INTRODUCTION

Tonle Sap Lake, also known as “Great Lake”, is located in central Cambodia. It is the largest freshwater lake in Southeast Asia. It is situated within the floodplain of the Mekong and represents a vast natural resource area. Fish, water plants, and the mineral-rich soil of the annually flooded shoreline attract human settlements. Water resources are intensively used, therefore, promoting the spread of water-borne infections, potentially also Schistosoma mekongi.

Schistosomiasis mekongi has been described in Kratie and Stung Treng Provinces in Cambodia, (Biays et al, 1999; Stich et al, 1999) and in Champassack Province of southern Lao PDR (Urbani et al, 2002). Although control efforts targeted against this severe parasitic infection have been undertaken in Lao PDR since 1983 and since 1994 in Cambodia, transmission continues (Ohmae et al, 2004) and patients with active infections of S. mekongi are still diagnosed in both countries. Neotricula aperta, the intermediate host snail, is found in the Mekong River but also in its tributaries, such as the Xe Kong River in southern Lao PDR and northern Cambodia (Attwood et al, 2004).

There has been considerable discussion whether the transmission of S. mekongi occurs in Tonle Sap Lake. On several occasions, patients with an S. mekongi infection were reported among refugees originating from the provinces bordering Tonle Sap Lake, in particular Battambang Province (Keittivuti et al, 1982a, 1982b, 1983). Furthermore, for health impact assessments of large-scale water resources development projects of the Mekong river system such as dams and lakes, an in-
depth understanding of the suitable transmission area of S. mekongi, and therefore its presence in Tonle Sap Lake, is of great importance.

The objective of the present study was to investigate S. mekongi and other intestinal parasitic infections, and intestinal symptoms and related complaints among school-age children and adolescents.

MATERIALS AND METHODS

Study area and population surveyed

The study was conducted between December 1998 and June 1999. Districts of all provinces around Tonle Sap Lake were visited, except those of Siem Reap Province. School-age children were selected for the study according to the following procedure: first, health authorities at the district level were asked about villages where schistosomiasis-related morbidity was suspected (reports of hepatomegaly, or blood or mucus in stool). Second, in the identified villages, teachers and health staff were interviewed about children who had suspected symptoms of schistosomiasis. Third, in each village children with suspected symptoms were included; and/or a sample of schoolchildren and adolescents were randomly selected at the local school (50 < n < 150, depending on the size of the school) and enrolled in the study.

Field and laboratory procedures

A single stool sample was obtained from each participant and examined for intestinal parasites using the Kato-Katz thick smear technique (Katz et al, 1972). One slide was examined per stool. A random sub-sample (50%) of the stools was fixed in sodium acetic-acetic acid-formalin (SAF) and examined at the National Malaria Center, Phnom Penh, for the presence of helminthic and protozoal intestinal parasites using a concentration technique (Yang and Scholten, 1977). A further random sub-sample (10%) was examined on the survey day for the presence of S. stercoralis larvae using the modified Baermann technique (Watson and Al Hafidh, 1957).

Children were clinically examined for the presence of hepatomegaly and splenomegaly, and screened for the presence of blood and mucus in stool, intestinal complaints, and risk factors for intestinal parasitic infections (water contacts such as bathing, and fishing; wearing of shoes, and utilization of latrines).

Data management and statistical analysis

Data was entered in EpilInfo (version 6.0) and analyzed with STATA (Stata Cooperation, College Station, TX, USA). Rates and means were calculated for categorical and continuous data, respectively. Standard statistical procedures (95% confidence interval, \( \chi^2 \) test, Student’s t-test) were applied where appropriate.

The study was approved by the Ministry of Health, and provincial and district health departments. Oral consent was obtained from head of the villages and school teachers. Diagnosed infections were treated appropriately.

RESULTS

We visited 23 villages in all districts of four of the five provinces bordering the lake (approximately equivalent to two-thirds of its shoreline) (Table 1). A total of 1,616 children were enrolled from whom stool samples were obtained and examined using the Kato-Katz technique. Forty-nine percent (789) and 12% (188) of the stools were examined by SAF concentration and Baermann technique, respectively. Ninety-eight percent (1,584) were examined clinically.

