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EXPERIENCES WITH THE CONTROL OF SCHISTOSOMIASIS MANSONI IN TWO FOCI IN CENTRAL AFRICA

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Experiences with population-based chemotherapy and other methods for the control of schistosomiasis mansoni in two subsaharan foci are described. In the forest area of Maniema (Zaire), intense transmission of Schistosoma mansoni, *high prevalences and intensities of infection, and important morbidity have been documented. Taking into account the limited financial means and the poor logistic conditions, the control strategy has been based mainly on targeted chemotherapy of heavily infected people (>600 epg). After ten years of intervention, prevalences and intensities have hardly been affected, but the initial severe hepatosplenic morbidity has almost disappeared. In Burundi, a national research and control programme has been initiated in 1982. Prevalences, intensities and morbidity were moderate, transmission was focal and erratic in time and space. A more structural control strategy was developed, based on screening and selective therapy, health education, sanitation and domestic water supply. Prevalences and intensities have been considerably reduced, though the results show focal and unpredictable variations. Transmission and reinfection were not significantly affected by chemotherapy alone, and the eventual outcome of repeated selective treatment appears to be limited by the sensitivity of the screening method. Intestinal morbidity was strongly reduced by community-based selective treatment, but hepatosplenic enlargement was hardly affected; this is possibly due to the confounding impact of increasing malaria morbidity. The experiences show the importance of local structures and conditions for the development of an adapted control strategy. It is further concluded that population-based chemotherapy is a highly valid tool for the rapid control of morbidity, but should in most operational conditions not be considered as a tool for transmission control. Integration of planning, execution and surveillance in regular health services are essential, and sanition, provision of domestic water supply, and health education remain the cornerstones of long-term control.*

Key words: *Schistosoma mansoni* – control – Burundi – Zaire

Since the development of safe, effective single dose-drugs such as oxamniquine and praziquantel, population-based chemotherapy has become the main strategy for the control of morbidity due to schistosomiasis (WHO, 1985). In major endemic countries with a reasonable degree of socio-economic development and relatively strong health services, such as Brazil, Egypt and China, large-scale programmes (partly) based on this new approach are now operational since a decade or more (WHO, 1985; Anonymous, 1985; Silveira, 1989; Webbe & El Hak, 1990). These programmes have achieved tremendous progress towards the control of severe morbidity, though continuing transmission necessitates sustained surveillance and intervention (Webbe & El Hak, 1990); part of the successes may also be due to socio-economic development (Kloetzel & Schuster, 1987).

Many other endemic countries, particularly in subsaharan Africa, lack the budgetary means and do not have sufficiently developed health services to maintain control interventions on the long term. Also, schistosomiasis is often given low priority among the depressing multitude of old and new health problems confronting these countries (Gryseels, 1989). For urinary schistosomiasis, the availability of

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simple indirect screening techniques facilitate primary health care-based approaches for the control of morbidity (Savioli et al., 1990), but schistosomiasis mansoni may be a more difficult problem. In most subsaharan countries, morbidity is limited to intestinal disease and mild organomegaly; decompensated portal hypertension with its dramatic symptoms is infrequent (Gryseels & Polderman, 1991). In such circumstances, it is difficult to convince policy makers and funding agencies to invest (heavily) in schistosomiasis control. Drugs are expensive, and reinfection in high transmission areas (where control is most needed) intense. Furthermore, active case finding requires important microscopic screening capacities, which health services simply do not have.

Nevertheless, various efforts to apply the new control tools have been made in recent years. We report on our own experiences with population-based chemotherapy and other control methods in two neighboring, yet completely different endemic areas in central Africa.

