

# Prevalence of Intestinal Helminths among Inhabitants of Cambodia (2006-2011)

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**Abstract:** In order to investigate the status of intestinal helminthic infections in Cambodia, epidemiological surveys were carried out on a national scale, including 19 provinces. A total of 32,201 fecal samples were collected from schoolchildren and adults between 2006 and 2011 and examined once by the Kato-Katz thick smear technique. The overall egg positive rate of intestinal helminths was 26.2%. The prevalence of hookworms was the highest (9.6%), followed by that of *Opisthorchis viverrini*/minute intestinal flukes (Ov/MIF) (5.7%), *Ascaris lumbricoides* (4.6%), and *Trichuris trichiura* (4.1%). Other types of parasites detected were *Enterobius vermicularis* (1.1%), *Taenia* spp. (0.4%), and *Hymenolepis* spp. (0.2%). The northwestern regions such as the Siem Reap, Oddar Meanchey, and Banteay Meanchey Provinces showed higher prevalences (17.4-22.3%) of hookworms than the other localities. The southwestern areas, including Koh Kong and Preah Sihanouk Provinces showed higher prevalences of *A. lumbricoides* (17.5-19.2%) and *T. trichiura* (6.1-21.0%). Meanwhile, the central and southern areas, in particular, Takeo and Kampong Cham Provinces, showed high prevalences of Ov/MIF (23.8-24.0%). The results indicate that a considerably high prevalence of intestinal helminths has been revealed in Cambodia, and thus sustained national parasite control projects are necessary to reduce morbidity due to parasitic infections in Cambodia.

**Key words:** Hookworm, intestinal helminth, prevalence, Cambodia

## INTRODUCTION

Cambodia is a tropical country located in the southern part of the Indochina Peninsula in Southeast Asia. Cambodia has an area of 181,035 square kilometers and lies entirely within the tropics, and its climate is dominated by monsoons, which are known as tropical wet and dry conditions because of the marked seasonal differences. It is bordered by Thailand to the west, Laos to the northeast, and Vietnam to the east. The total population is approximately 14.8 million. Administratively, Cambodia is divided into 24 provinces, including the capital

Phnom Penh; the political, economic, and cultural center of Cambodia.

There were a few local reports on intestinal helminth infections of public health importance in Cambodia, including soil-transmitted nematodes and food-borne trematodes [1,2]. There also were some reports that described the prevalence of a particular parasite, for example, *Strongyloides stercoralis*; it was rather frequently detected in 20.2% of children in villages bordering Tonle Sap Lake [2] and in 18.6-24.4% of children in Kandal Province [3]. In Kratie and Stung Treng Provinces, *Schistosoma mekongi* was reported to be fairly endemic [4]. In addition, high prevalences of *Opisthorchis viverrini* infection were reported in Takeo [5], Kratie [6], Kandal, Kampong Cham, and Kampong Thom Provinces [7].

Nevertheless, national scale data on the prevalence of intestinal helminths are yet unavailable, although control programmes with mass deworming directed to schoolchildren

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were launched on a large scale some ~15 years ago [8]. In the meantime, a Korea-Cambodia collaborative project on intestinal parasite control in schoolchildren and village people was started in 2006 and continued until 2011. The objectives of the project were survey and elimination of intestinal helminth infections and strengthening of the health care delivery system. This report summarizes the fecal survey results obtained during the 6-year collaborative project between Korea and Cambodia.

## MATERIALS AND METHODS

### Surveyed areas

Fecal specimens were collected from a total of 32,201 subjects (male/female=0.9) from 19 provinces, including 24,892 schoolchildren (6-12 years) and 7,309 adults (>15 years). The provinces surveyed were grouped into 4 categories, including northwestern (Banteay Meanchey, Battambang, Oddar Meanchey, Pailin, Preah Vihear, and Siem Reap), southwestern (Kampot, Koh Kong, and Preah Sihanouk), eastern (Kratie, Mondulakiri, Ratanakiri, and Stung Treng), and central and southern provinces (Kampong Cham, Kampong Chhnang, Kampong Thom, Pursat, Svay Rieng, and Takeo).

### Fecal examination

Fecal specimens were examined once for intestinal helminth eggs by the Kato-Katz thick smear technique. The ethical aspects of the fecal survey were approved by the Ministry of Health, Cambodia under the agreement of the Korea-Cambodia International Collaboration on Intestinal Parasite Control in Cambodia (2006-2011).

