

Morbidity control of schistosomiasis in China

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Abstract

After reviewing the schistosomiasis control program in China with focusing on the socio-economic impact on schistosomiasis endemicity, we introduce the promotion process of morbidity control strategy undertaken before and during the World Bank Loan Project (WBLP) on Schistosomiasis Control. We analyzed the data derived from case study of morbidity control for schistosomiasis, and evaluated the efficacy of chemotherapy. It is suggested that appropriate drug treatment declines worm burden and the intensity of infection as well as prevalence, but chemotherapy alone can hardly reduce the transmission because zoonotic *Schistosoma japonicum* infection has a great impact on the transmission of the disease. Therefore, the strategies in different (high, medium, and low) transmission areas during the maintenance stage were put forward in consideration of challenges in national control program in the future. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Morbidity control; *Schistosoma japonicum*; Case study; Chemotherapy; China

1. Introduction

In China, schistosomiasis due to *Schistosoma japonicum* is a big health problem. Great suffering and premature death among people existed for centuries. More than 100 million people were at risk of the infection in southern China (Chen, 1989; Yuan, 1992). The endemic areas were mainly distributed along the Yangtze River and down to the basin of the Yangtze River including

404 counties/cities in 12 province level (Fig. 1). Geographically, the northernmost limit of the endemic area is at 33°25' latitude north, the southernmost at 22°42' latitude north, the easternmost at 121°45' longitude east, and the westernmost at 99°05' longitude east. The high-risk areas are around the middle and lower reaches of the Yangtze River, Tongding Lake and Poyang Lake. Based on epidemiological pattern, the intermediate of the snail ecology in endemic areas, the endemic regions can be stratified into three types, that is plain regions, marshland and lake regions, hilly and mountainous regions.

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The schistosomiasis causes severe morbidity resulting in disability and death. Some of endemic areas had had the sad name of ‘village without villagers’, because most of the residents died from schistosomiasis and the others moved away before the national schistosomiasis control program started. It was also a serious disease for the cattle, pigs and other domestic animals. The intermediate host of *S. japonicum* is an amphibious snail that lives not only in water all the time, so daily activity of the farmers, cattle herding, fishing, grass harvesting in the marshlands along rivers and lakes led to intense water contact, and as a result, to get the infection.

2. Schistosomiasis control in China

2.1. Achievement of schistosomiasis control

Although China is a developing country, significant gains in health status and diseases control including anti-schistosomiasis have been achieved.

In China, schistosomiasis control has been put as a high priority in disease control. A national leading group for schistosomiasis control was set up since 1955. The leading group was composed of the members of political bureau of Central Committee of Chinese Communist Party (CCCP), ministers of health, agriculture and water resources. In the endemic areas, the special health sectors for anti-schistosomiasis had been set up at the provincial level, station at the county level and community level. These institutions have been fully supported by the governments at different levels.

Health workers in cities and medical schools were asked to work in the rural areas to help the control work.

Combined approaches of snail control, chemotherapy, health education and hygienic movement have been integral components of the control strategy practiced in the country. China has made substantial progress against schistosomiasis through these approaches.

Active community participation in schistosomiasis control plays an important part. Primary

health care was extended in the endemic areas through ‘barefoot doctor’ system.

The person with schistosomiasis was easy to get treatment. In endemic areas, all the cost on schistosomiasis control was parts of the government expenditure. The treatment was usually free of charge for the farmers.

After continued efforts over the past five decades, schistosomiasis has been successfully eliminated in the provinces of Guangdong, Fujian and Zhejiang, in the municipality of Shanghai and in the autonomous region of Guangxi. According to the data by the end of 1999, there were a total of 409 counties endemic for schistosomiasis. Among them, 238 counties have reached the criteria of transmission interruption, 56 counties have reached the criteria of transmission control where the prevalence is at a very low level and in remaining 115 counties, the disease is still endemic mainly distributed in the marshland and mountainous regions (Wang et al., 2000) (Fig. 2 and Table 1).

