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Brief communication (Original)

Geographic information system of *Opisthorchis viverrini* in northeast Thailand

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Background: Opisthorchiasis caused by *Opisthorchis viverrini* remains a major public health problem in many parts of Southeast Asia including Thailand, Lao PDR, Vietnam, and Cambodia. The epicenter of this disease is located in northeast Thailand, where high a prevalence of opisthorchiasis coexists with a high incidence of cholangiocarcinoma (CHCA), a major primary carcinoma of the liver with a very poor prognosis.

Objective: Determine the surveillance characteristics of *O. viverrini* infections in northeast Thailand.

Methods: Four thousand one hundred eighteen stool samples from 19 provinces were used in this study. All age groups were included, from below four years to more than 60 years. The geographic information system (GIS) was deployed to overlay the prevalence of disease on urban and agricultural areas as well as manmade land uses.

Results: Results showed a rate of Opisthorchiasis of 20.39% (840/4,118). Farmland and forests (loam soil) were highly associated with infection.

Conclusion: The rate of Opisthorchiasis is high in farmland and forests and lower in residential areas. Mass treatment targeted at high-risk areas may be a cost-effective control strategy and warrants further study.

Keywords: GIS, liver fluke, northeast Thailand, *Opisthorchis viverrini*

Opisthorchis viverrini infection remains a major public health problem in northeastern Thailand [1]. An acute infection with *O. viverrini* usually has no or few clinical manifestations. However, a case-control study performed with 103 cases of cholangiosarcoma showed that at least two-thirds were attributable to *O. viverrini* [2]. Many factors influence the survival and transmission rates of parasites. In the case of Opisthorchiasis, the consumption of raw or undercooked fish is the primary mode of infection [4]. In the northeast, several types of food preparations contain uncooked fish [2].

Of these, *Koi pla* (raw fish flesh chopped with garlic, lemon juice, fish sauce, chilly, roasted ground rice and vegetables) is probably the most infective, followed by fish preserved for less than seven days, then by *pla ra* and *jaewbhong*, in which viable metacercariae are rare [3, 4]. The main strategies for control of these infections are three interrelated approaches: 1) Identification and treatment, by stool examinations and treatment of positive cases with praziquantel to eliminate the human host reservoir 2) health education to promote the consumption of only cooked fish to prevent infection 3) the improvement of hygienic defecation for the interruption of disease transmission. This study provides useful data about the geographic information, health status and the risk behaviors that might be the targets for future interventions.

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Materials and methods

This cross-sectional survey was conducted in provincial villages in northeast Thailand in January 2009. Investigators visited eighty-eight stratified randomly selected areas of the northeast region of Thailand, accompanied by local Public Health Department officials. Subjects of all age groups were assigned to the study-population after informed consent was given. All subjects were interviewed and stool specimens were collected. Stool specimens were fixed with formalin and carefully stored before examination in a laboratory at the local public health office. The formalin-ether concentration technique was used to process all specimens. The presence of intestinal parasite eggs and larva was determined microscopically.

Statistical data were analyzed using the software EPI-INFO (Version 2, Centers for Disease Control and Prevention, Atlanta, USA). Descriptive statistics were used to describe the distribution of the demographic and socio-economic characteristics of the subjects. The chi-square test was used to compare differences in the distribution of categorical variables, or the chi-square test for trend when appropriate. A statistically significant difference was determined when p-value was less then 0.05.

A GIS database for the study of *O. viverrini* was implemented using ArcGIS desktop program from ESRI (California, USA). It mainly separates agricultural areas from urban areas, and other manmade land uses. Geographic coordinates of each area were determined with a Global Positioning System. The generated geo-referenced database was overlaid on the digitized state coverage of remotely sensed satellite sensor environmental data.

