

# Geographic Information of Helminthiasis in Thailand

Wongsaroj, T.,<sup>1</sup> Nithikathkul, C.,<sup>2</sup> Reungsang, P.,<sup>3</sup> Royal, L.,<sup>4</sup> Nak ai, W.,<sup>1,5</sup> Kraikas, D.,<sup>5</sup> and Ramasoota, P.<sup>6</sup>

<sup>1</sup>Bureau of General Communicable Diseases, Department of Disease Control, Ministry of Public Health, Thailand, E-mail: Tmthelma1@yahoo.com

<sup>2</sup>Faculty of Medicine, Mahasarakham University, Thailand, E-mail: choosak@hcu.ac.th

<sup>3</sup>Department of Computer Science, Khon Kaen University, Thailand

<sup>4</sup>Faculty of Liberal Arts, Huachiew Chalermprakiet University, Thailand

<sup>5</sup>Department of Biology, Faculty of Science, Silpakorn University, Bangkok, Thailand

<sup>6</sup>Faculty of Tropical Medicine, Mahidol University, Thailand

## Abstract

*Helminthiasis, including Opisthorchiasis viverrini (liver fluke) and Necator americanus (hookworm), is still a significant public health problem among high risk occupations and groups in Thailand. Endemic infections are closely related to socio-economic status and risk behaviors for parasitic infections among villagers in rural and remote areas. Currently, the helminthiasis control program managers have set up the national plan to prevent and control these diseases by the interaction and responses of the provincial public health offices. However, the program managers need to have information determined by evidence based needs. These data are representative of all age groups in Thailand and the data are derived from the nationwide household survey. The prevalence of Opisthorchis viverrini (liver fluke), Necator americanus (hookworm), and other helminthes in this study was evaluated in 75 provinces during the period from January to May 2009. A total of 15,555 stool specimen samples were obtained from the population by using 30 cluster random sampling under WHO guidelines. The Formalin Ether Concentration technique was applied to the fecal samples. The objectives of the study were: 1. to evaluate a GIS health model by using spatial analysis to investigate the prevalence of O. viverrini and hook worm infections in relation to the sea level and geographic positions in high risk areas, and 2. to analyze the factors that correlate with infections among rural Thai people. Logistical regression with an analysis of the determinant factors was used to correlate the prevalence of O. viverrini with the geographic information as determined by GIS. The result of this large scale survey showed the overall prevalence of helminthiasis among these selected groups of Thai people was 18.1%. The highest prevalence of O. viverrini was 85.3% at a village in Sri Sa Ket, in the Northeast region. This village is located in the Non Sung district at latitude 14°36'11" N and longitude 104°24'1" E, at an altitude of 161 meters above mean sea level. There, the mean rainfall was 246.2 cm per year, and the mean temperature was 28.2°C. In the Northeast region, the study results showed a correlation between a high prevalence of O. viverrini and geographic information regarding land use. The results indicated that land use of paddy fields with loam soil type was correlated with a high prevalence of O. viverrini, including mean rainfall measured per year. Residential land use with clay soil type also correlated with a high prevalence of O. viverrini infections among people in the northeast. In contrast, in the northern region, a high prevalence of O. viverrini infections was associated with GIS geographic information of orchard and forest land use with organic soil type. In the north, 80% of the land area is composed of forest and high hills. This is an important area for the fountainheads of rivers, and many species of natural freshwater fish are present. These support parasitic infections, and in turn those people who consume uncooked, freshwater fish. Frequent consumption of raw or uncooked fresh water fish is the main cause of O. viverrini infections among people in the north. However, in the southern region, the presence of hookworm and Strongyloides stercoralis (pinworm) showed a geographical heterogeneity with the highest prevalence occurring in regions with clay and mountain soil types. There were also statistically significant factors which influenced and correlated with O. viverrini infections. These included: 1. the consumption of raw fresh water fish (p-value<0.000) and 2. defecation in proper latrines as opposed to defecation outside of latrines or in unsanitary toilets (p-value<0.001). The strongest fit predictor for O. viverrini infections was the consumption of raw fresh water fish which had a 58.94% predictive value. In conclusion, the study results showed a high prevalence of liver fluke and hookworm infections associated with health behaviors and Geographical Information Systems. These results*



demonstrate that spatial analysis can help to identify patterns of high risk for *O. viverrini* (liver fluke), *Necator americanus* (hookworm) and *Strongyloides stercoralis* (pinworm) in order to facilitate prevention and control

