

Active screening of gastrointestinal helminth infection in migrant workers in Thailand

Journal of International Medical Research

2018, Vol. 46(11) 4560–4568

© The Author(s) 2018

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/0300060518786911

journals.sagepub.com/home/imr



Soraya J Kaewpitoon^{1,2}, Wararat Sangwalee^{1,3},
Jirawoot Kujapun^{1,4}, Jun Norkaew^{1,3},
Jirayut Chuatanam^{1,3}, Sukanya Ponphimai¹,
Wasugree Chavengkun^{1,3},
Natnapa Padchasuwan^{1,5},
Thirayu Meererksom¹, Taweesak Tongtawee¹,
Likit Matrakool¹, Sukij Panpimanmas¹,
Parichart Wakkhuwatapong¹ and
Natthawut Kaewpitoon¹

Abstract

Objective: This study aimed to detect gastrointestinal helminth infection in migrant workers in Thailand.

Methods: A cross-sectional survey study was conducted in 403 migrant workers in the factories of Nakhon Ratchasima Province, northeastern Thailand during October 2016 to June 2017. Gastrointestinal helminth infections were detected by the formalin ether acetate concentration technique and microscopy. The data were analyzed using the χ^2 -test and logistic regression.

Results: The rate of gastrointestinal helminth infection was 24.07%. The most common species involved in infection was *Opisthorchis viverrini* (11.91%), followed by hookworm (5.46%), *Trichuris trichiura* (5.21%), *Strongyloides stercoralis* (0.5%), *Ascaris lumbricoides* (0.5%), and *Taenia* spp. (0.5%). The majority of infections were found in men aged ≥ 40 years, married participants, uneducated

¹Parasitic Disease Research Center, Suranaree University of Technology, Nakhon Ratchasima, Thailand

²Family Medicine and Community Medicine, Institute of Medicine, Suranaree University of Technology, Nakhon Ratchasima, Thailand

³Faculty of Public Health, Vongchavalitkul University, Nakhon Ratchasima, Thailand

⁴Faculty of Liberal Arts and Science, Roi-Et Rajabhat University, Roi-Et, Thailand

⁵Faculty of Public Health, Khon Kaen University, Khon Kaen, Thailand

Corresponding author:

Soraya J Kaewpitoon, Parasitic Disease Research Center, Suranaree University of Technology, No. 111 University Avenue, Nakhon Ratchasima 30000, Thailand.
Email: Soraya.k@sut.ac.th



participants, laborers, those who worked for 1 year, and those who had an income of 9000 to 12,000 THB.

Conclusions: Gastrointestinal helminth infection is still found in migrant workers. Therefore, active surveillance is required in this large group for investigating and eradicating this type of infection.

Keywords

Gastrointestinal helminths, migrant worker, Thailand, infection, tropical disease, hookworm

Date received: 12 April 2018; accepted: 24 May 2018

Introduction

Gastrointestinal helminth infections remain a serious health problem worldwide, including in Southeast Asian nations (ASEAN), particularly in Lao People's Democratic Republic (PDR), Cambodia, and Myanmar. The most common gastrointestinal helminth infections are neglected tropical diseases that are associated with approximately 300 million infections in these regions. Among soil-transmitted helminth (STH) infections, 126.7 million people in ASEAN are infected with *Ascaris lumbricoides*, 115.3 million are infected with *Trichuris trichiura*, and 77.0 million have hookworm infections. Additionally, more than 10 million people suffer from either liver or intestinal fluke infections.¹ Liver fluke, including *Opisthorchis viverrini* and *Clonorchis sinensis*, are classified as Group 1 carcinogens by the World Health Organization's International Agency for Research on Cancer.² *O. viverrini* infection is associated with cholangitis, gallstones, hepatomegaly, cholecystitis, and cholangiocarcinoma.³⁻⁸ Infection by these gastrointestinal helminth infections is rarely diagnosed at early exposure and is thus frequently asymptomatic. Persistent and chronic infection can cause severe cancer complications,

particularly cholangiocarcinoma and other gastrointestinal diseases.⁹ Gastrointestinal helminth infection in ASEAN has spread because of increased labor migration among ASEAN Economic Community countries (Lao PDR, Thailand, Myanmar, Vietnam, and Cambodia) as a result of an open borders policy that was started in 2015.¹⁰

Therefore, gastrointestinal helminth infection constitutes an important and serious health problem in ASEAN and eradication of the infection is urgently required in these areas. A pilot project was conducted in migrant workers in factories from Nakhon Ratchasima Province, north-eastern Thailand. This study aimed to detect gastrointestinal helminth infections, which included intestinal tapeworms, roundworms, and liver flukes, in migrant workers. We used the formalin ethyl acetate concentration method to detect gastrointestinal helminth infections and then treated the infections and provided health education.