Results

In a total population of about twenty million, 4,118 subjects were recruited. These included all age groups from below four years to more than 60 years. Of these, 1,885 were males and 2.233 were females (male:female = 1:1.18). The demographic data are shown in **Table 1**. Microscopy revealed *O. viverrini* in 840 stool samples (20.39 percent). The highest prevalence (21.7%) was found in villagers aged 50-59 years. The majority of the population worked in agriculture and their education was at the primary level. **Table 2** shows the geographic information factors associated with infections**.**

Table 3 analyzes the predictors of Opisthorchiasis using a stepwise regression method. It was found that loam soil correlated with the prevalence of Opisthorchiasis in northeast of Thailand. The multiple regression coefficients of Opisthorchiasis was 0.25.

Table 1. Demographic data associated with infections

Variable	**n (%)**	**Result**	
		OV Positive n (%)	**MIF Positive n (%)**
Sex			
Male	1885 (45.8)	482 (25.6)	49 (2.6)
Female	2233 (54.2)	358 (16.0)	42 (1.9)
Age	Mean 47.34, SD 14.37, Max 89, Min 1		
Religion			
Buddhist	4102 (99.6)	838 (20.4)	91 (0)
Others	16 (0.31)	2 (30.0)	0 (0)
Education			
None	153 (3.7)	31 (20.3)	4 (2.6)
Primary	3162 (76.8)	686 (21.7)	73 (2.3)
Secondary	369 (9.0)	69 (18.7)	8 (2.2)
Higher than secondary	434 (10.6)	54 (33.2)	6 (5.4)
Occupation			
Agriculture	3354 (81.4)	737 (50.1)	70 (8.0)
Non-agriculture	763 (18.5)	103 (63.7)	11 (13.1)
Household member	Mean 4.01, SD 1.473, Max 14, Min 1		

Table 2. Geographic information factors associated with infections

Variable	n (%)	Prevalence			
		Max	Min	Mean	SD
Land used					
Forest	8 (9.2)	50.00	3.60	24.86	17.40
Paddy field	44 (50.6)	85.20	0.00	21.14	17.98
Agricultural Plants Farm	16 (18.4)	37.50	0.00	19.74	12.11
Grassland	1 (1.1)	19.00	19.00	19.00	0
Residence	13 (14.9)	48.70	0.00	12.66	13.01
Water resources	3 (3.4)	30.60	1.70	11.83	16.27
Orchard	2 (2.3)	22.50	0.00	11.25	15.91
Soil type					
Organic soil	1 (1.1)	30.60	30.60	30.60	0
Loam	67 (77.0)	85.20	0.00	21.57	16.73
Sandy soil	3 (3.4)	35.10	0.00	14.63	18.26
San	2 (2.3)	21.60	6.30	13.95	10.82
Clay	10 (11.5)	36.40	0.00	10.12	11.00
Combination of clay and loam	2 (2.3)	8.00	7.50	7.75	0.35
Mountain soil	0 (0)	0	0	0	0

Table 3. Influencing factors for the prediction of the prevalence of trematodes with geography analyzed by stepwise regression analysis

Variable	b	SE	β	T	p-value
Constant	12.055	3.507	–	3.437	0.001
Loam	9.518	3.997	0.25	2.381	0.019

SE_{est}=*15.685, R=0.25, R^2=0.063, F=5.671, P-value 0.019

Figures 1-3 show the Geographic information and mapping of Opisthorchiasis in region 5-7, respectively (The Ministry of Public Health in Thailand has divided its 78 provinces into 12 regions). When geographic data and soil types are known, the prediction equation for helminthiasis prevalence was calculated using the following equation:

