MALARIA INFECTION AMONG THE MIGRANT POPULATION ALONG THE THAI-MYANMAR BORDER AREA

Wisit Chaveepojnkamjorn and Natchaporn Pichainarong

Department of Epidemiology, Faculty of Public Health, Mahidol University, Bangkok, Thailand

Abstract. A population based case-control study was performed to determine factors associated with malaria infection among the migrant population, foreign nationals aged 15 years or over. Data were obtained from 217 malaria and 217 non-malaria patients attending the Vector-Borne Disease Control Units 6-9 (Thong Pha Phum and Sangkhla Buri districts) in Kanchanaburi Province and at the Vector-Borne Disease Control Units 1,9 (Mae Fa Luang and Mae Sai districts) in Chiang Rai Province, between June and December 2002. All study subjects were interviewed by trained interviewers using a structured interview form. The statistical analysis was carried out by the chi-square test and multivariate logistic regression: a p-value of less than 0.05 was considered to be statistically significant. The results showed that the study subjects were predominantly Thai-Yai and Myanmar. *Plasmodium falciparum* was the major type of the malaria (60.8%). Logistic regression analysis, controlling for possible confounding factors, revealed that residence located in the forest increased the risk of malaria infection by a factor of 6.29 (OR = 6.29, 95% CI = 1.56-25.42); outdoor stay < 7 and ≥ 7 days prior to the blood examination also increased the risk by a factor of 4.34 and 4.13 respectively (OR = 4.34, 95% CI = 1.05-17.99; OR = 4.13, 95% CI = 1.29-13.13).

INTRODUCTION

Malaria is one of the world's most important vector-borne diseases and one of the leading causes of morbidity and death worldwide, with about 500 million cases and at least two million deaths a year (WHO, 1997). At present, malaria is still a major public health problem. About 100 countries in the world are considered malarious areas. More than 2,400 million or approximately 40% of the world's population are at risk for malaria (WHO, 2000). Malaria is a serious health problem in Thailand. It was noted that the trend of total Thai malaria cases increased from 1.7 to 2.2 per 1,000 population in 1997 and 1999, although mortality rates decreased from 8.0 to 1.2 per 100,000 population in 1981 and 1999, respectively (Malaria Division, 2002; Office of the Permanent Secretary, 2001). In 2000, there were 91,703 malaria cases reported from the surveillance system of the Malaria Division, Center for Disease Control Department, Ministry of Public Health (Thailand). The proportions of Thais and foreign nationals of total malaria cases were 61.3% and 38.7%. The Thai cases (57.3%) were reported in border areas, especially (63%) along the Thai-Myanmar border whereas 19.5%, 4.1%, 1.7% and 17.4% were reported along the Thai-Cambodia, Thai-Lao PDR, Thai-Malaysia borders and other areas respectively. The ten leading provinces with the highest malaria cases were Tak, Kanchanaburi, Mae Hong Son, Sakaeo, Chanthaburi, Trat, Surat Thani, Prachuap Khiri Khan, Chiang Mai and Ratchaburi, respectively. Migration of malaria reservoirs was a key factor in drug resistance dynamics (Wernsdorfer, 1994). Migrations were prone to risk in a variety ways. Migrants are usually non-immune or partially-immune to malaria when they travel through endemic or high risk areas with highly efficient infectious vectors. Better understanding in the epidemiology of malaria patterns among the migrant populations with foreign nationals would certainly lead to proper solutions for malaria control in these groups. The aims of this study were to determine the risk factors of Malaria in migrant populations with foreign nationals in Kanchanaburi Province and Chiang Rai Province along the Thai-Myanmar border area in terms of descriptive epidemiology and to identify the association between these risk factors and malaria occurrence.

