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# INTESTINAL PARASITIC INFECTIONS AND SOCIOECONOMIC STATUS IN PREK RUSSEY COMMUNE, CAMBODIA

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**Objective** Possible relationships were explored between socioeconomic status (SES) and intestinal parasitic infections among residents of Prek Russey, a commune in a rural area near Phnom Penh.

**Methods** An epidemiological study was conducted in Prek Russey Commune, consisting of the following three villages: Kroppeu Ha (KH), Prek Russey (PR), and Prek AngChanh (PA), with respective populations of 3,401, 1,350, and 1,044. Examinations of intestinal parasitic infections and the interview survey were performed.

**Results** Among the residents of KH, PR, and PA, respectively, the prevalence rates of three major species of parasites were as follows: 17%, 27%, and 34% had hookworm; 14%, 17%, and 19% had *Ascaris lumbricoides*; and 13%, 17%, and 18% had *Strongyloides stercoralis*. The prevalence of each parasitic group tended to increase in the order of KH, PR, and PA. The greatest differences between the villages were in the prevalence of hookworm infection. Our epidemiological survey revealed three SES-related factors whose proportions increased or decreased in the order of KH, PR, and PA. First, the percentages of households purchasing relatively safe drinking water were 96%, 63%, and 2%, respectively. Second, whereas 82% and 78% of houses in KH and PR were equipped with a latrine, only 41% of houses in PA were so equipped. Third, the proportion of households whose main income was from farming increased in the order of KH, PR, and PA.

**Conclusion** The present study thus suggests that greater latrine use and less dependence on farming activity are related to a lower prevalence of intestinal parasitic infections, although the results are not conclusive due to the ecological nature of the study.

**Key words**: socioeconomic status, intestinal parasitic infections, hookworm, *Strongyloides stercoralis, Ascaris lumbricoides*, Cambodia

## I. Introduction

It is estimated that at least one-quarter of the world's population is chronically infected with intestinal parasites, and most of the infected people live in developing countries[1]. In Cambodia little research has been done on intestinal parasitic infections, although in 1992 the present author examined 100 villagers in Kok Trop Commune, 13 km from the present study area[2]. Recently, Sinuon et al. (2003)[3] carried out a survey on the prevalence of intestinal helminthic infections in schoolchildren (2,090 subjects) in several rural and urban areas of Cambodia. In their report, great area differences were found in the prevalence of hookworm (5–65%) and *A. lumbricoides* (10–40%) infections, but the mechanisms underlying these area differences remained unclear.

The prevalence of intestinal parasitic infections is considered to decrease as socioeconomic status (SES) improves. Likewise, the mass treatment of inhabitants with intestinal parasitic infections and the creation of a hygienic environment have often dramatically reduced the prevalence of parasitic infections, at least temporarily. Therefore, it is strongly suspected that intestinal parasitic infections are related to socioeconomic factors such as educational level, occupation, income, water supply, sanitary and garbage disposal systems, house type, and electric power supply. However, the literature is not entirely consistent in this regard. Though a relatively well-defined ecological study found an association between intestinal parasitic infections and SES, based on an examination of 292 subjects[4], at least five

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cross-sectional studies failed to show any association between intestinal parasitic infections and toilet use[5~9]. So far as we know, only one cross-sectional study has reported an association between greater latrine use and a lower prevalence of intestinal parasitic infections[10].

Therefore, we conducted surveys on intestinal parasitic infections in a rural area not far from Phnom Penh, Cambodia, and explored any possible relationship between the prevalence and socioeconomic conditions.

## II. Subjects and Methods

*Study Area*

We conducted an international cooperation project for the control of intestinal parasitic diseases in the Prek Russey Commune (Takmau District, Kandal Province, Cambodia). The commune, about 20 km south of Phnom Penh, neighbors the town of Takmau, the capital of Kandal Province (Figure 1). In the early 1990s, Cambodian and Japanese dentists initiated preventive programs in this commune to target periodontal disease. The major purpose of our project was to control intestinal parasitic infections in a rural community in Cambodia in collaboration with their oral health project.