$$Y^1 = 12.055+9.518 \text{ (loam)}$$

Discussion

This study demonstrated the presence of *O. viverrini* infections in endemic areas. Probable targets to minimize transmission are the standards of personal and public hygiene as well as education regarding food consumption and cooking behaviours. The majority of detected parasites (840 cases, 20.39%) were *O. viverrini*. Differences in the prevalence of infection presumably reflect variations in environmental conditions as well as social behaviors. The crude overall prevalence of infection in our study population was higher than the overall prevalence rate of 15.7% in northeast Thailand previously observed in 2001 [5, 7]. The variability among different geographic regions as well as seasonal variations may serve as an explanation for this discrepancy. Further studies are required to up-date the health status and health care needs in certain rural areas of Thailand. Additional studies on the efficacy of interventional programs that address health behaviour are recommended. Multi-prong approaches might offer a comprehensive strategy for the helminth dilemma. Nevertheless, data derived from our study demonstrated that there are still groups predisposed to higher infection rates. We were able to show that lower education is associated with higher prevalence rates, which reflect the inequity of access to information. Improved education regarding eating and cooking behaviors remains a crucial tool in the control of liver fluke infections. These educational programs should target individuals and communities at risk.

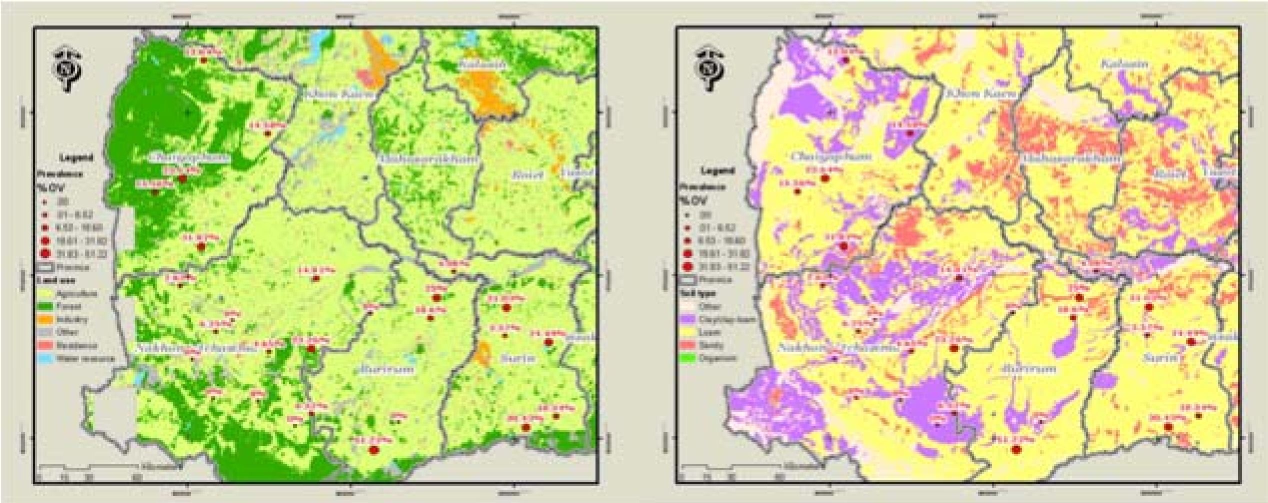

Figure 1. Geographic information and mapping of Opisthorchiasis in region 5, Thailand