AREAS, POPULATIONS AND CONTROL METHODS

The Maniema focus in Eastern Zaire (Fig. 1) has been described in detail by Polderman et al. (1982, 1985a, b). In this hilly primary forest area, open tin mining is the main economic activity. Isolated miners' villages are scattered throughout the forest, each situated near one or several open mine pits which must be provided with water for the separation of ore from the soil, generally through ill-maintained systems of artificial lakes and canals. In these man-created biotopes, *Biomphalaria pfeifferi* breeds – and transmits *Schistosoma mansoni* – either very well, or not at all, depending on the local geophysical conditions (Polderman et al., 1985b). As a consequence, some of the villages are highly endemic, others are virtually free of infection. The total endemic population, covered by the project, counts about 10,000 people. Adult men work for the mining company; women and children grow crops in the forest and go fishing in the lakes. Sanitary conditions, roads and communications are poor; no piped water is available. Water contact for various domestic and professional reasons is abundant. Snail densities and snail infection rates are high (up to 50% and more). The prevalences in endemic villages are virtually 100%, and in most endemic villages half of the population or more excrete more than 600 eggs per gram faeces (epg); egg counts over 10,000 epg are not uncommon. Gross bilharzial hepatomegaly and splenomegaly, and severe dysenteric syndromes are very frequent; remarkably enough, clinical cases of decompensated portal hypertension are virtually never seen (Polderman et al. 1985; Gryseels & Polderman, 1987).

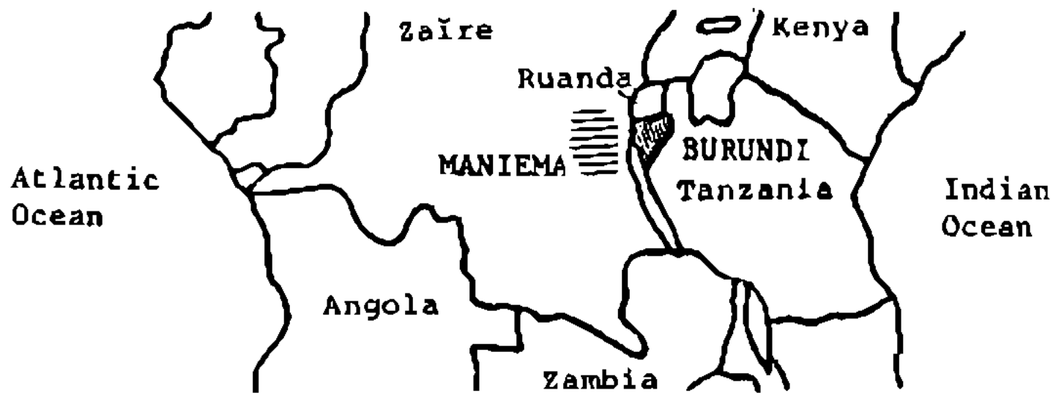


Fig. 1: geographical situation of the two project areas.

The control project started in 1978, on the request of the mining company which recognized the high direct and indirect costs of the problem. The control strategy was based on a series of epidemiological and chemotherapeutic studies, and practical and budgetary considerations (Polderman, 1984). All endemic communities were screened once every year, as far as logistic conditions allowed, with duplicate 25 mg Kato slides following an adapted Kato-Katz method (Polderman et al., 1985a). Only people excreting more than 600 epg received treatment, first with oxamniquine, and from 1983 on with praziquantel 40 mg/kg. Focal molluscicide was applied in some villages. Treatment is also given to symptomatic outpatients in dispensaries and hospitals.

The Burundese foci have been described in detail elsewhere (review see Gryseels, 1991). The main endemic area is the Rusizi plain, situated just north of lake Tanganyika, 1,000 km2 large and with a population of 140,000 people, living of cotton, rice and subsistence farming. The main intermediate host is *B. pfeifferi;* transmission takes place in a wide variety of natural and man-made water bodies. Snail densities and infection rates are low and erratic, but water contact for various domestic and occupational reasons is abundant. The overall prevalence of schistosomiasis is 33%, but local prevalences range from 3 to 63%, with strong micro-focal variations. Schistosomiasis control, based on molluscicide and passive case detection had been going on since 1966. As the quality and impact of the interventions had become doubtful, the ministry of health initiated a series of epidemiological and op-