Correspondence: Wisit Chaveepojnkamjorn, Department of Epidemiology, Faculty of Public Health, Mahidol University, 420/1 Rajvithi Road, Bangkok 10400, Thailand.
Tel: 66 (0) 2248 5554

MATERIALS AND METHODS

Study design and population

A population based, case-control study was carried out in Kanchanaburi Province (Thong Pha Phoom and Sangkhla Buri districts) and Chiang Rai Province (Mae Fa Luang and Mae Sai districts), from June to December, 2002, to determine socio-demographic and behavioral factors associated with malaria infection among migrant foreign nationals. Target populations were migrant foreign nationals who lived in the endemic areas along the Thai-Myanmar border area. All blood positive eligible patients were classified as "cases", whereas persons who had negative blood smears were classified as "controls". A total of 217 cases and 217 controls were recruited. Age, gender and district of residence were the variables used for frequency matching between the positive malaria cases and negative controls. Data collection was obtained by interviewing the study subjects by trained interviewers in the local language. The questionnaire comprised the socio-demographic status, namely age, educational level, marital status, occupation, and family income per month; behavioral characteristics and the surroundings of the residence. Socio-demographic characteristics were displayed by percentage, mean, median, standard deviation and quartile deviation. Chi square tests were utilized to differentiate proportional exposures between cases and controls for categorical variables. Univariate analysis, [odds ratio (OR), 95% confidence interval and corresponding p-value < 0.05] was employed in order to screen the suitable variables, and multiple logistic regression was used to identify and adjust for confounding variables in terms of the adjusted odds ratio.

Sample size

The sample size was calculated by the formula (Schlesselman and Stolley, 1982):

$$n = \frac{\{Z_{\alpha/2}\sqrt{2P(1-P)}+Z_{\beta}\sqrt{P_1(1-P_1)+P_0(1-P_0)}\}^2}{(P_1-P_0)^2}$$

Where n = minimum number of subjects that were included, P_o = proportion of exposure in controls = 0.32; P_1 = proportion of exposure in cases = 0.49; $Z_{\alpha/2}$ = 1.96 at α = 0.05; Z_{β} = 1.64 at β = 0.05; and P = 0.41. The calculated sample size in each group was at least 214.

RESULTS

The thick blood smear results showed that 60.8% of the cases were infected by falciparum malaria, 36.4% by vivax malaria and 2.8% by mixed infection of both types as shown in Table 1. Of the total 217 positive malaria cases, 69.6% were male patients. The majority of these studies were less than 35 years of age (73.7%); the average age of malaria cases and controls was 29.5 years. Most of the study subjects were Thai-Yai and Myanmar (74.2%). Employee, wood cutting and gathering forest products accounted for 65.2% of those studied. A significantly higher proportion of the non-malaria controls had attended primary schools (p = 0.009). There was no significant difference in marital status, race, occupation and family income in either groups. The socio-demographic characteristics of cases and controls are shown in Table 2.

There were 9 different factors ($p < 0.05$) included in the model, thus: outdoor stay prior to blood examined ≥ 7 days (OR = 5.57), outdoor stay prior to blood examined < 7 days (OR = 5.03), frequency of migration ≥ 2 (OR = 4.25), residence located in the forest (OR = 3.39), duration of staying less than 6 months (OR = 3.27), workplace located in the forest (OR = 2.15), low level of personal protection (OR = 1.82), frequency of

Table 1
Number and percentage of the subjects by malaria species in study cases.

Species	No.	%
P. falciparum		
-ring form (f)	111	51.2
-gametocyte (g)	4	1.8
-ring form and gametocyte (f+g)	17	7.8
P. vivax	79	36.4
Mixed infection (*P. falciparum* and *P. vivax*)	6	2.8

f = *P. falciparum* ring form alone
g = *P. falciparum* crescent form alone
f+g = *P. falciparum* ring form and crescent form

Table 2
Comparison of the selected socio-demographic characteristics between the malaria cases and the non-malaria controls.