The study group for oral health conducted a census registration prior to the oral health survey[11] and provided us with tentative local population registration data listing all the residents in the commune. During the survey we found discrepancies between the registration data and the actual status of some residents. A number of subjects had moved into the commune since the data were compiled. Therefore, we revised the local population registration data on the basis of the information collected during our home visits. Consequently, the total population of the commune under study was counted as 5,795.

The Prek Russey Commune consists of three villages: Kroppeu Ha (KH), Prek Russey (PR), and Prek AngChanh (PA), with respective populations of 3,401, 1,350, and 1,044. Despite their close proximity, these villages differ somewhat in socioeconomic conditions. As shown in Figure 1, National Highway Route 2 passes through KH and PR, and many residents of those villages commute to Phnom Penh for work or study. PA, by comparison, is less developed both economically and socially, and most of its residents make their living by farming. PA is located on the west side of a 10-meter-wide branch of the Bassak River, whereas the other two villages are on the east side. The main access route from PA to the neighboring villages is a 3-meter-wide bridge leading to PR.

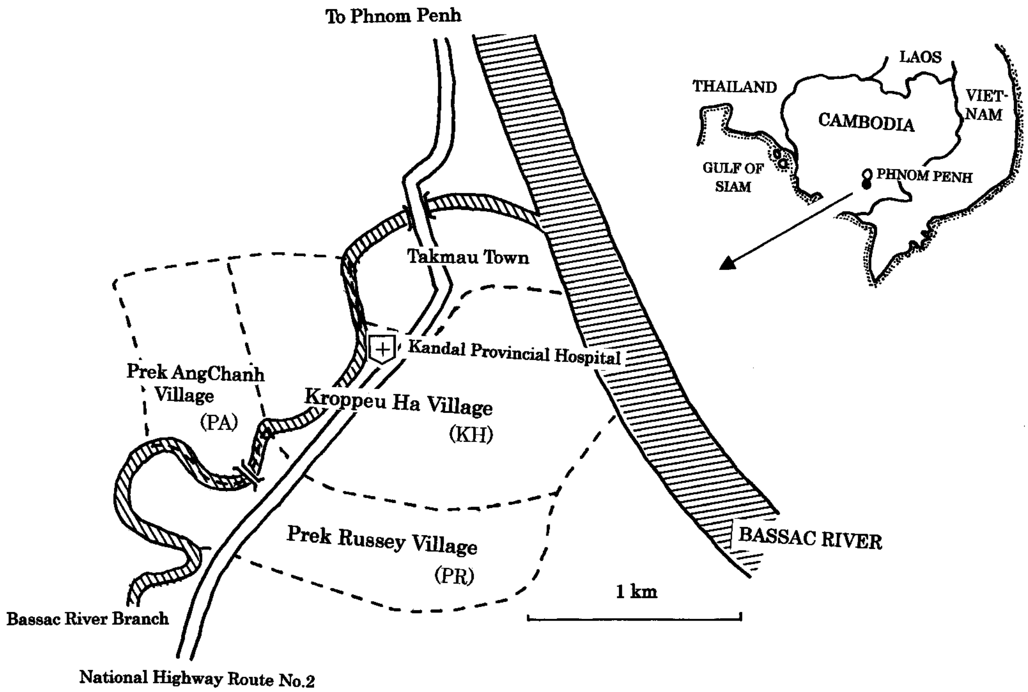


**Figure 1.** Map of Prek Russey Commune.

*Study Subjects*

The residents living at home during our study period were solicited to participate in a fecal examination survey. In all, 5,050 residents were solicited (Table 1). A considerable number of residents (745) were away from home for work, school, or other reasons. The frequency of those away from home was relatively high among those in their 20s.