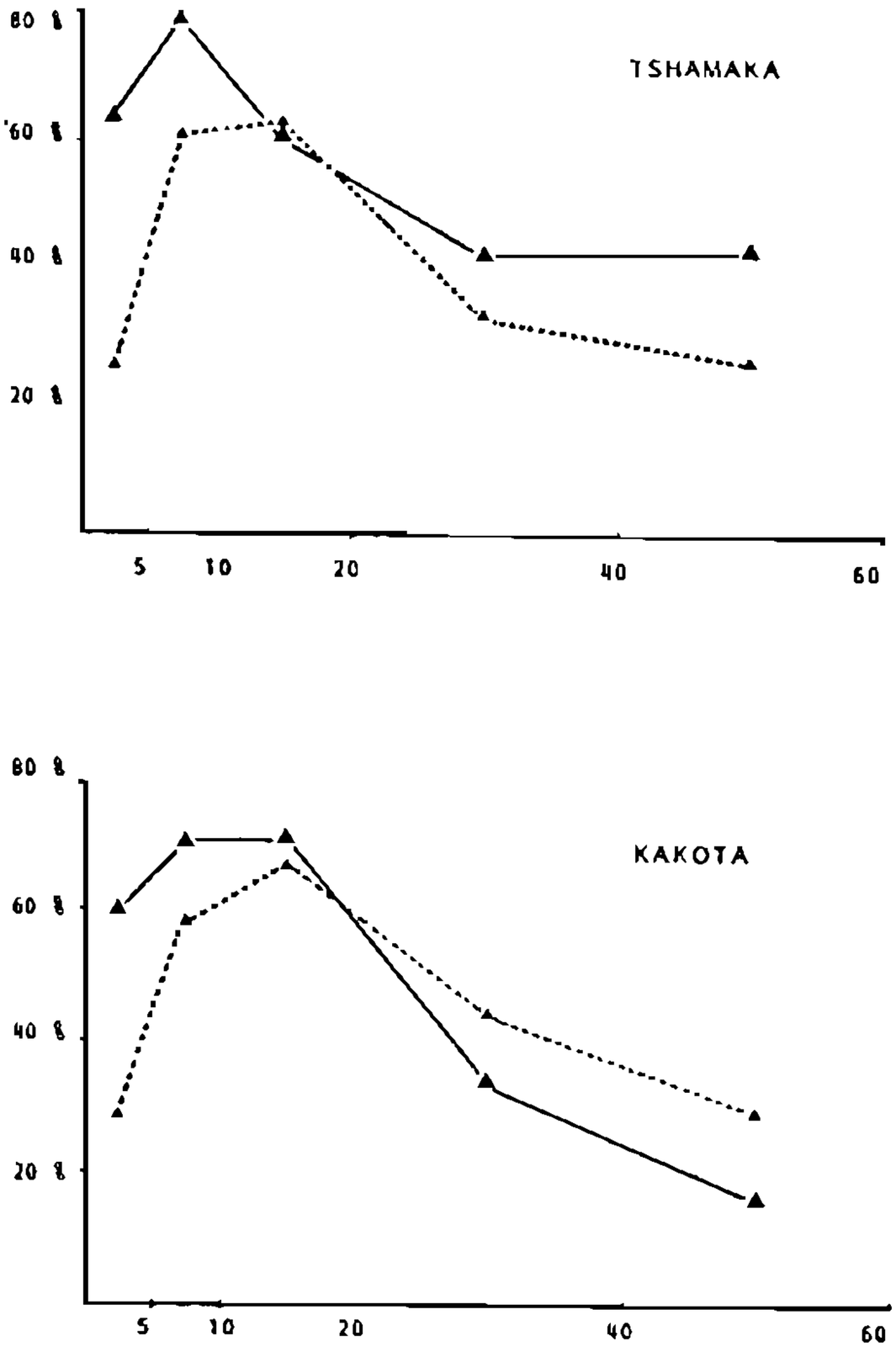


Fig. 2: control of *Schistosoma mansoni* in Maniema: age related prevalences of infection over 600 epg before (dashed line) and 20 months after (full line) treatment in Thsamaka (targeted chemotherapy alone) and Kakota (targeted chemotherapy + focal molluscicíding).

