Soil Contamination and Infections by Soil-transmitted Helminths in an Endemic Village in Southern Thailand.

Virasakdi Chongsuvivatwong*

Shoji Uga**

Wandee Nagnaen***

* Epidemiology, Faculty of Medicine, Prince of Songkla University, Hat Yai, 90112, Thailand, fax number 66-74-212900, e-mail: cvirasak@ratree.psu.ac.th

** Department of Medical Zoology, Faculty of Medicine, Kobe University, Japan

*** Graduate student, Faculty of Environmental Management, Prince of Songkla University, Thailand.

Running title: Soil contamination and helminthic infections

Suggested key words: Soil-transmitted helminth, soil contamination, contamination infection correlation.

Summary

The aim of this study was to test the association between soil contamination and infection of the household members by soil-transmitted helminths in dry and rainy seasons.

A lake-side community in southern Thailand with a population of 2340 was studied twice, in the dry season and rainy season of 1995. Fifty households were randomly selected. Soil samples near the latrine, in the yard, at the foot-washing area and under the trees were taken and analysed for presence of helminthic eggs. All members of the selected household were interviewed and stool samples obtained.

Age-adjusted odds ratios of presence of Ascaris and Trichuris eggs in the household soil for ascariasis and trichuriasis were 10.5 (95% CI 1.5-77.1) and 5.5 (95% CI 2.4-12.7) in dry season and 10.4 (95% CI 2.5-43.8) and 8.3 (95% CI 3.4-20.0) in rainy season. The levels of hookworm eggs detected in the soil were too low to test the association.

Soil analysis for eggs of Ascaris and Trichuris may be used to predict infections among the household members but not that for hookworm.

Introduction

Southern Thailand has been known for its high prevalence of soil-transmitted helminths compared to other parts of the country (Vacharasathira and Harinasutha, 1957; Preuksaraj et al,1982; Jaranasri et al,1990). Despite an intensive control program started in 1990, the prevalence remains high. The pitfalls in control were lack of proper health education and program management (Chongsuvivatwong et al,1994). In addition, a recent study showed that within the village, risk for hookworm infection is not associated with status of use of latrine, but with status of shoe wearing (Chongsuvivatwong et al,1996). Thus, studies on soil contamination are needed to gain better understanding of infection in the population.

The objectives of current study were to document the level of contamination of helminthic eggs in the soil around the houses in the endemic villages in dry season and rainy season and to determine the level of association between such contamination and the specific infections. As obtaining soil sample is more convenient than obtaining stool specimen from the villagers, if the association is strong enough, in the future, assessment of soil contamination may be used to partially replace or to supplement study of stool samples.

Materials and Methods

Study Community

A village in Pattalung Province which had been shown to have high prevalence of soil-transmitted helminthic infection in the latest survey was chosen. It is situated on the west coast of Songkla Lake, which is fresh water. There were 426 families with a population of 2340, a mixture of Muslim and Buddhists. Major occupations are labour, fishing, farming and petty trading. Rainy season is between July and January. The remaining months are relatively dry. The total rainfall in the year of study was 2357.7 mm. The average temperature at soil level is 28.6 degree Celsius.

Sampling technique and data collection

Fifty households were randomly selected. The selected houses were visited twice, first in April 1995, representing dry season, and again in October 1995, representing rainy seasons. In each season, duplicate soil specimens were collected from four sites in the household, viz. around the latrine, from the foot-washing area (at the entrance of the house), from the yard and from a shaded area under trees in the yard. At each site, approximately 200 g of top soil (less than 3 cm depth, in an area of approximately 1 square foot) was dug up, put into a labelled polyethylene bag and carried to the laboratory on the same day. In separate visits in both seasons, each member of the family was requested to hand in a stool specimen in a container provided by the research team.

Laboratory work

The method for analysis of the soil sample followed a previous report (Uga et al,1993). Briefly, the soil specimen was dried overnight at room temperature and sifted through sieves of 150 micron mesh. About 2 g powdered sand was suspended in about 8 ml sucrose solution with a specific gravity of 1.200 and centrifuged at 200 x g for 10 min. The tube was then filled to the brim with sucrose solution so that only a small bubble would form under a cover-slip placed on the tube. After the final centrifugation at 25 x g for 5 min., the cover-slip was removed onto a microscopic slide and examined for eggs. By this method, 200 g of soil can be examined at one time. The recovery rate efficiency has been reported at a level of 48 percent.

Stool specimens were examined by microscopy using modified Kato's thick smear technique (Kato and Miura, 1954).