**Table 1.** Characteristics of the study subjects.

| | | Solicited subjects[a] | Participants[b] | Response rate |
|---|---|---|---|---|
| sex[a,b] | female | 2,675 | 1,966 | 73% |
| | male | 2,342 | 1,567 | 67% |
| age[a,b] | 0–9 | 1,361 | 1,067 | 78% |
| | 10–19 | 1,279 | 885 | 69% |
| | 20–29 | 784 | 469 | 60% |
| | 30–49 | 1,079 | 723 | 67% |
| | 50– | 518 | 387 | 75% |
| village | 1 KH | 3,051 | 2,323 | 76% |
| | 2 PR | 1,107 | 707 | 64% |
| | 3 PA | 892 | 544 | 61% |
| total | | 5,050 | 3,574 | 71% |

[a] Number of solicited subjects to participate in the fecal examination survey. Sex and age were unknown in 33 and 29 subjects, respectively.

[b] Number of participants who submitted fecal specimens. Sex and age were unknown in 41 and 43 subjects, respectively.

In total, 3,574 residents agreed to provide fecal specimens.

*Examination of intestinal parasitic infections and performance of the interview survey*

From April through July 1995, we visited every house in all three villages to request fecal samples and to survey the residents. Handouts explaining the harm of intestinal parasitic infections and announcing the dates of upcoming examinations were distributed to all households in March 1995. Home visits for feces collection and interviews were conducted by our study team, consisting of a few Cambodian staff members of the Hygiene and Epidemiology Station (our Cambodian counterpart), a Japanese nurse, and the author. Parasitological examinations of collected fecal specimens were conducted by seven or eight Cambodian staff members of the Hygiene and Epidemiology Station. These associates had been trained in a nursing school to provide clinical examinations and, prior to the beginning of the study, underwent a four-day laboratory-training course on parasitological examination, given by the author.

At the first home visit, we gave a family member a sufficient number of containers in which to deposit a fecal specimen from each family member, and we explained the aim of the research and how to deposit the samples. We retrieved the samples the following day. If some of the family members had not provided specimens by that time, we visited their houses again so as to collect specimens from as many residents as possible.

**Table 2.** Results of the interview survey about hygienic environment for each household.

| | Kroppeu Ha | | Prek Russey | | Prek AngChanh | | *P* value[a] |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | |
| Having latrine* | 359 | 82% | 139 | 78% | 65 | 41% | <0.001 |
| Purchasing well water | 421 | 96% | 112 | 63% | 3 | 2% | <0.001 |
| Main resource of family income is agriculture | 23 | 5% | 55 | 31% | 76 | 48% | <0.001 |
| Boiling drinking water | 244 | 56% | 156 | 88% | 111 | 70% | <0.001 |
| Using human excreta as manure | 0 | 0% | 0 | 0% | 0 | 0% | — |
| Burning garbage | 236 | 54% | 86 | 48% | 84 | 53% | 0.447 |
| All family members wear shoes or sandals always | 276 | 63% | 137 | 77% | 84 | 53% | <0.001 |
| Prior visit to a hospital by any family member | 86 | 20% | 3 | 2% | 16 | 10% | <0.001 |
| Number of households answered (n=774) | 438 | | 178 | | 158 | | |
| Number of households in the population registration | 618 | | 249 | | 191 | | |
| Reply rate | 71% | | 71% | | 83% | | |

* Any type of latrine, including water-seal and pit latrines.

[a] *P* values were obtained from Pearson's Chi square test.

— *P* value cannnot be calculated.

In the questionnaire survey, we interviewed the head of the household or its surrogate. The questionnaire asked about environmental hygiene, SES-related factors, and others listed in Table 2.

The fecal specimens were sent to the Hygiene and Epidemiology Station, which was attached to the provincial hospital, close to the border between the commune and Takmau (Figure 1), and were examined for parasites at the Station on the same day they were retrieved. For this purpose, two different methods were applied: a formalin-ether concentration method[12] and a modified agar plate method. A fecal specimen was considered positive for parasites when a positive result was obtained from either method. The examination by the modified agar plate method was carried out according to a procedure the author and colleagues described previously[13]. Briefly, a 2–3 grams sample of feces was placed at the center of nutrient agar in a 9-cm petri dish; contained worms eventually crawl out onto the agar medium during incubation (at room temperature for 6 days). The agar plate method has often been reported to be highly effective at detecting *Strongyloides*[13~22] since Arakaki et al. in 1988 first introduced the method for this purpose[14]. In addition, the present author reported evidence of efficiency for detecting hookworm[13], and this finding was supported by Hasegawa et al.[15].

