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The global status of schistosomiasis and its control

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Summary

Schistosomiasis is being successfully controlled in many countries but remains a major public health problem, with an estimated 200 million people infected, mostly in Africa. Few countries in this region have undertaken successful and sustainable control programmes. The construction of water schemes to meet the power and agricultural requirements for development have lead to increasing transmission, especially of Schistosoma mansoni. Increasing population and movement have contributed to increased transmission and introduction of schistosomiasis to new areas. Most endemic countries are among the least developed whose health systems face difficulties to provide basic care at the primary health level. Constraints to control include, the lack of political commitment and infrastructure for public health interventions. Another constraint is that available anti-schistosomal drugs are expensive and the cost of individual treatment is a high proportion of the per capita drug budgets. There is need for increased support for schistosomiasis control in the most severely affected countries.

Schistosomiasis remains one of the most prevalent parasitic infections and has significant economic and public health consequences. While the distribution of schistosomiasis has changed over the last fifty years, and there have been successful control projects, the number of people infected or at risk of infection has not reduced (Savioli et al., 1997). It is estimated that 200 million people are infected, of whom 120 million are symptomatic and 20 million have severe disease. 600 million people are at risk of infection. In their comprehensive review, Iarotski and Davis (1981) presented the results of a questionnaire survey and information available to the WHO on the status of schistosomiasis and its control. Subsequent reviews by the WHO Expert Committee were published in 1985 and 1993. In this communication, information collected from national health authorities, research institutions and that available to the WHO is presented to show the current distribution of schistosomiasis and status of its control.

Iarotski and Davis (1981) estimated that 2.4 billion people lived in endemic countries, this had risen to 3.7 billion by 1995 (World Bank, 1997). This may not be appropriate to show the magnitude of the problem as in the endemic countries with the largest populations, such as Brazil, China and Indonesia, the population at risk of schistosomiasis is comparatively small, and as will be seen, control has been successful. On the other hand in the African Region of the WHO where there have been few attempts at control, the population had increased to 577.13 million in 1995 from 344.45 million in 1976.

Utroska et al., 1989, gave estimates of the number of people infected and those at risk of infection and discussed the limitations of their assumptions. The validity of such estimates is

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open to debate (Chandiwana, 1988; Ratard et al., 1992). The most accurate data may be those provided by national control programmes or from national surveys. National surveys have been conducted in Cameroon, Guinea, Malawi, Senegal and Zimbabwe (Taylor and Makura, 1985; Teesdale and Chitsulo, 1985; Ratard et al., 1990; Ndhlovu et al, 1992; Ndir et al, 1996; Adou-Bryn et al, 1997). Only for Cameroon, Cote d'Ivoire, Malawi, Mali and South Africa have estimates of national prevalence or number of people infected been given (Teesdale and Chitsulo, 1985; Ratard et al., 1992; Schutte et al., 1995a; Adou-Bryn et al, 1997; Traore et al., 1998).

In the absence of accurate epidemiological data, estimates must still be used to determine the possible burden of infection due to schistosomiasis. For this purpose, the estimates of Utroska et al., on the average prevalence of infection and the proportion of the population at risk of infection for each country have been applied to the 1995 population (World Bank, 1997) to calculate the number of people at risk of infection and those infected. These are given in table 1 as 652 million people at risk of infection and 193 million infected by all species of schistosomiasis. Based on these calculations, 85% of the estimated number of infected people are on the African continent.

Geographic distribution

Schistosomiasis is endemic in 74 countries and territories (Table 1). There is an addition of Eritrea, which became independent in 1993 and is endemic for *Schistosoma mansoni* (Doumenge et al, 1987; WHO, 1993) and removal of Japan and Montserrat, where transmission is thought not to occur. With the introduction of *S. mansoni* to Mauritania, Senegal and Somalia, intestinal schistosomiasis is found in 54 countries, including the Arabian peninsular, Egypt, Libya, Sudan, sub-Saharan Africa, Brazil, some Caribbean islands, Suriname and Venezuela (WHO, 1993; Southgate, 1997; Urbani et al, 1997). *S. intercalatum* has been reported from 10 countries in Africa (WHO, 1993). Its presence in Mali (Corachan et al, 1992), an atypical sahelian environment, requires confirmation as other surveys have failed to detect it (De Clerq et al., 1994). Transmission of this species in the Central African Republic, Chad, Congo and Nigeria should also be confirmed (WHO, 1993). *S. japonicum* is endemic in China, Indonesia and the Philippines and has been reported from Thailand. Another oriental schistosome is *S. mekongi* found in Cambodia and Laos (Sturrock, 1993). *S. malayensis* infects aboriginal people in a small jungle focus of Malaysia (WHO, 1993).

