MALARIA INFECTION AND LIFE-STYLE FACTORS AMONG HILLTRIBES ALONG THE THAI-MYANMAR BORDER AREA, NORTHERN THAILAND

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Abstract. A cross sectional study was conducted between January, 2001 and June, 2002 to determine the life-style factors associated with malaria infection among hilltribes in the Chiang Rai Province, Mae Fah Luang district located along the Thai-Myanmar border, northern Thailand. The data collected were a thick blood film examination and a face-to-face interview using a local language interviewer at a mobile clinic or a home visit. The chi-square test, odds ratio, 95% confidence interval and multiple logistic regression were used as data analysis. *P. vivax* (61.3%) was detected more than *P. falciparum* (38.2%). Parasitic infection was seen in 45.8% of a total of 417 blood examinations. The study area was in a valley covered with forests and small streams, which was ideal for a malaria epidemic. The communities were distributed along different ethnic groups. There were 12 ethnic groups, dominated by the Muser, Eko, and Akha tribes (60-70%). The risk factors included living or working in the forest, accompanying their family during movement through the forest, age ≤14 years (40.9%), poor knowledge of how to protect against malaria (75-80%), and unavailability of protection against malaria via long sleeved clothes, topical repellents, and insecticide treated nets (use and carry), which resulted in an increased exposure to malaria and risk for malaria infection.

INTRODUCTION

Malaria is a major vector-borne disease. The worldwide incidence is estimated to be 300-500 million clinical cases each year, mostly caused by *P. falciparum*. The mortality due to malaria has been estimated to be between 1.5 and 2.7 million deaths each year. Of these deaths, about 1 million are children under the age of 5 years (WHO, 2000). Other high-risk groups are pregnant women, non-immune travellers, refugees, displaced persons, laborers and other workers entering endemic areas. Malaria remains a serious health problem in Thailand. The government provides malaria treatment free of charge, with an average expenditure of more than 100 million baht each year. In 2001, there were 67,749 malaria cases in Thais and 58,846 malaria cases in aliens who mainly live on the Thai-Myanmar border (91.15%) (Malaria Division, 2001). The common parasites are *P. vivax* (53.20%) and *P. falciparum* (46.29%), which differs from the past year where *P. falciparum* was detected more often than *P. vivax*. Other malaria parasites are very rare (Malaria Division, 2001). Nomadic hilltribes are at risk in several ways. They travel through endemic or high-risk areas with highly efficient infectious vectors. Nomadic hilltribes often have inadequate self-protection, such as chemo-prophylactic drugs, bednets, or repellent. They irregularly use nets because nets are unaffordable and too bulky to carry with them when moving (Plasai and Thimasarn, 1999).

Chiang Rai is similar to other provinces in northern Thailand, which have many hilltribes. The hilltribes are scattered across different provinces. This study aimed at determining the life-style factors in the hilltribe population of Mae Fah Luang district, Chiang Rai Province which put them at risk for malaria, and to identify the association between those suspected risk factors and malaria infection.

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MATERIALS AND METHODS

Study design and population

A cross-sectional study was carried out in

Chiang Rai Province, Mae Fah Luang district, between January, 2001 and June, 2002, to assess the risk factors that contribute to malaria infection among hilltribes. The target population was nomadic hilltribes who lived in the endemic areas along the Thai-Myanmar border. All thick blood film (TBF) positive patients were classified as cases, whereas persons who were TBF negative were classified as controls. Mobilization was classified according to the length of stay in the visited area, namely daily movement (≤24 hours) and periodic movement (> 24 hours to one month, or up to one year) (WHO, 2000). The housing was identified as either permanent or temporary. Permanent was defined as having a complete wall, roof, and high quality construction materials. Temporary had the opposite meaning. Protection was defined as knowledge and activities, which were either preventive or harmful, relevant to malaria infection. This comprised bednet utilization, repellent use, warming near a smoky fire, clothes protection, or chemo-prophylactic drugs. A total of 191 cases and 226 controls were recruited. The TBF testing and interviewing were performed by a mobile clinic and home visits in the Mae Fah Luang district. A questionnaire consisting of six sections: general information, mobilization, dwelling, residential surrounding, knowledge, and practice towards primary protection was utilized. Details of the study were explained verbally to all the participants and informed consent was obtained in writing or by thumb print. The questionnaire was developed and used in the Thai language since the respondent groups were from different ethnic groups and the trained interviewers translated the questionnaire into their local language. The interviewers were able to communicate by using the local language in order to formulate informative validity. General information was described by percentage, mean, median, standard deviation and quartile deviation. Chi-square tests were performed to differentiate proportional exposures between cases and controls for qualitative variables. Univariate analysis, odds ratio, and 95% confidence interval were used for the external variables. Multiple logistic regression was utilized to verify and adjust for possible confounding variables, with statistical significance defined as $p < 0.05$.