### Statistical analysis

The prevalences of hookworms and other helminths were compared between different provinces and between schoolchildren and adults, and results were statistically evaluated by the chi-square test. The *P*-values of <0.05 were considered statistically significant.

## RESULTS

The overall average helminth egg positive rate among the surveyed people was 26.2% (8,449 positive cases among 32,201 subjects examined) and the rate varied from 5.5% to 44.1% among different provinces (Table 1). The rate was highest in the Takeo Province (44.1%), followed by the Preah Siha-

nouk (39.8%), Kampong Cham (31.7%), and Koh Kong Provinces (31.5%). The lowest positive rate was observed in the Battambang Province (5.5%), followed by the Pailin (5.7%) and Kampong Thom Provinces (8.2%).

Among the helminth species detected, hookworms (including *Ancylostoma duodenale*, *A. ceylanicum*, and *Necator americanus*) were the most highly prevalent species with an average egg positive rate of 9.6% (Table 1). The second most prevalent species was *O. viverrini*/minute intestinal fluke (Ov/MIF; 5.7%) followed by *Ascaris lumbricoides* (4.6%), *Trichuris trichiura* (4.1%), *Enterobius vermicularis* (1.1%), *Taenia* spp. (0.4%), and *Hymenolepis nana* (0.2%). Other kinds of helminth eggs detected were *Trichostrongylus* sp., *Hymenolepis diminuta*, echinostomes, dicrocoelids, and fasciolids.

The prevalence of hookworms varied among the different provinces surveyed (Table 1; Fig. 1). The rate was highest in Oddar Meanchey Province, followed by Siem Reap and Banteay Meanchey Provinces, all of which are located in the northwestern area of Cambodia (Fig. 1). The next highest rates were detected in Kampot, Takeo, and Mondulakiri Provinces. The prevalence of Ov/MIF eggs was highest in Kampong Cham Province, followed by Takeo, Kratie, Ratanakiri, Preah Vihear, and Stung Treng Provinces. The prevalences of *A. lumbricoides* and *T. trichiura* were highest in southwestern provinces, in particular, Preah Sihanouk and Koh Kong Provinces. Kampot Province also showed comparatively high prevalences of *A. lumbricoides* and *T. trichiura*. All other provinces showed prevalences of 0-2.0% for these nematodes.

*Taenia* spp. eggs were detected in fecal samples collected from 13 provinces. The highest prevalence was found in Koh Kong and Mondulakiri Provinces, followed by Ratanakiri, Preah Vihear, and Svay Rieng Provinces. *H. nana* eggs were detected in a few fecal samples collected from 9 provinces, including Mondulakiri, Ratanakiri, and Koh Kong Provinces. Eggs of *E. vermicularis* were detected in fecal samples collected from all provinces except Stung Treng, and the egg positive rate ranged from 0.2% to 1.8% (Kampot Province). There were a substantial number of positive cases for eggs of *Trichostrongylus* sp., *H. diminuta*, echinostomes, dicrocoelids, and fasciolids.

The prevalence of helminth eggs was slightly different between schoolchildren and adults. The overall average egg positive rate was notably higher (*P*<0.05) in adults (36.4%) than in schoolchildren (23.2%) (Fig. 2). Adults showed significantly (*P*<0.05) higher prevalences of hookworms, *A. lumbricoides*, *T. trichiura*, Ov/MIF, and *Taenia* spp. compared with school-

