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High latrine coverage is not reducing the prevalence of soil-transmitted helminthiasis in Hoa Binh province, Vietnam

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Summary

Baseline epidemiological survey for parasite infections was conducted with 155 villagers in a rural commune in Hoa Binh province, Vietnam. The prevalence of *A. lumbricoides*, *T. trichiura* and hookworm infection was 13.5%, 45.2% and 58.1%, respectively. 72.3% of the samples detected at least one of the parasites. We found no association between the infection with *A. lumbricoides* or *T. trichiura* and engagement in agriculture, while hookworm infection was more prevalent in population having a frequent contact with soil. Agricultural use of nightsoil was not correlated with any of the infections. We suggest that the consumption of vegetables fertilized with human nightsoil, rather than direct reuse of nightsoil, led to contamination of crops and the subsequent high infection rates with *A. lumbricoides* and *T. trichiura*. This also explains the high infection prevalence despite high latrine coverage (98.1%) in the study population: presence of latrines alone is not sufficient to reduce the prevalence in a rural agricultural community if fresh nightsoil is used as fertilizer.

Keywords

Ascaris lumbricoides; *Trichuris trichiura*; Hookworm; latrine; Vietnam

Introduction

Parasitic infection poses a major public burden in many tropical countries (Crompton and Savioli, 2006; Montresor, 2007). Parasites of high prevalence are soil-transmitted helminths such as *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms. In Vietnam, of a total population of approximately 80 million, over 33 million are estimated to be infected with *A. lumbricoides*, 17 million with *T. trichiura*, and 21 million with hookworms (van der Hoek et al., 2003). Eggs of soil-transmitted helminths are passed into the environment from the gut of an infected person as excreta and reach the soil where they develop into an infective stage. Human infection with *A. lumbricoides* and *T. trichiura* occurs when the infective eggs are

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ingested with soil or vegetables, while hookworm infection occurs through dermal penetration of infective hookworm eggs in soil. A peak of infection intensity with *A. lumbricoides* and *T. trichiura*, is typically observed in school-aged children (Needham et al., 1998; Bundy et al., 1987; Elkins et al., 1986). Due to the associated morbidity of this group, epidemiological studies and control efforts are often focused on this group (Olsen et al., 2006). However, in many developing countries including Vietnam where human feces (nightsoil) is traditionally used as fertilizer in agriculture, a high prevalence of soil-transmitted helminth infection through consumption of vegetables grown in such lands or occupational contact with contaminated soil is expected not only among children but also among the rest of the population (van der Hoek et al., 2003; Olsen et al., 2006). In Vietnam, the common habit of eating fresh salads might further favour transmission of soil-transmitted helminths. This study was undertaken to examine the prevalence and intensity of infection with soil-transmitted helminths in a rural community in northern Vietnam, and to investigate the association between the infection and potential risk factors, namely engagement in agriculture, use of nightsoil in agriculture and absence of sanitation.

Materials and Methods

Data collection

Study was conducted between December 2007 and January 2008 in Tien Xuan commune, Luong Son district, Hoa Binh province, Vietnam. Hoa Binh province is located 74km southwest of Hanoi with population of 744,000. Meetings were held with commune leaders, local doctors and health staffs of the commune health center to gain acceptance of the study. 200 residents of two hamlets in Tien Xuan commune, namely Dong Cao and Go Choi, were randomly selected from the list of the commune residents. Selected individuals were visited by local health staffs and field staffs of the National Institute of Malariology, Parasitology and Entomology (NIMPE) for questionnaire survey to gather information on age, gender, occupation, presence and types of latrines at home, and use of animal manure and nightsoil in agriculture if engaged in agriculture. Each study participant was given a container labelled with the participant's name for collection of stool samples. Stool samples were collected by local health staffs 3 days after the distribution of the containers. Collected samples were immediately transported to NIMPE for parasitological examination. After the stool examination, all the village inhabitants received treatment with albendazole 400 mg.

Parasitological examination of stool samples

Kato-Katz technique was employed for enumeration of eggs of helminths, namely *A. lumbricoides*, *T. trichiura*, and hookworm. Two slides were prepared from each stool samples. Eggs were counted from each slide and the mean eggs per gram feces (epg) were determined. Parasite-positive individuals were grouped into three categories (light, moderate and heavy infections) according to WHO (2002).

