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Control of *Schistosoma mekongi* in Cambodia: results of eight years of control activities in the two endemic provinces

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Summary In Cambodia, schistosomiasis is transmitted in the provinces of Kratie and Stung Treng where approximately 80 000 individuals are estimated to be at risk of infection. The baseline prevalence of infection was estimated to be between 73% and 88%, and cases of severe morbidity (hepatosplenomegaly, puberty retardation) and mortality were very common. In 1994, the Ministry of Health of Cambodia started schistosomiasis control applying universal chemotherapy with praziquantel (40 mg/kg). The coverage of the programme was between 62% and 86% for 8 years. This simple control measure resulted in the control of the disease: no cases were reported in 2004 and only three cases were reported in 2005. In addition, there are no longer reports of cases of severe morbidity due to schistosomiasis. Since the beginning of the control programme, a single dose of mebendazole (500 mg) has been combined with praziquantel during the mass chemotherapy; as a result the prevalence of *Ascaris lumbricoides* and hookworms dropped from 74.5% to 10% and from 86% to 40% respectively. The experience in Cambodia demonstrates that, with political commitment, control of parasitic diseases is achievable even in a situation of minimal resources. The programme represents a successful model for other developing countries.

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1. Introduction

Schistosomiasis is one of the most prevalent parasitic infections in the world. It is endemic in 76 countries and continues to be a public health concern in the developing world (Engels et al., 2002). In Cambodia the disease is caused by *Schistosoma mekongi* (Voge et al., 1978), and the intermediate host is *Neotricula aperta*, a river snail that lives in the fissures of partially submerged rocks (Mouchet, 1995). Pigs and dogs have been found to be animal reservoirs of the parasite (Strandgaard et al., 2001). Symptoms and signs associated with *S. mekongi* infection include cachexia, hepatosplenomegaly, stunting and retardation of puberty, portal hypertension, ascites and rupture of oesophageal varices (Biays et al., 1999). Pathology associated with the infection consists in periportal thickening and portal vein enlargement (Hatz, 2001).

In 1994, 20 villages in Kratie Province were identified as the origin of severe cases of schistosomiasis (Stich et al., 1999). In the same year, the Ministry of Health started control activities with the initial support of Médicins Sans Frontières (MSF) and subsequently of the WHO. The control measures consisted mainly of periodic administration of praziquantel (40 mg/kg) to the entire population, except for children under 2 years of age and pregnant women.

At the same time, surveys were conducted to accurately establish the extent of the endemic area. From 2000, the campaigns covered districts in Stung Treng Province, which were inaccessible in the past due to lack of security. Since 2001, the campaign has covered 80 000 people in Kratie and Stung Treng (Figure 1). No new endemic areas have been identified since then.

The parasitological stool surveys carried out for schistosomiasis monitoring also revealed high infection rates for soil-transmitted helminths (STH). This finding led to the simultaneous administration of mebendazole (single dose 500 mg) to all the individuals treated with praziquantel.

The data presented in this paper were collected for monitoring purposes. Despite some gaps and lacks of continuity in the intervention, and in the data collection and recording (due to temporary lack of funds, armed conflicts and other unpredictable events), we consider the present data to be interesting for managers of similar programmes.

The paper aims to demonstrate that a major reduction of schistosomiasis prevalence can be obtained with mass distribution of anthelminthics and that this can be obtained also in a situation of minimal resources. The paper also shows the feasibility of integrating different anthelminthics in the same distribution system.

2. Materials and methods

2.1. Identification of the endemic area

Epidemiological assessments were conducted in the zones previously reported as endemic: Kratie (Audebaud et al., 1968; Jolly et al., 1970), Strung Treng (Urbani and Socheat, 1997), Rattanakiri and Kampong Cham (Ijima, 1970).

Three methods were used in order to delimit the area of intervention:

- questionnaires
- stool surveys in households and schools
- serological surveys.

Normally the first investigation was done with a questionnaire and then the positive data confirmed with parasitological or serological methods.