*Statistical procedures*

For the analysis comparing SES among the three villages, we used Pearson's Chi square test. For prevalence of parasitic infections, odds ratios were calculated as measures of association[23] and adjusted odds ratios were obtained by logistic analysis. Two sided P values and 95% confidence intervals were calculated.

## III. Results

Fecal specimens were obtained from 3,574 residents, or 71% of the solicited subjects (Table 1). Table 1 summarizes the sex and age distributions of the solicited subjects and of the participants in the fecal examination survey.

For the interview survey, a total of 774 households (73%) responded to our survey (Table 2). The response rates in KH, PR, and PA were 71%, 71%, and 83%, respectively. Table 2 shows the SES-related factors, revealing evident area differences, i.e., variation among the villages. There were three SES-related factors whose proportions increased or decreased in the order of KH, PR, and PA. First, the proportions of households purchasing relatively safe drinking water were 96%, 63%, and 2%, respectively. Second, whereas 82% and 78% of houses in KH and PR were equipped with a latrine, only 41% of houses in PA were so equipped. Third, the proportion of households with the main income from farming increased in the order of KH, PR, and PA.

The results of the parasitological examinations are shown in Table 3. Intestinal parasites were detected in 1,504 (42.1%) of the 3,574 examinees. The three intestinal parasites most frequently found in this area were hookworm (*Ancylostoma duodenale* and *Necator americanus*) (21.8%), *Ascaris lumbricoides*

**Table 3.** Prevalence of intestinal parasitic infections among residents of Prek Russey Commune.

| | Total | | Kroppeu Ha Village | | Prek Russey Village | | Prek AngChanh Village | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| Examinees | 3,574 | | 2,323 | | 707 | | 544 | |
| Cases with parasitic infections[a] | 1,504 | 42.1% | 872 | 37.5% | 343 | 48.5% | 289 | 53.1% |
| Hookworm[b] | 779 | 21.8% | 402 | 17.3% | 194 | 27.4% | 183 | 33.6% |
| *Ascaris lumbricoides* | 552 | 15.4% | 331 | 14.2% | 119 | 16.8% | 102 | 18.8% |
| *Strongyloides stercoralis* | 521 | 14.6% | 304 | 13.1% | 117 | 16.5% | 100 | 18.4% |
| *Hymenolepis nana* | 81 | 2.3% | 39 | 1.7% | 21 | 3.0% | 21 | 3.9% |
| *Giardia lamblia* | 59 | 1.7% | 47 | 2.0% | 8 | 1.1% | 4 | 0.7% |
| *Entamoeba coli* | 41 | 1.1% | 33 | 1.4% | 6 | 0.8% | 2 | 0.4% |
| *Trichuris trichiura* | 30 | 0.8% | 20 | 0.9% | 9 | 1.3% | 1 | 0.2% |
| *Enterobius vermicularis* | 13 | 0.4% | 8 | 0.3% | 2 | 0.3% | 3 | 0.6% |
| *Trichomonas vaginalis* | 7 | 0.2% | 5 | 0.2% | 2 | 0.3% | 0 | 0.0% |
| only worm track | 19 | 0.5% | 3 | 0.1% | 6 | 0.8% | 10 | 1.8% |

[a] Positive cases were those having any of the intestinal parasites listed in the table.
[b] Almost all were *Ancylostoma duodenale*.

**Table 4.** Proportion of residents infected with three major parasites according to sex, age and village.—Results of multiple logistic regression analysis.