erational studies, which have led to the development and implementation of a renewed control programme from 1985 onwards. At first the strategy was mainly based on selective chemotherapy, with priority to areas with a prevalence over 30%. A test-and-screen procedure, with a quick 25-mg Kato method and praziquantel 40 mg/kg was adopted. In rural areas, all age groups were targeted; in urban areas, the programme is confined to annual screening and selective treatment of primary school children. Focal molluscicíding is applied where possible. Monitoring is based on the annual examination of random 8-10% population samples; re-intervention is considered when the prevalence is over 30% again. The impact of (repeated) chemotherapy and focal molluscicíding has also been evaluated in more detail in representative study villages.

RESULTS

A detailed analysis of the results of both control programmes or pilot studies has or will be given elsewhere (Polderman et al., 1982; Polderman 1984; Polderman & De Caluwé, 1988; Gryseels & Nkulikyinka 1989; Gryseels, 1990; Gryseels et al., 1991; Engels et al., 1993). Here, we will only present a broad summary of relevant results and conclusions.

Maniema – The first treatment trials in this project made clear that reinfection was very intense. Most treated individuals, children and adults alike, were reinfected to their initial intensity level, 12 to 20 months after treatment. Focal molluscicíding had no significant effect on the reinfection rates (Fig. 2). However, as the communities and medical staff unanimously praised the beneficial effect of the treatments, and because there were no practical alternatives for control, the mining company agreed to continue the chemotherapy programme. During the period 1978-1987, a total of 30,000 examinations have been performed by a special control team; about 13,000 treatments have been given. With some exceptions due to logistical and other problems, the annual schedule has been fairly well maintained.

Figure 3 shows the evolution of over-all prevalences and intensities of infection in a few representative villages. Obviously, the repeated chemotherapeutic interventions have had no or little impact on the high prevalences of infection; in some villages there was a reduction of the frequency of heavy infection. In spite of these at first sight very disappointing results, the morbidity patterns in the endemic communities have been drastically altered (Polderman & De Caluwé, 1988). The very impressive organomegaly observed before the control programme started, has almost disappeared, and the frequency and intensity of splenomegaly has been greatly reduced (Fig. 4). The frequency of (bloody) diarrhoea has also been reduced, though less impressively; most people do claim that the dysenteric complaints have also become much less severe. The cost of the control programme has been estimated at 2.20 US$ per capita per year, 25% of which was spent on the purchase of drugs (De Caluwé & Polderman, 1988).

Burundi – Though transmission is clearly much less intense than in Maniema, the first chemotherapeutic trials in Burundi were also followed by surprisingly rapid reinfection, particularly in children (Fig. 5). Repeated selective treatment (with praziquantel 40 mg/kg, screening based on a single 25 mg Kato-slide