**Table 1.** Prevalence of intestinal helminths among inhabitants of Cambodia (2006-2011)

Province (Fig. 1)	No. of subjects examined	No. of cases positive for helminth eggs (%)								
		Overall positive cases	Hookworms <sup>a</sup>	<i>Ascaris lumbricoides</i>	<i>Trichuris trichiura</i>	<i>Opisthorchis viverrini</i> /MIF <sup>b</sup>	<i>Hymenolepis nana</i>	<i>Taenia</i> spp.	<i>Enterobius vermicularis</i> <sup>c</sup>	Others <sup>d</sup>
Northwestern regions										
Banteay Meanchey	820	167 (20.4)	143 (17.4)	3 (0.4)	8 (1.0)	5 (0.6)	0 (0.0)	0 (0.0)	3 (0.4)	10 (1.2)
Battambang	807	44 (5.5)	8 (1.0)	3 (0.4)	2 (0.2)	2 (0.2)	0 (0.0)	0 (0.0)	6 (0.7)	26 (3.2)
Oddar Meanchey <sup>e</sup>	2,449	604 (24.7)	545 (22.3)	0 (0.0)	5 (0.2)	32 (1.3)	3 (0.1)	5 (0.2)	15 (0.6)	26 (1.1)
Pailin	793	45 (5.7)	16 (2.0)	3 (0.4)	6 (0.8)	1 (0.1)	0 (0.0)	0 (0.0)	5 (0.6)	15 (1.9)
Preah Vihear	862	122 (14.2)	52 (6.0)	7 (0.8)	6 (0.7)	23 (2.7)	5 (0.6)	4 (0.5)	10 (1.2)	15 (1.7)
Siem Reap	493	126 (25.6)	109 (22.1)	2 (0.4)	0 (0.0)	2 (0.4)	0 (0.0)	0 (0.0)	1 (0.2)	17 (3.4)
Southwestern regions										
Kampot	2,732	691 (25.3)	442 (16.2)	110 (4.0)	162 (5.9)	1 (0.04)	0 (0.0)	1 (0.04)	48 (1.8)	14 (0.5)
Koh Kong	2,902	914 (31.5)	202 (7.0)	558 (19.2)	176 (6.1)	16 (0.6)	21 (0.7)	47 (1.6)	48 (1.7)	56 (1.9)
Preah Sihanouk	3,807	1,517 (39.8)	373 (9.8)	667 (17.5)	800 (21.0)	22 (0.6)	3 (0.08)	7 (0.2)	42 (1.1)	49 (1.3)
Eastern regions										
Kratie <sup>f</sup>	3,034	422 (13.9)	138 (4.5)	23 (0.8)	19 (0.6)	103 (3.4)	6 (0.2)	4 (0.1)	30 (1.0)	108 (3.6)
Mondulkiri	837	176 (19.7)	102 (12.2)	1 (0.1)	7 (0.8)	5 (0.6)	8 (1.0)	13 (1.6)	15 (1.8)	22 (2.6)
Ratanakiri	959	149 (15.5)	26 (2.7)	4 (0.4)	17 (1.8)	27 (2.8)	8 (0.8)	11 (1.1)	12 (1.3)	44 (4.6)
Stung Treng	975	97 (9.9)	44 (4.5)	11 (1.1)	9 (0.9)	24 (2.5)	0 (0.0)	1 (0.1)	0 (0.0)	8 (0.8)
Central and southern regions										
Kampong Cham	2,593	822 (31.7)	80 (3.1)	4 (0.2)	16 (0.6)	622 (24.0)	0 (0.0)	9 (0.3)	23 (0.9)	178 (6.9)
Kampong Chhnang	1,795	494 (27.5)	147 (8.2)	27 (1.5)	9 (0.5)	10 (0.6)	0 (0.0)	2 (0.1)	14 (0.8)	261 (16.2)
Kampong Thom	846	69 (8.2)	35 (4.1)	0 (0.0)	2 (0.2)	11 (1.3)	3 (0.4)	0 (0.0)	13 (1.5)	8 (0.9)
Pursat <sup>g</sup>	770	163 (21.2)	26 (3.4)	0 (0.0)	8 (1.0)	3 (0.4)	0 (0.0)	0 (0.0)	7 (0.9)	126 (16.4)
Svay Rieng	838	112 (13.4)	59 (7.0)	17 (2.0)	11 (2.0)	5 (0.6)	0 (0.0)	4 (0.5)	3 (0.4)	11 (1.3)
Takeo <sup>h</sup>	3,889	1,715 (44.1)	554 (14.2)	38 (1.0)	52 (1.3)	924 (23.8)	9 (0.2)	7 (0.2)	66 (1.7)	160 (4.1)
Total	32,201	8,449 (26.2)	3,101 (9.6)	1,478 (4.6)	1,315 (4.1)	1,838 (5.7)	66 (0.2)	115 (0.4)	361 (1.1)	1,144 (3.6)

<sup>a</sup>The species of hookworms were not determined.

<sup>b</sup>These eggs may include those of *O. viverrini* and minute intestinal flukes, such as *Haplorchis* spp..

<sup>c</sup>The results are based on the Kato-Katz fecal smear technique and not on the celloctape anal swab method.

<sup>d</sup>Including the eggs of *Trichostrongylus* sp., *Hymenolepis diminuta*, echinostomes, dicrocoelids, and fasciolids.

