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Factors Associated with Malaria Infection in Vibhavadi District, Surat Thani Province, Southern Thailand

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Abstract

This research aimed to identify the factors associated with malaria infection in Vibhavadi District, Surat Thani Province. A cross-sectional study was performed to determine the relationship between groups of malaria infection and non-malaria infection during June to December 2010. Eighty-eight samples of malaria infection group and 176 samples of non-malaria infection group were drawn from malaria clinic in Vibhavadi District, Surat Thani Province, Southern Thailand. Data collected were the results of blood test and face-to-face interviews. Multiple logistic regressions were used to analyze for risk factors of malaria infection. The results showed that the factors significantly associated with malaria infection at 95% confidence level were as follows: occupation (AOR = 0.40, 95% CI = 0.22-0.72, P-value = 0.00), education (AOR = 1.89, 95% CI = 1.05-3.39, P-value = 0.03), duration of living in the area (AOR = 2.15, 95% CI = 1.14-4.05, P-value = 0.02), and stayed out of their own residence (AOR = 2.71, 95% CI = 1.26-5.86, P-value = 0.01). The risks might be reduced by community-based health education with emphasis on malaria, targeted to comparatively high-risk groups of people. Further study could assess effects of such prevention and control measures on malaria, in the same locality.

Keywords: malaria, factors affecting malaria infection, Surat Thani Province

Introduction

Malaria is a mosquito-borne disease of humans, caused by protozoa belonging to the genus *Plasmodium*. There are 5 species of *Plasmodium* that can infect humans, *i.e.*, *P. falciparum, P. vivax, P. ovale, P. malariae* and *P.*

knowlesi [1-3]. *P. knowlesi* was found in Thailand during 2006-2007 at approximately 0.8% of all malaria cases indentified even though it is the dominant strain in Malaysian Borneo [4]. The most severe malarial infection in human is due to *P. falciparum*. The parasites are transmitted to people through the bites of infected *Anopheles* mosquitoes [5,6]. Symptoms of malaria include fever, headache and hemolysis, in severe cases anemia and potentially death despite several drugs available for treating malaria infection,

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such as chloroquine, quinine, mefloquin, and artesunate [7,8]. The World Health Organization (WHO) currently recommends artemisinin-based combination therapies (ACTs) as the best first-line treatment for uncomplicated *P. falciparum* [9-12]. This disease remains a severe global public health problem while WHO promotes guidelines on prevention and control practices. The prevention and control programs induce health care costs, investment costs, and loss of tourism. Malaria infections are common in poverty stricken countries with poor education, especially in Africa. The incidence rates of malaria infection in Africa, Asia and North America are about 59%, 38% and 3%, respectively. *P. falciparum* accounts for up to 74% of malaria in Africa, and only about 1% in Asia [13]. However, malaria is still viewed as an important health problem in Thailand. In 2008, southern Thailand suffered an outbreak of malaria [14]. During 2005 to 2009, Vibhavadi was among the top five districts in Surat Thani Province, with a high incidence of malaria infections [15]. The current study aimed to identify risk factors contributing to malaria infections in Vibhavadi district, to determine the risk of malaria infection, and to contribute to such guidelines for the prevention and control of malaria surveillance in the area that incidence of malaria could be sustainably reduced.

Materials and methods

Study design and population

The study investigated factors contributing to prevalence of malaria infection in Vibhavadi district, Surat Thani province, Southern Thailand. For this purpose it was necessary to assess the presence of malaria infection in subjects, in a consistent manner. Samples were collected from people who live in both Takuk Tai sub-district and Takuk Nuea sub-district during June to December 2010. These samples were examined for Plasmodium infection by the malaria clinic in Vibhavadi district. The samples were labeled "malaria infected" for thick blood film (TBF) positive cases; and "non-malaria infected" for TBF negative cases.

Sample size

The sample size was calculated by modified Kelsey' s formula [16]

$$n = \frac{(Z_{\alpha/}2 + Z_\beta)^2 \bar{P}(1 - \bar{P})(r + 1)}{(d^*)^2 r}$$

where

n = Required sample size,

r = The expected ratio of the number of the patients with malaria infection who stayed out of own rest area to the number of the patients with non-malaria infection who stayed out of own rest area.