Materials and methods

Ethical considerations

This study was approved by the Ethics Committee for Research Involving Human

Subjects of Suranaree University of Technology, Thailand (EC-59-39). Before participating in the study, all participants provided written informed consent. Permission was granted by the owners of the factories.

Study areas

A cross-sectional survey pilot study was performed in migrant workers in the Nakhon Ratchasima area, which is in the northeast region of Thailand. Nakhon Ratchasima (often called Khorat) is one of the northeast provinces of Thailand. This area is the country's largest province by area (20,494 square kilometers [7,913 square miles]), with a population of approximately 2.7 million (the country's second largest province in terms of the number of people). Nakhon Ratchasima produces approximately 250 billion THB in GDP, which is the highest in the northeast region. Nakhon Ratchasima is 259 kilometers (161 miles) from Bangkok, which is the capital of Thailand. This province is divided into 32 districts, 263 sub-districts, and 3743 villages (Department of Provincial Affairs, 2015).

Study population

There are currently 1,778,964 migrant workers in Thailand. The majority of these workers (approximately 1,563,269 workers) are from Myanmar, Cambodia, and Lao PDR. There were 8,146 migrant workers in Nakhon Ratchasima Province during October 2016 to June 2017. These workers included 4267 in Myanmar, 2670 in Cambodia, and 1209 in Lao PDR (foreigner workers administration office, Thailand, 2017). Participants included 193 among 8,146 who worked in Sung Neon, Khon Buri, and Pak Chong District, Nakhon Ratchasima Province. We further included one fold the amount of

participants for the best representative population ($n = 386$ participants). A further 17 migrant workers were interested in participating in this screening project. Therefore, we asked permission from their employers and then included the workers in the study. Consequently, the total population of this study was 403 migrant workers. Purposive sampling of the participants was according to those who were interested and the factories' permission.

Survey

We used a constructive questionnaire, which included important questions on sociodemographic characteristics and the working period in Thailand. A questionnaire survey was conducted among the participants while we collected their stool samples. All questionnaires were translated to languages used in Myanmar, Cambodia, and Lao PDR. Participants completed the questionnaires by themselves.

Stool sample collection and examination

Stool specimens of all participants were collected in plastic containers (protected transmission) and then transferred to the standard laboratory of the Parasitic Disease Research Center at Suranaree University of Technology. The presence of gastrointestinal helminth eggs, including flukes, tapeworms, and roundworms, was determined by using the formalin ether concentration method.¹¹ Briefly, 1 g of each fecal sample was selected and then fixed with 10% formalin in a 10-mL test tube. The specimen was further processed according to the formalin ethyl acetate method and then examined for gastrointestinal helminth infections. Each specimen was examined under a microscope, and initially screened with a low-power objective lens. Suspected gastrointestinal helminths were subsequently examined under a high-power objective lens

with a microscope. All of the samples were examined by two laboratory technologists from the Parasitic Disease Research Center. Patients who were infected with gastrointestinal helminths and other known parasites were treated with anti-gastrointestinal helminth drugs and also asked to attend health education.

Data analysis

Statistical analyses were performed using SPSS Version 22.0 (IBM Corp., Armonk, NY, USA). The χ^2 test was used for computing differences in infections and characteristics. A P value of <0.05 was considered statistically significant. Unconditional logistic regression was used to analyze the positive rate of eggs and their characteristics.

Results

Among the 403 participants surveyed, 97 (24.07%) were positive for gastrointestinal helminth infections. The highest rate of infection was due to *O. viverrini* (11.91%), followed by hookworm (5.46%), *T. trichiura* (5.21%), *S. Stercoralis* (0.50%), *A. lumbricoides* (0.50%), and *Taenia* spp. (0.50%). Gastrointestinal helminth eggs were found in fecal samples from the 403 participants (Table 1).