Over 30 000 questionnaires were distributed in the provinces of Kratie, Stung Treng, Rattanakiri and Kompong Cham (Urbani et al., 2002), over 1300 individuals were investigated using the Kato-Katz method (WHO, 1980) during household surveys and over 1200 during school surveys (Stich et al., 1999), and 12 villages were screened using

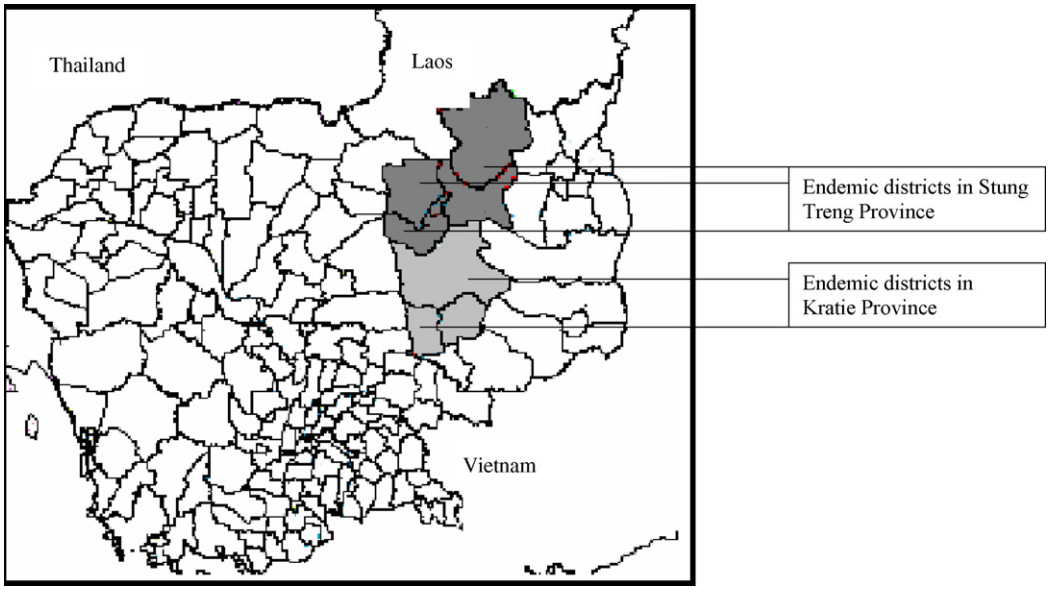

Figure 1 Location of districts endemic for *Schistosoma mekongi* in Cambodia.

an ELISA with soluble egg antigen of *S. japonicum* (Homae, 2004).

The data collected with the different assessments were analyzed, checked for consistency, assembled and then used to prepare maps showing the areas to be covered with mass distribution of anthelminthics.

2.2. Control intervention

Every year, between February and April, the campaign was conducted by a team from the National Center for Parasitology, Entomology and Malaria Control, and local health staff. Drugs were administered under direct observation of health staff. Treatments were combined with health education, in order to increase health awareness and to reduce contact with water on the rocky banks of the river.

From 1994 to 2005, the area of intervention increased from the 20 villages where schistosomiasis was originally reported to include all new areas that were identified successively. Since 2001, the campaign has covered 80 000 people. The target population for each campaign and details of the type of mass treatment applied in different years are presented in Table 1.

2.2.1. Coverage

The programme coverage has been evaluated through the drug distribution reports: on the occasion of each drug distribution campaign, forms recording age, sex, weight and number of tablets of praziquantel given to each individual were compiled by health staff. The coverage was calculated as the number of people treated divided by population estimates (census data periodically updated by the health centres).

2.2.2. Impact on schistosomiasis prevalence

The programme's impact on schistosomiasis prevalence has been periodically estimated with three methods:

- Parasitological surveys were conducted in randomly selected villages: between 2000 and 3000 individuals in an average of 20 villages were selected every year. The sample size in each village was between 70 and 150. Stool samples were examined with the Kato-Katz method and data on STHs were also collected.
- Annual parasitological surveys were conducted in primary schools of four sentinel villages in Kratie Province (Achen, Chatnaol, Srekheurn and Sambok) (from 1995) and in Sdau village in Stung Treng Province (from 1997). After the year 2000 in each site, three consecutive stool samples were examined with the Kato-Katz method.
- There was active search and follow up of cases of severe schistosomiasis during the mass treatment and the parasitological survey.

The monitoring surveys have been conducted in school-aged children because this age group is easily accessible and can provide indications of the situation in other age groups (Guyatt et al., 1999).