2.2. The socioeconomic impact on schistosomiasis endemicity during economic reform

The endemic situation of schistosomiasis fluctuated in the 1980s. The data of National Disease Information System showed that the positive rates of stool examination among the residents in the 1980s had increased considerably. For instance, in Hunan Province, stool positive rate from 2.742% in 1980 increased to the 4.834% in 1989; in Hubei Province, stool positive rate from 4.703% in 1980 increased to the 7.355% in 1989; in Jiangxi Province, stool positive rate from 4.616% in 1980 increased to the 8.331% in 1989 (Chen et al., 1990). The national schistosomiasis sampling survey in 1989 showed that the estimated number of the persons with schistosomiasis in the marshland areas was 1.30 millions, making up 79.35% of 1.638 million infected persons in whole country (Zheng, 1992, Table 2). The endemic areas of high mountain were mainly located in Yunnan and Sichuan provinces. The number of infected persons was estimated to be 308 334 in these two provinces (Wang, 1989; Yuan, 1992; Gao, 1993). During 1980s, the acute cases of schistosomiasis in the marshland endemic areas increased yearly.

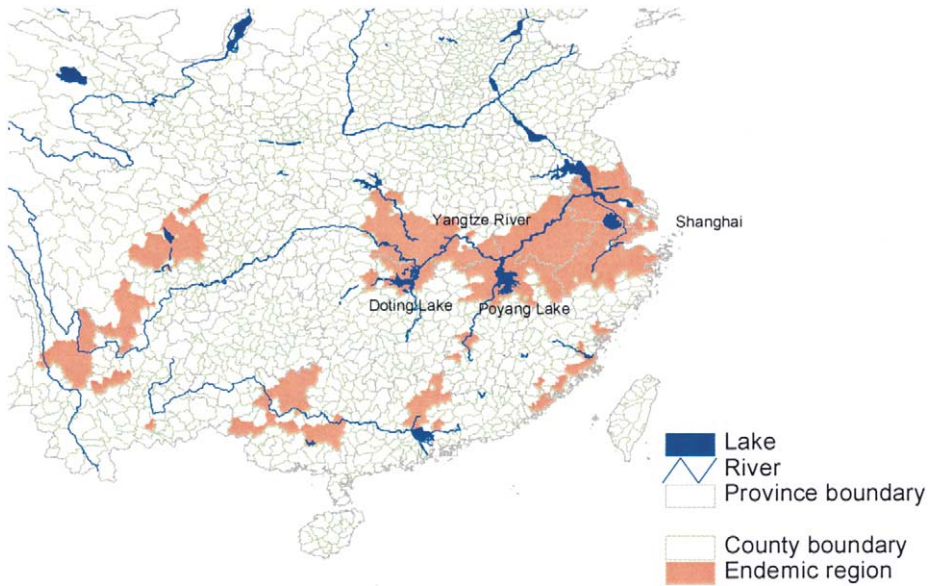


Fig. 1. The regional distribution of schistosomiasis before the 1950s in China.

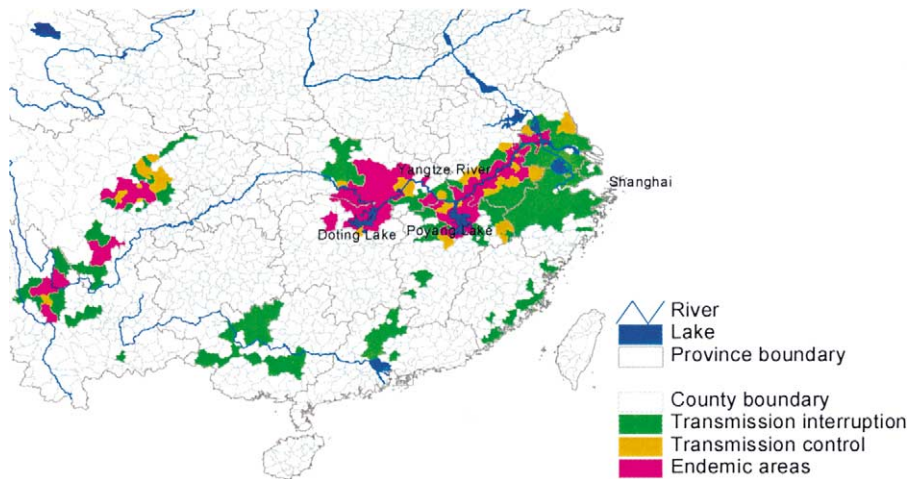


Fig. 2. Schistosomiasis regional distribution in 2000 in south of China.

