Acta Tropica 141 (2015) 289–294

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Epidemiology of *Strongyloides stercoralis* on Mekong islands in southern Laos

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ARTICLE INFO

Article history:
Available online 5 October 2014

Keywords:
Strongyloides stercoralis
Epidemiology
Baermann technique
Mekong island
Laos

ABSTRACT

Strongyloides stercoralis is a neglected helminth infection potentially that can lead to systemic infection in immunocompromised individuals. In Lao People's Democratic Republic (Lao PDR, Laos), information on *S. stercoralis* infection is scarce. We assessed *S. stercoralis* infection and associated risk factors and symptoms on the Mekong islands in Southern Laos. Baermann and Kato-Katz techniques were performed on two stool samples from each individual to detect *S. stercoralis* larvae and concomitant helminth infections. Among 729 individuals, 41.0% were infected with *S. stercoralis*. Men were at higher risk than women (OR 1.97, 95% CI 1.45-2.67). Urticaria and body itching was associated with *S. stercoralis* infection (OR 2.4, 95% CI 1.42-4.05). Infection with *Opisthorchis viverrini* (72.2%), *Schistosoma mekongi* (12.8%), and hookworm (56.1%) were very common. Few infections with *Trichuris trichiura* (3.3%), *Ascaris lumbricoides* (0.3%) and *Taenia* spp. (0.3%) were detected. The majority of helminth infections were of light intensity, with prevalences of 80.4%, 92.9%, 64.5%, 100% and 100%, for *O. viverrini*, hookworm, *S. mekongi*, *T. trichiura* and *A. lumbricoides*, respectively. Nevertheless, heavy infection intensities were observed for *O. viverrini* (1.0%), *S. mekongi* (14.0%) and hookworm (2.9%). *S. stercoralis* is highly endemic on the islands of Khong district, Champasack province, Southern Laos. The national helminth control programme should take action to control this helminth infection.

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1. Introduction

Strongyloides stercoralis is one of the most neglected soil-transmitted helminthiases (STH) (Olsen et al., 2009). It is transmitted through unprotected contact with soil and is endemic in tropical and temperate regions (Schär et al., 2013). Today, an estimated 30–100 million people are infected worldwide (Bethony et al., 2006).

The life cycle of *S. stercoralis* is complex. Humans acquire the infection through direct skin contact with infective third stage larvae (L_3). Chronic infection occurs through repeated endogenous auto-infection that may last for several decades (Becker et al., 2013). Infection among immunocompromised patients may lead to hyper-infection syndrome and may be fatal if not treated adequately (Becker et al., 2013; Siddiqui and Berk, 2001).

In Lao Peoples' Democratic Republic (Lao PDR, Laos,) information on *S. stercoralis* infection is scarce. The diagnostic techniques used in the country, i.e. direct smears and the Kato-Katz technique (Katz et al., 1972) have a very low sensitivity (Requena-Mendez et al., 2013). Therefore, hospital laboratory diagnosis might miss *S. stercoralis* infection, leading to underestimated prevalence rates. In 1996, the prevalence of *S. stercoralis* in Laos was estimated at 19% in Thakek and Hinboun district, Khammouane province, in the middle of the country by using agars plate culture method (Vannachone et al., 1998). In many parts of the country, e.g. on the Mekong islands in Champasack province, or Saravane province, water supply and sanitation facilities are absent (Sayasone et al., 2007). The rural populations' life style and farming activities favour transmission (e.g. intense skin contact with soil). Other helminthiasis such as STH, food-borne trematodiasis (FBT) and schistosomiasis mekongi

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http://dx.doi.org/10.1016/j.actatropica.2014.09.016
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are highly prevalent (Forrer et al., 2012; Rim et al., 2003; Sayasone et al., 2007, 2011).

We aimed to assess *S. stercoralis* infection and the risk of infection among the populations on the Mekong islands of Khong district, where other helminthiases have been reported previously. We conducted a cross-sectional study on three islands in Khong district, Champasack province, in Southern Laos.