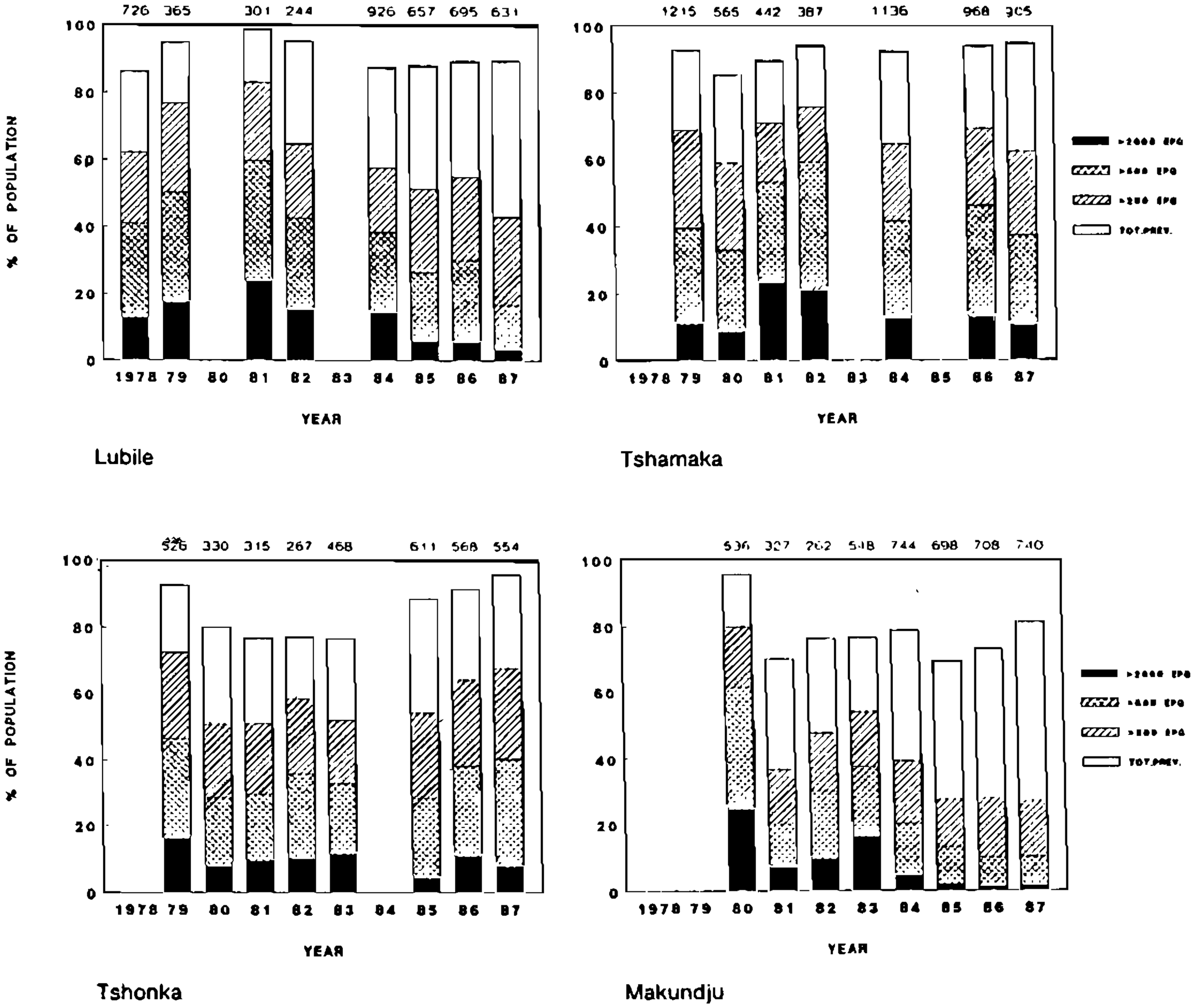


Fig. 3: impact of repeated targeted treatment (of those excreting over 600 epg) on overall prevalences and intensities of infection with *Schistosoma mansoni* in four villages in Maniema; treatment was given after each survey.