This trend was probably attributed to the change of socioeconomic reform starting from late 1970s. The economic reform changed the governmental budgets for schistosomiasis control that usually came from three levels (county, province and central governments). After the reform, nearly all the budget for schistosomiasis control came from local government. Most of schistosomiasis endemic areas were located in the poor economic zone,

and the local government budget was very limited for the control. The resources could not meet the need of schistosomiasis control.

The other socioeconomic change was the ownerships of land from 'commune' to households, and the communities were no more an economic body again after the reform. Due to the budget problem, the facilities of anti-schistosomiasis supplied usually by the provincial government were

moved to the county. Some county anti-schistosomiasis stations only had the budget for personnel and they did not have any more resource to purchase drug and chemicals for schistosomiasis control. The local health facilities and station were encouraged to charge patients for services or to operate the other business to meet the need of the personnel and operational costs.

Accompanying the changes in financial system, the national organization of anti-schistosomiasis system had been reorganized. Before 1986, there was a special national organization on anti-schistosomiasis that was under CCCP. During the economic reform, the national leading group for schistosomiasis control was disestablished and schistosomiasis control was directly under the leadership of the Ministry of Health. A new bureau, the Bureau of Endemic Diseases Control, in the Ministry of Health was established in 1988.

3. Application of morbidity control strategy in China

According to the WHO global strategy of morbidity control for schistosomiasis (WHO, 1993), taking into consideration the real situation in China, the national experts put forward the objec-

tives for the control program at three levels: (1) morbidity control, (2) transmission control, (3) transmission interruption. People in different endemic regions can select different objectives based on feasibility and level of economic development. The objectives can be achieved from low level to high level in different stages. For instance, in the marshland regions and mountainous regions, the objectives for the control program are morbidity control, and in some regions with better condition transmission control may be the target of choice, and only in a few regions the target of transmission interruption can be reached. In accordance with the different control objectives, national criteria for control and elimination of schistosomiasis were formulated.

3.1. Promotion of morbidity control strategy

The morbidity control strategy was put forward by WHO in 1984. During 1985–1989, field pilot studies undertaking morbidity control were carried out in Hunan, Hubei, and Anhui provinces. During the ‘Seventh 5-Year Plan’ (1986–1990) and the ‘Eighth 5-Year Plan’ (1991–1995) of the national control program, investigation projects on optimum strategy were carried out in endemic provinces. The World Bank Loan Project (WBLP)

Table 1
Schistosomiasis endemic areas in China and progress made as of 1999

Province	Formerly endemic population (in 10 000)	Counties in endemic areas	Number of counties transmission interrupted	Number of counties transmission under control	Still endemic
Shanghai	291.66	9	9	0	0
Jiangsu	3576.26	57	35	7	15
Zhejiang	947.09	54	54	0	0
Guangdong	712.74	12	12	0	0
Guangxi	74.37	19	19	0	0
Anhui	589.24	41	14	13	14
Fujian	246.88	14	14	0	0
Jiangxi	403.28	37	19	7	11
Hubei	1354.73	58	20	6	32
Hunan	541.54	29	7	1	21
Sichuan	1581.76	62	25	20	17
Yunnan	134.93	17	10	2	5
Total	10 454.48	409	238	56	115

Data from Department of Diseases Control, Ministry of Health.