## 1. Introduction

Liver fluke, *Opisthorchis viverrini* and soil transmitted diseases, hookworm infections are still significant public health problems in Thailand (Jongsuksuntigul et al., 1992, Jongsuksuntigul Imsomboon, 2003, Bureau of General Communicable Diseases, 1992, Nithikathkul, 2000 and Wattanayingcharoenchai et al., 2011). Most evidence of helminthiasis comes from the national survey (Jongsuksuntigul and Imsomboon, 2003 and Bureau of General Communicable Diseases, 1992). In order to assess the effectiveness of the national helminthiasis control program, an analysis of the current situation and the magnitude of helminthes infection at national level are required. *O. viverrini* infection usually has a high mortality from Cholangiocarcinoma (CHCA) in Thailand (Sithithaworn and Haswell-Elkins, 2003 and Sripa, 2010). Hookworm infections are also important, especially among children. Infections with hookworm can cause anemia, induce malabsorption of nutrients, stunt growth and lower IQ (Okuda et al., 2002 and Upatham et al., 1984). Geographical information systems (GIS) can be applied to analyze helminth ecology including mapping of available epidemiological information and related factors (Nithikathkul, 2008). Data concerning geographic information were studied with regard to land use, soil types and helminth infections and their determining factors. These were correlated with *O. viverrini* and hookworm infections among Thai people. The aim of this study consisted of 3 categories to determine prevalence of helminthiasis among Thai people (over the age of 6 months) in 75 provinces of Thailand. Logistic regression was used to analyze the correlation between geographic information and helminthic infections using the determinant factors. These indicated a correlation between a high prevalence of *O. viverrini* infections in the north and northeastern regions and a correlation of hookworm infections in the southern region with the types of land use and soil types. This correlation with geographic information was accomplished by using spatial analysis.

## 2. Methodology

### 2.1 Cross-Sectional Studies Research

To represent the whole population in the study, a minimal sample size of 8,712 samples was calculated from the following statistical formula:

$$n = \frac{Z_{(\alpha/2)}^2 NP_{(1-p)}}{Z_{(\alpha/2)}^2 P_{(1-p)} + (N-1)d^2} \times \text{design effected (2)}$$

Equation 1

Therefore, 15,555 samples were collected from 75 provinces in Thailand during February 2009 to June 2009 in the study. The Formalin Ether Concentration Technique (FECT) was applied to identify the prevalence of opisthorchiasis, hookworm, and other helminthes (Katz et al., 1972, Ritchie, 1948 and WHO, 1980). The correlation among behavioral factors, helminthic infections and other determinant factors was analyzed by using logistic regression. To find the correlation between the prevalence of *O. viverrini* with geographic information of land use and soil types, spatial analysis from a GIS software package was applied.

### 3. Data Analysis

Data were analyzed by the following statistical techniques:

1. Basic descriptive statistics using percentages, mathematical means and standard deviation were analyzed for prevalence rates, intensity and health behaviors.
2. The correlation between behavioral factors of *O. viverrini* and hookworm infections was analyzed by binary regression, significant at a p value of 0.05
3. A GIS database for the study of helminthiasis was implemented using ArcGIS Desktop program with spatial analyst extension from ESRI company. It primarily distinguishes agricultural areas from urban and other more highly developed usage areas. Geographic coordinates within each land use 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. A geographic information system (GIS) integrates hardware, software and data to capture, manage, analyze and display all forms of geographically referenced information.

#### 4. Results

The study results showed a high prevalence of *O. viverrini* infections associated with geographic information (GIS). Infections were high in areas with a land use of rice paddy fields and loam soil types.