<sup>e-h</sup>Some part of the data was published by Sohn et al. (2011a<sup>b</sup>; 2011b<sup>g</sup>; 2011c<sup>e</sup>; 2012<sup>h</sup>) and Yong et al. (2012)<sup>h</sup>.

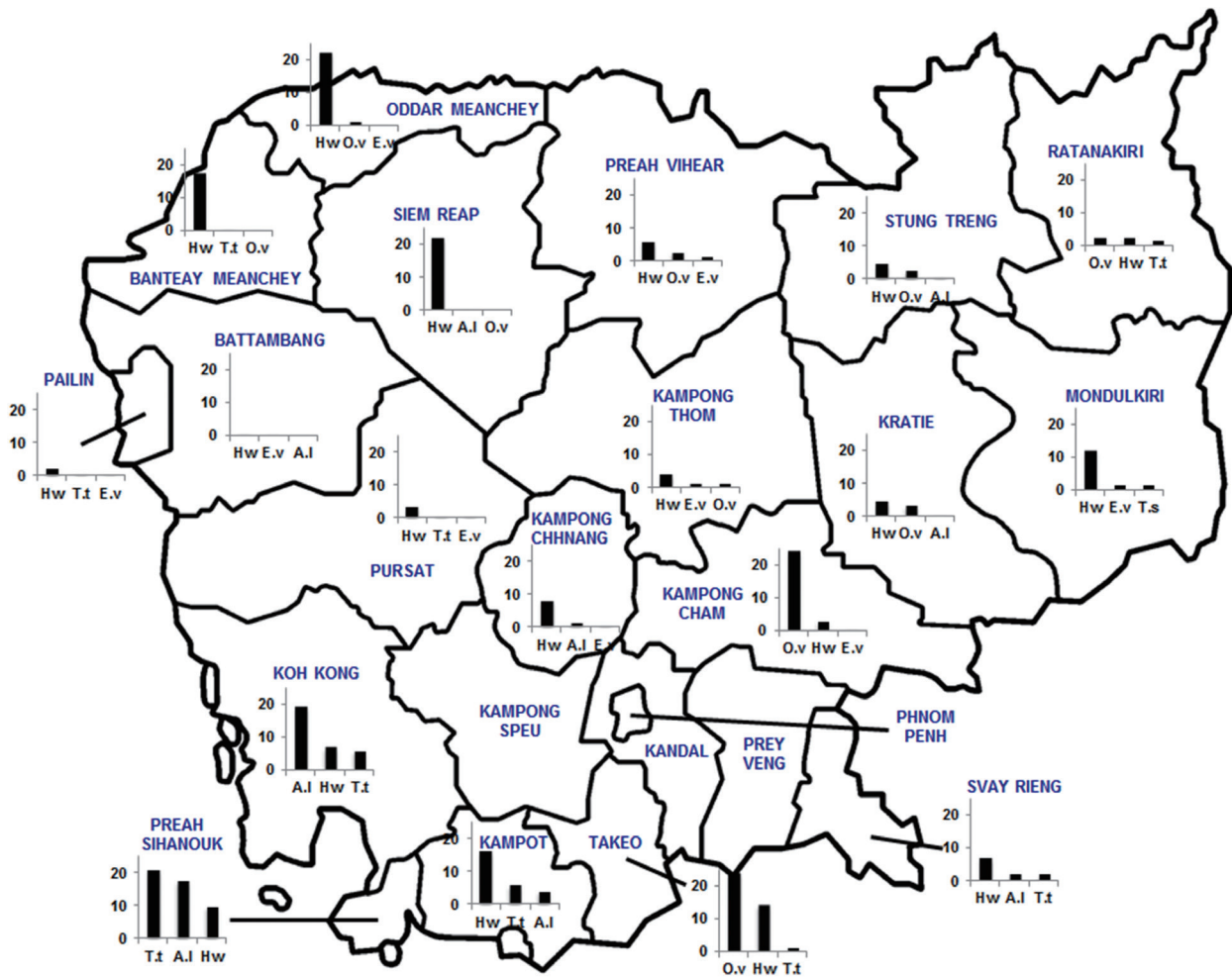
children. However, the prevalence of *E. vermicularis* was significantly higher ( $P < 0.05$ ) in schoolchildren than in adults. No age difference was noted between subjects infected with *H. nana* and other kinds of parasites. There was no significant gender difference in the prevalence of these helminths (data not shown).