Table 2

The results of schistosomiasis situation from a nationwide sampling survey in 1989

Province	Geography	Infected people	%	Snail-infested area (10 ⁴ m ²)	%
Hunan	Lake regions	341 192	20.83	170 266.04	47.99
Hubei	Lake regions	551 409	33.66	76 106.93	21.45
Jiangxi	Lake regions	272 100	16.61	70 973.17	20.01
Anhui	Lake regions	120 068	7.33	22 495.91	6.34
Jiangsu	Plain and lake regions	15 000	0.92	5940.70	1.67
Sichuan	Mountainous regions	184 934	11.29	6033.93	1.70
Yunnan	Mountainous regions	123 400	7.53	2915.98	0.82
Zhejiang	Plain and hill regions	30 000	1.83	38.41	0.01
Total		1 638 103	100.00	354 771.07	100.00

on Schistosomiasis Control started from 1992. In China, morbidity control strategy has been practiced on a large scale in endemic areas during the WBLP period with sustained decrease in prevalence to a low level. The acute schistosomiasis outbreaks became a rarity since then.

3.2. Strategies for morbidity control applied in the WBLP for schistosomiasis control in China

Based on schistosomiasis transmission level, the objectives for the WBLP for schistosomiasis control were divided into the following three levels. They were:

- (A) reduction of prevalence rate and control of outbreak of acute schistosomiasis;
- (B) control of transmission effectively and the prevalence maintaining at a low level;
- (C) interruption of transmission of the diseases without new infection.

The WBLP for schistosomiasis control was initiated in 1992. The indexes of the project objectives were as follows: a reduction of human infection rate by 40%, infection rate of cattle and buffaloes by 40%, and infected snail areas, by 50–60%. The project has been carried out in 202 endemic counties in eight provinces, including Hunan, Hubei, Jiangxi, Anhui, Jiangsu, Yunnan, Sichuan and Zhejiang.

The different chemotherapy methods were carried out in different areas based on the endemic situation, which can be divided into three cate-

gories: (1) Mass chemotherapy was given in high endemic areas with prevalence rate $\geq 15\%$; (2) intermittent mass chemotherapy or selective chemotherapy was given in medium endemic areas (prevalence between 3 and 15%); (3) selective chemotherapy was given in low endemic areas (prevalence $\leq 3\%$).

The numbers of screening and treatment of schistosomiasis during the period of 1995–2000 are shown in Table 3.

Extending chemotherapy was given in high risk regions and persons with a risk of the infection.

In villages where the prevalence was over 20%, people with significant signs or symptoms possibly related to schistosomiasis were given chemotherapy. In endemic areas where prevalence was over 20%, or the people were interviewed, if the person had a history of contact with infested water in the year after last chemotherapy, or the people were accompanied with skin itch, fatigue, abdominal pain or diarrhea, chemotherapy was given. The following data showed that 309.856 thousand cases of schistosomiasis had been treated and 2084.2 thousand persons were provided extending chemotherapy in 1999 without preliminary screening (Table 4).

The data showed that about 2 million people were given extending chemotherapy yearly during WBLP period. About 300 thousand chronic cases of schistosomiasis were treated every year. The number of chronic, acute and advanced cases of schistosomiasis had a big decrease.

4. Case study on the morbidity control for schistosomiasis

Although the institutions for schistosomiasis control existed in each endemic county, city, province, the economic situation is constrained in those endemic areas. This problem requires us to carefully analyze local situation and review to assess the feasibility of control with limited resources.

4.1. Field background and study sampling selection

The case study was carried out in a marshland area in Guichi County of Anhui Province and shore of the Quipu River whose water runs into the Yangtze River.

The whole study was divided into two stages. The first 4 years was the implementation period (stage one). In this stage the community received the approach of mass chemotherapy. After stopping the intervention, we continued the observation for another 4 years, maintenance period (stage two), to observe the long-term effects of the approach. In the maintenance stage, the mass chemotherapy approach was stopped, selective chemotherapy was given instead. Annual data of prevalence of schistosomiasis and control approaches were collected for 8 years. Those data are used to calculate the results of cost and effectiveness of each alternative. The persons with schistosomiasis asking for treatment were treated by local health workers. In the whole study period, the residents were examined in spring. All other anti-schistosomiasis approaches were given after the examination.

In the whole study period, all residents in research communities aged between 3 and 60 years were the subjects for observation. All people were annually examined by Kato–Katz method for *S. japonicum* eggs. The prevalence of schistosomiasis in the three groups was analyzed annually. All people in the study areas were recorded with age, sex, residence and results of examination. The data were fed into the computer as the database file for analysis.