Statistical analysis

Descriptive statistics and cross-tabulation were mainly used. Logistic regression (Breslow and Day, 1980) was used for multivariate analysis. The data from the two seasons were modelled separately. Specific infection status was taken as the outcome. The main independent variable was soil contamination in the household. Adjustment for age was made since it was shown to be major determinant of defecation behaviour. Computation for exact odds ratio was performed when the prevalence of exposure or outcome was too small for the regression.

Results

Not all of the 50 houses could provide soil specimens from all 4 sites. For example, in the dry season, 44 houses had latrines, 15 of which were inside houses paved with cement. Four latrines outside the houses were also surrounded with cement, leaving 25 houses eligible for analysis of soil surrounding the latrine. In the rainy season, two more houses had constructed latrines. The numbers of houses studied on soil contamination at each site are listed in Table 1.

Total number of subjects in the sample household was 248. After excluding infants under 2 years old, the total number of subjects who handed in stool samples in both seasons was 133. The reasons for non-response were not quantified, but the major reason was that the subjects had to leave the village early in the morning for work in the city.

Trichuris egg was the most common helminthic egg found in soil specimens. The yard was the most common place to find helminthic eggs, followed by foot-washing area and around the latrine. No egg could be detected from soil samples obtained from the shade under the tree. There are no significant differences in the rates between dry season and rainy season in any of the places.

Prevalence rates of ascariasis, trichuriasis and hookworm infection were 4, 50 and 44 percent, respectively, in the dry season. These rates increased to 8, 59 and 59 percent, respectively, in the rainy season. Changing of individual infection status is shown in Table 2.

The middle two columns of Table 2 give the numbers of subjects who changed infection status. The outer two columns are numbers of subjects who did not change status. Among those who changed status, the number which converted from negative to positive is significantly higher than the reverse in trichuriasis and hookworm infection but not in ascariasis.

The association between the infection of particular helminths and the presence of the eggs at each place is shown in Table 3.

Status of soil contamination with Ascaris and Trichuris eggs in the house is a strong predictor for specific helminthic infections among the household member. Age-adjusted odds ratios for ascariasis (10.5 in dry season and 10.4 in rainy season) and those for trichuriasis (5.5 in dry season and 8.3 in rainy season) were statistically significant. The prevalence of hookworm eggs in the soil sample was too low to test the association with hookworm infection.

Discussion

In summary, the prevalence rate of soil contamination and infection of soil-transmitted helminths in the study area was high. The presence of Ascaris and Trichuris egg in the house vicinity was strongly and moderately associated with infection of the household member. But the soil analysis technique was not sensitive enough to detect contamination of hookworm larva.

Despite the fact that 44 of the 50 houses had a latrine, the prevalence rate of infection was still high. The number of infected persons increased in the rainy season in spite of increasing latrine coverage. This suggests that availability of latrine in the study area neither adequately prevented soil contamination around the house nor adequately prevented the individual members from infection.

In both seasons, a consistent association between infection and soil contamination was found in ascariasis and trichuriasis, but not in hookworm infection. The 95 percent confidence interval for ascariasis was wide due to relatively low prevalence of infection. Although the associations are strong and statistically significant, the associations could not be used to define the exact direction of causal relation. In one direction, an infected resident may pass the helminthic eggs and contaminate the soil. In the opposite direction, contamination of helminthic eggs in the soil may increase the risk of infection among the residents.

Inconsistency between a rise in prevalence of infection and no rise in prevalence of soil contamination was found in hookworm infection.

This can be explained by current low detection rates. In contrast to a previous study in West Bengal (Hominick et al,1987) where hookworm larvae were harvested from soil at the defecation site, we have rather low recovery of the larvae in our study. This difference may be explained by the fact that the places where we collected the soil samples were far from the defecation sites than those in the previous study.

Many previous studies have tried to measure the level of contamination of helminthic eggs in soil (Dada, 1979; Dada and Lindquist, 1979; Quinn et al,1980; Nunes et al,1994), but to our knowledge, the current study is the first to report on the association between soil contamination and infection with human nematodes.

Soil contamination with helminthic eggs in the house vicinity of the study sample was an important problem in the study area. Status of soil contamination with Ascaris and Trichuris may predict infection status of the resident and thus could be a useful tool in evaluation of the helminthic control programme. Soil survey might be more feasible than stool survey in a situation where villagers are mobile and less co-operative. However, this technique is not useful for studying hookworm problems. Further research and development of assessment of hookworm contamination in the soil are needed.

Acknowledgement

This project was partially supported by the Ministry of Education, Japan and Thailand Research Fund.

Table 1. Number of houses found to have helminthic eggs in the dry season and rainy season.

