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Progress in the national schistosomiasis control programme of Iran

J. MASSOUD,[1] F. ARFAA,[2] I. FARAHMANDIAN,[2] A. ARDALAN,[3] & A. MANSOORIAN[4]

A combination of chemotherapy and molluscicide has been used in Khuzestan, south-west Iran, since 1966, to try to control urinary schistosomiasis. The total amount of molluscicide used each year varied between 702 and 3505 kg and between 287 and 1320 infected persons were detected and treated annually. The prevalence of infection has gradually declined from 8.3% in 1970 to 0.7% in 1979. Similarly, the incidence of infection among schoolchildren decreased from 3.5% in 1970 to 0.7% in 1979. The proportion of Bulinus*-infested habitats also decreased from 10% in 1971 to 2.4% in 1979.*

Schistosomiasis is frequently found in arid areas where the chief occupation is farming. A major component of economic development in such areas is the installation of irrigation schemes and the creation of lakes to store water and to provide hydroelectric power. These projects may, however, lead to an increase in the prevalence and severity of schistosomiasis among the inhabitants, with consequent disability and loss of productivity (*1*).

Khuzestan, in the south-west of Iran, is endemic for urinary schistosomiasis. The province covers an area of about 157 000 km^2 and has a population of approximately 2 170 000 (1 260 000 in urban and 910 000 in rural areas). It is a continuation of the Mesopotamian plain, and is bordered on the south by the Gulf, on the west by Iraq, and on the north and east by the Zagros mountains. Five major rivers draining the southwestern slopes of the Zagros mountains cross Khuzestan. The area is semi-arid and the relative humidity is generally low. Maximum temperatures reach 52 °C in summer and 12 °C in winter and the annual rainfall ranges between 150 and 300 mm. Most of the soil in the plains is alluvial.

Environmental sanitation and health education are generally poor in the rural sectors of Khuzestan. Approximately one-third of the rural population (300 000) are at risk of exposure to *Schistosoma haematobium* infection, mainly in the areas around Dezful, north of Ahwaz, Susangird, and Shushtar (Fig. 1).

Several development programmes are now under way in Khuzestan province, including the construction of hydroelectric and agricultural dams and large-scale extension of irrigation schemes. The development of irrigation systems will extend the spread of schistosomiasis unless effective and long-term control measures are implemented. The prevalence of schistosomiasis is increasing in many endemic areas of the world, and only a few countries have succeeded in controlling the infection. The present report describes the changes in disease prevalence and incidence that occurred between 1970 and 1979 as a result of selective chemotherapy and molluscicide in Khuzestan.

Attempts to control urinary schistosomiasis in Iran were started in 1959, and a large amount of baseline data was collected before experimental and large-scale control operations were introduced (*2 – 4*).

These investigations demonstrated that infection was limited to a few foci in Khuzestan province and the number of infected persons was estimated to be 25 000 – 30 000, living in the Dezful, Ahwaz, Shushtar, and Dasht-i-Mishan (Susangird) areas. Control measures were started in 1968, using a combination of chemotherapy with various antischistosomal drugs and snail control, including sanitary measures, environmental improvement, and focal molluscicide of snail habitats (*5*). Selective population chemotherapy and molluscicide were carried out throughout the year, but the main activities were concentrated in spring and autumn.

One of the most important components in any operational programme of disease control is a periodic assessment of changes in the pattern of infection. In the case of schistosomiasis, selective population chemotherapy has already been shown to be one of the most effective methods of control (*6*). The success of the snail control operations was assessed by

[1] Associate Professor and Chief, Khuzestan Medical Research Station, Institute of Public Health Research, School of Public Health, Teheran University, Teheran, Iran.

[2] Formerly Professor of Parasitology, School of Public Health, Teheran University, Teheran, Iran.

[3] Senior Field Technologist, Khuzestan Medical Research Station, Institute of Public Health Research, Teheran University, Teheran, Iran.

[4] Instructor, School of Public Health, Teheran University, Teheran, Iran.