4.2. The efficacy of chemotherapy

The prevalence of schistosomiasis after chemotherapy is shown in Table 5. Before control, the prevalence of schistosomiasis was 19.23%. During the chemotherapy period, the prevalence was decreasing. When the mass chemotherapy approach stopped, the prevalence increased quite soon. In the sixth and seventh year, mollusciciding was given by local anti-schistosomiasis station. If there were no such approach, the prevalence of schistosomiasis would increase more quickly.

The results of chemotherapy showed that by 1 year selective mass chemotherapy, the prevalence of schistosomiasis reduced from 19.23 to 7.98%. After 4-year chemotherapy, the prevalence reduced to 4.92%. After 4 years implementation, the selective mass chemotherapy stopped, the prevalence of schistosomiasis rose quickly. When chemotherapy stopped for 2 years, the prevalence rose again from 4.92 to 13.58%. The effect on schistosomiasis chemotherapy was evident in just 1 or 2 years in these areas. In this type of endemic area, schistosomiasis would reemerge yearly. Al-

Table 3
Numbers of screening and treatment of schistosomiasis during the year 1995–2000 in China

Year	Number of screening	Treatment of schistosomiasis	Treatment of acute cases	Treatment of chronic cases	Treatment of advanced cases
1995	10 880 323	339 512	1286	328 733	9493
1996	10 070 290	320 508	1771	309 285	9452
1997	10 176 184	294 372	617	285 154	8601
1998	10 233 435	344 485	1899	335 113	7473
1999	9 487 059	309 856	513	302 431	6912
2000	9 272 674	357 158	664	349 969	6525

Table 4
Schistosomiasis chemotherapy and extending chemotherapy in 1999

	Acute	Chronic	Advanced	Extending chemotherapy (thousand)
Hunan	198	63 311	3942	331.2
Hubei	104	140 987	2413	1082.4
Jiangxi	48	91 502	700	94.7
Anhui	118	1788	16	181.2
Jiangsu	9	1310	69	17.8
Zhejiang	0	0	0	7.1
Guangxi	0	3	0	0
Sichuan	25	2918	219	295.9
Yunnan	11	612	3	74.0
Total	513	302 431	6912	2084.2

though chemotherapy can decrease the prevalence in humans, without complemented with snail control, the intensity of transmission is still at a high level. The yearly mass treatment still needs to be recommended in this area.

The national data showed us the effect of chemotherapy in schistosomiasis control. During the WBLP period acute, chronic and advanced case of schistosomiasis had decreased almost yearly in China (Table 6).

Chemotherapy has been an important basis of schistosomiasis control. The study demonstrated that appropriate drug treatment lowers worm burden and decreases the intensity of the infection as well as prevalence. Chemotherapy alone can hardly reduce the transmission, because zoonotic *S. japonicum* infection has a great impact on the epidemiology and control of the diseases.

5. Maintenance stage of morbidity control

It should be noted that schistosomiasis control is a long-term commitment even though chemotherapy can effectively reduce the prevalence and number of cases. According to the data of 1999, there are 96.3481 million person lived in the endemic areas (Table 7). Areas of snail habitat was 3.466 billion m². Out of which 94.5% (3.276 billion m²) of the snail habitats were in the marshland areas, 4.450% (154 million m²) in the mountainous and hilly areas and 1.05% (36.5 million m²) in the plain areas (Table 7).

The data from schistosomiasis information system showed us that during the WBLP period, the estimated number of infected persons decreased from 927 314 (1995) to 694 788 (1999), the cattle infection rate reduced from 50 to 5.36%. However, a lot of work is needed to maintain a low transmission of schistosomiasis in a long time period. Particularly at present, the end of the World Bank Loan Project on schistosomiasis control in the country will make it difficult in the maintenance stage of the control program. Therefore, attention should be paid to the following aspects.

