SPATIAL ANALYSIS OF ENTEROBIASIS INFECTIONS AMONG THAI SCHOOLCHILDREN IN SAMUT PRAKAN PROVINCE, USING A GEOGRAPHIC INFORMATION SYSTEM

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ABSTRACT:

Enterobius vermicularis (Nematoda: Oxyuroidae) is a nematode worm, parasitic in the intestine of humans, and especially infecting schoolchildren in most parts of the world. Infection occurs after ingesting drinks or food contaminated by the eggs and reveals behaviors encouraging exposure. In Samut Prakan province, located south-east of Bangkok metropolitan area, a total of 1,255 schoolchildren from eleven primary schools were drawn by stratified random sampling and tested for the presence of *E. vermicularis* eggs from December 2000 to March 2001. Diagnostic results as well as socioeconomic information about students and their family were integrated into a Geographic Information System (GIS) and spatially interpreted, using SavGIS. Other environmental data, extracted from satellite images by remote sensing, were used for further analysis. Laboratory analysis revealed a 17.5% overall prevalence with 10.5% of the children having a low, 2.6% a moderate, and 4.4% a heavy infection rate. The prevalence of *E. vermicularis* showed geographical heterogeneity with the lowest prevalence in the provincial administrative center. Parents' occupation was significantly correlated with the presence of infection. In conclusion, results of this analysis demonstrate that spatial analysis can help to identify patterns of high risk for oxyuriasis in order to facilitate prevention and control.

KEY WORDS: *Enterobius vermicularis*, pinworm, Geographic Information System, Thailand

1. INTRODUCTION

Enterobius vermicularis, or pinworms, are the most common nematode parasite of humans with a worldwide distribution. Adult pinworms living in the large intestines are highly infectious. Caused by the female pinworm laying her eggs, symptoms are generally mild and consist of perianal itching (Cerva *et al*., 1991) but can also conduct to the invasion of the appendix (Jones, 1988). Eggs become infective a few hours after being deposited and can survive a few days on clothing or bed linens, allowing a person-to-person transmission. An airborn transmission is also possible (Hugot, *et al.,* 1999). High prevalences are usually linked with high population densities and found in overcrowded areas such as slums (Vajarasthira & Harinasuta, 1960; Tepmongkol *et al*., 1980; Mameechai *et al*., 1992) but highest rates of infection are found among schoolchildren (Wahah and Ratanaponglakh, 1992; Nithikathkul, 2000).

In Thailand where a rapid economic development has conducted to major social changes since the eighties, the public health system has been developed with a nation-wide coverage and access for all. In parallel, prevention and control programs dealing with parasitic diseases were implemented. However, in spite of these advances, parasitic diseases still remain a serious health concern. Previous studies of *E. vermicularis* conducted in different provinces in Thailand showed that it is particularly widespread among elementary school-aged children (Table 1).

In order to help parasitic diseases programs, by spatially targeting actions, a geographic information system (GIS) was set up in Samut Prakan province. It integrates remotely sensed environmental data but also demographic and health data to allow a spatial analysis and search for any spatial patterns, which could explain pinworm infections.

Table 1. Previous studies of *E. vermicularis* among elementary school-aged children in Thailand

Location	Infection rate	Reference
Bangkok (Klong Toei slum areas)	53%	Tepmongkol *et al*., 1980
Khon Khaen	50.9%	Kaewkes *et al*., 1983
Bangkok-Nonthaburi	65%	Mameechai *et al*., 1992
Nakhon Pathom (urban area)	38.2%	Wahah & Ratanaponglakh, 1992
Samut Prakan (Bang Phli district)	38.8%	Nithikathkul *et al*., 2001b
Samut Prakan	21.9%	Nithikathkul *et al*., 2001a

2. MATERIALS AND METHODS

2.1 Study area

Samut Prakan province is located to the south of Bangkok, by the side of the Gulf of Thailand, at the mouth of the Chao Phraya river (Figure 2). The western side of the river consists mostly of aquaculture, rice fields and mangrove forests, while the eastern part is mainly urbanized. Some districts are considered part of Bangkok metropolitan area, with industrial estates or residential areas. The province has a coastline of approximately 47.2 kilometers, not oriented toward tourism.