Sample size

The sample size was calculated by the formula (Kelsey *et al*, 1996).

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

Where n = the minimum number of subjects that were included, P_o = the proportion working in the forest 2 weeks prior to blood examination in controls = 0.18 (Fungladda *et al*, 1987), P_1 = proportion of those working in the forest 2 weeks prior to blood examination in cases = 0.34, $Z_{\alpha/2}$ = 1.96 at α = 0.05, Z_{β} = 1.28 at β = 0.10, P = 0.26, the calculated sample size in each group was at least 158.

RESULTS

The TBF test results revealed that 61.3% of the positive cases were infected with *P. vivax*, whereas 38.2% were infected with *P. falciparum*. This differs from the previous year where *P. falciparum* was detected more often than *P. vivax*. Of the total 191 positive malaria infected cases, approximately 69% were male. The majority of the cases were age ≤ 14 years (40.9%). The controls were mostly aged greater than 34 years (53.5%). The average age was 22.8 years in the cases and 35.8 years in the controls. Most of them (60.7% of cases, 83.6% of controls) had no schooling. The two most common occupations among the cases were agriculture (42.5%) and unemployment (33.9%), and among the controls were agriculture (52.2%) and employees (11.5%). The malaria cases had a higher median family monthly and daily income than the controls (2,400.0 baht/month, 70.0 baht/day in the cases; 900.0 baht/month, 50.0 baht/day in the controls) (1 US$ = 40 baht). The study was conducted among the hilltribes, most of them being Muser and Eko (66.7%) in the cases; and Muser, Eko, and Akha (71.6%) in the controls. More than half of them resided near a stream (58%), and almost half of them had a workplace near a stream (45.6%). The average distance to a stream from their residence was 1,432.9 ± 1,192.3 m in the cases and 1,435.0 ± 873.6 m in the controls (p = 0.680). The average distance to the forest from their residence was 1,212.7 ± 966.7 m in the cases and 873.6 ± 863.4 m in the controls (p = 0.642).

Table 1
Comparison of the selected socio-demographics, movement and environment between the malaria cases and the non-malaria controls.

Characteristics	Malaria infection				p-value
	Positive		Negative		
	N	%	N	%	
Age (yr) (N=417)					<0.001[a]
0-4	7	3.7	2	0.9	
5-14	71	37.2	6	2.7	
15-24	37	19.4	35	15.5	
25-34	27	14.1	62	27.4	
35-44	31	16.2	69	30.5	
≥45	18	9.4	52	23.0	
Mean ± SD	22.8 ± 14.9		35.8 ± 12.6		
Gender (N=417)					0.790
Male	131	68.59	153	67.7	
Female	60	31.41	73	32.3	
Education (N=417)					<0.001[a]
No schooling	116	60.7	189	83.6	
≥Primary school	75	39.3	37	16.4	
Occupation (N=412)					<0.001[a]
Agriculture	79	42.5	118	52.2	
Wood cutting and gathering forest products	4	2.2	18	8.0	
Employee	9	4.8	26	11.5	
Merchant	12	6.5	14	6.2	
Unemployment	63	33.9	14	6.2	
Others	19	10.1	36	15.9	
Family income (baht/month) (N=297)					<0.001[a]
< 1,000	11	10.1	107	56.9	
1,001-2,000	30	27.5	52	27.7	
2,001-3,000	54	49.6	25	13.3	
> 3,000	14	12.8	4	2.1	
Mean±SD	2,431.8±1,078.8		1,226.7±950.1		
Median±QD	2,400.0±750.0		900.0±450.0		
Family income (baht/day) (N=176)					<0.001[a]
≤ 30	5	8.5	13	11.1	
31-60	20	33.9	74	63.2	
61-90	16	27.1	20	17.2	
> 90	18	30.5	10	8.5	
Mean±SD	72.1±30.4		56.3±21.2		
Median±QD	70.0±25.0		50.0±15.0		
Ethnic groups (N=379)					<0.001[a]
Akha	12	7.5	58	27.0	
Hou	16	10.1	29	13.5	
Muser	37	23.3	52	24.1	
Eko	69	43.4	44	20.5	
Lesaw	17	10.7	21	9.8	
Other (Yao, Lahu, Mong, Maew, Awa)	8	5.0	11	5.1	
Movement (N=417)					< 0.243
Yes	150	78.5	187	82.7	
No	41	21.5	39	17.3	
Forest stay 14 days prior to being sick (N=413)					<0.001[a]
Yes	126	66.0	62	27.9	
No	65	34.0	160	72.1	
Dwelling location (N=396)					0.003[a]
Employer provided	12	6.5	16	7.6	
Their own	165	89.7	168	79.2	
Others	7	3.8	28	13.2	
House condition (N=414)					0.031[a]
Permanent	166	88.3	180	79.6	
Temporary	22	11.7	46	20.4	
House construction (N=415)					0.255
Hut / bamboo	153	80.5	174	77.3	
Brick / wood	37	19.5	51	22.7	
Wall type (N=413)					0.140
Thatch/leaf/ bamboo	161	85.2	177	79.0	
Brick/wood	28	14.8	47	21.0	
Wall completeness (N=392)					0.271
Yes	168	92.3	187	89.0	
No	14	7.7	23	11.0	
Roof type (N=365)					0.064
Thatch/leaf	136	82.4	146	73.0	
Ceramic/ galvanized iron	29	17.6	54	27.0	
Dwelling in the forest (N=417)					<0.001[a]
Yes	90	47.1	61	27.0	
No	101	52.9	165	73.0	
Workplace in the forest (N=417)					<0.001[a]
Yes	154	80.6	101	44.7	
No	37	19.4	125	55.3	
Malaria knowledge (N=417)					0.168
High	47	24.6	43	19.0	
Low	144	75.4	183	81.0	