Characteristics	Cases		Controls		p-value
	No.	%	No.	%	
Ages (years)					1.000
15-24	78	35.9	78	35.9	
25-34	82	37.8	82	37.8	
35-44	33	15.2	33	15.2	
≥ 45	24	11.1	24	11.1	
Mean ± SD	29.5 ± 10.2		29.5 ± 9.9		
Gender					1.000
Male	151	69.6	151	69.6	
Female	66	30.4	66	30.4	
VBDU[b]					1.000
Kanchanaburi Province					
6	38	17.5	38	17.5	
7	36	16.6	36	16.6	
8	18	8.3	18	8.3	
9	34	15.7	34	15.7	
Chiang Rai Province					
1	78	35.9	78	35.9	
9	13	6.0	13	6.0	
Marital status					0.333
Married	179	82.5	189	87.1	
Single	12	5.6	11	5.1	
Widowed/Separated	26	11.9	17	7.8	
Race					0.107
Myanmar	82	37.8	58	26.7	
Thai-Yai	84	38.7	98	45.2	
Karen	27	12.4	33	15.2	
Others	24	11.1	28	12.9	
Educational level					0.009[a]
No schooling	156	71.9	130	59.9	
Primary school	49	22.6	78	35.9	
≥ Secondary school	12	5.5	9	4.2	
Occupation					0.332
Unemployment	46	21.2	32	14.7	
Employee	67	30.9	83	38.2	
Wood cutting and gathering forest products	67	30.9	66	30.4	
Agriculture	10	4.6	12	5.5	
Others	27	12.4	24	11.2	
Family income per month (Baht)					0.241
≥ 3,000	162	74.7	147	67.7	
3,001-5,000	40	18.4	54	24.9	
> 5,000	15	6.9	16	7.4	
Mean ± SD	3,103.9 ± 3,919.6		2,982.6 ± 2,060.7		
Median ± QD	2,400.0 ± 782.8		2,600.0 ± 1,200.0		
Min-Max	420-45,000		200-15,000		

[a]Statistically significant at $\alpha = 0.05$
[b]VBDU = the Vector-Borne Disease Control Units

Table 3
Adjusted odds ratios of various risk factors by multiple logistic regression.

Variables	OR	95% CI	p-value
Residence located in the forest	6.29	1.56 - 25.42	0.009[a]
Outdoor stay prior to blood examined (days)			
< 7	4.34	1.05 - 17.99	0.043[a]
≥ 7	4.13	1.29 - 13.13	0.017[a]
Duration of stay (months)			
< 6	2.29	0.15 - 34.25	0.548
≥ 6	0.85	0.06 - 11.85	0.907
Low level of personal protection	2.12	0.74 - 6.01	0.157
Low level of knowledge of malaria	1.64	0.93 - 2.87	0.080
Frequency of migration			
1	0.85	0.41 - 1.77	0.673
≥ 2	1.60	0.47 - 5.43	0.449
Workplace located in the forest	1.11	0.48 - 2.56	0.812

[a]Statistically significant at $\alpha = 0.05$

migration once (OR = 1.79), and low level of knowledge of malaria (OR = 1.79). The left variables which were not statistically significant were ruled out.

To evaluate the effect of risk factors and adjust for confounding variables, all potential variables were included in the final model. After adjusting for potential confounders, adjusted odds ratios of the 7 factors are shown in Table 3.

Only three independent variables were significantly associated with malaria infection among migrant foreigners. Subjects whose residences were located in the forest were 6.29 times more at risk to develop malaria illness compared with those which were not (95% CI = 1.56-25.42). Subjects with outdoor stay prior to blood examined < 7 and ≥ 7 days were 4.34 and 4.13 times more at risk than those who did not (95% CI = 1.05-17.99, 1.29-13.13).

DISCUSSION

The results of the analysis of the socio-demographic characteristics of the study population show that malaria cases were predominantly male (the sex ratio of male to female malaria patients was 2.3:1), a finding similar to those of other studies (Fungladda *et al*, 1987; Thimasarn, 1997; Hossain *et al*, 2001). Men were more likely to get malaria and more likely than women to work in the jungle, where exposure to mosquitos was more frequent (Kanjanapan, 1983). The age groups of 15-24 and 25-34 years exhibited the majority of infections (73.7%). This finding is similar to previous studies (Kanjanapan, 1983; Butraporn *et al*, 1986). Moreover, most of the study population were Thai-Yai (38.7% in cases and 45.2% in controls). This study revealed that the main occupations of the study subjects were general employee, wood cutting and gathering forest products, where their workplaces were mostly near the forest (61.8% in cases and 68.6% in controls). The majority of family incomes per month in both groups was less than 3,000 Baht (74.7% in cases and 67.7% in controls). The proportion of the educational levels in malaria cases was lower than in non-malaria controls. Poverty or near-poverty was the motivating reason for people to seek more money from activities that might expose them to higher risks. Poverty forced these people to risk contracting malaria in ways such as going back to the forest to hunt or gather food, which agree with Sornmani *et al* (1983) and Panvisavas (2001). Migration to search for jobs and family members in the forest also exposed them to malaria (Panvisavas *et al*, 2001). After adjusting for potential confounders by multivariate analysis, it was found that the study subjects who had residences located in the forest showed odds of a malaria infection were 6.29 times higher