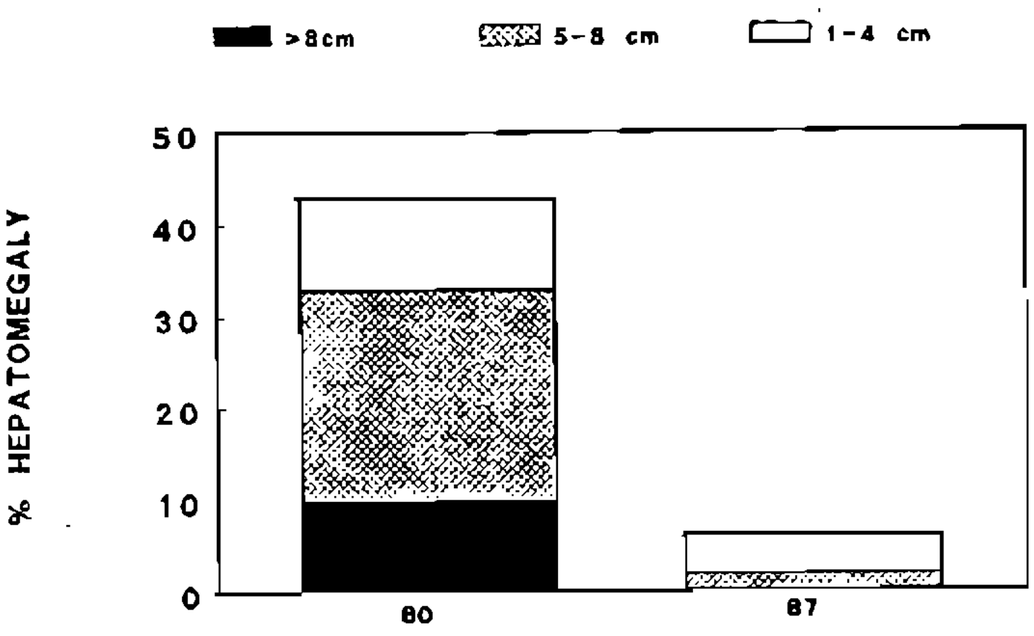


Fig. 4: impact of seven years of annual targeted treatment (of those excreting over 600 epg) on frequency and intensity (cms under costal arch) of hepatomegaly in Maniema.

but monitoring on duplicate slides) in four study villages resulted in a reduction of the prevalences to about 25%, and of infections over 100 epg to about 5%, irrespective of the initial endemicity level (Fig. 6); the sensitivity of the screening method appeared to be the limiting factor for a further reduction (Gryseels & Nkulikyinka, 1989; Gryseels et al., 1991). The results of focal molluscicide were disappointing; in spite of a considerable reduction of the snail populations, reinfection in villages benefiting from molluscicide was not less intense than elsewhere (Fig. 7). Main problems were the complexity of the identification and monitoring of a large number of small-scale focal transmission sites, and the rapid reinvasion by snails of focally treated sites.

In the study villages, the frequency of diarrhoea decreased from 20-33% before treatment, to 10% after three treatments (Fig. 8). However, the impact on hepatomegaly and splenomegaly was virtually unnoticeable; probably increasing malaria morbidity due to spreading pharmaco-resistance in the same