2. Materials and methods

2.1. Ethics statement

The study was approved by the Lao National Ethics Committee for Health Research (NECHR), Ministry of Health, Laos. All procedures were explained to provincial, district and village authorities and their approval was obtained. Study participants were informed on study procedures, benefits and risks of the study as well as their rights to withdraw at any time. Before enrolment written informed consent was obtained from all study participants and parents or legal guardians of children below the age of 15 years. In addition a written assent was obtained from children and adolescent (<18 years). Participants were informed about the examinations. All infections diagnosed were treated according to the Lao national treatment guidelines (MOH, 2004). Those infected with *S. stercoralis* were treated with a single 200 μg/kg dose of ivermectin free of charge (Satoh and Kokaze, 2004; Suputtamongkol et al., 2011).

2.2. Study area and population

The study was conducted in March 2011 on three islands, i.e. Donlong, Donthan and Donlieng island located in the Mekong River in Khong district, Champasack province, southern Laos. Donlong island composes of four villages, namely Haulong, Longsong, Longkang and Hanglong village whereas Donthan and Donlieng islands compose of one village each namely Donthan and Donlieng village, respectively. Donlong, Donthan and Donlieng have a population of approximately 2174 (Haulong: 567; Longsong: 543; Longkang: 510 and Hanglong: 554), 586 and 137 inhabitants, respectively. The main occupation of villagers in these three islands is rice subsistence farming, vegetable plantation, and fishing activities in the Mekong. Additionally, in Donlong a considerable number of farmers cultivate tobacco.

The study islands represent typical islands of the Khong districts. In the study villages the Provincial Health Office reported very low proportion of households with latrines. Twenty to thirty households were chosen from the households list of the head of the village, using a simple random sampling procedure. All household members aged 2 years or older were invited to participate in the study.

2.3. Field procedures and laboratory examinations

A household and an individual questionnaire were administered. The household questionnaire was addressed to the head of household. The following information was collected: having and using latrine at home, wearing shoes (slippers), and socioeconomic conditions by using household assets including electric devices, engines, agricultural land and livestock owner, etc.. The individual questionnaire collected information on demographic data, hygiene behaviour, history of illness including urticaria (skin itching), and consumption of antihelminthic drugs in the past two weeks.

Two stool samples were collected per study participants within a five day period. Each sample was examined by using Kato-Katz thick smears technique (Katz et al., 1972) and Baermann technique (Garcia and Burckner, 2001). Pre-labeled plastic 30 ml stool containers (ID numbers, name, age and date of stool collection) were handed out to each participant. They were asked to provide a full container of stool. Each morning, filled containers were collected and replaced with empty ones for stool collection on the following day. The stool samples were stored at ambient temperature and transferred to the laboratory of the Khong district Hospital within 2–3 h post-collection where they were further processed.

Kato-Katz and Baermann tests are described in detail elsewhere (Khieu et al., 2013a; Sayasone et al., 2011). In brief, approximately 5 g of each stool sample was divided from each stool sample for performing Baermann test (Garcia and Burckner, 2001). The stool sample was placed on a gauze-lined mesh in a glass funnel equipped with a rubber tube and a clamp, and covered with de-chlorinated tap-water. After 2 h, the water (approx. 50 ml) was centrifuged and the sediment was examined under a microscope for *S. stercoralis* larvae (L_1-stage). A single Kato-Katz thick smear (Katz et al., 1972) was prepared for each stool sample and examined within 1 h of preparation. Helminth eggs were counted and recorded separately to obtain species-specific infection intensity estimates.