## DISCUSSION

The present study revealed a considerably high prevalence of intestinal helminths (average 26.2%) among schoolchildren and village people in 19 provinces of Cambodia. The areas covered were located almost nationwide, and some apparent trends could be seen from the results. First of all, hookworms appeared to be the most important helminth species with an average egg positive rate of 9.6%. The prevalence of hookworms

was slightly but significantly higher in adults than in schoolchildren. This finding was different from the general trend; children show a higher prevalence than adult population. This may be due to the recent national helminth control programmes in Cambodia that mostly covered schoolchildren [8,9]. These control programs may also have exerted some effects on the different levels of prevalence by different survey areas.

Based on molecular epidemiologic surveys, *N. americanus* and *A. ceylanicum* are the 2 most common hookworm species infecting humans in Asia [10]. In Thailand, Laos, and Malaysia, 6-23% of persons positive for hookworm eggs were infected with *A. ceylanicum* [10]. In a rural village of Preah Vihear Province, Cambodia, 47.6% of hookworm egg positive cases were molecularly diagnosed as *N. americanus* infection and 46.0% were confirmed as *A. ceylanicum* infection; only 3.2% were found infected with *A. duodenale* [10]. Viewing from this



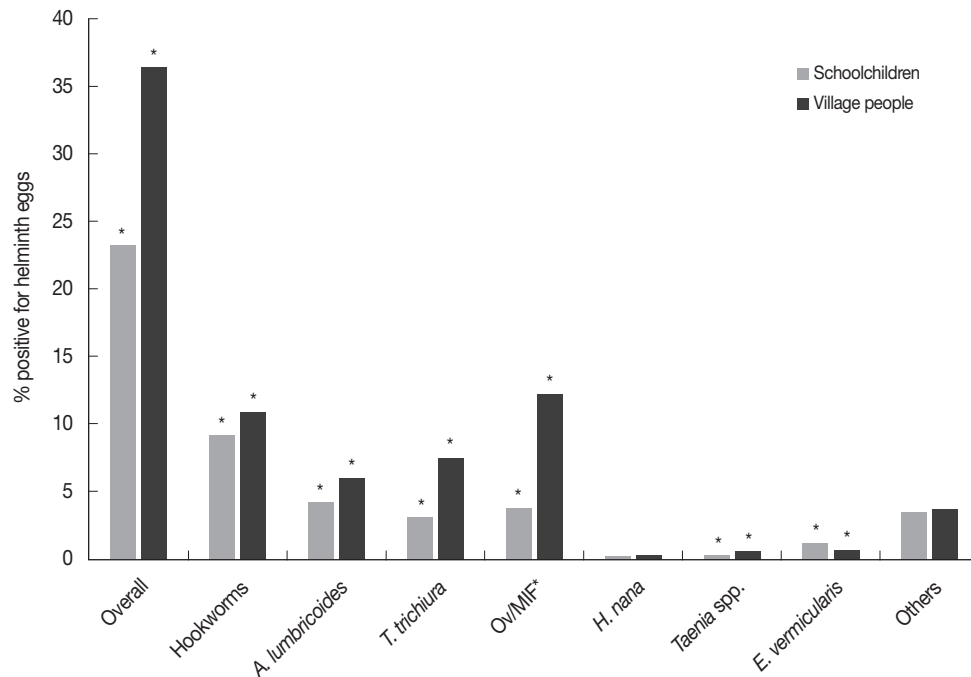
**Fig. 1.** Map of Cambodia showing the prevalence of intestinal helminths (3 most important species in each province) during 2006 and 2011. Note that hookworms are highly prevalent particularly in the northwestern provinces (Oddar Meanchey, Banteay Meanchey, and Siem Reap) followed by the southwestern provinces (Koh Kong and Kampot). *O. viverrini*/minute intestinal flukes (MIF) are prevalent in the Kampong Cham and Takeo Provinces. Hw, hookworms; A.I., *Ascaris lumbricoides*; T. t., *Trichuris trichiura*; O.v., *Opisthorchis viverrini*/MIF; E.v., *Enterobius vermicularis*; T.s., *Taenia* spp..

report, we could speculate that the hookworm egg positive cases in our study were infected predominantly with *N. americanus* and *A. ceylanicum*, and only a small proportion may be *A. duodenale*. However, this trend should be confirmed by surveys in each hookworm endemic area.