Hookworm

| | | + | N | +/N | OR | 95%CI | *P* |
|---|---|---|---|---|---|---|---|
| sex | female | 393 | 1,964 | 20% | 1@ | | |
| | male | 376 | 1,564 | 24% | 1.3 | 1.1–1.5 | *P*=0.004 |
| age | 0–9 | 123 | 1,066 | 12% | 1@ | | |
| | 10–19 | 274 | 885 | 31% | 3.4 | 2.7–4.4 | |
| | 20–29 | 110 | 469 | 23% | 2.3 | 1.8–3.1 | |
| | 30–49 | 86 | 721 | 12% | 1.9 | 1.5–2.5 | |
| | 50– | 59 | 387 | 15% | 3.4 | 2.5–4.5 | *P* for heterogeneity<0.001 |
| village | 1 KH | 396 | 2,290 | 17% | 1@ | | |
| | 2 PR | 193 | 705 | 27% | 1.8 | 1.5–2.2 | |
| | 3 PA | 180 | 533 | 34% | 2.4 | 2.0–3.0 | *P* for heterogeneity<0.001 |

*Strongyloides*

| | | + | N | +/N | OR | 95%CI | *P* |
|---|---|---|---|---|---|---|---|
| sex | female | 251 | 1,964 | 13% | 1@ | | |
| | male | 260 | 1,564 | 17% | 1.4 | 1.1–1.6 | *P*=0.001 |
| age | 0–9 | 74 | 1,066 | 7% | 1@ | | |
| | 10–19 | 149 | 885 | 17% | 2.7 | 2.0–3.6 | |
| | 20–29 | 88 | 469 | 19% | 3.1 | 2.2–4.3 | |
| | 30–49 | 114 | 721 | 16% | 2.5 | 1.8–3.4 | |
| | 50– | 86 | 387 | 22% | 3.8 | 2.7–5.4 | *P* for heterogeneity<0.001 |
| village | 1 KH | 296 | 2,290 | 13% | 1@ | | |
| | 2 PR | 117 | 705 | 17% | 1.3 | 1.1–1.7 | |
| | 3 PA | 98 | 533 | 18% | 1.5 | 1.2–2.0 | *P* for heterogeneity=0.001 |

*A. lumbricoides*

| | | + | N | +/N | OR | 95%CI | *P* |
|---|---|---|---|---|---|---|---|
| sex | female | 311 | 1,964 | 16% | 1@ | | |
| | male | 234 | 1,564 | 15% | 0.9 | 0.78–1.1 | *P*=0.475 |
| age | 0–9 | 218 | 1,066 | 20% | 1@ | | |
| | 10–19 | 175 | 885 | 20% | 1.0 | 0.8–1.2 | |
| | 20–29 | 53 | 469 | 11% | 0.5 | 0.4–0.7 | |
| | 30–49 | 64 | 721 | 9% | 0.4 | 0.3–0.5 | |
| | 50– | 35 | 387 | 9% | 0.4 | 0.3–0.6 | *P* for heterogeneity<0.001 |
| village | 1 KH | 328 | 2,290 | 14% | 1@ | | |
| | 2 PR | 119 | 705 | 17% | 1.2 | 1.0–1.5 | |
| | 3 PA | 98 | 533 | 18% | 1.3 | 1.1–1.7 | *P* for heterogeneity=0.035 |

+: number of residents infected with each parasite.
N: number of examinees.
Odds ratio and 95%CI were obtained from multiple logistic analysis, where all the variables listed in the table were included in the logistic model.
KH: Kroppeu Ha Village. PR: Prek Russey Village. PA: Prek AngChanh Village.
@ reference category.

(15.4%), and *Strongyloides stercoralis* (14.6%), while other parasites infected less than 3% of examinees.

We excluded 46 residents because we did not know their sex or age, leaving 3,528 subjects for statistical analysis. The proportions of residents infected with hookworm, *Strongyloides*, or *A. lumbricoides* are shown in Table 4. The prevalence of hookworm and *Strongyloides* infections was significantly higher among men than among women ($P=0.004$ for hookworm and 0.001 for *Strongyloides*, respectively).