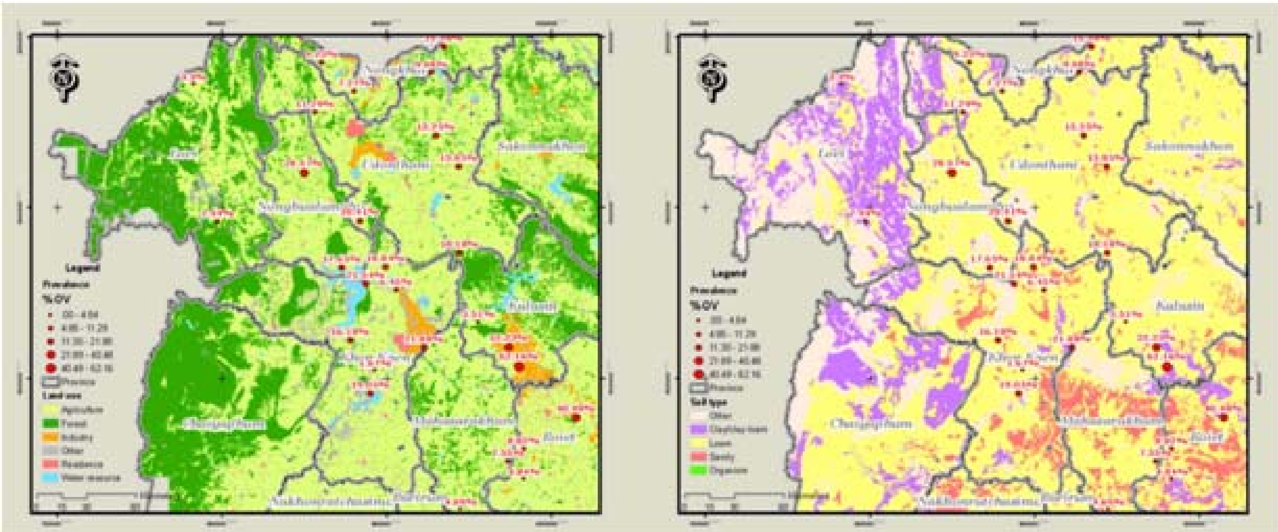

Figure 2. Geographic information and mapping of Opisthorchiasis in region 6, Thailand

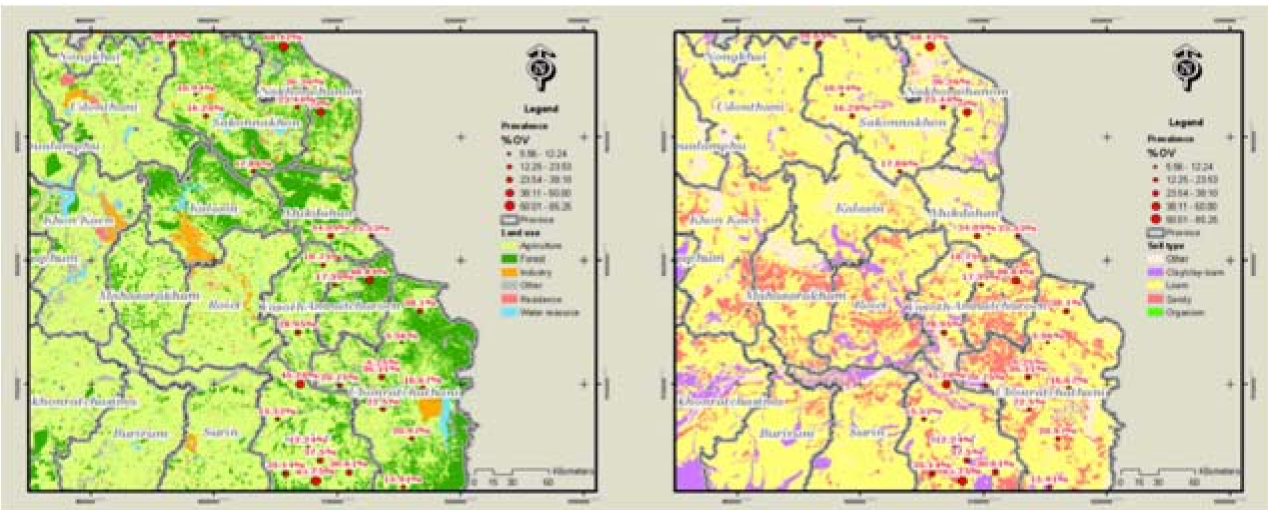

Figure 3 Geographic information and mapping of Opisthorchiasis in region 7, Thailand

Further sociological studies are recommended to elucidate risk behaviors in the transmission of Opisthorchiasis and other intestinal parasites. Mass treatment targeted at high-risk areas might be a cost-effective option.

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