5.1. Compliance of chemotherapy

The tendency of the decrease in the compliance rate was found with the practice of chemotherapy every year in some places. The best method to

Table 5
Prevalence of schistosomiasis in the community accepted chemotherapy

Year	Female	Male	Total
Before control	19.18	19.28	19.23
1-	7.93	8.03	7.98
2-	4.25	7.29	5.79
3-	6.21	8.10	7.17
4-	6.25	3.71	4.92
5-	4.69	7.58	6.21
6-	11.79	15.16	13.58
7-	8.73	14.81	11.90
8-	8.48	10.03	9.27

Table 6
Reported cases of schistosomiasis during the year 1995–2000

Year	Total cases	Acute cases	Chronic cases	Advanced cases
1995	927 314	1286	889 827	36 201
1996	810 502	1771	781 247	27 484
1997	790 851	617	760 526	29 708
1998	762 016	1899	734 264	25 853
1999	756 762	513	731 837	24 412
2000	694 788	664	671 400	22 786

improve the compliance was the implementation of health education. After undertaking health education in the Bai national minority in Yunnan province, the compliance rate was improved. The level of knowledge on schistosomiasis significantly increased the coverage rate of chemotherapy in the group receiving health education as compared with the control group. The decrease of human infection rate in experimental group with health education was 52.2% higher than in the control group without the education.

5.2. Schistosomiasis transmission still exists in most of the marshland and mountain areas

Effective chemotherapy can reduce human infection rate and intensity of the infection quickly. However, it is difficult to interrupt the transmission. The achievements from chemotherapy are not easy to be consolidated due to the reinfection in residents with a rate between 5 and 47% after chemotherapy according to different authors (Yuan, 1992). Since 1987, synchronous chemotherapy both for humans and bovine had been implemented in Hunan for 10 years. However, human infection rate was fluctuated around 6% since the second year of chemotherapy, i.e. 1988. It was difficult to further decrease the infection rate due to a high reinfection rate. The high-risk persons are the key target population for chemotherapy who need treatment more than once a year.

5.3. Bovine as the main infection source of schistosomiasis

In China, 40 mammalian species have been found naturally infected with *S. japonicum*. Cat-

tle, buffaloes and pigs are of great importance in contamination of the marshland. It is quite difficult to treat those animals in the areas. Cattle and buffaloes are major infection source in the marshlands. Mobile cattle population increased recently along with economic development. Cattle are the economic source for the farmers in the region. Although cattle were screened yearly and chemotherapy was given during WBLP period in some areas, the number of infected animals did not have a substantial decrease (Table 8). Cattle as the source of infection are more important than humans in the swamp and lake regions. If we can not control the cattle from schistosome infection, it would be very difficult to control the transmission of schistosomiasis.

5.4. The strategy in the maintenance period

It has been noted that the impact of chemotherapy can be maintained for a long time in some places where the snail-infested area is small and people and livestock living in the transmission area are non-migrants. It is clear that large scale chemotherapy can considerably reduce infection rates. Even if encouraging short-term results have been obtained, we are still far from satisfactory in long-term solution. If we stop mass chemotherapy for 1 or 2 years, the prevalence would rise again. As long as transmission continues, mass or selective chemotherapy will have to be repeated indefinitely.

Now the approaches we can use for schistosomiasis control in high transmission areas (prevalence above 10%):

- yearly mass chemotherapy to target population;
- snail control by chemical mollusciciding;
- health education;
- safe water supply and sanitation.

In the medium transmission areas (prevalence between 5 and 10%):

- yearly selective mass chemotherapy to target population;
- health education;
- snail control where feasible;
- safe water supply and sanitation.

In the low transmission areas (prevalence less than 5%):

- selective chemotherapy once every 2 or 3 years;
- health education;
- snail elimination;
- safe water supply and sanitation.