p-value of Pearson chi-square; [a]Statistical significance at $\alpha \leq 0.05$

The average number of family members in both the groups were equivalent (5.8 ± 2.3). Nearly 100% of both groups had no prophylactic drug use. As expected, the majority of the cases worked

Table 2
Comparison of the protective activities between the malaria cases and the non-malaria controls.

Variables	Malaria infection				p-value
	Positive		Negative		
	N	%	N	%	
Use of bednets (N=415)					0.410
Yes	103	54.5	114	50.4	
No	86	45.5	112	49.6	
Bednet condition (N=269)					0.002[a]
Good	97	80.8	103	69.1	
Poor	23	19.2	46	30.9	
Insecticide treated net use (N=230)					0.006[a]
Yes	63	60.0	53	42.4	
No	42	40.0	72	57.6	
Sleep under bednets (N=249)					<0.001[a]
Never	7	6.5	25	17.7	
Sometimes	50	46.3	34	24.1	
Every night	51	47.2	82	58.2	
Carried bednets (outdoor stay) (N=275)					0.364
Never	81	61.4	74	51.7	
Sometimes	30	22.7	38	26.6	
Regular	21	15.9	31	21.7	
Use of carried bednets (N=145)					0.039[a]
Never	4	7.0	18	70.5	
Sometimes	34	59.7	37	42.0	
Regular	19	33.3	33	37.5	
Go to bed (N=128)					0.312
After midnight	2	3.6	7	9.7	
After 10 PM	35	62.5	38	52.8	
Early evening	19	33.9	27	37.5	
Mosquito repellent use (N=372)					0.001[a]
Yes	7	3.7	27	14.7	
No	181	96.3	157	85.3	
Wear long sleeve dress inside (N=394)					0.191
Never	6	3.3	3	1.4	
Sometimes	70	38.7	98	46.0	
Everyday	105	58.0	112	52.6	
Wear long sleeve dress outdoors (N=413)					0.001[a]
Never	6	3.1	1	0.4	
Sometimes	100	52.4	91	41.0	
Everyday	85	44.5	130	58.6	
Repel mosquitos by smoky fire (N=414)					0.279
Never	44	23.0	41	18.4	
Sometimes	84	44.0	93	41.7	
Everyday	63	33.0	89	39.9	
Insecticide spray use (N=412)					<0.001[a]
Never	19	10.1	50	22.4	
Partial spray	71	37.6	101	45.3	
Complete spray	99	52.3	72	32.3	
Insecticide indoor spraying by officers (N=410)					<0.001[a]
Never	91	48.6	151	67.7	
Once/year	62	33.2	45	20.2	
Twice/year	34	18.2	27	12.1	

p-value of Pearson chi-square; [a]Statistical significance at $\alpha \leq 0.05$

in the forest (80.6%). There were significant differences in age, education, occupation, family income, ethnic groups, forest stay 14 days prior to being sick, dwelling location, house permanence, working or living in the forest, and preventive activities, namely sleeping under bednets, the condition of the bednets, carrying the bednets, chemical bednet use, repellent use, protective outdoor clothes, and insecticide indoor spraying by officers ($p < 0.001$). The other variables had no statistical significance in either group (Tables 1-2).