Data analysis

Data were entered into Excel 2000 (Microsoft, USA) and subjected to statistical analysis using Epi Info 3.3.2 (CDC, Atlanta, GA, USA). The prevalence and intensity of infection as measured by epg were calculated for each parasite species. The study participants were

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subdivided into six age groups: (1) < 16 years; (2) 16 – 29 years; (3) 30 – 39 years; (4) 40 – 49 years; (5) 50 – 59 years; and (6) > 59 years. Associations between infection intensity and risk factors were analyzed by Kruskal-Wallis test, while the relationships between the prevalence and risk factors were analyzed using chi square test. The followings were included as potential risk factors: gender, age, occupation (agriculture, non-agriculture), availability of latrines at home, use of animal manure in agriculture, and use of nightsoil in agriculture. Significance level of 95% was applied where appropriate.

Ethical approval

The study protocol was approved by the authority of Hoa Binh Provincial Department of Health and the Luong Son District Department of Health. Informed consent was sought from staffs of the local health center in Tien Xuan community and each study participant.

Results

Profile of study population

Stool samples were collected from 155 residents (55 households) of the study area. The profile of the study participants is shown in Table 1. Gender distribution was even with 74 males (47.7%) and 81 females (52.3%). The study participants included 101 people (65.2%) engaged in agriculture and 37 students (23.9%) below secondary school.

Presence and use of latrines

152 study participants out of 155 (98.1%) had latrines at home. The typical latrines used in the community were pit latrines (78.7%) and double vault latrines (9.7%). A pit latrine has a pit below the latrine, while a double vault latrine has 2 pits below the latrine. In both cases, the pits are used for depositing nightsoil. The pit has an access door from which residents insert straws to mix with nightsoil and every 4 to 6 months take them out to reuse in agriculture as fertilizer. Urine is discharged through a separate pipe into a drain ditch or local canal. Among the agricultural population, 17.4% of the agricultural population reported use of human nightsoil in agriculture. There are 3 households (9.7%) having biogas generators. Biogas generators automatically collect nightsoil from latrines and accumulate for methane gas generation. In this system, residents have no access to the nightsoil for reuse purpose. Incidentally, more than half (54.8%) used animal manure in agriculture.

Prevalence and intensity of helminth infection

Over 70 % of the individuals investigated was positive at least for one STH. Details of the prevalence and intensity of helminth infection among the study population are presented in Table 2.

The prevalence of infection with hookworm increased with age (chi square for trend = 5.47, $p<0.05$) reaching its peak in the oldest age group, while neither of the prevalence of *A. lumbricoides* or *T. trichiura* infection showed a statistically significant trend with age (chi square for trend =0.73, $p>0.05$ for *A. lumbricoides*; chi square for trend = 0.83, $p>0.05$), reaching its peak in 16 – 29 years age group. There was no significant difference by gender in the prevalence of any of the three parasites.

Similar to the prevalence pattern, the intensity of infection with hookworm increased with age ($p<0.05$) reaching its peak in the oldest age group, while those of *A. lumbricoides* and *T. trichiura* infection remained light regardless of age ($p>0.05$ for both *A. lumbricoides* and *T. trichiura*).

Risk factors associated with infection

Neither of infection with *A. lumbricoides* infection or *T. trichiura* was associated with age or agricultural use of nightsoil. On the other hand, the prevalence of hookworm infection was 2 fold higher among the population engaged in agriculture than the non-agricultural population (OR=2.16, $p<0.05$) with 3 fold higher infection intensity ($p<0.01$). None of the infections was associated with agricultural use of nightsoil or animal manure. None of the infections was associated with availability of latrines at home.

Discussion

Our study showed a high endemic level of helminth infection, particularly *T. trichiura* and hookworm, in this rural community. The prevalences of all the three parasite infections were higher than those reported in Thailand (Anantaphruti et al., 2004). The prevalence of *T. trichiura* (45.2%) and hookworm (58.1%) was also higher than those in Laos (Rim et al., 2003). Extensive review on soil-transmitted helminth infection in Vietnam can be found in van der Hoek et al. (2003). Our results were generally comparable with the prevalence in other areas of Vietnam. There was no significant difference by gender in the prevalence of any of the three parasites. This result agrees with those previously documented by Naish et al. (2004), Steinmann et al. (2007) and Ellis et al. (2007).