The majority of gastrointestinal helminth infections were found in men

(25.0%), those aged ≥ 40 years old (27.0%), those who were uneducated (30.3%), those who were married (23.2%), laborers (21.6%), those who worked for 1 year (37.8%, $P < 0.001$ vs 2–3 years+, χ^2 test), those who had an income of 9000 to 12,000 THB (22.8%), those who worked at factory sites in Pak Chong District (28.6%, $P = 0.003$ vs Sung Neon and Khon Buri Districts, χ^2 test), and those who stayed in private dormitories (25.0%) (Table 2). By nationality, the positive rate of gastrointestinal helminth eggs that were detected in workers from Cambodia was 27.27%, followed by 22.87% in Myanmar, and 22.03% in Lao PDR. Linear regression analysis showed that nationality, sex, age, education, marital status, occupation, and income (THB) were not significantly associated with gastrointestinal helminth infections (Table 3).

Discussion

Poverty and neglected tropical diseases are found in ASEAN.¹ Pullan et al.¹² reported that 126.7, 115.3, and 77.0 million people are infected with *A. lumbricoides*, *T. trichiura*, and hookworm, respectively. An infection with STH can lead to malnutrition in children and older aged people. STH infections may impair cognitive development and growth in children. The present study examined the overall infection rate

Table 1. Gastrointestinal helminth infection in 403 migrant workers in Nakhon Ratchasima Province, Northeastern Thailand.

Nationality	No. of participants	No. of infections (%)	<i>Opisthorchis viverrini</i>	Intestinal helminth infection (no. of infections (%))				
				Hookworm	<i>Trichuris trichiura</i>	<i>Strongyloides stercoralis</i>	<i>Ascaris lumbricoides</i>	<i>Taenia</i> spp.
Myanmar	223	51 (22.87)	8 (3.43)	19 (8.15)	21 (9.01)	1 (0.45)	2 (0.90)	0 (0)
Cambodia	121	33 (27.27)	31 (25.62)	1 (0.83)	0 (0)	1 (0.83)	0 (0)	0 (0)
Lao PDR	59	13 (22.03)	9 (15.25)	2 (3.39)	0 (0)	0 (0)	0 (0)	2 (3.39)
Total	403	97 (24.07)	48 (11.91)	22 (5.46)	21 (5.21)	2 (0.50)	2 (0.50)	2 (0.50)

Table 2. Positive rate of gastrointestinal helminth eggs categorized by general characteristics.

Characteristics	Total	Helminth-negative, n (%)	Helminth-positive, n (%)	χ^2 test	P value
Nationality				2.444	0.299
Myanmar	233	182 (78.11)	51 (22.87)		
Cambodia	121	88 (72.72)	33 (27.27)		
Lao PDR	59	46 (77.97)	13 (22.03)		
Sex				1.12	0.29
Female	287	229 (79.80)	58 (20.20)		
Male	116	87 (75.00)	29 (25.00)		
Age				1.284	0.257
<40 years old	340	270 (79.40)	70 (20.60)		
≥40 years old	63	46 (73.00)	17 (27.00)		
Education				3.995	0.262
Primary school	274	219 (79.90)	55 (20.10)		
Junior secondary school	42	35 (83.30)	7 (16.70)		
Senior secondary school	21	16 (76.20)	5 (23.80)		
Uneducated	66	46 (69.70)	20 (30.30)		
Marital status				2.145	0.143
Single	88	74 (84.10)	14 (15.90)		
Married	315	242 (76.80)	73 (23.20)		
Occupation				0.015	1
Housekeeper	10	8 (80.00)	2 (20.00)		
Laborer	393	308 (78.40)	85 (21.60)		
Working period in Thailand				26.309	0.001
1 year	119	74 (62.20)	45 (37.80)		
2–3 years	114	122 (84.70)	22 (15.30)		
>3 years	140	120 (85.70)	20 (14.30)		
Income (THB)				0.793	0.373
<9000	127	103 (81.10)	24 (18.90)		
9000–12,000	276	213 (77.20)	63 (22.80)		
Factory site (district)				11.403	0.003
Pak Chong District	147	105 (71.40)	42 (28.60)		
Sung Neon	223	179 (80.30)	44 (19.70)		
Khon Buri	33	32 (97.00)	1 (3.00)		
Residency				0.085	0.727
Private dormitory	12	9 (75.00)	3 (25.00)		
Factory accommodation	391	307 (78.50)	84 (21.50)		

among migrant workers in Nakhon Ratchasima Province, Thailand and showed that 24.07% of them were positive for gastrointestinal helminth infections.