After adjusting for potential confounders, 7 independent variables were significantly associated with malaria infection in the final model of multiple logistic regression. These include age (0-14 years), occupation (merchant, unemployment), family income ≥ 2001 baht/month, ethnic groups (Muser, Eko), forest stay 14 days prior to being sick, working or living in the forest (adjusted OR = 15.27, 8.85, 16.41, 9.10, 5.67, 6.56, 19.49, 3.23, 4.83, respectively) (Table 3).

DISCUSSION

According to the univariate analysis the results show that the sociodemographic status and living or working in the forest are associated with malaria infection. These findings are similar to previous studies (Butraporn *et al*, 1986; Fungladda *et al*, 1987). Practical preventive activities, such as using insecticide treated bednets, repellent, pro-

Table 3
Crude and adjusted odds ratio of various risk factors by multiple logistic regression.

Variables	OR_c	OR_a	95% CI (OR_a)	p-value
Age (yr)				
0-14	24.58	15.27	2.26-103.60	0.005[a]
15-34	15.01	0.77	0.39-1.55	
≥ 35	1.00			
Education				
No schooling	3.30	1.23	0.55-2.75	0.607
≥ Primary school	1.00			
Occupation				
Wood cutting and gathering forest products	0.33	0.48	0.12-1.98	0.311
Employee	0.52	0.65	0.15-2.82	0.568
Merchant	1.28	8.85	2.21-35.37	0.002[a]
Unemployment	6.72	16.41	5.42-49.73	<0.001[a]
Others	0.79	1.28	0.51-3.23	0.595
Agriculture	1.00			
Family income (baht / month)				
≥ 2,001	9.09	9.10	3.04-27.22	<0.001[a]
< 2,000	1.00			
Ethnic groups				
Hou	2.67	1.67	0.44-6.35	0.453
Muser	3.44	5.67	1.97-16.30	0.001[a]
Eko	7.57	6.56	2.36-18.25	<0.001[a]
Lesaw	3.91	2.03	0.65-6.35	0.223
Others	3.51	2.28	0.46-11.34	0.312
Akha	1.00			
Forest stay 14 days prior to being sick	5.81	19.49	9.17-41.44	<0.001[a]
House condition	1.88	1.99	0.50-2.81	0.690
Dwelling in the forest	2.41	3.23	1.47-7.13	0.004[a]
Work place in the forest	5.15	4.83	2.14-10.89	<0.001[a]

[a]Statistical significance at $\alpha \leq 0.05$

tective clothing (wearing long sleeved shirts and trousers) and insecticide indoor spraying were inversely associated with malaria infection, which is concordant with the randomized controlled trials (RCTs) of Croft (2000). The significant variables from multivariate analysis were age (0-14 years), unemployment, income, ethnic group, and working or living in the forest. Living in the forest has an association with malaria infection similar to a previous study (Chaveepojnkamjorn and Pichainarong, 2004). Previous studies reported that the older age groups of 15-34 years exhibited the majority of infections but this study found age ≤14 years was more often infected. This disagrees with Kanjanapan *et al* (1983) and Butraporn *et al* (1995). Many young unemployed hilltribe people accompany their families into the forest. This problem increases the risk of malaria infection in young hilltribe people. Malaria is commonly a jungle disease, requiring a stream nearby. It is transmitted by the bite of an infected female anopheline mosquito (Baudon and Martet, 1997), which bite at dusk and during the night (White, 1996). The hilltribe lifestyle in the forest requires preventive action, such as wearing long sleeved shirts and trousers to reduce the incidence of malaria, p = 0.02 (Shoepke *et al*, 1998). It would seem sensible to wear long sleeved shirts and trousers (long traditional clothes) at dusk, and to wear light, rather than dark, colors, as insects prefer landing on dark surfaces (Bradley and Warhurst, 1997). Infants and young children have sensitive skin. Some researchers advise that only plant base topical repellents, such as citronella oil, are safe for the young and pregnant (Bouchaud *et al*, 1998). Insecticide treated nets constitute one of the cheapest, simplest, and

most effective methods of preventing morbidity and mortality from malaria in Africa and Asia (Lengeler, 2002; Armstrong-Schellenberg *et al*, 2001). The use of insecticide treated nets in Thailand resulted in no evidence of toxic effects to mothers or fetuses (Dolan *et al*, 1993). The greatest challenge over the next decade will be to expand the use of affordable nets among disadvantaged and poor people, who often need the nets the most. New ways of protecting individuals include using insecticides applied to a variety of surface, such as blankets, tents, mats, curtains or incorporated into the fiber of plastic tarpaulins used as shelter materials/dwellings (Hewitt *et al*, 1995; Rowland *et al*, 1999). Such measures, according to some studies; have good short term results, and are easy to implement by nomadic hilltribes.

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