S. haematobium is endemic in 53 countries in the Middle East and most of the African continent including the islands of Madagascar and Mauritius. It may have been erroneously reported to be endemic in Sao Tome and Principe (Almeda et al, 1994). There is also an ill defined focus *S. haematobium* in India (Agrawal, 1997).

Along with reconfirming the distribution of *S. intercalatum* and a proper study of the *S. haematobium* focus in India, it is time to determine in which countries transmission has ceased. *S. japonicum* has been eradicated from Japan as the last case of infection in man was in 1977 and infected snails were last detected in 1982 (Tanaka and Tsuji, 1997). Transmission of *S. mansoni* appears to have been interrupted in the Caribbean islands of

Antigua, Guadeloupe, Martinique and St. Lucia (WHO, 1997). Recent studies in Puerto Rico suggest that transmission of this infection is at a low level (Giboda et al., 1997; Tsang et al., 1997). It is unlikely that *S. haematobium* is of public health significance in Lebanon, Mauritius, Oman, Syria, Tunisia, and Turkey as transmission is low or non-existent.

Iarotski and Davis (1981) determined that the most severely affected countries in Africa were, Angola, Central African Republic, Chad, Egypt, Ghana, Madagascar, Malawi, Mozambique, Nigeria, Senegal, Sudan, the United Republic of Tanzania and Zambia. To these should be added Mali, Uganda and Zimbabwe (Taylor and Makura, 1985; Ndhlovu et al, 1992; Kabatereine et al, 1992; Kabatereine et al, 1996; Bukenya and Nsungwa, 1994; Traore et al., 1998). Brazil, with 25 million people living in the endemic areas and 3 million infected, is the most affected country in the Americas (FNS, 1997). China is the most affected country in Asia with an estimated 900,000 people infected, in 1997, even though Iarotski and Davis had listed Philippines because they had no data on China. Yemen has the most infected people in the Middle East.

Population Increases and Water Development

The increase in population in endemic areas means that more people may be at risk of infection. Requirements of an increasing population and development lead to large scale water impoundment for electricity and irrigation which can result in increased transmission of parasitic diseases (Hunter et al., 1993; Kay, 1990). Dams have led to the increase or introduction to new areas of urinary schistosomiasis in Cameroon, Cote d'Ivoire, Ghana, Mali, Namibia, Senegal and Sudan (Hunter et al., 1993; Elias et al, 1994; Southgate, 1997; N'Goran et al., 1997). *S. mansoni* has been introduced to new areas in Ghana, Mali, Uganda, Senegal (WHO, 1985; Southgate, 1997; Brinkmann et al, 1985).

Ecological changes wrought by the Aswan High Dam resulted in an change in the relative importance of *S. mansoni* vis-à-vis *S. haematobium, as S. mansoni* is now more prevalent in the Nile delta. El-Katsha and Watts (1995) have discussed the difficulties associated with *S. mansoni* diagnosis and control in this setting. While *S. haematobium* is still the predominant infection in Middle and Upper Egypt, the ecological changes and irrigation practices have introduced *S. mansoni* and its vector, *Biomphalaria alexandrina,* to these areas (Wilmott, 1987). Land reclamation has extended transmission of schistosomiasis to new areas in Egypt (El-Sayed et al, 1995) such that the number of infected people in Egypt has not reduced significantly (Savioli et al, 1997). Implementation of major water resource schemes in southern China may increase transmission of *S. japonicum* and extend the endemic area. Population movement from north-east Brazil has extended transmission of *S. mansoni* to new areas (FNS, 1997).

Public Health Impact and Control Programmes

The increasing transmission and public health importance of schistosomiasis did not result in active intervention or implementation of control programmes in many countries. According to Iarotski and Davis, only Brazil, Dominican Republic, Egypt, Iran, Iraq, Morocco, Puerto Rico, St. Lucia, Tunisia and Venezuela had national control programmes.

To these should have been added China and the Philippines which had on-going control programmes but may not have responded to the questionnaire (Mao and Shao, 1982; Santos, 1984).