	Near latrine	Foot-washing area	Yard	Tree shade	Any of the four places
Dry season (n)	25	47	48	44	
Ascaris	0	2	6	0	6
Trichuris	1	7	10	0	14
Hookworm	1	0	0	0	1
Any helminth	2	8	12	0	17
Rainy season (n)	27	47	48	44	
Ascaris	2	3	8	0	10
Trichuris	2	6	15	0	19
Hookworm	0	0	1	0	1
Any helminth	3	6	18	0	21

Table 2. Change of infection status from dry season to rainy season among the study subjects

Infection in Dry season	Yes		No		P value*
Infection in rainy season	Yes	No	Yes	No	
Trichuriasis	63	3	16	51	0.0044
Ascariasis	3	2	7	121	0.1797
Hookworm infection	57	2	22	52	<0.0001

* 2-tailed sign test

Table 3. Association between specific infection and soil contamination in the household.

Presence of eggs in soil specimen	yes		no		
Infection of the individuals	yes	no	yes	no	Adjusted OR @ * (95% CI)
Dry season					
Trichuris	32	10	33	57	5.50(2.39-12.68)
Ascaris	3	13	2	115	10.55(1.50-74.14)
Hookworm	0	2	59	72	(0-6.67)**
Rainy season					
Trichuris	46	8	33	46	8.28(3.42-20.06)
Ascaris	7	23	3	100	10.45(2.49-43.84)
Hookworm	3	0	76	54	(0.28-infinity)**

@ having soil contaminated with specific helminthic egg v. otherwise

* Odds ratio adjusted for age of the subjects in ascariasis and trichuriasis computed by logistic regression.

** Point estimate of the odds ratio could not be defined due to zero value in one cell. 95% CI was computed by exact method.

References

Breslow NE, Day NE. ; Davis W, editors. *Statistical Methods in Cancer Research. Vol 1 - The Analysis of Case-control Studies.* Lyon: International Agency for Research on Cancer, 1980; 6, Logistic Regression for Large Strata. p. 192-249.

Chongsuvivatwong V, Pas-Ong S, Ngoathammatasna W, McNeil D, Vithsupakorn K, Bridhikitti V, Jongsuksuntigul P, Jeradit C. Evaluation of hookworm control program in southern Thailand. *Southeast Asian J Trop Med Public Health* 1994;25:745-51.

Chongsuvivatwong V, Pas-Ong S, McNeil D, Geater A, Duerawee M. Predictors for the risk of hookworm infection: experience from endemic villages in southern Thailand. *Trans R Soc Trop Med Hyg* 1996;90:630-3.

Dada BJ. A new technique for the recovery of Toxocara eggs from soil. *J Helminthol* 1979;53:141-4.

Dada BJ, Lindquist WD. Studies on flotation techniques for the recovery of helminth eggs from soil and the prevalence of eggs of Toxocara spp in some Kansas public places. *J Am Vet Med Assoc* 1979;174:1208-10.

Hominick WM, Dean CG, Schad GA. Population biology of hookworms in west Bengal: analysis of numbers of infective larvae recovered from damp pads applied to the soil surface at defaecation sites. *Trans R Soc Trop Med Hyg* 1987;81:978-86.

Jaranasri U, Jongsuksuntigul P, Jeradit C. A survey on helminthic infection in Southern Thailand in 1989. *Journal of Communicable Diseases* 1990;15:391-404.

Kato K, Miura M. Comparative examination (abstract). *Japanese Journal of Parasitology* 1954;3:35

Nunes CM, Sinhorini IL, Ogassawara S. Influence of soil texture in the recovery of Toxocara canis eggs by a flotation method. *Vet Parasitol* 1994;53:269-74.

Preuksaraj S, Jeradit C, Sthitthai A, Sidolrasmi S, Kijwannee S. Prevalence rate and intensity of intestinal helminthic infections in rural Thailand. *Journal of Communicable Diseases (in Thai)* 1982;8:245-69.

Quinn R, Smith HV, Bruce RG, Girdwood RW. Studies on the incidence of Toxocara and Toxascaris spp. ova in the environment. 1. A comparison of flotation procedures for recovering Toxocara spp. ova from soil. *J Hyg (Lond)* 1980;84:83-9.

Uga S, Matsumura T, Tozuka S, Kida T, Kataoka N. Method for the recovery of Toxocara eggs from sand pits. *Journal of Medical Technology (in Japanese)* 1993;37:685-8.

Vacharasathira S, Harinasutha C. A study of helminthic infections in Thailand. *Journal of Medical Association of Thailand* 1957;40:309-39.