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...
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, Palin, Preah Vihear, and Siem Reap), southwestern (Kampot, Koh Kong, and Preah Sihanouk), eastern (Kratie, Mondulkiri, 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 Sihanouk (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 Anclylostoma 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 Mondulkiri 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 0-0.0% for these nematodes.

Taenia spp. eggs were detected in fecal samples collected from 13 provinces. The highest prevalence was found in Koh Kong and Mondulkiri 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 Mondulkiri, 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 | Overall positive cases | Hookworms* | Ascaris lumbricoides | Trichuris trichiura | Opisthorchis viverrini/MIF† | Hymenolepis nana | Taenia spp. | Enterobius vermicularis | Others* |
|-------------------|--------------------------|------------------------|------------|----------------------|-----------------|-------------------------|-----------------|-------------|-----------------------|---------|
| Northwestern regions |                          |                        |            |                      |                 |                         |                 |             |                       |         |
| Banteay Meanchey   | 820                      | 167 (20.4)             | 143 (17.4) | 3 (0.4)              | 8 (1.0)         | 5 (0.6)                 | 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†   | 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 (2.3)   | 3 (0.4)              | 6 (0.8)         | 1 (0.1)                 | 0 (0.0)         | 0 (0.0)     | 5 (0.6)               | 15 (1.9) |
| Preah Vhear        | 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 |                          |                        |            |                      |                 |                         |                 |             |                       |         |
| Kampong            | 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†            | 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†            | 770                      | 163 (21.2)             | 26 (3.4)   | 0 (0.0)              | 8 (1.0)         | 3 (0.4)                 | 0 (0.0)         | 0 (0.0)     | 7 (0.8)               | 126 (16.4) |
| Svay Rieng         | 838                      | 112 (13.4)             | 59 (7.3)   | 17 (2.0)             | 11 (2.0)        | 5 (0.6)                 | 0 (0.0)         | 4 (0.3)     | 3 (0.4)               | 11 (1.3) |
| Takeo†             | 3,889                    | 1,715 (44.1)           | 564 (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) |

*The species of hookworms were not determined.
†These eggs may include those of O. viverrini and minute intestinal flukes, such as Haplorchis spp.
‡The results are based on the Kato-Katz fecal smear technique and not on the celotape anal swab method.
§Including the eggs of Trichostongylus sp., Hymenolepis diminuta, echinostomes, dicrocoelids, and fasciolids.
**Some part of the data was published by Sohn et al. (2011a; 2011b; 2011c; 2012) and Yong et al. (2012)c.

children. However, the prevalence of *E. vermiculatis* 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...
In the 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
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 determine 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.

REFERENCES

1. Sinuon M, Anantaphruti MT, Socheat D. Intestinal helminthic infections in schoolchildren in Cambodia. Southeast Asian J Trop Med Public Health 2003; 34: 254-258.
2. Chhakda T, Muth S, Socheat D, Odermatt P. Intestinal parasites in school-aged children in villages bordering Tonle Sap Lake, Cambodia. Southeast Asian J Trop Med Public Health 2006; 37: 859-864.
3. Khieu V, Schär F, Marti H, Satasone S, Duong S, Sinuon M, Odermatt P. Diagnosis, treatment and risk factors of Strongyloides stercoralis in schoolchildren in Cambodia. PLoS Negl Trop Dis 2013; 7: e2035.
4. Stich AH, Biays S, Odermatt P, Men C, Saem C, Sokha K, Ly CS, Legros P, Philips M, Lordmand JD, Tanner M. Foci of schistosomiasis mekongi, Northern Cambodia: II. Distribution of infection and morbidity. Trop Med Int Health 1999; 4: 674-685.
5. Yong TS, Shin EH, Chai JY, Sohn WM, Eom KS, Lee DM, Park K, Jeoung HG, Hoang EH, Lee YH, Woo HJ, Lee JH, Kang SI, Cha JK, Lee KH, Yoon CH, Sinuon M, Socheat D. High Prevalence of Opisthorchis viverrini Infection in a Riparian Population in Takeo Province, Cambodia. Korean J Parasitol 2012; 50: 173-176.
6. Sohn WM, Yong TS, Eom KS, Pyo KH, Lee MY, Lim H, Choe S, Jeong HG, Sinuon M, Socheat D, Chai JY. Prevalence of Opisthorchis viverrini infection in humans and fish in Kratie Province, Cambodia. Acta Trop 2012; 124: 215-220.
7. Miyamoto K, Kirinoki M, Matsuda H, Hayashi N, Chigusa Y, Sinuon M, Chuo CM, Kitiloon V. Field survey focused on Opisthorchis viverrini infection in five provinces of Cambodia. Parasitol Int 2014; 63: 366-373.
8. World Health Organization. Cambodia leads the way in the protection of children against worms. Bull WHO 2004; 82: 636.
9. Schär F, Inpankaew T, Traub RJ, Khieu V, Dalsgaard A, Chimnoi W, Chhoun C, Sok D, Marti H, Sinuon M, Odermatt P. The prevalence and diversity of intestinal parasitic infections in humans and domestic animals in a rural Cambodian village. Parasitol Int 2014; 63: 597-603.
10. Inpankaew T, Schär F, Dalsgaard A, Khieu V, Chimnoi W, Chhoun C, Sok D, Marti H, Sinuon M, Odermatt P, Traub RJ. High prevalence of Ancylostoma ceylanicum hookworm infections in humans, Cambodia, 2012. Emerg Infect Dis 2014; 20: 976-982.
11. Lee KJ, Bae YT, Kim DH, Deung YK, Ryang YS, Kim HI, Im KI, Yong TS. Status of intestinal parasites infection among primary school children in Kampongcham, Cambodia. Korean J Parasitol 2002; 40: 153-155.
12. Moore CE, Chhat HP, Sona S, Sopheary S, Lee SJ, Parry CM, Day NPI, Stesser N. Chaging patterns of gastrointestinal parasite infections in Cambodian children: 2006-2011. J Trop Pediatr 2012; 58: 509-512.
13. Touch S, Komalanisra C, Radomyos P, Waikagul J. Discovery of Opisthorchis viverrini metacercariae in freshwater fish in southern Cambodia. Acta Trop 2009; 111: 108-113.
14. Sohn WM, Shin EH, Yong TS, Eom KS, Jeong HG, Sinuon M, Socheat D, Chai JY. Adult Opisthorchis viverrini flukes in humans, Takeo, Cambodia. Emerg Infect Dis 2011; 17: 1302-1304.
15. Jeon HK, Yong TS, Sohn WM, Chai JY, Hong SJ, Han ET, Jeong HG, Chhakda T, Sinuon M, Socheat D, Eom KS. Molecular identification of Taenia tapeworms by cox1 gene in Koh Kong, Cambodia. Korean J Parasitol 2011; 49: 195-197.
16. Sohn WM, Chai JY, Yong TS, Eom KS, Yoon CH, Sinuon M, Socheat D, Lee SH. Echinostoma revolutum infection in children, Pursat Province, Cambodia. Emerg Infect Dis 2011; 17: 117-119.
17. Sohn WM, Kim HI, Yong TS, Eom KS, Jeong HG, Kim IK, Kang AR, Kim MR, Park JM, Ji HS, Sinuon M, Socheat D, Chai JY. Echinostoma ilocanum infection in Oddar Meanchey Province, Cambodia. Korean J Parasitol 2011; 49: 187-190.