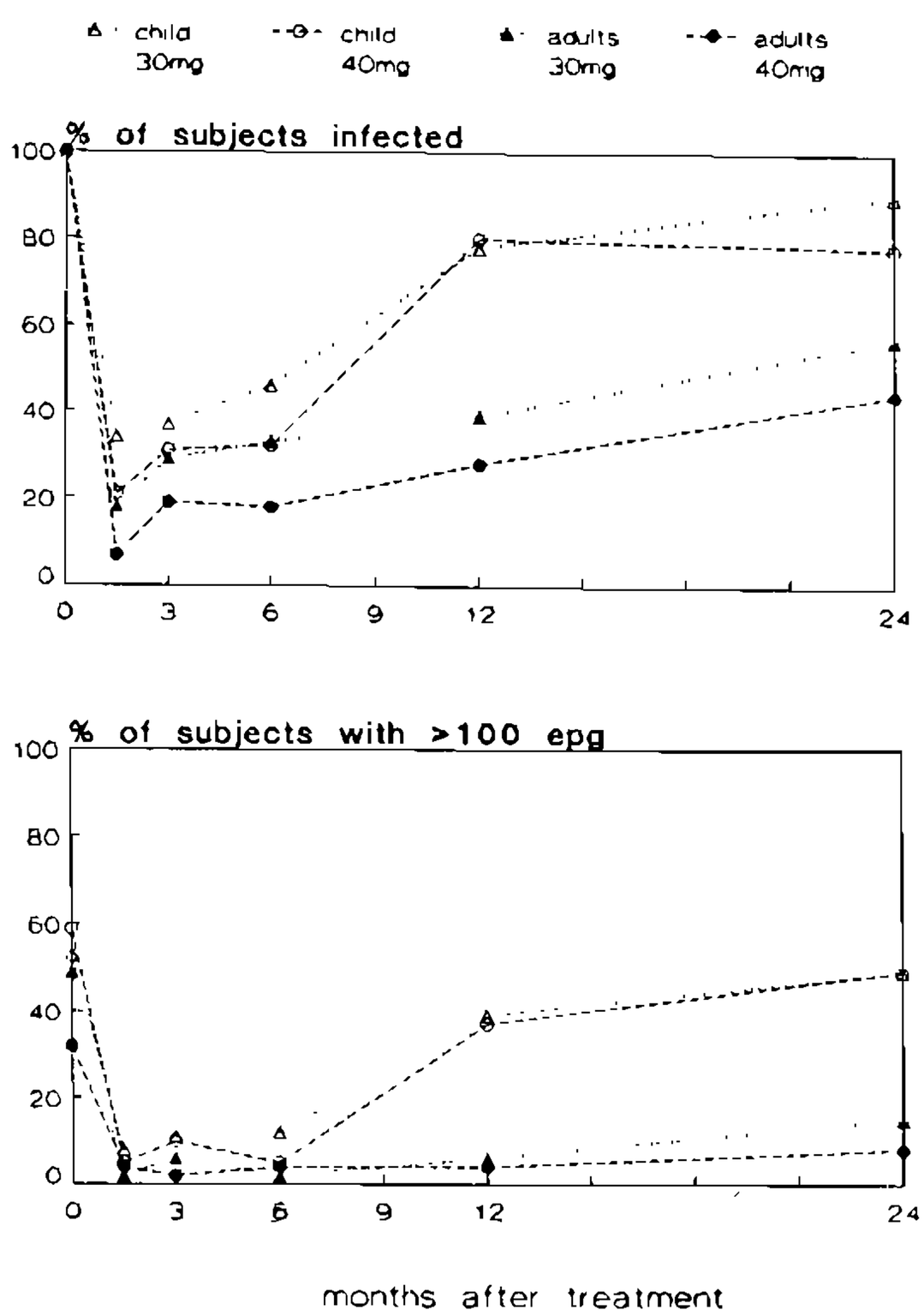


Fig. 5: reinfection after chemotherapeutic trials in Burundi: evolution of prevalences and prevalences of infection over 100 epg in months after treatment with praziquantel 30 mg/kg or 40 mg/kg in children (<20 yrs) and adults (≥20).