Control was initiated in countries where the public health importance of schistosomiasis was appreciated. In China and Japan, the high morbidity and mortality due to *S. japonicum* leading to the disintegration of communities and consequent reduction in agricultural production justified control (Mao and Shao, 1982; Chen, 1989; Tanaka and Tsuji, 1998). In Brazil schistosomiasis was among the three top public health problems (Machado, 1982). Control was initiated in Egypt because irrigation is the mainstay of agriculture and it was felt that morbidity due to schistosomiasis would reduce production (Mobarak, 1982). Gryseels (1989) and Gryseels and Polderman (1991) argued that compared to Brazil, Egypt and Sudan, sub-Saharan Africa had less morbidity and therefore special schistosomiasis control programmes were not justified. They recommended that morbidity be controlled by ensuring the availability of schistosomicides in health facilities. Recent research may modify this perspective (Vennervald et al., 1998).

Political Will and National Resources

Factors in initiating control programmes are the need for political support and willingness to use local resources (WHO, 1993). Thus in China and Brazil, control programmes followed political directives (Mao and Shao, 1982; Machado, 1982). It can be seen from table 1, that those countries without control programmes are the least developed. The only countries with a low GNP per capita income with control programmes are China and Egypt, with per capita incomes of $620 and $790, respectively in 1995. Only two endemic countries, Gabon and Namibia, with a per capita income above $1000 have no control programmes. Along with political support and resources, there is need for a public health infrastructure to undertake the control interventions (Liese et al., 1991).

Morbidity Control and Programme Costs

It was expected that the new strategy for morbidity control, with chemotherapy as the main operational component, would lead to more countries undertaking control (WHO, 1985, 1993). The point to note is that countries undertaking control started with available methods and success was achieved with different methods, ranging from environmental modification to eliminate vector snails, chemical molluscicides, and chemotherapy (Yokogawa, 1976; Jobin, 1979; Massoud, 1982; McCullough et al., 1980; Davis, 1993; Tanaka and Tsuji, 1997).

With the new strategy for morbidity control, the availability of new single dose, oral drugs, and the use of rapid, field applicable diagnostic techniques, several control projects where initiated in sub-Saharan Africa with bilateral funding (Brinkmann et al, 1988b; Savioli, 1990; Dhunputh, 1994; Schutte et al., 1995b). There was short term success in terms of reduction in prevalence and intensity of infection. Few of these projects are continuing as local authorities could not meet the costs of maintenance. A major part of these costs of maintenance are the prices of single dose, oral drugs.

Studies on the costs of schistosomiasis control have invariably concluded that the cost of control is inordinately high compared to the per capita health expenditure in sub-Saharan Africa (Korte, et al., 1986; Brinkmann et al., 1988b; Rohde, 1989; Gryseels, 1989; Guyatt et al., 1994). These studies and that by Savioli et al., 1989, have also shown that the relative contribution of drug cost to the cost of control are variable, ranging from 8.5% to almost 89% of the cost of control. While the price of these single dose, oral drugs have fallen sharply over the past twenty years (Reich, 1998), the price is still above the per capita health budgets of many endemic areas and would not be affordable through cost recovery mechanisms.

The advent of the HIV/AIDS epidemic, with its heavy economic burden, the need to address other health issues and low economic performance have made it difficult for many countries to invest in schistosomiasis control (World Bank, 1993; 1997).

Conclusion

Progress has been made in the control of schistosomiasis over the last twenty years. Elimination and/or eradication of the infection is within reach in the Caribbean islands, Japan, Mauritius and Tunisia. Morbidity and mortality control is being achieved in Brazil, Cambodia, China, Egypt, Laos and the Philippines. Control has also been successful in Botswana, Iran, Iraq and Morocco where prevalence of infection is low though transmission continues. In many areas of Brazil and Egypt, prevalence of infection has been reduced to lower levels but it appears difficult to reduce it even further because transmission continues at high level. There is thus need to apply efficient methods for transmission control in conjunction with chemotherapy. Along with chemical snail control, more permanent methods such as the provision of safe water and sanitary facilities are required to limit infective water contact and contamination of the environment.

The adoption of a strategy for morbidity control by the WHO Expert Committee was a synthesis of the experience gained from many countries on operational components effective in schistosomiasis control. Tools are available for all countries to apply within the limitations of resources. For most endemic situations, chemotherapy will be the major operational component focused on school age children and other high-risk groups. In some situations, treatment once a year or every two years will be sufficient to control morbidity. In areas of extremely high transmission, there may be need for more frequent treatment as in Senegal (Picquet et. al., 1998). The WHO Expert Committee (1993) also recommended use of the other operational components, such as water supply and sanitation, environmental management, snail control, and health education along with chemotherapy in an integrated and inter-sectoral manner.