P_1 = The proportion of the patients with malaria infection who stayed out of own rest area,

P_0 = The proportion of the patients with non-malaria infection who stayed out of own rest area,

d^* = Non null value of the difference in proportions, here chosen equal to 0.20

$P = \dfrac{P_1 + rP_0}{1 + r}$

After reviewing the literature, the sample size was calculated based on the study of risk factors of malaria infection in Thai - Myanmar Border: Ranong Province, for P_1, P_0 and r [17].

A cross-sectional study assessed the relationship between malaria infection and non-infected cases. Two groups of samples were conducted in the 88 infected cases: 176 non-infected cases at the malaria clinic in Vibhavadi district. *Plasmodium* malaria was diagnosed using thick blood smear, and the parasite species were identified under a light microscope.

Data were collected from both of infected and uninfected persons by face-to-face interview questions. The questionnaire included three parts: the first part elicited socio-demographic details (gender, age, marital status, occupation, family income and educational level); the second part investigated behavioral factors of malaria prevention and treatment; the third section investigated environment and living conditions of all study cases.

Interview was conducted only after the informed consent was obtained from each research

participant. The malaria infected patients were treated with standard regimens, i.e., chloroquine, quinine, mefloquin, or artesurnate, by the malaria clinic in Vibhavadi district, Surat Thani Province.

Statistical analysis

Multiple Logistic Regression Analysis was used to assess the risk factors contributing to malaria infection.

Ethical consideration

The study was approved by Ethics Committee of the Faculty of Medicine, Prince of Songkla University, Thailand (Approval No. 560281963).

Results

Prevalence of malaria infection

The prevalence of malaria infection in Vibhavadi district, Surat Thani Province, was investigated from June to December, 2010. The study cases consisted of 264 individuals. A total of 88 malaria cases were identified; 65.9% with *P. falciparum* and 34.1% with *P. vivax*. The overall prevalence was 0.6%; and the infection prevalence in Takuk Nuea sub-district was higher than that of Takuk Tai sub-district (0.5% *vs* 0.1%).

Table 1 **Socio-demographic characteristics of infected malaria and non- infected cases in Vibhavadi District, Surat Thani Province.**

Characteristics	Malaria infection n = 88 (%)	Non-malaria infection n = 176 (%)
Gender		
Male	54 (61.4)	88 (50.0)
Female	34 (38.6)	88 (50.0)
Age		
< 14	9 (10.2)	8 (4.5)
15 - 29	30 (34.1)	36 (20.5)
30 - 44	24 (27.3)	70 (39.8)
45 - 59	16 (18.2)	48 (27.3)
> 60	9 (10.2)	14 (8.0)
	$\overline{X} = 35.2$, SD = 18.6	$\overline{X} = 39.6$, SD = 15.3
Marital Status		
Single	32 (36.3)	31 (17.6)
Married	46 (52.3)	127 (72.2)
Others	10 (11.4)	18 (10.2)
Occupation		
Agriculture	49 (55.7)	135 (76.7)
Others	39 (44.3)	41 (23.3)
Family income (Baht/year)		
< 100,000	32 (36.4)	55 (31.2)
100,000 - 300,000	40 (45.4)	88 (50.0)
> 300,000	16 (18.2)	33 (18.8)
	$\overline{X} = 146,536.4$, SD = 133,227.5	$\overline{X} = 162,738.6$, SD = 127,097.8
Education		
Primary school	61 (69.3)	103 (58.5)
Secondary school	27 (30.7)	60 (34.1)
Bachelor's degree or higher	0 (0)	13 (7.4)

Socio-demographic characteristics of the samples

Of the total 88 malaria infected cases, 54 were males. Among five age groups categorized, the group of 15-29 years old contributed to 34.1% of infected cases. Among occupations, agriculture workers were the largest fraction of infected cases at 55.7% (49/88). The income group of 100,000-300,000 baht per year contributed to 45.4% of the infected cases. The three education levels were found to be associated with infection rates, while no infected cases were found in participants holding Bachelor's degree or higher (Table 1).