A striking feature of this survey was that the prevalence of *A. lumbricoides* was lower than that of hookworms in most of the surveyed areas except for Koh Kong and Preah Sihanouk Provinces. This finding was different from the previous results. For example, in primary schoolchildren in Kampong Cham Province, the prevalence of hookworms was 6.4%, whereas that of *A. lumbricoides* was 26.3% [11]. Similarly, in schoolchildren in Kratie Province, the prevalence of hookworms was 28.9% and

that of *A. lumbricoides* was 49.0% [1]. On the other hand, similar prevalences were observed for hookworms and *A. lumbricoides* among schoolchildren and adolescents in 5 provinces bordering the Tonle Sap Lake [2]. A trend similar to our results was also reported; in a provincial hospital in Siem Reap Province, the egg positive rate of hookworms was 5.1% among the 16,372 children examined, while that of *A. lumbricoides* was only 0.3% [12]. It is suggested that soil-transmitted helminths, in particular, *A. lumbricoides* and *T. trichiura* were found to be under control owing to the recent national helminth control programmes directed to schoolchildren in Cambodia [8,9].

*Strongyloides stercoralis*, another species of soil-transmitted helminths, was excluded from our survey because we used the



**Fig. 2.** Comparative prevalence of intestinal helminths between schoolchildren and adults in 19 provinces, Cambodia (2006-2011). The overall egg positive rates of helminths, hookworms, *A. lumbricoides*, *T. trichiura*, *O. viverrini*/MIF, and *Taenia* spp. were significantly ( $P < 0.05$ ) higher in adults than in schoolchildren. Conversely, the prevalence of *E. vermicularis* was significantly ( $P < 0.05$ ) higher in schoolchildren than in village people. Others included *Trichostrongylus* sp., *Hymenolepis diminuta*, echinostomes, dicrocoelids, and fasciolids.

Kato-Katz fecal examination technique which cannot detect the larvae of *S. stercoralis*. There are an increasing number of reports on *S. stercoralis* infection among children in Cambodia [2,3,9]. In Kandal Province, the reported prevalence of *S. stercoralis* ranged from 18.6% to 24.4% based on the detection technique used; Koga agar plate culture versus Baermann technique [3]. A national survey is needed to determine the precise status of strongyloidiasis in Cambodia.

The liver fluke *O. viverrini* was not considered to be distributed in Cambodia until several recent studies that reported about its distribution [5-7,13,14]. Its metacercarial stage was first detected in various species of fresh water fish caught in southern Cambodia, including Takeo and Kandal Provinces [13], and confirmed human cases by adult worms were first reported in Takeo Province [14]. Subsequently, endemic foci of human opisthorchiasis were found in Takeo [5], Kratie [6], Kandal, Kampong Cham, and Kampong Thom Provinces [7]. The present study suggests several more provinces, including Preah Vihear, Ratanakiri, and Stung Treng Provinces as low-grade endemic areas of opisthorchiasis in Cambodia.

*Taenia* spp. eggs were detected most frequently in the fecal samples collected from Koh Kong Province. In order to deter-

mine the species of *Taenia* in this area, we analyzed the *cox1* gene isolated from the eggs, and the results (either *T. saginata* or *T. solium*) have been published separately [15]. The risk factors for *Taenia* infection in Koh Kong area remain to be elucidated. Some of the echinostome eggs were identified to be eggs of *Echinostoma revolutum* in Pursat Province [16] and *Echinostoma ilocanum* in Oddar Meanchey Province [17] through recovery of adult flukes after anthelmintic treatment and purging. Dicrocoelid eggs were detected in a few cases; however, these cases may be spurious infections caused by eating cattle liver infected with adult dicrocoelid flukes (e.g., *Dicrocoelium dendriticum*).

Regarding the prevalence of *E. vermicularis*, it should be reminded that the figures obtained in this study do not reflect the real status of infection because the examination was performed only by the Kato-Katz technique in this study. Therefore, the egg positive rate of *E. vermicularis* (av. 1.1%) obtained must have been an underestimated value. To cope with this problem, the cello-tape anal swab technique should be applied which can detect *E. vermicularis* eggs properly.

Conclusively, hookworms, followed by Ov/MIF, *A. lumbricoides*, and *T. trichiura* were found to be the most highly preva-



lent intestinal helminth among inhabitants of Cambodia. Sustained helminth control projects are necessary to further reduce morbidity due to parasitic infections in Cambodia.

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## CONFLICT OF INTEREST

We have no conflict of interest related to this work.

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