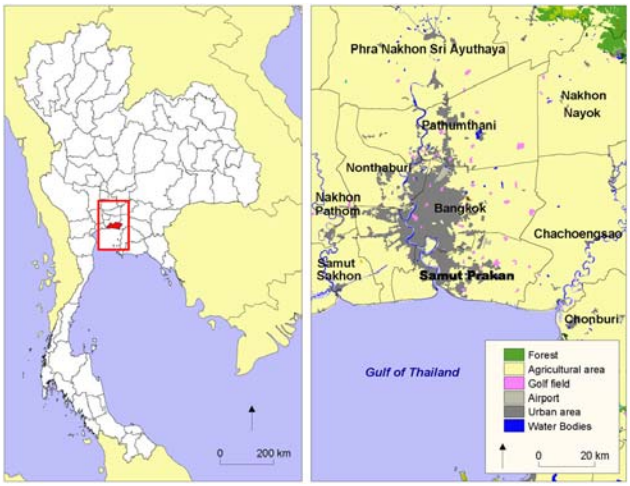

Figure 2: Location of Samut Prakan province in Thailand

Investigations were undertaken in eleven primary schools drawn in five districts of Samut Prakan province: Wat Phraekasa and Phichaisongkram schools in Muang district, Wat Saunsom, Wat Laeam and Suksawad schools in Phra Pradaeng district, Phra Samut Chedi and Wat Yai schools in Phra Samut Chedi district, Wat Bang Phli Yai Nai and Klong Paladpliang schools in Bang Phli district, Wat Banrakard and Klong Kanya schools in Bang Bo district (Figure 3).

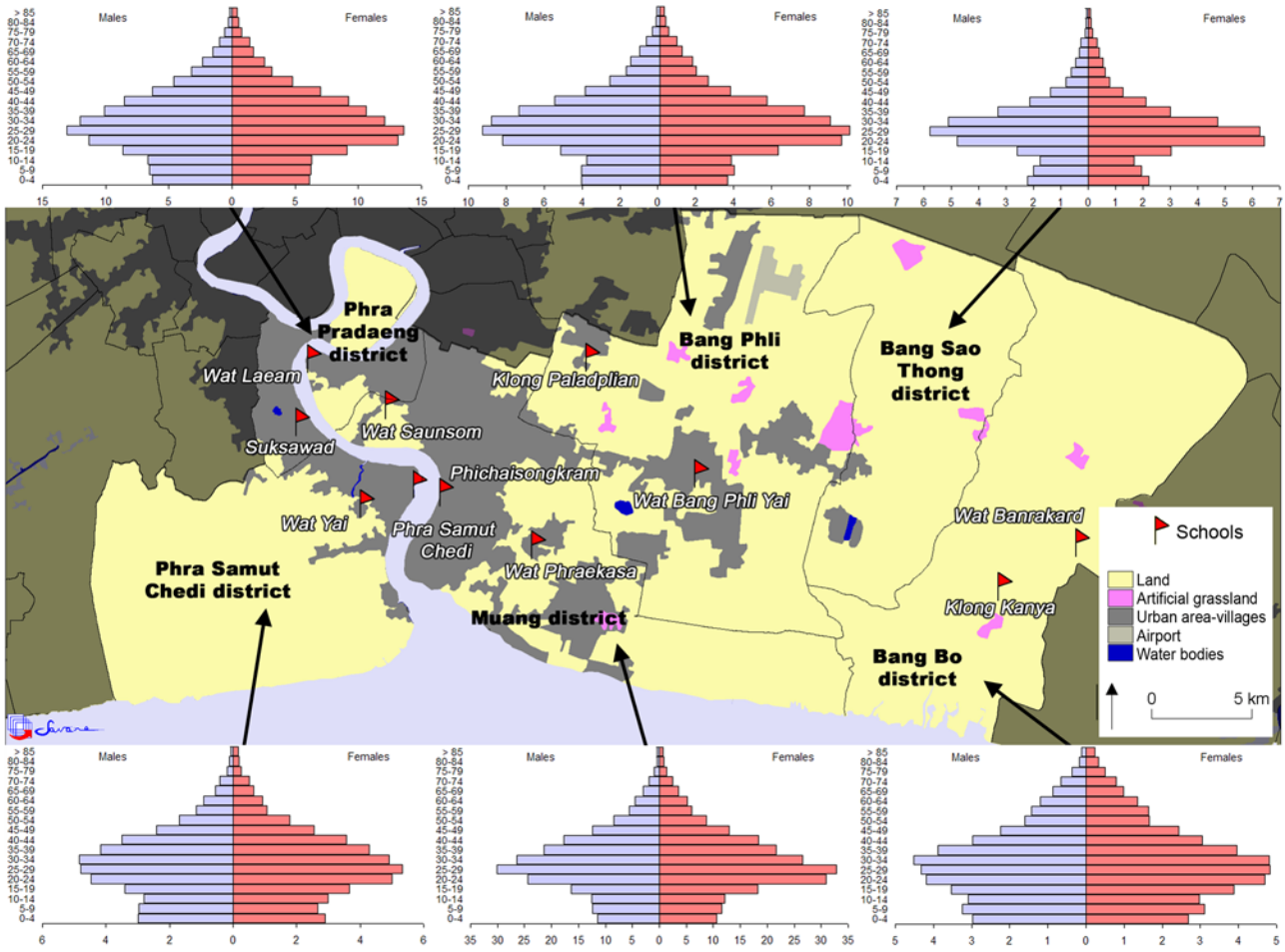

Figure 3: Age pyramids in each district of Samut Prakan province (in thousands), and location of the school investigated.