Behavioral factors, prevention and treatment of malaria infection

While the use of bednet, repellent cream, protective clothes, and insecticide appeared to protect research participants against malaria infection, some users were infected. Most of the infected cases (97.7%) had used bednet, and 90.9% of them had used mosquito repellent cream. About 89.8% of infected respondents wore protective clothes, and about 82.9% of persons infected with malaria had used insecticide treated net (Table 2).

Environmental factors and living conditions

Table 3 reports the numbers of malaria and non-malaria cases which vary by some characteristics that might contribute to malaria infection. The characteristics being considered in this study were the duration of living in the area, staying out of their own residence, work place, housing location, housing condition, physical environment, deforestation and being indigenous population or immigrants. Higher proportions of malaria infection were found in the cases who lived in the area for 5 years or longer, did not stay out of their own residence, did not work in the forest, had permanent housing, stayed in open land environment with no deforestation.

Assessment of factors associating with malaria infection in Vibhavadi District, Surat Thani Province

The factors significantly associated with malaria infection were occupation, education, living time and staying out of own rest area (*p* < 0.05). A group of people related to malaria infection was agriculture (adjusted OR 0.40, 95% CI 0.22-0.72, P-value 0.00), education of primary school level (adjusted OR 1.89, 95% CI 1.05-3.39,

Table 2   The behavioral prevention and treatment of infected malaria and non- infected cases in Vibhavadi District, Surat Thani Province.

Characteristics	Malaria infection n = 88(%)	Non-malaria infection n = 176(%)
Use of bednet/sleeping under a bednet		
Yes	86 (97.7)	174 (98.9)
No	2 (2.3)	2 (1.1)
Use mosquito repellent cream		
Yes	80 (90.9)	152 (86.4)
No	8 (9.1)	24 (13.6)
Wearing protective clothes such as long sleeve shirts and long pants		
Yes	79 (89.8)	171 (97.2)
No	9 (10.2)	5 (2.8)
Possessing insecticide treated mosquito net		
Yes	73 (82.9)	130 (73.9)
No	15 (17.1)	46 (26.1)

Table 3 The environmental measures and living condition of malaria infection and non- infected respondents in Vibhavadi District, Surat Thani Province.

Characteristics	Malaria infection n = 88(%)	Non-malaria infection n = 176(%)
Duration of living in the study area (year)		
< 5	40 (45.5)	40 (22.7)
≥ 5	48 (54.5)	136 (77.3)
Staying out of their own residence		
Yes	21 (23.9)	20 (11.4)
No	67 (76.1)	156 (88.6)
Work place		
In the forest	40 (45.5)	63 (35.8)
Outside the forest	48 (54.5)	113 (64.2)
Housing location		
In the forest	42 (47.7)	70 (39.8)
Outside the forest	46 (52.3)	106 (60.2)
Housing condition		
Permanent	84 (95.5)	171 (97.2)
Temporary	4 (4.5)	5 (2.8)
Physical Environment		
Open land	53 (60.2)	116 (65.9)
Forest area	35 (39.8)	60 (34.1)
Deforestation		
Yes	7 (7.9)	12 (6.8)
No	81 (92.1)	164 (93.2)
Foreign workers		
Yes	44 (50.0)	78 (44.3)
No	44 (50.0)	98 (55.7)

P-value 0.03), less than 5 years living in study area (adjusted OR 2.15, 95% CI 1.14-4.05, P-value 0.02), not staying out of their own residence (adjusted OR 2.71, 95% CI 1.26-5.86, P-value 0.01) (Table 4).

Discussion

This study indicated a 0.6% prevalence rate of malaria infection. The infection rate with *P. falciparum* was higher than with *P. vivax* (65.9% *vs* 34.1%). A previous study in southern Thailand during 1998-2000 reported that *P. falciparum* increased from 45% to 56% [18]. In contrast, in the southern part from 1991 to 1994, *P. vivax* was more prevail than *P. falciparum* [19]. In addition,

the infection rate of *P. falciparum* was higher in the wet season than in the dry. Probably, the higher prevalence in the wet season was due to *Anopheles* mosquitoes [20]. The study found that most malaria infected cases were men (61.4% *vs* 38.6%). Similarly, in previous report, malaria infection and life-style factors among hilltribes along the Thai-Myanmar border area, in northern Thailand, showed that the infection rate in men were higher than that in women (68.6% *vs* 31.4%) [21]. This finding suggested that women were more interested in the disease prevention than men. The age group of most infected cases varied from 10-60 years old [22,23]. Meanwhile, the agriculture worker was infected with 55.7%

Table 4 Factors assosiated with malaria infection in Vibhavadi District, Surat Thani Province analyzed by Multiple Logistic Regression (95% CI).