than those which were not (OR = 6.29, 95% CI = 1.56-25.42), which agreed with Fungladda *et al* (1987) and Butraporn *et al* (1986). Subjects who stayed outdoors prior to having their blood examined < 7 days and ≥ 7 days had 4.34 and 4.13 times higher risk of malaria respectively (OR = 4.34, 95% CI = 1.05-17.99; OR = 4.13, 95% CI = 1.29-13.13). Although links between lower levels of personal protection and the occurrence of malaria was weak, ignorance regarding personal protection, namely bed-nets etc. might lead to non-use of bed-nets at night, thus increasing contact with mosquitos (Tin-Oo *et al*, 2001). In addition, it was demonstrated that a workplace located in the forest was not significantly related to malaria infection after adjusting for potential confounders (OR = 1.11, 95% CI = 0.48-2.56), which disagreed with Fungladda *et al* (1987) and Butraporn *et al* (1986).

ACKNOWLEDGEMENTS

The authors thank the staff of the Vector-Borne Disease Control Units 6-9 in Kanchnaburi Province and the Vector-Borne Disease Control Units 1,9 in Chiang Rai Province. We also thank those whom we did not mention for their kindness and encouragement.

REFERENCES

Butraporn P, Sornmani S, Hungsapruek T. Social, behavioral, housing factors and their interactive effects associated with malaria occurrence in East Thailand. *Southeast Asian J Trop Med Public Health* 1986; 17: 386-92.

Fungladda W, Sornmani S, Klongkamnuankarn K, Hungsapruek T. Sociodemograhpic and behavioral factors associated with hospital malaria patients in Kanchanaburi, Thailand. *J Trop Med Hyg* 1987; 90: 233-7.

Hossain SM, Bhuiya A, Rasheed S. Correlates of perceived malarial episodes and treatment-seeking behavior in a malaria-endemic rural area in Bangladesh. *Southeast Asian J Trop Med Public Health* 2001; 32: 707-19.

Kanjanapan W. Health effects of labor mobility: a study of malaria in Kanchanaburi Province, Thailand. *Southeast Asian J Trop Med Public Health* 1983; 14: 54-7.

Malaria Division, Department of Communicable Disease Control, Ministry of Public Health. Annual report 2001. Bangkok: The War Veterans Organization of Thailand, 2002 (in Thai).

Office of the Permanent Secretary, Ministry of Public Health. Public Health Statistics A.D. 1999. Bangkok: Bureau of Health Policy and Planning Office, 2001: 76 (in Thai).

Panvisavas S. Poverty and malaria: a study in a Thai-Myanmar border area. *Southeast Asian J Trop Med Public Health* 2001; 32: 608-14.

Panvisavas S, Dendoung S, Dendoung N. Social and cultural aspects of malaria. *Southeast Asian J Trop Med Public Health* 2001; 32: 727-32.

Schlesselman JJ, Stolley PD. Case-control studies: design, conduct, analysis. New York: Oxford University Press, 1982.

Sornmani S, Butraporn P, Fungladda W, Okanurak K, Dissapongsa S. Migration and disease problems: a study of patterns of migration in an endemic area of malaria in Thailand. *Southeast Asian J Trop Med Public Health* 1983; 14: 64-8.

Thimasarn K. Epidemiology and the situation of malaria in Thailand. In: Loathavon J, Looareesuwan S, eds. Malaria. 1st ed. Bangkok: Saksopha Printing, 1997: 1-11 (in Thai).

Tin-Oo, Pe-Thet-Htoon, Khin-Thet-Wai, Parks W, Bryan J. Gender, mosquitos and malaria: implications for community development programs in Laputta, Myanmar. *Southeast Asian J Trop Med Public Health* 2001; 32: 588-94.

Wernsdorfer HW. Epidemiology of drug resistance in malaria. *Acta Tropica* 1994; 56: 143-56.

World Health Organization. The state of world health: the World Health Report 1996-fighting disease, fostering development. *World Health Forum* 1997; 18: 1-8.

World Health Organization. WHO Expert Committee on Malaria: twentieth report. Geneva: WHO, 2000.