Fifty-four percent (876) of the enrolled children were male. The sex ratio of the sub-samples for SAF concentration technique (57% male, \( p = 0.2 \)), Baermann technique (56% male, \( p = 0.6 \)), and clinical examination (54% male, \( p = 0.9 \)) did not differ significantly...
The overall mean age was 11.2 years (95% CI: 11.1-11.4). The mean ages for the sub-samples were 11.3 (95% CI: 11.0-11.4), 11.5 years (95% CI: 11.2-11.8), 11.3 years (95% CI: 11.1-11.4) for the SAF concentration technique, Baermann technique, and clinical examination sub-samples, respectively. There were no significant differences between the mean ages of the overall sample and the sub-samples (SAF concentration technique: p = 0.93; Baermann technique: p = 0.06; clinical examination p = 0.97).

Table 2 summarizes the results of the parasitological examinations. We found no child with a S. mekongi infection. Furthermore, none of the health staff at provincial, district or village levels reported a child or adult with the typical signs and symptoms of advanced schistosomiasis.

The clinical examination of the children revealed only very low prevalence rates of hepatomegaly (4.0%) and splenomegaly (0.1%) (Table 3). Enlargement of the liver and spleen, when present, was modest.

Behavior risk factors for potential transmission of schistosomiasis were reported in high frequencies (Table 3). For example, 68.1% of the children reported that they do not have access to any latrine or toilet at home, and 34.5% reported regular recreational swimming and bathing in the lake. In addition, 7.0% mentioned regular fishing activities.
frequencies. Others identified were Enterobius vermicularis, Taenia spp and Giardia lamblia. Twenty point two percent of the Baermann technique analysis yielded a positive result for S. stercoralis infection.

As expected, a high level of intestinal symptoms was reported. Within the previous three days, 44.3, 55.1, 20.0, and 15.6% of the children reported having had diarrhea, abdominal pain, and blood and mucus in their stool, respectively.

The risk factors for intestinal helminths were highly prevalent, thus assuring the transmission of soil-transmitted helminths. More than two-thirds of the children (68.1%) reported not having a latrine or toilet in the household. Only one-third of the children (32.6%) were wearing shoes on the survey day, and only two-thirds of them (62.5%) reported wearing shoes when defecating.

**DISCUSSION**

No S. mekongi infection has been detected in any of the more than one thousand persons examined by the two diagnostic tech-
niques. Neither the Kato-Katz technique (the standard diagnostic field approach) nor the SAF concentration technique (used to screen light infections) obtained any infection with this parasite. Furthermore, typical clinical signs, such as hepatosplenomegaly, were rare and of low degree only. This was not comparable to the clinical burden detected in the schistosomiasis endemic province of Kratie where, in 1995, more than half of the population had hepatomegaly (Biays et al, 1999).

The Mekong River contributes heavily to the annual flooding of Tonle Sap Lake via the Tonle Sap River. During this event the intermediate snail host, N. aperta, can easily be transported into the lake. However, the main ecological features of the shoreline of the Grant Lake are distinctly different from those of the Mekong river shores. The lake’s water is stagnant; its’bed is mainly clay, which produces turbid waters, and this is likely less favorable for sustaining N. aperta snails, which require predominantly clear waters, and sandy or rocky substrates (Urbani et al, 2002). Snail surveys should be conducted in the future to confirm these observations. Finally, additional studies carried out in the province of Kampong Chnang confirmed the absence of S. mekongi in schoolchildren (Sinuon et al, 2003).

The present study confirmed the high level of soil-transmitted helminths and associated risk-factors for transmission that have been largely documented in Southeast Asian countries. However, more importantly, it showed that S. stercoralis may reach substantial prevalence rates. This parasite is rarely diagnosed in surveys because it requires a specific concentration technique (Baermann technique). Clinically, this infection may lead to skin (larva currents) or to gastro-intestinal diseases. In immune-depressed subjects, S. stercoralis may lead to systemic disease due to its ability for autoinfection. Therefore, infection with S. stercoralis requires more attention.

Our study demonstrated that schistosomiasis mekongi is not present in the studied villages along the Tonle Sap Lake, and that it is very unlikely that it is transmitted in Tonle Sap Lake. This conclusion is of importance to water development projects that create artificial lakes featuring similar ecological settings.

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REFERENCES