2.4. Data management and analysis

Questionnaire and stool data were double entered in EpiData version 3.1 (EpiData Association; Odense, Denmark) and validated. Statistical analyses were performed in STATA version 10 (StataCorp.; College Station, USA). Only participants with complete questionnaire and stool examination were analyzed. The intensity of helminth egg counts was expressed as eggs per gram of stool (EPG) obtained from Kato-Katz examination. Intensity of helminthic infections was classified as light, moderate and heavy infection (Sayasone et al., 2009; Upatham et al., 1984; WHO, 2002). An univariate logistic regression analysis was carried out to associate potential risk factors with *S. stercoralis* infection status for which matched odds ratio (OR) and its 95% confidence interval (CI) and *p*-value were calculated. The variables with $p < 0.2$ in the univariate analysis were included in the multivariate logistic regression analysis. Socioeconomic status (SES) conditions in the household were calculated according to an asset-based method such as electric devices, engines, agricultural land and livestock owner, indicator data were defined by principal component analysis (PCA). SES conditions in the household were categorized into five wealth quintiles (i) most poor; (ii) very poor; (iii) poor; (iv) less poor; and (v) least poor according to their cumulative standardized asset scores. Details of this widely used approach have been presented elsewhere (Sayasone et al., 2011). A "smoothed" age prevalence curve was used to present the infection prevalence by mean age and sex of participants.

3. Results

3.1. Study population

In total, 729 individuals had complete data records (Fig. 1). They originated from 247 households on the three islands: 347 (47.6%) and 382 (52.4%) individuals from Donlong and Donthan/Donlieng islands, respectively; 45.7% (333) were male; all were ethnic Laoloum. Age ranged from 2 to 95 years with a median age of 30.6 years. Among the participants, illiterate, and primary and secondary school graduate were 7.0%, 60.8% and 29.6%, respectively (Table 1). Only 2.6% had a technical/university level training. They lived in Donthan and Donlieng villages. The main occupation of the villagers was farming (61.9%) such as rice, tobacco, and vegetable farming while only a few were government employees (2.5%). The

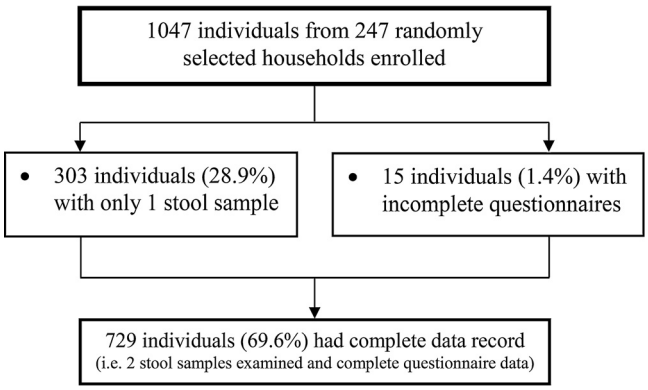

Fig. 1. Study diagram.

socio-economic status on Donlong was significantly lower than on the other two islands ($p = 0.032$).

3.2. Strongyloides stercoralis *infection and co-infections*

The overall *S. stercoralis* infection prevalence was 41.0% (Table 2). The infection rate did not differ between the islands (Donlong 44.1% *vs.* Donthan/Donlieng 38.2%, $p = 0.107$). The highest infection rate was observed with *O. viverrini* (72.2%), followed by hookworm (56.1%) and *S. mekongi* (12.8%). *T. trichiura* (3.3%), *A. lumbricoides* (0.3%) and *Taenia* spp. (0.3%). Infection prevalence of *O. viverrini* (76.1% *vs.* 68.6%, $p = 0.024$) and *S. mekongi* (25.6% *vs.* 1.0%, $p < 0.001$) was significantly higher on Donlong than on the other two islands. In contrast, hookworm infection prevalence was significantly higher on Donthan/Donlieng islands (63.9% *vs.* 47.6%, $p < 0.001$).

Among the 729 individuals, only 11.1% were free of helminth infection. In 65.3% of the study participants two or more helminth infections were diagnosed. Multiple helminth infections were significantly less frequent on Donthan and Donlieng than on Donlong ($p = 0.001$, Table 2).

The infection intensity of the diagnosed intestinal parasitic infections is given in Table 3. Most infections were of light intensity, e.g. 80.4% of *O. viverrini* infections. However, heavy infection intensities were found in patients with *S. mekongi* (14.0%), hookworm (2.9%) and *O. viverrini* (1.0%) infections.