Many of the control programmes or interventions undertaken over the last twenty years have been with bilateral or donor funding. The exceptions are Iran, Iraq, Morocco, Puerto Rico, Saudi Arabia, and Venezuela, where local resources were used. The major source has been the World Bank, which has provided health sector credits to many countries. These credits were probably affordable to middle income countries. The German government was the other major funding partner, through the German Agency for Technical Cooperation (GTZ),

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with projects in Congo, Madagascar, Malawi, Mali, and Yemen. Other bilateral donors supported control projects in a number of countries.

The success of schistosomiasis control over the past twenty years has still left almost 200 million people infected. Schistosomiasis remains a problem in Africa because very few countries have undertaken successful and sustainable control programmes. The construction of water resources schemes to meet the power and agricultural requirements for development have lead to increasing transmission of schistosomiasis, especially *S. mansoni*. The introduction of *S. mansoni* to new areas may lead to much greater morbidity than previously seen. Intestinal schistosomiasis is much harder for people to appreciate compared to urinary schistosomiasis which is universally known as red urine disease. It is also harder to diagnose intestinal schistosomiasis compared to the urinary form, for which there are many rapid detection tools.

As the control of schistosomiasis is a public health need, all governments in endemic areas should be encouraged to undertake control interventions. A beginning would be the provision of anti-schistosomal drugs at primary health care level so that those symptomatic can receive treatment. There are probably prerequisites or criteria to determine in which countries to initiate or support control interventions. There has to be recognition of schistosomiasis as a public health problem by policy makers and a willingness to invest in control. Investment in control may include revenue funds or health sector credits from lending organizations and the setting up of an infrastructure for implementation. Control may only be feasible where such an infrastructure exists or where there is experience in public health interventions (Liese, 1986). Application of the recommended strategy for schistosomiasis control alone may not succeed in eliminating infection. There is also need for other social sector investments to give alternatives to the population for avoiding use of infested water and contamination of the environment (Esrey et al., 1991; Kloetzel, 1992). These alternatives can be provided through intersectoral planning and implementation. It has to be recognized that schistosomiasis is a long-term undertaking. Most of the countries implementing control interventions have done so for more than 20 years.

While local authorities should create the conditions for schistosomiasis control, external organizations could foster an environment leading towards this. As discussed above, donor agencies, especially the World Bank, have supported all the major initiatives for schistosomiasis control over the past two decades. Conditions for countries to access these credits for disease control could be widely published and made flexible. For some countries, even sector credits may not be affordable. Most of the remaining countries endemic for schistosomiasis are among the least developed, whose health systems face severe strains to provide basic care at the primary level. They can only undertake schistosomiasis control through grants. Where this is the case, grant support should be based on the presence of a functional health system and a willingness to control schistosomiasis. For some countries that had initiated control programmes with donor support, the price of anti-schistosomal drugs made these interventions unsustainable (WHO, 1991). It is acknowledged that the price of some anti-schistosomal drugs have been reduced significantly but the price may still be beyond many developing country health budgets. Schistosomiasis control is feasible.

With the commitment of endemic country governments and their development partners it can be a reality in the next century.

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Table 1

Geographic distribution of schistosomiasis by species, with estimated population at risk, infected and per capita incomes of endemic countries.

Region/Country	Population (millions)	GNP per capita	Population at risk (millions)	Population infected (millions)	*S.h.*	*S.m.*	*S.i.*
African	577.13		477.079	164.776			
Algeria	28	1600	6.552	2.1	+	-	-
Angola	10.8	410	10.8	4.8	+	+	-
Benin	5.5	370	5.5	1.95	+	+	-
Botswana	1.5	3020	1.5	0.15	+	+	-
Burkina Faso	10.4	230	10.4	6.24	+	+	-
Burundi	6.3	160	2.8	0.84	-	+	-
Cameroon	13.3	650	11.38	3.02	+	+	+
Central African Republic	3.3	340	3.3	0.33	+	+	+
Chad	6.4	180	5.056	2.78	+	+	+
Congo	2.6	680	1.82	0.89	+	+	+
Congo, Dem. Rep. (Zaire)	49	120	38.22	13.84	+	+	+
Cote d'Ivore	14	660	14	5.6	+	+	-
Equatorial Guinea	0.4	380	0.08	0.008	-	-	+
Eriteria	3.6		1.91	0.26	-	+	-
Ethiopia	56.4	100	29.89	4	+	+	-
Gabon	1.1	3490	1.1	0.5	+	+	+
Gambia	1.1	320	0.88	0.33	+	+	-
Ghana	17.1	390	17.1	12.4	+	+	-
Guinea	6.6	550	6.6	1.7	+	+	-
Guinea-Bissau	1.1	250	1.1	0.33	+	+	-
Kenya	26.7	280	26.7	6.14	+	+	-
Liberia	2.7		2.16	0.648	+	+	-
Madagascar	13.7	230	13.7	7.54	+	+	-
Malawi	9.8	170	9.8	4.2	+	+	-
Mali	9.8	250	9.8	5.88	+	+	+
Mauritania	2.3	460	2.3	0.63	+	+	-
Mauritius	1.1	3380	0.37	0.016	+	-	-
Mozambique	16.2	80	16.2	11.3	+	+	-
Namibia	1.5	2000	0.187	0.009	+	+	-
Niger	9	220	9	2.4	+	+	-
Nigeria	111.3	260	101.28	25.83	+	+	+
Rwanda	6.4	180	3.84	0.38	-	+	-
Sao Tome and Principe	0.13	350	0.024	0.005	-	-	+
Senegal	8.5	600	8.5	1.3	+	+	-
Sierra Leone	4.2	180	3.7	2.5	+	+	-
South Africa	41.5	3160	25.73	4.5	+	+	-