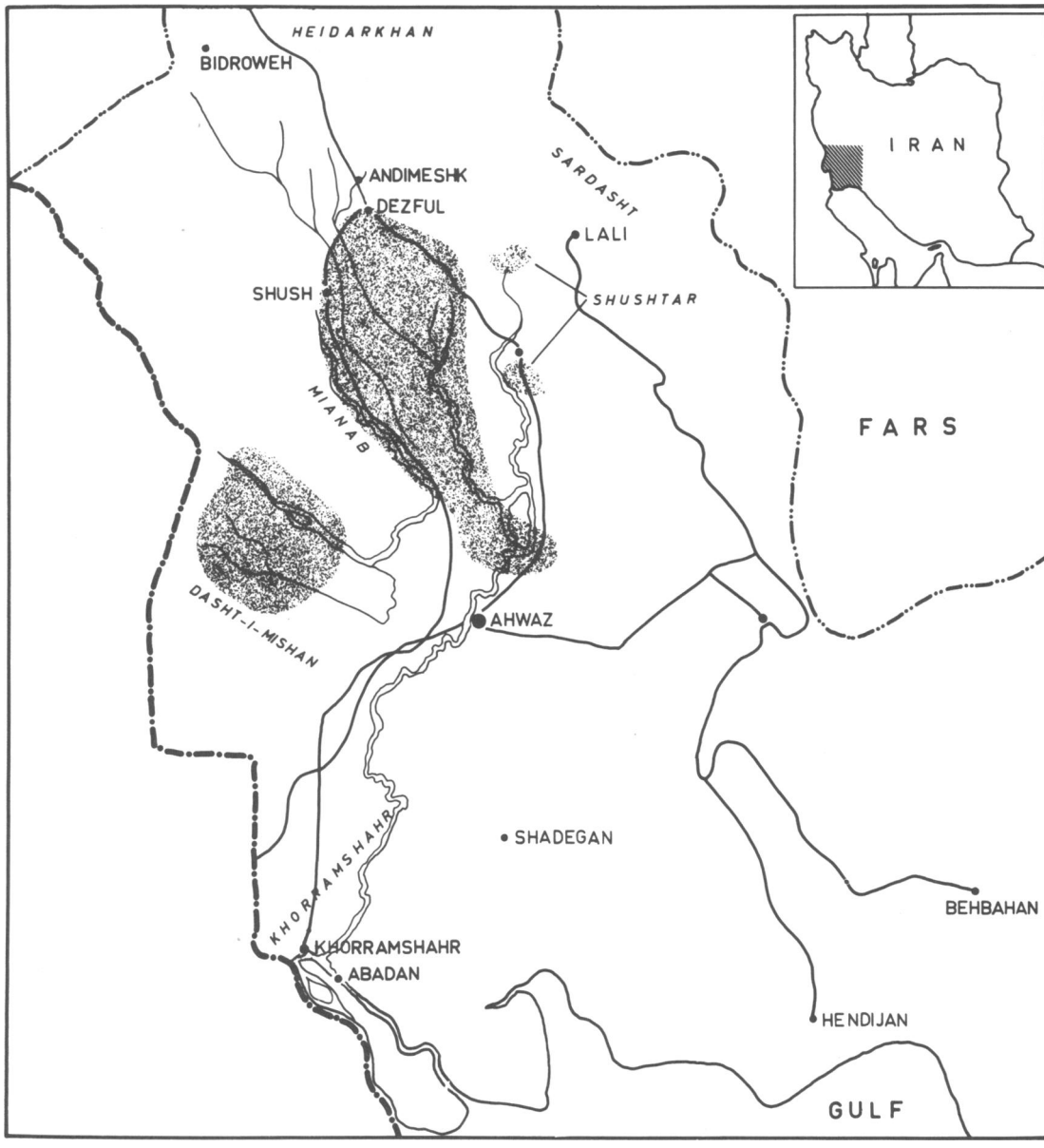

Fig. 1. The major endemic foci of urinary schistosomiasis in Khuzestan, south-west Iran.

monitoring the incidence of infection among schoolchildren in various localities.

MATERIALS AND METHODS

The prevalence of infection in the rural areas of Khuzestan was assessed annually by examination of urine samples. These were collected at 10h 00 and sediments of each sample were examined for *S. haematobium* ova under a stereoscopic microscope. Infected subjects were then treated with 30 mg of niridazole per kg of body weight, daily for 4 consecutive days.

Changes in the level of transmission of infection were also assessed by examination of urine samples from children less than 15 years old from several villages in various parts of the endemic area. All children found negative in the initial survey were re-examined at yearly intervals in order to determine the incidence of infection.

The snail intermediate host of *S. haematobium* in Iran is *Bulinus truncatus*, which also acts as the snail host for *S. bovis* and *Paramphistomum microbothrium* in ruminants. Bulinid snails were found in various habitats such as borrow-pits, swamps, and canals. The peak snail population was seen in May–July and October–December. Most of the potential habitats in the area were surveyed twice a year using a wire-mesh net, and infested habitats were treated with a niclosamide molluscicide. Meanwhile, various sanitary measures were instituted, such as draining of the huge swamps, improvement of the canals, and provision of a standard latrine and fresh water supply for each family.