3.3. *Risk factors associated with* S. stercoralis *infection*

The results of the risk analyses for a *S. stercoralis* infection are presented in Table 4. The most important risk factor was sex. Male study participants had a significantly higher risk for a *S. stercoralis*

Table 1
Demographic characteristics of the study participants.

Characteristic	Overall *n* (%)	Locality		x^2	*p*-Value
		Donlong *n* (%)	Donthan/Donlieng *n* (%)		
N	729	347 (47.6)	382 (52.4)		
Age (years)					
Mean (range)	30.6 (2–95)	28.1 (2–81)	32.8 (2–95)		
Sex					
Female	396 (54.3)	187 (53.9)	209 (54.7)	0.049	0.824
Male	333 (45.7)	160 (46.1)	173 (45.3)		
Educational level					
Illiterate	51 (7.0)	27 (7.8)	24 (6.3)	25.053	<0.001
Primary school	443 (60.8)	231 (66.6)	212 (55.5)		
High school	216 (29.6)	89 (25.6)	127 (33.2)		
Technical school/university	19 (2.6)	0	19 (5.0)		
Occupation					
Farmer	451 (61.9)	216 (62.3)	235 (61.5)	15.934	0.001
Student	212 (29.1)	101 (29.1)	111 (29.0)		
Child	48 (6.6)	29 (8.4)	19 (5.0)		
Government employee	18 (2.5)	1 (0.3)	17 (4.5)		
Socio-economic status					
Most poor	146 (20.0)	55 (15.9)	91 (23.8)	10.575	0.032
Very poor	147 (20.2)	69 (19.9)	78 (20.4)		
Poor	145 (19.9)	82 (23.6)	63 (16.5)		
Less poor	149 (20.4)	73 (21.0)	76 (19.9)		
Least poor	142 (19.5)	68 (19.6)	74 (19.4)		

Table 2
Prevalence of helminth infections among villagers in the islands of Khong district, Champasack province (n = 729).

Infections	Overall *n* = 729 (%)	Donlong *n* = 347 (%)	Donthan/Donlieng *n* = 382 (%)	x^2	*p*-Value
Nematodes					
Strongyloides *stercoralis*	299 (41.0)	153 (44.1)	146 (38.2)	2.59	0.107
Ascaris lumbricoides	2 (0.3)	0	2 (0.5)	1.82	0.177
Trichuris trichiura	24 (3.3)	12 (3.5)	12 (3.1)	0.05	0.811
Hookworm	409 (56.1)	165 (47.6)	244 (63.9)	19.67	<0.001
Trematodes					
Opisthorchis viverrini	526 (72.2)	264 (76.1)	262 (68.6)	5.08	0.024
Schistosoma mekongi	93 (12.8)	89 (25.6)	4 (1.0)	98.87	<0.001
Cestodes					
Taenia spp.	2 (0.3)	1 (0.3)	1 (0.3)	0.004	0.946
Multiparasitism					
Non infection	81 (11.1)	31 (8.9)	50 (13.1)	18.8	0.001
Single infection	172 (23.6)	84 (24.2)	88 (23.0)		
Double infection	276 (37.9)	121 (34.9)	155 (40.6)		
Triple infection	169 (23.2)	86 (24.8)	83 (21.7)		
Quartile infection	31 (4.3)	25 (7.2)	6 (1.6)		

Table 3
Intensity of helminth infections among villagers in the islands of Khong district, Champasack province ($n = 729$).

Parasites	Light *n* (%)	Moderate *n* (%)	Heavy *n* (%)
Trematodes			
Opisthorchis viverrini	423 (80.4)	98 (18.6)	5 (1.0)
Schistosoma mekongi	60 (64.5)	20 (21.5)	13 (14.0)
Nematodes			
Ascaris lumbricoides	2 (100)	0	0
Trichuris trichiura	24 (100)	0	0
Hookworm	380 (92.9)	17 (4.2)	12 (2.9)

infection than female participants taking into account the age of the study participants (adjusted OR 1.97, 95% CI 1.45–2.67).