3. Results

3.1. Epidemiology

The epidemiological assessment identified 114 villages along the Mekong River and its tributaries Sesan and Sekong as endemic for schistosomiasis: the villages were in two districts of Kratie Province and in five districts of Stung Treng Province (Figure 1). About 80 000 individuals living along the Mekong River were estimated to be at risk of infection (Urbani et al., 2002). The area between Kratie and Sambo, on the left bank of the Mekong River, was identified as the most affected (over 70% positive answers to the questionnaire). No evidence of *S. mekongi* transmission came from Kampong Cham and Rattanakiri.

Table 1 Mass drug administration campaigns for the control of schistosomiasis in Cambodia, 1994–2005

Year	Province covered	Type of mass treatment conducted	Organizing institution	Approximate target population
1994/95	Kratie	Universal	MoH-MSF	45 000
1996	Kratie	Universal	MoH-MSF	45 000
1997	Kratie and Strung Treng	Universal	NMC-MSF	60 000
1998	Kratie and Strung Treng	No MDA[a]	NMC-MSF	–
1999	Kratie and Strung Treng	Universal	NMC-MSF	60 000
2000	Kratie and Strung Treng	Universal	NMC-MSF-WHO	70 000
2001	Kratie and Strung Treng	Universal	NMC-WHO	80 000
2002	Kratie and Strung Treng	Universal	NMC-WHO	80 000
2003	Kratie and Strung Treng	Targeted[b]	NMC-WHO	78 500
	Kratie and Strung Treng	Universal[c]	NMC-WHO	1 500
2004	Kratie and Strung Treng	Universal	NMC-WHO	80 000
2005	Kratie and Strung Treng	Universal	NMC-WHO	80 000

MoH: Ministry of Health; MSF: Médicins Sans Frontières; NMC: National Center for Parasitology, Entomology and Malaria Control.
[a] Mass drug administration was not conducted because of lack of funds.
[b] In 112 villages.
[c] In three villages.

Table 2 Prevalence of *Schistosoma mekongi* in Stung Treng (estimated in villages randomly selected every year)

Year	Coverage	Prevalence survey (by village)			
		No. of villages surveyed	No. of exams	No. of villages with active transmission (%)	Range of prevalence in positive villages (%)
1997	64%	13	1033	11 (85)	6—88%
1998	—[a]	6	401	9 (83)	5.1—43.1%
1999	63%	8	676	5 (62)	1.8—7.7%
2000	64%	13	849	10 (76)	2—19.6%
2001	67%	13	1029	5 (39)	1.4—7.2%
2002	62%	13	999	5 (39)	1.3—4.5%
2003	—[b]	14	1573	0	—
		5	502	0	—
2004	83.6%	8	905	0	—
2005	81.5%	10	1298	3 (30%)	0.7—3.5%

[a] Mass drug administration was not conducted because of lack of funding.
[b] Coverage was not estimated.

3.2. Mass treatment

The coverage of mass treatment was maintained between 62% and 74% between 1996 and 2002 with the exception of 1998 when universal drug administration was not conducted because lack of funds. In 2000 and 2001, the campaigns covered new areas, previously inaccessible due to lack of security. Since 2001 the campaign has covered 50 000 people in 56 villages in two districts of Kratie Province, and about 30 000 people in 58 villages in five districts of Stung Treng Province.

3.3. Programme impact on schistosomiasis

The initial surveys performed by MSF in Kratie Province between 1994 and 1995 revealed a prevalence of schistosomiasis in primary school children of 72.9% (Stich et al., 1999). Table 2 shows the decline in the number of villages presenting cases of schistosomiasis in Stung Treng and the range of prevalence. For Kratie, only the data on declining schistosomiasis prevalence in the four sentinel sites are available (Figure 2).

3.4. Clinical morbidity

Before the start of the intervention several new cases of severe schistosomiasis morbidity (hepatosplenomegaly, cachexia, anaemia, ascites, haematoemesis) and mortality were reported every year at the Provincial Hospital of Kratie and the District Hospital of Sambour as well as in the surrounding communities (Biays et al., 1999). In a survey in 1999, the number of cases identified with signs and symptoms of severe schistosomiasis reached 124 in Kratie Province. After treatment with praziquantel, 101 of them improved and were then able to perform light labour, four patients died and in eight cases the disease remained severe. Of the 11 patients who received surgical treatment between 2000 and 2002 at the National Calmette Hospital, 10 patients recovered and one patient died a few days after the operation. In Stung Treng Province, the registration and follow-up could not be done because people move more frequently from their home villages to field huts on farms.