RESULTS

In the past 10 years, the prevalence of schistosomiasis in Khuzestan has been significantly reduced, and transmission is now at a very low level; in some areas it has been completely interrupted. The combined approach of chemotherapy and snail control has led to a decrease in incidence, prevalence, and intensity of infection in the whole area. The environmental modifications, such as provision of domestic water supplies and alterations in the land drainage in the area were also useful in interrupting transmission and inhibiting the breeding of bulinid snails in the large swamps and marshes where molluscicide alone was not effective.

As shown in Table 1, of 21 878 urine samples examined in 1970, 1822 infections (8.3%) were detected. The annual infection rate has decreased gradually, until in 1979, when the last annual report was prepared, only 674 infected cases were detected among 91 022 samples (0.7%).

Table 1. Annual prevalence of *S. haematobium* infection in Khuzestan, 1970–79

Year	No. of urine samples examined	No. positive	Infection rate (%)
1970	21 878	1822	8.3
1971	19 919	1060	5.3
1972	30 421	1160	3.8
1973	60 534	1899	3.1
1974	71 300	1206	1.7
1975	65 370	832	1.3
1976	56 057	655	1.2
1977	34 973	258	0.74
1978	90 046	801	0.89
1979	91 022	674	0.74

Table 2 shows the changes in transmission during control operations; the overall incidence of infection decreased from 3.5% in 1970 to 0 in 1977. However, a few newly infected cases were detected in 1978–79 among schoolchildren under 15 years of age in several villages around Dezful (0.11% in 1978 and 0.7% in 1979.)

Chemotherapy with niridazole often produced side-effects on the 3rd and 4th day of treatment, as a result of which some patients, particularly children, refused to complete the prescribed course. It is now planned to use metrifonate in the treatment of infected persons in the area. Between 1974 and 1979, approximately 500 infected individuals were treated

Table 2. Annual incidence of *S. haematobium* infection in Khuzestan, 1970–79

Year	No. of urine samples examined	No. positive	Infection rate (%)
1970	1066	38	3.5
1971	822	17	2.1
1972	1121	48	4.3
1973	1054	33	3.1
1974	1627	12	0.74
1975	904	8	0.88
1976	2783	11	0.4
1977	3891	0	0
1978	1238	2	0.16
1979	1140	8	0.7

Table 3. Administration of niridazole to persons with *S. haematobium* infection in Khuzestan, 1970–79

Year	No. of known infected persons	Persons treated	
		No.	(%)
1970	1591	1320	83
1971	752	649	86
1972	768	558	73
1973	1551	1091	70
1974	941	673	72
1975	832	453	54
1976	710	509	72
1977	653	287	44
1978	801	557	70
1979	674	473	70

annually in Khuzestan province (Table 3). Repeated annual chemotherapy in the area proved to be highly effective in the control of this disease. Among subjects who continued to excrete schistosome eggs after treatment, the mean concentration was reduced from 15 700 eggs per litre of urine in 1967 (*3*) to 11 800 per litre in 1976.

Annual malacological surveys were carried out on a large number of potential snail breeding places, including ponds, borrow-pits, swamps, drains, and canals. A habitat was considered to be infested if any *Bulinus* snails were found during a 10-minute search. As shown in Table 4, the proportion of habitats infested with *B. truncatus* decreased from 10.1% in 1971, to 2.0% in 1978, with a slight increase again in 1979 to 2.4%.

Table 4. Proportion of *Bulinus*-infested habitats and details of mollusciciding in Khuzestan, 1970–79

Year	No. of habitats tested	Positive habitats		No. of habitats treated	Amount of niclosamide used (kg)
		No.	%		
1970	5080	322	6.3	190	942.5
1971	3148	318	10.1	199	1775
1972	3164	336	10.6	105	1193
1973	5946	408	6.9	110	2362
1974	8420	412	4.9	122	3034.5
1975	11 520	325	2.8	189	1125.5
1976	12 727	288	2.3	94	3505
1977	9952	244	2.5	25	869.5
1978	12 184	242	2.0	44	702
1979	14 374	348	2.4	104	1372

Molluscicide using niclosamide (1 mg/litre of water) was carried out in stagnant and running water as indicated in Table 4. The number of habitats treated each year varied from 199 in 1971 to 25 in 1977. The amount of niclosamide used each year varied from 702 kg to 3505 kg, according to the number and size of the treated habitats (Table 4).

Some infested habitats, such as the large swamps, could not be effectively treated with molluscicide, and drainage and environmental sanitation measures were usually used in these areas. These included provision of safe water supplies, construction of latrines, and installation of drainage systems.