S. stercoralis infection was diagnosed in participants of all ages. Children of the age group ≤5 years had the lowest infection prevalence (33.3%). However, in none of the older age groups the infection risk increased significantly. Interestingly, the age infection prevalence was distinctly different between male and female study participants (Fig. 2). In male participants, the infection prevalence reached peaked at 60% in the age group between 20 and 30 years, and remained at around 50% in the older age groups. In female participants the infection reached a plateau of 38% in 10 year olds, remained constant up to 40 years and dropped thereafter.

In our analyses, none of the socio-economic risk factors such as socio-economic status, occupation and level of education was associated with *S. stercoralis* infection. Hygiene behaviours such as wearing shoes (slippers), having and using a latrine and having been treated with antihelminthic drugs in the past six months were not significantly associated with *S. stercoralis* infection.

During interview, participants were asked to report symptoms from the last two weeks. Urticaria and/or body itching during the previous two weeks was the only reported symptom significantly associated with *S. stercoralis* infection. Having urticarial and/or experiencing itching was strongly associated with an *S. stercoralis* infection (adjusted OR 2.40, 95% CI 1.42–4.05, $p = 0.001$).

Table 4
Association among *S. stercoralis* infection and risk factors in the islands of Khong district, Champasack province.

Characteristics	Positive, *n* (%)	Crude OR (95% CI)	*p*-Value	Adjusted OR (95%, CI)	*p*-Value
Age group (years)					
≤5	17 (33.3)	1.00	0.708	na	na
6–15	82 (40.8)	1.37 (0.72–2.63)			
16–25	44 (43.6)	1.54 (0.76–3.11)			
26–35	44 (45.4)	1.66 (0.81–3.36)			
36–45	39 (43.3)	1.52 (0.74–3.12)			
≥46	73 (38.6)	1.25 (0.65–2.41)			
Sex					
Female	134 (33.8)	1.00	<0.001	1.00	<0.001
Male	165 (49.6)	1.92 (1.42–2.58)		1.97 (1.45–2.67)	
Occupation					
Farmer	189 (41.9)	1.00	0.693	na	na
Student	86 (40.6)	0.94 (0.67–1.31)			
Government employee	8 (44.4)	1.10 (0.42–2.86)			
Child	16 (33.3)	0.69 (0.36–1.29)			
Educational level					
Illiterate	17 (33.3)	1.00	0.418	na	na
Primary school	177 (40.0)	1.33 (0.72–2.46)			
High school	97 (44.9)	1.63 (0.86–3.09)			
Technical school/university	8 (42.1)	1.45 (0.49–4.29)			
Having latrine at home					
No	194 (42.2)	1.00	0.405	na	na
Yes	105 (39.0)	0.87 (0.64–1.19)			
Habit of defecation					
Latrine	105 (39.5)	1.00	0.802	na	na
Bush	156 (41.7)	1.09 (0.79–1.51)			
Rice field	38 (42.7)	1.14 (0.70–1.85)			
Last defecation					
Latrine	107 (39.2)	1.00	0.715	na	na
Bush	153 (41.8)	1.11 (0.80–1.53)			
Rice field	39 (43.3)	1.18 (0.73–1.92)			
Wearing slippers (shoes)					
Yes	249 (41.8)	1.00	0.375	na	na
No	50 (37.6)	1.19 (0.80–1.75)			
Worked in rice field last year					
No	91 (38.2)	1.00	0.288	na	na
Yes	208 (42.4)	1.18 (0.80–1.62)			
Treated with anthelminthic drugs in past 6 months					
No	264 (42.1)	1.00	0.314	na	na
Yes	33 (34.0)	0.70 (0.45–1.11)			
Do not remember	2 (40.0)	0.91 (0.15–5.52)			
Socioeconomic status					
Most poor	69 (47.3)	1.00	0.231	na	na
Very poor	52 (35.4)	0.61 (0.38–0.97)			
Poor	64 (44.1)	0.88 (0.55–1.39)			
Less poor	56 (37.6)	0.67 (0.42–1.06)			
Least poor	58 (40.9)	0.77 (0.48–1.22)			
Study villages					
Donthan/Donlieng	146 (38.2)	1.00	0.107	na	na
Donlong	153 (44.1)	1.27 (0.94–1.71)			

na Not applicable.