The prevalence of hookworm and *Strongyloides* infections increased with age, peaking and fluctuating slightly in adulthood. The prevalence of *A. lumbricoides* infection was highest in children, then decreased with age in adulthood. With respect to area differences, the infection rate of each parasite tended to increase in the order of KH, PR, PA. All of those area differences were statistically significant.

## IV. Discussion

This study showed a tendency for the prevalence of hookworm, *Strongyloides*, and *A. lumbricoides* infections to increase in the order of KH, PR, PA, the greatest differences among the villages being found for hookworm infection. Among the SES-related factors, the prevalence of latrine use and the practice of purchasing water decreased in the order of KH, PR, and PA, while engagement in agriculture increased. Note here that hookworms infect humans by infectious larval entry through the skin or, occasionally, through oral ingestion. As the infectious larvae spend their lives within a few inches of the place where the eggs were deposited[24)], it seems unlikely that hookworm larvae crawl into water depositories or that hookworm infection occurs by drinking contaminated water. Therefore, the present study suggests that farming and non-latrine use may be associated with infection by intestinal parasites, particularly hookworm.

In our comparison of SES-related factors in the three villages, we were unable to use individual data obtained from the survey, since the individual records for each household were accidentally dumped after the summary was prepared. Nevertheless, our survey on intestinal parasitic infections was a large-scale research study of a commune and covered the residents as a whole, with little sampling error. Because the three villages neighbor each other, it is very likely that nonsocioeconomic factors, such as climate, are almost the same among the villages.

Gamboa et al. (1998)[4)] compared three socioeconomically different areas in the city of La Plata, Argentina, and reported that the prevalence of intestinal parasitic infections was significantly related to inferior sanitary and environmental conditions. However, the mechanisms connecting the SES and intestinal parasitic infections were not entirely clear in their study. It has been suspected that the use of a toilet system may prevent intestinal parasitic infections. However, at least five cross-sectional studies failed to show any association between intestinal parasitic infections and toilet use[5~9)]. So far as we know, only one report has documented a link: a cross-sectional study conducted by Tsuyuoka et al.[10)] in Brazil revealed the prevalence of *T. trichiura* and *A. lumbricoides* infections to be higher among students who lived in houses without than with a toilet.

In the present study, as in others, the prevalence of hookworm infection increased with age[15,25~27)]. In hyperendemic areas it has been reported to increase until the age of 20 and then remains relatively stable[28)], suggesting that partial immunity may be acquired during childhood[24)]. The age distribution of *Strongyloides* infection in this study was similar to that of hookworm infection, whose prevalence increases with age and plateaus at around 40–50 years. Human infection by *Strongyloides* occurs usually when intact skin is penetrated by infectious filariform larvae that survive in moist soil contaminated with human feces. This mode of transmission is exactly comparable with that of the hookworms *Ancylostoma duodenale* and *Necator americanus*[29)]. On the other hand, the age distribution of *A. lumbricoides* infection in the present population differed from those of hookworm and *Strongyloides*, being highest in childhood and then decreasing with age. This agrees with other studies that found the prevalence of *A. lumbricoides* usually peaks around age 5 and declines slightly in adulthood[17,24,28)]. Infection results from ingestion of viable ova that have been shed by infective humans onto humid and shady soil.

Regarding sex distribution, both hookworm and *Strongyloides* infections tend to be more prevalent among males than among females, as reported in many previous studies conducted in endemic areas[15,17,26,30)]. The cause of this sex difference remains unclear, but occupational activity as well as the hormonal and genetic background may play a role. An animal experiment[31)] showed male mice to be more susceptible than females to murine *Strongyloides ratti* infection, and the administration of androgen to female mice increased susceptibility.

In the present study, the response rates of study subjects differed from village to village. However, it is unlikely that this factor affected our major conclusions, since intestinal parasitic infections are mostly asymptomatic and therefore parasitic infections are unlikely to affect participation.

Finally, from our results we conclude that greater latrine use and employment other than farming are related to a lower prevalence of intestinal parasitic infections, although the results are not conclusive due to the ecological nature of the study.

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