The highest rate of infection in our study was *O. viverrini* (11.91%) in the participants. The majority of *O. viverrini* infections were detected in workers from

Cambodia, followed by Lao PDR and Myanmar. Opisthorchiasis has been reported in Cambodia and Lao PDR.^{13–15} *O. viverrini* is commonly found in Lao PDR, particularly in the central and southern areas, and it constitutes a serious health problem. Vonghachack et al.¹³ showed that the infection rate and heavy intensity

Table 3. Factors associated with gastrointestinal helminth infection using logistic regression analysis.

Characteristics	OR	95% confidence interval	P value	OR _{adj}	95% confidence interval	P value
Nationality			0.153			0.338
Myanmar	1			1		
Cambodia	1.46	0.87–2.46		2.08	0.72–5.98	
Lao PDR	0.93	0.45–1.94		1.69	0.58–4.96	
Sex			0.291			0.687
Female	1			1		
Male	1.32	0.79–2.19		1.19	0.59–2.20	
Age			0.259			0.866
<40 years old	1			1		
≥40 years old	1.42	0.77–2.64		1.04	0.53–2.11	
Education			0.567			0.053
Primary/secondary school	1			1		
Uneducated	1.2	0.64–2.23		1.77	0.99–3.59	
Marital status			0.146			0.074
Single	1			1		
Married	1.59	0.85–2.99		1.84	0.94–3.74	
Occupation			0.902			0.791
Housekeeper	1			1		
Laborer	1.1	0.23–5.30		1.16	0.20–8.42	
Income (THB)			0.374			0.587
<9000	1			1		
9000–12,000	0.79	0.47–1.33			0.43–1.60	

OR: odds ratio; OR_{adj}: adjusted odds ratio.

infection rate of *O. viverrini* were 60.7% and 4.2%, respectively. Nakamura¹⁴ reported the present situation of helminthic infections in the capital city, Vientiane, and found that the infection rate was high (54%–59%). In particular, *O. viverrini* infection had the highest rate, ranging from 51% to 53%. Additionally, a field survey in Cambodia with 16,082 stool samples from five provinces showed that 1232 were positive for eggs with *O. viverrini* infection (7.70%). The endemic areas of *O. viverrini* infection include four Cambodian provinces.¹⁵ Moreover, the *O. viverrini* infection rate was 4.6% among 2101 residents along the Mekong River, Kratie Province, Cambodia.¹⁶ In Myanmar, *O. viverrini* infection was first reported in communities from lower

Myanmar by Aung et al.¹⁷ Their stool surveys of rural populations in three regions showed that the positive rate of *Opisthorchis* eggs was 9.30%. Our study is the second report of *O. viverrini* infection in humans from Myanmar, but is the first report on people from Myanmar who migrate to work in Thailand.

Other gastrointestinal helminth eggs were detected in migrant workers in our study, particularly hookworm (5.46%), *T. trichiura* (5.21%), *S. Stercoralis* (0.50%), *A. lumbricoides* (0.50%), and *Taenia* spp. (0.50%). The positive rate of gastrointestinal helminth eggs that were detected was highest in migrant workers from Cambodia, followed by Myanmar and Lao PDR. Gastrointestinal helminth infections in migrant workers included