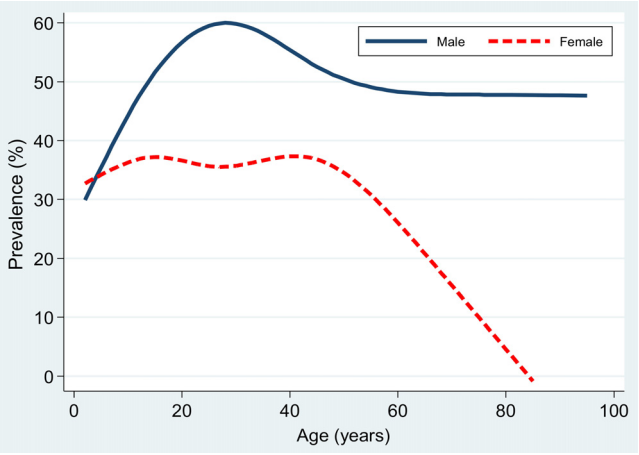

Fig. 2. Age prevalence distribution by sex of *S. stercoralis* infection in villagers from Southern Laos.

4. Discussion

S. stercoralis is one of the most neglected tropical diseases (Olsen et al., 2009). In resource poor countries with tropical climate, conditions are favourable for transmitting the parasite. Hence, *S. stercoralis* is most probably underreported in these settings (Schär et al., 2013). In Southeast Asia, a relative small number of studies document *S. stercoralis* infection. However, recent work in Cambodia reported very high infection rates of 25% in Kandal and Takeo provinces (Khieu et al., 2013a; Khieu et al., 2014b) and almost 50% in the most Northern Preah Vihear province (Khieu et al., 2014a). Furthermore, low socioeconomic status and low hygienic living conditions of the rural population were strongly associated with *S. stercoralis* infections.

Given the similar socioeconomic and environmental living conditions of the rural population in Laos, we aimed to document the level of *S. stercoralis* infection rates and risk factors in Southern Laos. We used a rigorous diagnostic approach conducting a Baermann test on two stool samples from each participant. We found a very high *S. stercoralis* infection prevalence of 41.0%. Of the risk factors examined only sex was significantly associated with *S. stercoralis.* Furthermore, reported urticaria (body itching) was significantly associated with the infection.

In Laos, only a very few studies of *S. stercoralis* have been conducted using an adequate diagnostic approach. Most data on *S. stercoralis* infection stem from studies examining other soil-transmitted helminthes and/or food-borne trematodes and reported prevalence rates below 20% (Paboriboune et al., 2014; Sayasone et al., 2011). Given the inadequate diagnostic techniques these studies used, their findings most like underestimate the true infection burden in the country. Therefore, more attention should be paid to *S. stercoralis* in Laos by incorporating sensitive diagnostic approaches in helminth surveillance activities.

In our study, we used the Baermann method on two stool samples per enrolled participant. The infection prevalence was comparable to recent reports from Cambodia (Khieu et al., 2013a, 2014a,b), but substantially higher than infection prevalences reported from neighbouring China (Steinmann et al., 2007, 2008) and Thailand (Jongsuksuntigul et al., 2003; Sithithaworn et al., 2003). Our diagnostic procedures could have been improved by examining more stool samples per person and by adding additional diagnostic techniques. For example, in a study of Cambodian children three stool samples were examined per child with a combination of Baermann technique and Koga agar plate. Taking this approach as 'gold' standard, our examination of two samples with the Baermann technique results in a sensitivity of approximately 70%; in combination with the Koga agar plate method a 93% sensitivity could have been reached (Khieu et al., 2013a). However, the substantial material costs and time investments required to conduct the Koga-Agar plate culture must be taken into account when planning a field investigation. In our study, these factors did not allow for this method to be added to the diagnostic study procedures.

