease surveillance or other environmentally related factors including vectors (Ketkaew *et al*, 1998). One such factor may be the possible movement of malaria vectors

between Thailand and Cambodia.

The main malarial vectors reported in Sa Kaeo area are *An. minimus* and *An. dirus*. However, *An. barbirostris*, *An. aconitus* also act as secondary vectors (Ketkaew *et al*, 1998) and *An. barbirostris* has been reported to be a vector for *P. vivax* (Somboon *et al*, 1994). In Cambodia, the major vectors have been reported to be *An. dirus*, *An. minimus*, *An. maculatus* and *An. sundaicus* (Danis and Meek, 1992). We found that the prevalence of malaria infection occurred in all age groups between 10-59 years who stayed in the endemic areas. A previous study has shown that migrant laborers show higher malaria rates than the non-migrant groups for every age category except the youngest and the oldest ones. The middle-aged groups characteristically have the highest morbidity rates (Kanjanapan, 1983). In this study, as in others, males two times more likely than females to be infected with malaria due to the increased likelihood that they worked in forests where they were exposed more frequently to mosquitos (Kanjanapan, 1983; Butaporn *et al*, 1995; Mendez *et al*, 2000).

The data show that those who had no education appeared to have a higher prevalence of malaria compared to those who had some education. It is plausible that this may be due to difference in health behavior, personal protection, and knowledge of or attitude toward prevention between these groups (Kanjanapan, 1983).

Although, high-risk groups are soldiers, gem miners in the western part of Cambodia and people working or living in the forests (Danis and Meek, 1992), we found that traders or laborers were also associated with a high risk of malaria infection in this area.

People who passed through the border more than once per week were at high risk of infection. It is suspected that mobile people play an important role in maintaining the transmission of this disease (Kanjanapan, 1983). Those who took antimalarials for prevention or cure had a rate of infection due to malaria similar to those who never used drugs (2.5%: 2.5%). Incorrect drug administration or incomplete treatment can lead to an increasing in resistance to antimalarials (Wongsrichanalai *et al*, 2001). The opportunity of infections occurred in both people who have had malaria before and those who have never been infected. However, in a follow-up of vivax malaria patients in Sa Kaeo in 1997, Ketkaew *et al* (1998) found that the reinfection rates 14 and 28 days after treatment were 0.5% and 0.8%, respectively.

In our study, we also included a pilot survey on microfilariae because outbreaks of malaria and elephantiasis in border provinces have been reported along the Thai-Myanmar and Thai-Malaysian border (Division of Filariasis, 1998). However, no filarial infections were found.

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