6. Challenges and planning in national control program in China

At present, we are facing new challenges although great achievements have been made through 50 years' efforts in the national control program. It will be more difficult to maintain the prevalence or morbidity at a low level after mass chemotherapy has been taken for years. More arduous work should be performed to consolidate the achievements gained and to further minimize

the transmission areas, to reduce prevalence as well as intensity of infection. Future challenges we are facing are as follows:

1. With the completion of the WBLP on schistosomiasis control in the country by the end of 2000, there are still large areas where schistosomiasis is transmitted (Table 9). The coverage rate and intensity of chemotherapy will decline because of limited resources.
2. After the serious flood in the Yangtze River valley in 1998, both snail-infested areas and the possibility of infection with *S. japonicum* through water contact have been increased. Furthermore, in order to reduce the impact of flood, the China State Council adopted a policy on anti-flooding by 'returning cultured land into the lake and relocation of farmers from endemic areas to newly established towns'. It is one of the new issues in the schistosomiasis control program that needs investigation, since the policy may contribute to the increase of snail habitats on a large scale, increase of possibility for people in close contact with infested water, and increase of prevalence of schistosomiasis in some areas.
3. The impact of the Three Gorges Dam project on transmission of schistosomiasis in the middle and lower reaches of the Yangtze River is still unclear. There is a need to strengthen the investigation and surveillance on the impact of water levels to the distribution and dispersal of *Oncomelania* snail in the Yangtze River valley.

Table 7
Population in endemic areas of schistosomiasis in 1999

Province	Number of endemic county	Population in endemic counties (thousand)	Number of farm in endemic areas	Farm population in endemic areas (thousand)	Population in endemic areas (thousand)
Hunan	29	5415.4	13	334.1	5749.5
Hubei	58	13 547.3	34	396.3	13 943.6
Jiangxi	37	4032.8	19	292.3	4325.1
Anhui	41	5892.4	4	70.1	5962.5
Jiangsu	57	35 762.6	0	0	35 762.6
Zhejiang	54	9470.9	0	0	9470.9
Fujian	14	2467.9	0	0	2467.9
Guangxi	19	743.7	0	0	743.7
Sichuan	62	15 817.6	3	5.4	15 823.0
Yunnan	17	1349.3	0	0	1349.3
Total	338	95 249.9	75	1098.2	96 348.1

Table 8
Screening and treatment for cattle and buffaloes in endemic areas

Year	Number of screening	Number of positive	Number of treated	Number of extending chemotherapy
1995	660 486	18 394	16 590	321 611
1996	620 272	48 813	17 612	289 087
1997	626 587	16 224	15 075	340 363
1998	639 073	21 589	20 026	380 337
1999	640 559	22 445	21 626	348 901
2000	616 489	21 270	20 594	283 607

Table 9
The distribution of Snail habitats in 1999 (1000 m²)

Province	Snail habitats			
	Total area	Marshland area	Plain area	Mountain area
Hunan	1 748 366	1 700 046	31 019	17 301
Hubei	586 205	576 564	0	9641
Jiangxi	683 154	670 940	0	12 214
Anhui	285 472	263 508	0	21 964
Jiangsu	70 613	64 674	5256	682
Zhejiang	722	0	5	717
Fujian	14	0	0	14
Sichuan	62 733	0	227	62 507
Yunnan	29 186	0	0	29 186
Total	3 466 465	3 275 732	36 507	154 226

To overcome the problems we are facing, the following activities are to be implemented in the future:

1. Continuing the activities on strengthening the control program under government leadership, with involvement by relevant departments, and insisting on the policy of taking comprehensive treatment with scientific control approaches.
2. Adjusting the control strategy in time: the control strategy will be adjusted in time after the end of the WBLP. Different endemicity in the endemic areas will be stratified based on the actual situation and changes of prevalence in the country; and different control strategies will be implemented in different endemic areas based on local economic situation as well as on levels of prevalence. The adjusted plan will be studied carefully by experts, and implemented after being critically reviewed by professional staff at different levels. At the same time, the environmental modification will be continued in combination with the construction activities in agriculture and water resources.
3. Strengthening the epidemiological surveillance: it is necessary to strengthening the surveillance in different types of endemic regions. More surveillance pilots will be set up in order to understand the changes of transmission and prevalence in time and provide reliable information for decision making.
4. Strengthening scientific researches: more attention will be paid to the research projects, for instance, the impact of environmental changes on transmission of schistosomiasis. International experts are welcome to get involved in the researches and to cooperate in projects with mutual interests. More international funding for schistosomiasis control and research is, of course, needed.

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