We identified gender as the most important risk factor in our study area. Boys and men had almost twice the risk for a *S. stercoralis* infection than did girls and women. This finding is in agreement with earlier reports from Cambodia (Khieu et al., 2014a,b) and Laos (Vannachone et al., 1998). It is most probably the gender specific daily activities of boys (recreational) and men (agricultural) that increase the exposure to contaminated soil, and hence lead to higher infection rates.

A striking finding of our study was the high infection rate among young children. One third (33.3%) of the children under 6 years of age were infected with *S. stercoralis*. Given the fact that these children have few daily activities outside the household, the transmission of *S. stercoralis* must take place at home. A similar observation was reported in Cambodia (Khieu et al., 2014a). In addition, in Cambodian households dogs were examined for intestinal infection and tested positive for *Stronyloides* larvae (Schär et al., 2014). We hypothesise that humans and dogs in the same household share the *Strongyloides* parasites and are responsible for contaminating the soil. However, further genetic studies on human and dog derived *Strongyloides* parasites are required in order to draw conclusions about anthropo-zoonotic transmission. In this context it is most interesting to note, that in the same Cambodian households, the dog hookworm *Ancylostoma ceylanicum* was found as a predominant hookworm species in humans (Inpankaew et al., 2014) indicating zoonotic transmission from dogs to humans. Given that fact that hookworm and *S. stercoralis* have the same transmission route a similar human–dog transmission pattern of the latter parasite seems likely.

In our study, we did not find any association between *S. stercoralis* infection and risk factors related to socio-economic status, access to sanitation facilities and hygiene behaviour of the population. These results were most surprising, as earlier studies identified clear a association between the parasite and low economic status and absence of sanitation facilities. For example, Cambodian school children had an almost five fold increased risk for a *S. stercoralis* infection when no latrine was present at home (Khieu et al., 2013a). In addition, attributable risk analysis showed that 70% of *S. stercoralis* infectins could be averted if adequate sanitation were present (Khieu et al., 2013a).

Recent developments in our study area might have led to the absence of these associations. We selected the villages precisely because the Provincial Health Office reported low numbers of households with latrines in the island villages of the Khong district. However, during our investigations, we found that more than 40% of the households had a latrine. Indeed, in the last year, a number of health related intervention were undertaken in the Khong district, including general health promotion activities, and latrine construction and mass-deworming campaigns. Though the new developments account for the absence of the expected associations, people however remained infected with *S. stercoralis.*

Although *S. stercoralis* infection is highly prevalent in many settings its clinical significance is not understood. Long-lasting infection may contribute to chronic gastro-intestinal and skin morbidity. In our study, *S. stercoralis* infection was associated with reports of urticarial and/or itching in the previous weeks. A Cambodian study reported a very similar result. There, urticaria with intensive itching on all body parts was reported by patients. The symptoms were resolved after ivermectin treatment (Khieu

et al., 2013b). However in this report, abdominal pain was also associated with *S. stercoralis* infection.

In our study, *O. viverrini* was the most frequent helminth infection (72.2%), followed by hookworm (56.1%) and *S. stercoralis* (41.0%) infections. In addition, a considerable *S. mekongi* infection prevalence was detected on Donlong island (25.6%). Therefore, multiparasitism was very common. However, the clinical consequences of concurrent helminth infections are unknown. Recently, it was shown that co-infection with *S. mekongi* aggravates *O. viverrini* related morbidity (Sayasone et al., 2012). However, information on the contribution of *S. stercoralis* to the overall morbidity of individuals infected with multiple helminth species is unknown and will require further in-depth studies.

In conclusion, *S. stercoralis* infection is highly endemic in the islands of the Khong district, Champasack province, southern Lao PDR. The results of this study and other *S. stercoralis* reports from the country should be noted by the national helminth control programme. County-wide assessments of *S. stercoralis* infection prevalence and related morbidity would be most useful to further push the agenda of an intensified integrated soil-transmitted helminth control intervention in which *S. stercoralis* is adequately addressed.

Acknowledgements

We are grateful to all study participants in Donlong, Donthan and Donlieng villages and the local authorities for the kind collaboration. We thank all laboratory technicians.

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