STHs. Also called geohelminths, STHs are a group of intestinal parasites that belonging to the phylum Nematoda and are transmitted primarily through contaminated soil. STHs are typically from the following families of nematodes: *A. lumbricoides*, *T. trichiura*, hookworms, and *S. stercoralis*. In our study, the infection rate of STHs was 45.50% (47 cases among 403 participants; hookworms, 22 cases; *T. trichiura*, 21 cases; *A. lumbricoides*, 2 cases; and *S. stercoralis*, 2 cases), and migrant workers were infected by one or more helminth (Table 1). The rates of STHs, including hookworm, *T. trichiura*, and *A. lumbricoides* were higher in Myanmar than in Cambodia and Lao PDR. Additionally, a food-borne helminth infection (*Taenia spp.*) was found in migrant workers. Our findings indicate that STH and food-borne helminth infections remain a serious problem and may occur in migrant workers. These infections may further spread to other countries during workers' migration. Sagnuankiat *et al.*¹⁸ examined gastrointestinal helminth infections in 372 migrant children in Samut Sakhon Province, central Thailand. They found that gastrointestinal helminth infections were highly prevalent, with a rate of 71.0%. These infections were identified as *T. trichiura* (50.8%), *Enterobius vermicularis* (25.2%), *A. lumbricoides* (15.3%), hookworm (11.6%), and *Blastocystis hominis* (0.5%). Ngrenngarmert *et al.*¹⁹ investigated gastrointestinal helminth infections in 213 Myanmar migrant workers in Samut Sakhon and Bangkok Provinces, Thailand. The overall prevalence of gastrointestinal helminth infections was 13.6%, including *A. lumbricoides* (3.3%) and *T. trichiura* (2.3%). Nuchprayoon *et al.*²⁰ performed a study of gastrointestinal helminth infections in 284 Myanmar migrants who worked in the Thai food industry in Samut Sakhon Province, Thailand. They found that the gastrointestinal helminth infection rate

was 62.3%, and identified *T. trichiura* (22.2%) and *A. lumbricoides* (1.8%).

Our study showed that characteristics such as nationality, sex, age, education, marital status, occupation, and income were not associated with gastrointestinal helminth infections. Therefore, our demographic data could not explain gastrointestinal helminth infections. The prevalence of parasitic species of *O. viverrini*, hookworm, and *T. trichiura* in Southern Lao PDR has been previously reported.¹³ *O. viverrini* infection appears to be acquired at a young age, and its prevalence gradually increases with age. Hookworm infection is also acquired at a young age. The prevalence of hookworm peaks in adolescents aged 10 to 20 years and plateaus in older age groups in men and women. The prevalence of *T. trichiura* is distributed similarly among men and women independent of age.¹³ The associations of risk factors with *S. stercoralis* were studied in Myanmar and its prevalence did not significantly differ between men and women ($P=0.193$). However, the prevalence of *S. stercoralis* infection significantly increased with age ($P=0.041$).²¹ Occupation and income in our study were not associated with gastrointestinal helminth infections.

Many studies have shown that gastrointestinal helminth infections are neglected tropical diseases and they are recognized as a major public health concern in many low- and middle-income countries in the tropics and sub-tropics, including in Myanmar, Cambodia, and Lao PDR.²²⁻²⁵ STHs are among the most prevalent infections in these three countries. Liver fluke, *O. viverrini*, and *Taenia spp.* are endemic in Thailand, Cambodia, and Lao PDR. Infections with these helminths negatively affect human health and wellbeing. The high gastrointestinal helminth infection rate in this study and previous studies in migrant workers is a serious public health problem. The effect of gastrointestinal

helminth infections on public health is well known. These infections can spread and be transmitted from infected areas to uninfected areas via fecal oral transmission from unclean contaminated water, vegetables, and food.

Conclusions

In conclusion, gastrointestinal helminth infection is common in many migrant workers. To consolidate progress and ascertain long-term sustainability, other control measures, such as active screening on a large scale, treatment, and health education, should be considered for gastrointestinal helminth infection.

Acknowledgements

We are grateful to all of the migrant workers and their companies for participating in this study. The present study was supported by the Suranaree University of Technology Research and Development fund, Suranaree University of Technology, Thailand.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