#### 4.1 Influencing Factors for Transmitted *Helminthes*

Clay and clay mixed with mountain soil correlated with the prevalence of hookworm and *Strongyloides stercoralis* infections in people in Southern Thailand. The multi-coefficient of hookworm and *S. stercoralis* infection was 0.497 and it predicted a prevalence of 24.7% for hookworm and *S. stercoralis* infections with a statistical significance ( $p$ -value < 0.001) and standard deviation for prediction of  $\pm 8.624$ . The prediction equation for hookworm and *S. stercoralis* infection is the following:

$$Y = 17.825(\text{Clay soil}) + 8.995(\text{mountain soil})$$

Equation 2

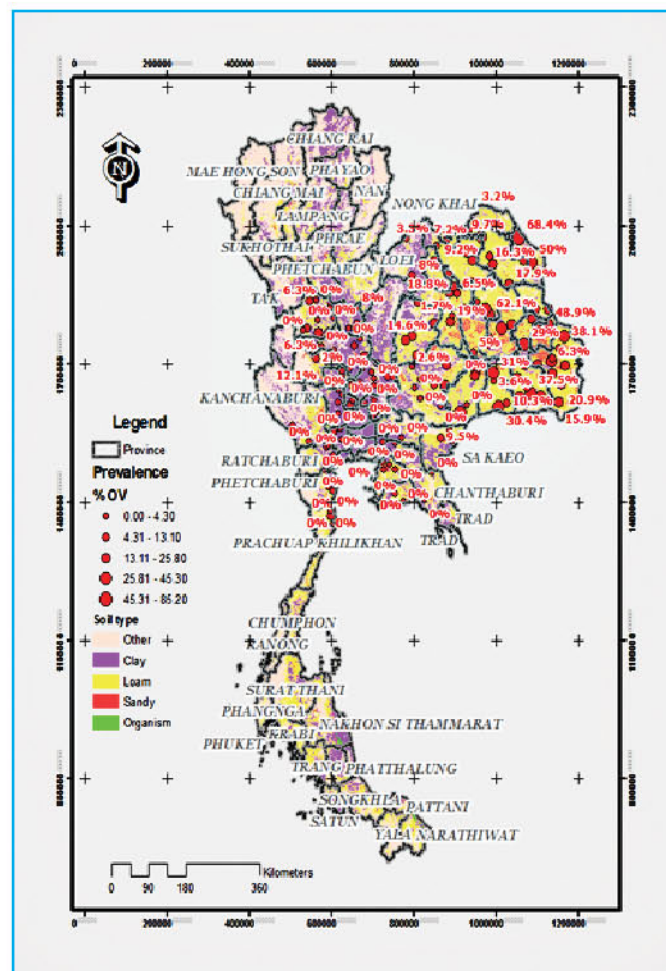


Figure 1: Geographic information by soil types and mapping of Opisthorchiasis in Thailand