Every year during the stool survey, clinical examination has been conducted to assess signs and symptoms including liver and spleen enlargement. Since 2003 no new symptomatic case has been observed in the provinces' health facilities.

3.5. Soil-transmitted helminths

The prevalence of STHs was examined in a sample of villages in Kratie and Stung Treng in 1997.

In Kratie, the prevalence of *Ascaris lumbricoides* was between 9.5% and 74.5%, *Trichuris trichiura* between 0% and 15.9%, and hookworms between 18.2% and 86%. Since 1997, mebendazole 500 mg has been combined with praziquantel during the mass drug administration. The prevalence of *A. lumbricoides* and *T. trichiura* decreased dramatically while

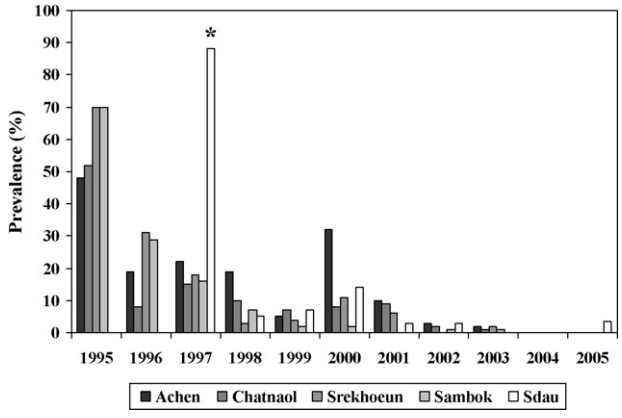

Figure 2 Changes in schistosomiasis prevalence in sentinel sites during the control programme implementation. * In Stung Treng Province the treatment started in 1998: Sdau is the only sentinel site in Stung Treng.

Table 3 Changes in prevalence of soil-transmitted helminths in selected villages of Kratie and Stung Treng between 1997 and 2005

	1997			2005		
	Ascaris lumbricoides	*Trichuris trichiura*	Hookworms	*Ascaris lumbricoides*	*Trichuris trichiura*	Hookworms
Achen	25	1.6	54.7	0	0	14.3
Chartnol	9.5	2.4	46.4	0.9	0	6.1
Sambok	16.2	2.1	45.1	0	0	9
Srekhoeun	13.8	3.4	50	0	0	5.7
Sdau	51.3	9.5	86	0	0.7	18.4
Koh Sneng	34	2.1	55.3	5.4	2.0	15.6
K. Chanh Tuk	69.6	2.2	67.4	0	0	26

the prevalence of hookworms has halved but remains relatively high. Table 3 presents the STH prevalence in villages for which data for both 1997 and 2005 are available.

4. Discussion

According to the UNDP Human Development Report (2003), Cambodia ranks 130th out of 175 countries on the human development index. Despite this low ranking and because decision makers are strongly committed, Cambodia was able to organize universal administration of praziquantel and mebendazole for 8 years resulting in a reduction of schistosomiasis and STH infection, so that:

- No new cases of severe morbidity due to schistosomiasis have been reported in the past four years in the health facilities in the area.
- Relevant nutritional benefits are expected after the reduction of STH (WHO, 2002).

We interpret the presence of new cases in three villages in 2005 as probably due to contamination by animal reservoirs (Strandgaard et al., 2001), immigrants from Laos or infected people that were not covered by the control programme. The new cases demonstrate also that all the conditions are in place for the resurgence of the disease if the control measures are interrupted. Experiences from Lao PDR demonstrated that, after a drastic reduction in prevalence, if the drug pressure is not maintained the parasite could easily return to original levels (Urbani et al., 2002). We suggest that the drug distribution should be maintained until sanitation standards have improved significantly. A possible option to maintain the disease under control and to reduce the cost of the yearly mass distribution would be to increase the intervals between mass administrations (i.e. every 2 years) and associate this with a very sensitive (ELISA) monitoring of the prevalence of the infection (Homae et al., 2004).

The experience in Cambodia demonstrates that with political commitment, parasitic disease control is achievable even in situation of minimal resources and that different anthelminthic drug can be provided by the same delivery system. The programme represents a successful model for other developing countries.

Conflicts of interest statement
The authors have no conflicts of interest concerning the work reported in this paper.

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