In our study, we found no association between the infection with *A. lumbricoides* or *T. trichiura* and engagement in agriculture, while hookworm infection was more prevalent in the agricultural population. A possible hypothesis is as follows: hookworm infection occurs through dermal contact with soil or vegetables containing hookworm larvae, and thus agricultural population having a higher contact chance with soil shows higher infection rates than non-agricultural population. On the other hand, infection with *A. lumbricoides* and *T. trichiura* is caused by oral intake of those eggs with soil or vegetables. Vegetables consumed in the study community are mostly cultivated in local farmlands and marketed within the community. Our results might reflect that the villagers were infected with those two parasites through consumption of locally-produced vegetables, rather than directly ingesting soil, regardless of occupation. We also observed no association between age and *A. lumbricoides*/*T. trichiura* infection in contradiction to typical findings elsewhere that a peak of infection with *A. lumbricoides*/*T. trichiura* occurred in school-age group (Needham et al., 1998; Elkins et al., 1986; Brooker et al., 2007; Pritchard et al., 1990, Bradley et al., 1992). More detailed studies on possible contamination of vegetables cultivated in the local farmland as well as the soil are clearly required.

No association was found between the use of nightsoil in agriculture and infection with any of the three parasites. This explained the fact that it is not the manipulation of nightsoil that induce infection but the consumption of vegetables fertilized with nightsoil or wastewater contaminated with nightsoil. We therefore hypothesized that the nightsoil users contaminate

the vegetable and therefore are responsible for the high prevalence of infection in the entire community.

In conclusion, we reported a high prevalence of soil-transmitted helminthiasis despite a coverage of latrines of over 98%. One of the reason is probably the fact that the stools deposited was periodically collected and used in farmlands as fertilizer. An important implication of our findings was that improvement of latrine coverage alone cannot control infection in areas where nightsoil is widely used in agriculture. A need for further studies on appropriate composting duration of nightsoil in pits before reuse that can significantly reduce the capacity of helminth eggs to transmit infection was realized. Testing of the capacity of earthworms to further reduce the number and viability of the helminth eggs in soil and manure was also suggested as one of the simplest and feasible control measures in the local settings.

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Table 1

Profile of the study population in Tien Xuan commune, Luong Son district, Hoa Binh province in Jan. 2008 (n=155)

Factor	Variable	Male		Female		Total	
		n	%	n	%	n	%
Age	<16	13	8.4	12	7.7	25	16.1
	16-29	21	13.5	24	15.5	45	29.0
	30-29	12	7.7	14	9.0	26	16.8
	40-49	15	9.7	13	8.4	28	18.1
	50-59	11	7.1	12	7.7	23	14.8
	>59	2	1.3	6	3.9	8	5.2
	Sub-total	74	47.7	81	52.3	155	100.0
Occupation	Agriculture	49	31.61	52	33.55	101	65.2
	Aquaculture	0	0.00	0	0.00	0	0.0
	Sellers	1	0.65	1	0.65	2	1.3
	Labor	0	0.00	5	3.23	5	3.2
	Office workers	3	1.94	4	2.58	7	4.5
	Students	20	12.90	17	10.97	37	23.9
	Retired	1	0.65	2	1.29	3	1.9
	Sub-total	74	47.7	81	52.3	155	100.0
Toilet at home	Yes	72	97.3	80	98.8	152	98.1
	No	2	2.7	1	1.2	3	1.9
Use of manure in agriculture *	Yes	41	55.4	44	54.3	85	54.8
	No	8	10.8	8	9.9	16	10.3
Use human nightsoil in agriculture *	Yes	12	16.2	15	18.5	27	17.4
	No	37	50.0	37	45.7	74	47.7

*Among the population engaged with agriculture.

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Table 2

Summary of the prevalence and intensity of infection with *A. lumbricoides*, *T. trichiura* and hookworm in Tien Xuan commune, Luong Son district, Hoa Binh province, Vietnam in Jan. 2008. (n=155)