Bang Sao Thong district, established in 1993 as a residential area for high-income families was not part of the survey.

2.2 Population

Samut Prakan province is densely populated (1,024 inhabitants/sq. km.) with Muang Samut Prakan district, the capital district having the highest population of all districts in Thailand. Population structure is very unusual expressing the multiple identities of Samut Prakan inhabitants. Age pyramids show a general diamond-shape drawn by the high percentage of active people in the population (Figure 3). There are really few elders indicating that settlements are recent, resulting from immigrations from rural provinces. It is highlighted in Bang Phli district where industrial areas have attracted worker classes, living in dormitories, near the factories. Bang Bo district, to the east of the province, is more agricultural with older settlement and a more equilibrated pyramid. Muang, Phra Pradaeng and Phra Samut Chedi appear in the continuity of Bangkok, with an urban structure.

2.3 Data collection

In each of the eleven sampled primary schools, a target of at least 100 schoolchildren was randomly selected (about 10% of the total students in each school). A total of 1,255 students, 661 males and 594 females, aged between six and ten years, were included in the study. Examination took place in each school, as soon as children reached school, without bathing in the morning. The transparent tape technique (a two by six centimeter rectangle) was used to collect *E. vermicularis* eggs on the perianal skin. Slides were examined under the light microscope in laboratory. Different level of infections were defined regarding the number of eggs: a low infection level under 50 eggs, a medium infection level between 51 and 100 eggs, and a high infection level over 100 eggs.

In addition, a questionnaire was filled by each family to inform about the children personal data and the parental socioeconomic status (i.e. parents' occupations, education and income).

2.4 GIS project

A GIS database for the study of pinworms was implemented using *SavGIS*©, a GIS freeware developed by the IRD (French Development Research Institute).

A land use map of Samut Prakan province, realized by the Royal Forestry Department, was derived from a mosaic of Landsat V TM images from 2000. It mainly discriminates agricultural areas from urban areas, and other man-made land uses (Figure 3). Geographic coordinates of each school were determined with a Global Positioning System. The generated georeferenced database was overlaid on the digitized state coverage of remotely sensed satellite sensor environmental data.

3. RESULTS

3.1 Infection rates

Of the 1,255 schoolchildren, 17.5% were infected with *E. vermicularis*. Boys exhibited a very slightly higher rate of infection (18.2% for males and 16.8% for females) but there were no significant statistical difference (student t-test, $\rho<0.9$), indicating that exposure is similar for boys and girls but probably dependant on the family hygiene or social environment.

The highest infection rates were found in the children of agricultural workers (24%), followed in decreasing order by industrial workers (19.9%), private workers (16.6%), unemployed people (11.3%) and the children of government workers (5.7%). A positive significant correlation was found between the total infection rate and the percentage of children from working class families (employees) and negative significant correlations with children from private and government sectors families (Table 4).

Table 4. Correlation coefficient between Total infection rate and occupation of families (in % of total)

Occupation	Unemployed	Farmers	Labor	Private	Government
Correlation coefficient	-0.41	0.35	0.66*	-0.62*	-0.63*

* marked correlations are significant ($\rho<0.05$)

Multiple regression analysis shows that the percentage of industrial workers and agricultural workers are the best predictor of pinworm infections but it is not statistically significant. No significant correlation was found between the total infection rate and income of families, but nevertheless a trend can be observed in the coefficient correlation values (Table 5).

Table 5. Correlation coefficient between Total infection rate and occupation of families (in % of total)

Income	0-5,000	5,000-10,000	10,000-20,000	> 20,000
Correlation coefficient	0.39	0.03	-0.25	-0.47

Correlation is positive under a 5,000 bahts monthly income, nil for average incomes and negative for high incomes. The correlation coefficient is decreasing from low incomes to high incomes, showing a positive effect of higher incomes in lowering infections.

3.2 Spatial distribution

Families living from agriculture are mostly in Bang Bo district where Wat Banrakard and Klong Kanya schools recorded high rates of pinworm infections (Figure 6).