The entire control programme in Iran cost about $400 000 in 1979, to protect a population of about 300 000 living in the 4 major endemic foci in Khuzestan ($1.3 per person). Jobin (*7*) calculated that in 1972 the cost of the schistosomiasis control programme in Iran was $120 000 or $0.4 per person. The increased cost was partly a result of an increase in the cost of living and partly because of expansion of the programme.

DISCUSSION

Schistosomiasis is a growing health problem in many tropical regions, mainly as a result of the expansion of irrigation networks and the migration of people to the newly developed areas.

The results of the control efforts in Khuzestan have shown that, under suitable conditions, schistosomiasis can be well controlled by a combination of molluscicide and mass-population chemotherapy. However, ecological changes resulting from the extension of irrigation networks in the endemic area have occasionally hindered the snail control efforts.

The data presented in this paper clearly indicate the effect of long-term combined control measures on the schistosome infection rate in Khuzestan. The overall prevalence of infection fell from 8.3% in 1970 to 0.7% in 1979. The slight increase in the incidence of the disease in 1978 and 1979 to 0.7% may be attributed to the political upheavals in the country, which reduced the level of field activities during this period.

A reduction in the prevalence of various animal trematodes in the area was also achieved. The *Bulinus* snail is an intermediate host for *S. bovis*, and the control operations produced a reduction in infection from 1964 levels of 20.8% in cattle and 14% in sheep (*8*), to 0.8% in cattle and 0% in sheep in 1970 (*9*). From 1972 to 1979, no cases of *S. bovis* infection

were detected in animals in the Khuzestan area, indicating complete eradication of the disease. However, in two areas, one in Abjirob sector in the north of Khuzestan and the second in central Khuzestan, 40 km north of Ahwaz, transmission could not be completely interrupted because of the presence of large marshes and swamps, where mollusciciding was of little use for snail control.

There are currently two large sugar cane projects in Khuzestan, one in Haft-tapeh in the south of Dezful, and the other in the south of Shushtar. Both these areas have many large water reservoirs which have already become infested with *B. truncatus*. This may cause problems in the future.

Jelnes (*10*) has suggested that prolonged use of molluscicide has led to the development of resistance in Iranian bulinid snails. However, extensive trials carried out in our laboratory have shown no such resistance in snails from the Khuzestan area. Details of these tests will be published later.

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RÉSUMÉ

PROGRÈS DU PROGRAMME NATIONAL DE LUTTE CONTRE LA SCHISTOSOMIASE EN IRAN

Au Khouzistan, dans le sud-ouest de l'Iran, la schistosomiase sévit à l'état endémique. Le problème est aggravé par l'exécution d'un vaste programme de développement, qui comporte la construction de plusieurs barrages et l'extension à grande échelle des réseaux d'irrigation. Depuis 1966 on s'efforce de lutter contre la schistosomiase urinaire en combinant la chimiothérapie de choix au niridazole (30 mg par kg de poids corporel) pendant 4 jours et l'application locale de molluscicide dans les divers types d'habitat des mollusques (utilisant 1 mg de niclosamide par litre d'eau) pour éliminer *Bulinus truncatus*, mollusque hôte intermédiaire de *Schistosoma haematobium*.

La chimiothérapie et l'application de molluscicide ont été poursuivies pendant toute l'année, mais les principales activités ont été concentrées sur le printemps et l'automne. Les données recueillies de 1970 à 1979 indiquent que la prévalence de l'infection dans cette zone a graduellement diminué de 8,3% en 1970 à 0,74% en 1979. De même, le nombre des habitats infestés de *Bulinus* a aussi décru à la suite de l'application de molluscicide. Le pourcentage des habitats infestés a diminué progressivement de 10,9% en 1971 à 2,4% en 1979.

En plus des enquêtes régulières sur la prévalence de l'infection, on a évalué les modifications survenant dans la transmission de l'infection en examinant des échantillons d'urine d'enfants de moins de 15 ans venant de divers villages de la zone. Tous les enfants que l'on a trouvé négatifs au cours de l'enquête initiale ont été réexaminés à des intervalles d'une année, afin de déterminer l'incidence de l'infection dans la zone. Les résultats obtenus au cours de cette investigation indiquent que l'incidence de l'infection dans la zone a régressé de 3,5% en 1970 à 0,7% en 1979.

La quantité totale de niclosamide utilisée a varié de 702 kg à 3505 kg par année, et entre 287 et 1320 personnes infectées ont été traitées chaque année.

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