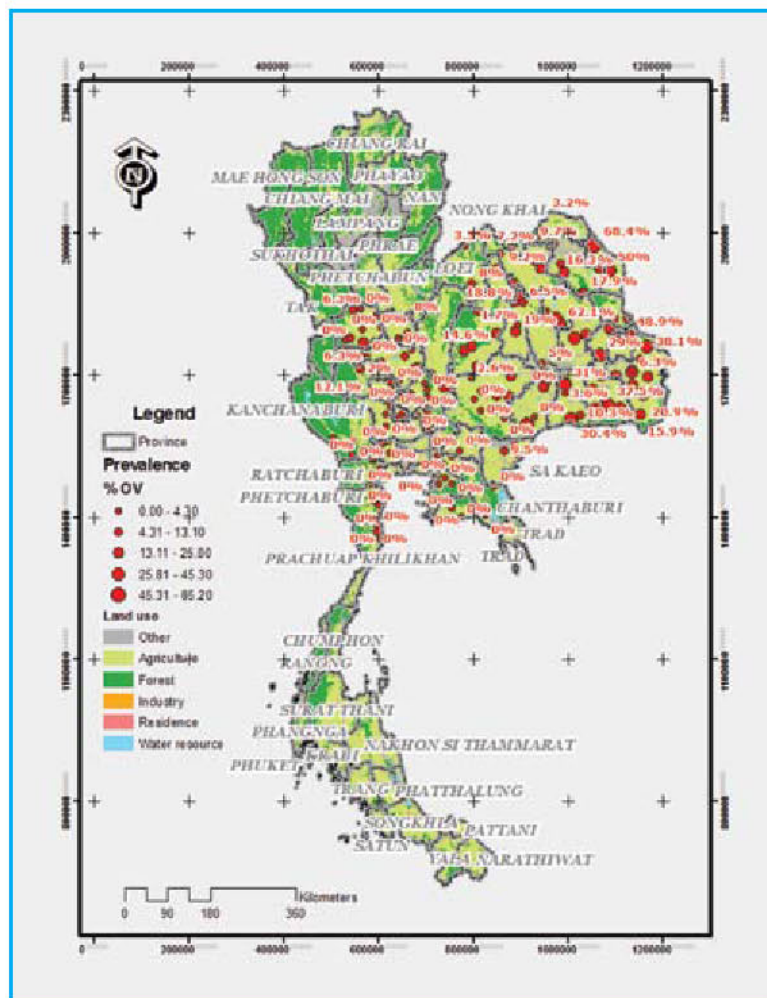


Figure 2: Geographic information by land use and mapping of Opisthorchiasis in Thailand

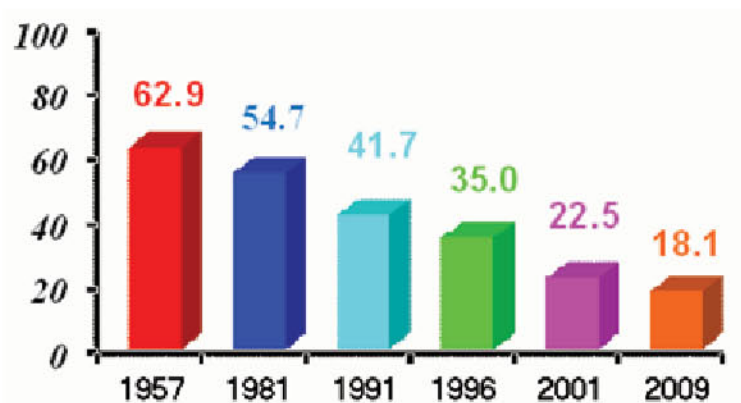


Figure 3: Prevalence rates of helminthiasis in Thailand for the years 1957, 1981, 1991, 1996, 2001 and 2009

Prevalence [%].

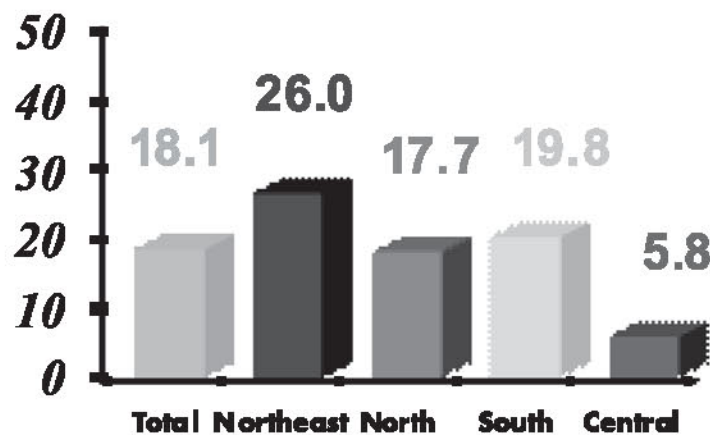


Figure 4: Prevalence rates of helminthiasis in Thailand by region in 2009

### 5. Conclusion and Discussion

The study results showed a high prevalence of liver fluke and hookworm infections associated with geographic information. These results demonstrate that spatial analysis can help to identify patterns of high risk for *O. viverrini*, hookworm and *Strongyloides stercoralis* in order to facilitate a prevention and control program in Thailand. Liver fluke, *O. viverrini* and hookworm infections require similar public health interventions in order to reduce and eliminate their transmission. Although the control programs for *O. viverrini* and hookworm by the Ministry of Public Health have been implemented continuously, these diseases are still widely distributed. The factors influencing the *O. viverrini* and hookworm infection rates may include personal hygiene, levels of parental care, social interactions and parental knowledge of hygiene. These infections can be reduced by motivating individuals in high risk areas to change their habits with regard to: 1. proper cooking of fish, 2. the habit of wearing shoes, and 3. improved knowledge and attitudes about sanitation and waste disposal. People at high risk should therefore be educated on how to protect themselves against the helminthes infections rather than self-treatment with drugs after infection (Dietrich, 1984, Fronberg, 1984 and WHO, 1990). They should also be encouraged to participate in the prevention and control programs in their own communities, in order to make the program successful. Community participation should help to achieve a better quality of life for all Thai people.

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