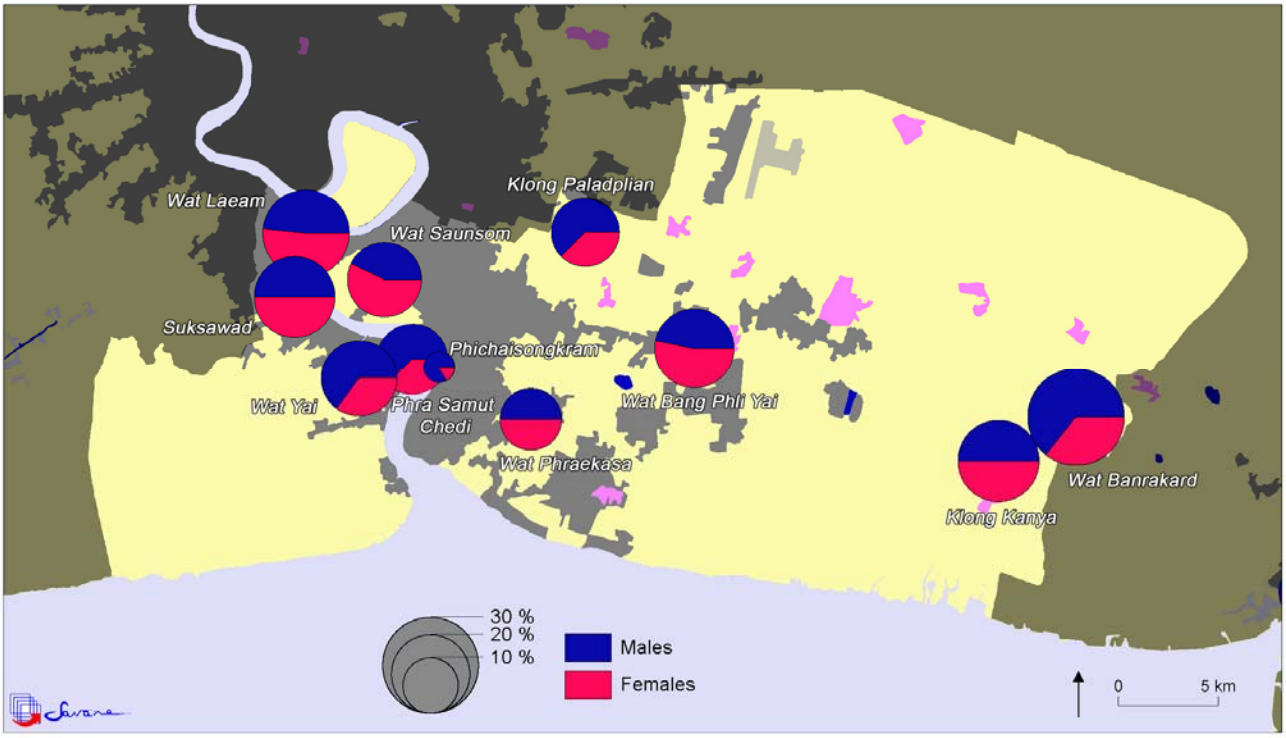

Figure 6: Total oxyuriasis infection rate (%) and sex distribution by school

Schoolchildren come from small villages, and are likely to play in gardens or fields. Exposure is then related with the agricultural environment. In Phra Pradaeng and Phra Samut Chedi districts, in the western part of the province, where high prevalences were recorded, over 80% of schoolchildren parents are living from industries. The lowest prevalences were found in Phichisongkram School in the heart of the city Muang Samut Prakan. Only 44% of schoolchildren's families are industrial workers, while 30% are government workers and 20% private workers.

4. DISCUSSION

Factors influencing the infection rate may include personal hygiene, levels of parental care, social interactions at school, and teacher knowledge of and attention to hygiene. Positive students from low income families and younger students exhibited a slightly higher rate of the infection. Infections seem to be linked with parental occupation. Health care and hygiene can be potentially related to the income and acting in the infection rate.

Considering that the infection rates are linked to the occupation of families, the spatial distinction between rural areas, urban areas and industrial estates, with remotely sensed images allows to focus on different kind of exposure for children. The use of high resolution images would help to delineate industrial estates, residential areas and distance between houses and places of work.

The season of the year may also affect infection rates due to climatic and weather factors such as humidity and temperature. These factors could potentially affect the infection rate of *E. vermicularis*. These concerns might be studied in a dynamic spatial analysis.

These investigations focus on six to ten-year-old children with the highest infection rates in six- to seven-year-old children, while earlier studies (Tepmongkol, 1980; Nithikathkul, 2001b) found the highest prevalences to be in eight to nine-year-old children. Either social or environmental factors could account for the discrepancy between studies. Further studies may investigate people younger than six years old.

5. CONCLUSION

This work is a first step in the use of space technologies to understand spatial patterns of pinworm infections. More data are needed on hygiene conditions and demographic environment around each school investigated. However a spatial approach is needed early to plan field work and for a comprehensive implementation of programs for the prevention and control of pinworm infections and thus decrease the prevalence of *E. vermicularis*.

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