Variable	Adjusted OR	95% CI Adjusted OR	P-value
Gender			
Male	1.59	0.91-2.79	0.11
Female	1.00		
Age			
Age dependency	2.01	0.87-4.68	0.10
Working	1.00		
Marital status			
Single	2.01	0.95-4.28	0.07
Married	1.00		
Occupation			
Agriculture	0.40	0.22-0.72	0.00*
Other	1.00		
Family income			
≤ 100,000	0.67	0.34-1.30	0.24
> 100,000	1.00		
Education			
Primary school	1.89	1.05-3.39	0.03*
Higher than primary school	1.00		
Use of bednets/Sleep in bednets			
Yes	0.12	0.01-1.09	0.06
No	1.00		
Repellent cream			
Yes	2.28	0.82-6.35	0.12
No	1.00		
Wearing long sleeve clothes indoors			
Yes	0.22	0.05-1.01	0.05
No	1.00		
Insecticide treated mosquito net			
Yes	2.15	0.95-4.88	0.07
No	1.00		
Living time (year)			
< 5	2.15	1.14-4.05	0.02*
≥ 5	1.00		
Stayed out of own rest area			
Yes	2.71	1.26-5.86	0.01*
No	1.00		
Work place			
In the forest	1.19	0.48-2.92	0.71
Outside the forest	1.00		
Housing location			
In the forest	0.90	0.37-2.23	0.83
Outside the forest	1.00		
Housing condition			
Permanent	1.40	0.24-8.80	0.72
Temporary	1.00		
Physical Environment			
Open land	2.68	0.42-16.98	0.30
Forest area	1.00		
Deforestation			
Yes	0.59	0.18-1.94	0.38
No	1.00		
Foreign workers			
Yes	0.82	0.45-1.52	0.53
No	1.00		

* Statistically significant at 0.05

(adjusted OR 0.40, 95% CI 0.22-0.72, P-value = 0.00). The occupation was associated with malaria infection, especially agriculture [24,25]. Education level showed that the infection rate in subjects with primary school level was higher than those with the secondary school level (37.2% *vs* 31%), but no *Plasmodium* infection in a group of Bachelor's degree or higher level (adjusted OR 1.89, 95% CI 1.05-3.39, P-value = 0.03). This study indicated that education level were associated with malaria infection, the lower level of education, the more chance to be infected with malaria [26]. For environmental factors and living conditions of peoples found that living in the study area of less than 5 years were infected more than those who stayed 5 years or more with 50% (adjusted OR 2.15, 95% CI 1.14-4.05, P-value = 0.02). In Kanchanaburi Province, people who lived in the malaria endemic area less than 5 years were most likely to be infected with malaria [27]. Moreover, those who stayed out of their own residence were infected with 23.9% (adjusted OR 2.71, 95% CI 1.26-5.86, P-value = 0.01). The previous suggested that stayed out of their own residence before the blood test ≥ 7 days had more risk of malaria infection than those who do not stayed out [28]. Even though prevention and control programs have been conducted worldwide, malaria is still a major problem. Thus, preventing malaria control must be performed with the use of measures such as spraying mosquito-borne chemical depot, chemical plating nets, the fogging, environmental control, with the use of measures such as health education and public relations person, and participation of the community. Malaria trends for prevention and control program of malaria infection should be provided knowledge about malaria transmissions, prevention and treatment practices, and risk perception of the disease.

In conclusion, the study investigated the risk factors of malaria infection in Vibhavadi District, Surat Thani Province, southern Thailand. A cross-sectional study assessed the relationship between malaria infection and non-infected cases. These findings indicate that Vibhavadi District, Surat Thani Province is a risk area for malaria infection.

The risk factors that were significantly associated with malaria infection from Multiple Logistic Regression were occupation, education, duration of staying in the area and staying out of their own residence (P-value < 0.05).

Acknowledgements

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