Region/Country	Population (millions)	GNP per capita	Population at risk (millions)	Population infected (millions)	*S.h.*	*S.m.*	*S.i.*
Swaziland	0.9	1170	0.9	0.23	+	+	-
Togo	4.1	310	4.1	1.03	+	+	-
Uganda	19.2	240	19.2	6.14	+	+	-
United Rep. of Tanzania	29.6	120	29.6	15.24	+	+	-
Zambia	9	400	9	2.39	+	+	-
Zimbabwe	11	540	11	4.4	+	+	-
European					S.h.	S.m.	S.i.
Turkey	61.1	2780	0.062	0.0006	+		
Eastern Mediterranean	220.2		61.143	19.4144			
Egypt	57.8	790	50.3	10.06	+	+	
Iran	64.1		4.17	0.042	+	-	
Iraq	20.1		5.29	0.024	+	-	
Jordan	4.2	1510	0.024	0.0001	+	-	
Lebanon	4	2660	0	0	+	-	
Libya	5.4		1.78	0.27	+	+	
Morocco	26.6	1110	0.798	0.06	+	-	
Oman	2.2	4820	0.018	0.0001	+	+	
Saudi Arabia	19	2150	3.23	0.165	+	+	
Somalia	9.5		4.75	1.71	+	+	
Sudan	26.7		24.03	4.85	+	+	
Syria	14.1	1120	1.35	0.003	+	-	
Tunisia	9	1820	0.403	0.0002	+	-	
Yemen	15.3	260	15.3	2.23	+	+	
Americas	193.778		46.348	7.3324			
Antigua	0.065		0.00032	0.000084		+	
Brazil	159.2	3640	35.02	7.01		+	
Dominican Republic	7.8	1460	4.6	0.23		+	
Guadeloupe	0.42		0.223	0.033		+	
Martinique	0.38		0.067	0.005		+	
Montserrat			0	0		+	
Puerto Rico	3.71		0.742	0.015		+	
St. Lucia	0.158	3370	0.019	0.0019		+	
Suriname	0.41	880	0.037	0.0037		+	
Venezuela	21.7	3020	5.64	0.0338		+	
South-East Asia	1180.9		0.106	0.00042		*S. j.*	
India	929.4	340	0.011	0.00022	+	-	
Indonesia	193.3	980	0.095	0.0002		+	
Thailand	58.2	2470	0	0		+	

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Region/Country	Population (millions)	GNP per capita	Population at risk (millions)	Population infected (millions)	*S.h.*	*S.m.*	*S.i.*
Western Pacific	1429		67.37	1.68			
Cambodia	10	270	0.7	0.07		-	*S. me.*
China	1200.2	620	60.01	1.06		+	
Japan	125.2	39640	0	0		+	
Laos	4.9	350	0.49	0.12		-	*S. me.*
Malaysia	20.1	3890	0	0		-	*S. ma.*
Philippines	68.6	1050	6.17	0.43		+	
Total estimates	3662.108		652.108	193.20382			

Based on World Bank (1997) population estimates and per capita incomes for 1995.
Number at risk and infected based on Utroska et al., 1989.
S.h. = Schistosoma haematobium, S.m. = S. mansoni, S.ma. = S. malayansensis, S. i. = S. intercalatum, S. j. = S. japonicum, Sme. = S. mekongi.