- Hotez PJ, Bottazzi ME, Strych U, et al. Neglected tropical diseases among the association of Southeast Asian Nations (ASEAN): Overview and Update. *PLoS Neglect Trop Dis* 2015; 9: e0003575.
- International Agency for Research on Cancer (IARC). "IARC monographs on the evaluation of carcinogenic risks to humans". Lyon: World Health Organization, International Agency for Research on Cancer, 2011.
- Thamavit W, Bhamarapavati N and Sahaphong S. Effects of dimethylnitrosamine on induction of cholangiocarcinoma in *Opisthorchis viverrini*-infected Syrian golden hamsters. *Cancer Res* 1978; 38: 4634–4639.
- Harinasuta T, Riganti M and Bunnag D. *Opisthorchis viverrini* infection: pathogenesis and clinical features. *Arzneimittelforschung* 1984; 34: 1167–1169.
- Jongsuksuntigul P and Imsomboon T. Opisthorchiasis control in Thailand. *Acta Trop* 2003; 88: 229–232.
- Sripa B, Kaewkes S, Sithithaworn P, et al. Liver fluke induces cholangiocarcinoma. *PLoS Med* 2007; 4: e201.
- Sripa B. Concerted action is needed to tackle liver fluke infections in Asia. *PLoS Negl Trop Dis* 2008; 2: e232.
- Shin HR, Oh JK and Masuyer E. Epidemiology of cholangiocarcinoma: an update focusing on risk factors. *Cancer Sci* 2010; 101: 579–585.
- Feng M and Cheng X. Parasite-associated cancers (blood flukes/liver flukes). *Adv Exp Med Biol* 2017; 1018: 193–205.
- Andrews RH, Sithithaworn P and Petney TN. *Opisthorchis viverrini*: an underestimated parasite in world health. *Trends Parasitol* 2008; 24: 497–501.
- Allen AV and Ridley DS. Further observations on the formol-ether concentration technique for faecal parasites. *J Clin Pathol* 1970; 23: 545–546.
- Pullan RL, Smith JL, Jasrasaria R, et al. Global numbers of infection and disease burden of soil-transmitted helminth infections in 2010. *Parasite Vec* 2014; 7: 37.
- Vonghachack Y, Odermatt P, Taisayavong K, et al. Transmission of *Opisthorchis viverrini*, *Schistosoma mekongi* and soil-transmitted helminthes on the Mekong Islands, Southern Lao PDR. *Infect Dis Povert* 2017; 6: 131.
- Nakamura S. Present situation of opisthorchiasis in Vientiane capital, Lao Peoples' Democratic Republic. *Nihon Eiseigaku Zasshi* 2017; 72: 101–105.
- Miyamoto K, Kirinoki M, Matsuda H, et al. Field survey focused on *Opisthorchis*

- viverrini* infection in five provinces of Cambodia. *Parasitology Int* 2014; 63: 366–373.
16. Sohn WM, Yong TS, Eom KS, et al. Prevalence of *Opisthorchis viverrini* infection in humans and fish in Kratie Province, Cambodia. *Acta Trop* 2012; 124: 215–220.
 17. Aung WPP, Htoon TT, Tin HH, et al. First report and molecular identification of *Opisthorchis viverrini* infection in human communities from Lower Myanmar. *PLoS One* 2017; 12: e0177130.
 18. Sagnuankiat S, Wanichsuwan M, Bhunnachet E, et al. Health status of immigrant children and environmental survey of child daycare centers in Samut Sakhon province, Thailand. *J Immigrant Minor Health* 2016; 18: 21–27.
 19. Ngrenngarmert W, Kritsiriwuthinan K and Nilmanee N. Prevalence of intestinal parasitic infections among Myanmar workers in Bangkok and Samut Sakhon. *Asia J Public Health* 2012; 3: 53–58.
 20. Nuchprayoon S, Sanprasert V, Kaewzaithim S, et al. Screening for intestinal parasitic infections among Myanmar migrant workers in Thai food industry: a high-risk transmission. *J Immigrant Minor Health* 2009; 11: 115–121.
 21. Senephansiri P, Laummaunwai P, Laymanivong S, et al. Status and risk factors of *Strongyloides stercoralis* infection in rural communities of Xayaburi Province, Lao PDR. *Korean J Parasitol* 2017; 55: 569–573.
 22. Sripa B, Kaewkes S, Intapan PM, et al. Food-borne trematodiasis in Southeast Asia epidemiology, pathology, clinical manifestation and control. *Adv Parasitol* 2010; 72: 305–350.
 23. Utzinger J, Bergquist R, Olveda R, et al. Important helminth infections in Southeast Asia diversity, potential for control and prospects for elimination. *Adv Parasitol* 2010; 72: 1–30.
 24. WHO. Prevention and control of schistosomiasis and soil-transmitted helminthiasis: first report of the joint WHO expert committees. Geneva: World Health Organization Technical Report Series, 2002; 912: 912.
 25. Rim HJ, Chai JY, Min DY, et al. Prevalence of intestinal parasite infections on a national scale among primary schoolchildren in Laos. *Parasitol Res* 2003; 91: 267–272.