	Case	Prevalence (%)	Intensity					
			Light [a] (%)	Moderate [a] (%)	Heavy [a] (%)	AM [b] (epg)	S.D.	Max (epg)
A. lumbricoides	21	13.5	21 (13.5)	0 (0)	0 (0)	136.3	530.2	3288
T. trichiura	70	45.2	70 (45.2)	0 (0)	0 (0)	95.2	167.9	840
Hookworm	90	58.1	77 (49.7)	9 (5.8)	4 (2.6)	560.4	1177.1	7152
Positive with at least 1 species	112	72.3						
Infection with 3 species	14	9.0	12 (7.7)	2 (0.6)	0 (0)	-	-	-
Infection with 2 species	40	25.8	32 (20.6)	7 (4.5)	1 (0.6)	-	-	-
Infection with 1 specie	58	37.4	55 (35.5)	0 (0)	3 (1.9)	-	-	-

[a] The number of cases classified into each infection intensity class by WHO (2002)

[b] Arithmetic mean egg counts per gram feces

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Table 3

Prevalence of soil-transmitted helminth infection and its association with risk factors in Tien Xuan commune, Luong Son district, Hoa Binh province, Vietnam in Jan. 2008. (n=155)

Factor	n	A. lumbricoides			T. trichiura			Hookworm		
		Case	OR [a]	95% CI [b]	Case	OR [a]	95% CI [b]	Case	OR [a]	95% CI [b]
Gender										
Male	74	8	0.63	0.25 – 1.63	27	0.51	0.27 – 0.97*	40	0.73	0.38 – 1.38
Female	81	13			43			50		
Age										
<16	25	4			10			9	0.34	0.14 – 0.83*
>16	130	17	1.27	0.39 – 4.14	60	0.78	0.33 – 1.86	81		
Occupation										
Agriculture	101	14	1.10	0.41 – 2.86	47	1.17	0.61 – 2.28	64	2.16	1.10 – 4.24*
Others	54	7			23			24		
Latrine at home										
Yes	152	21	–	–	69	1.66	0.15 – 18.73	88	0.69	0.06 – 7.75
No	3	0			1			2		
Use of animal manure in agriculture										
Yes	85	12	1.15	0.23 – 5.71	44	1.52	0.52 – 4.66	57	2.62	0.88 – 7.76
No	16	2			6			7		
Use of nightsoil in agriculture										
Yes	27	1	0.18	0.02 – 1.45	10	0.52	0.24 – 1.45	13	0.42	0.17 – 1.03
No	74	13			37			51		

[a] OR: Odds Ratio

[b] CI: Confidence Interval

Asterisks (*) show statistical significance at the 5% level ($p<0.05$). Since all the study participants engaged in agriculture was above 15 years old, engagement in agriculture was considered as the main risk factor for hookworm infection.

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Table 4

Intensity of soil-transmitted helminth infection and its association with risk factors in Tien Xuan commune, Luong Son district, Hoa Binh province, Vietnam in Jan. 2008. (n=155)

Factor	n	A. lumbricoides			T. trichiura			Hookworm		
		AM epg [a]	S.D. [b]	*P* value [c]	AM epg [a]	S.D. [b]	*P* value [c]	AM epg [a]	S.D. [b]	*P* value [c]
Gender										
Male	74	109.95	431.91	0.35	90.49	186.01	0.09	372.32	837.22	0.16
Female	81	160.30	608.06		99.56	150.46		732.15	1401.72	
Age										
<16	25	195.84	612.54	0.68	75.84	150.63	0.51	162.24	401.67	< 0.01
>16	130	124.80	514.77		98.95	171.28		636.92	1259.89	
Occupation										
Agriculture	101	100.89	424.78	0.82	95.05	174.41	0.74	215.11	427.09	< 0.01 *
Others	54	155.17	579.89		95.56	165.16		744.95	1392.18	
Latrine at home										
Yes	152	138.95	535.11	0.82	96.79	169.13	0.46	548.05	1171.37	0.37
No	3	0	0		16.00	27.71		1184.00	1578.41	
Use of animal manure in agriculture										
Yes	85	158.12	606.12	0.89	91.20	151.01	0.70	801.32	1454.67	0.12
No	16	139.50	429.17		115.50	231.57		445.50	978.50	
Use of nightsoil in agriculture										
Yes	27	93.33	484.97	0.09	114.67	194.10	0.74	668.44	1577.91	0.08
No	74	177.73	612.33		87.89	154.13		772.86	1328.64	

[a] Arithmetic mean egg counts per gram feces.

[b] S.D. : Standard Deviation

[c] *P* values from univariate analysis for each risk factor.

* Since all the study participants engaged in agriculture was above 15 years old, engagement in agriculture was considered as the main risk factor for high hookworm infection intensity.