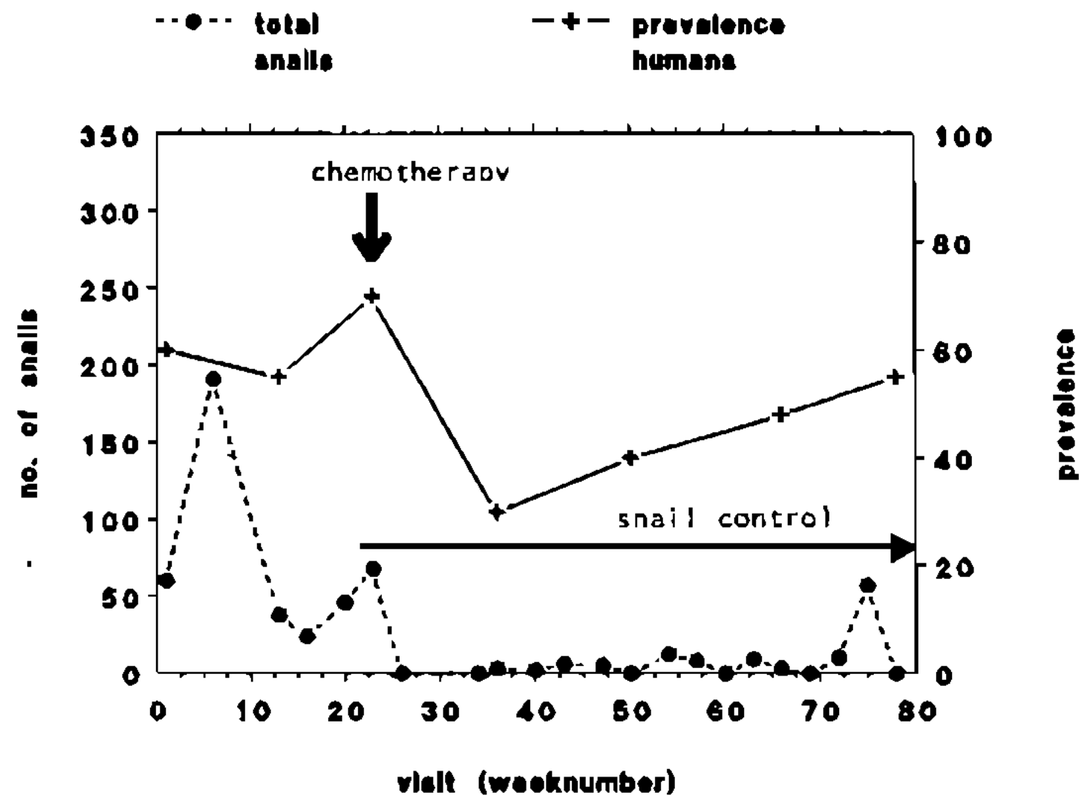
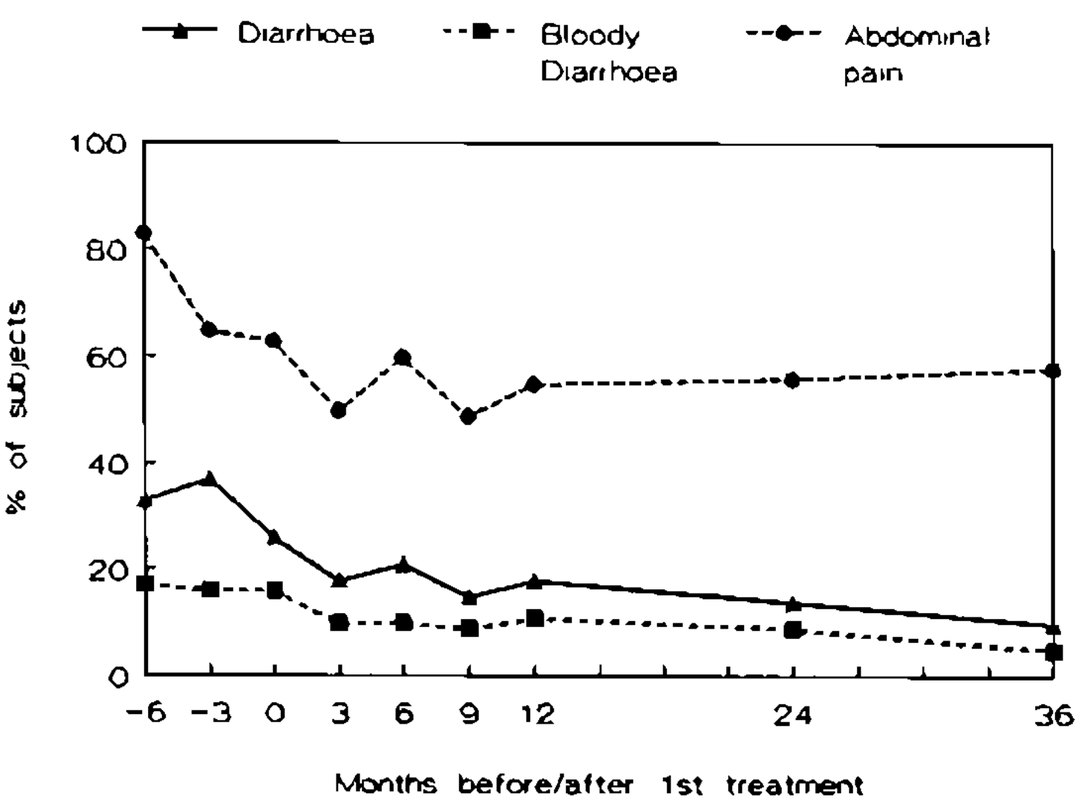


Fig. 7: reinfection in one village where selective chemotherapy was combined with intensive focal molluscicide.



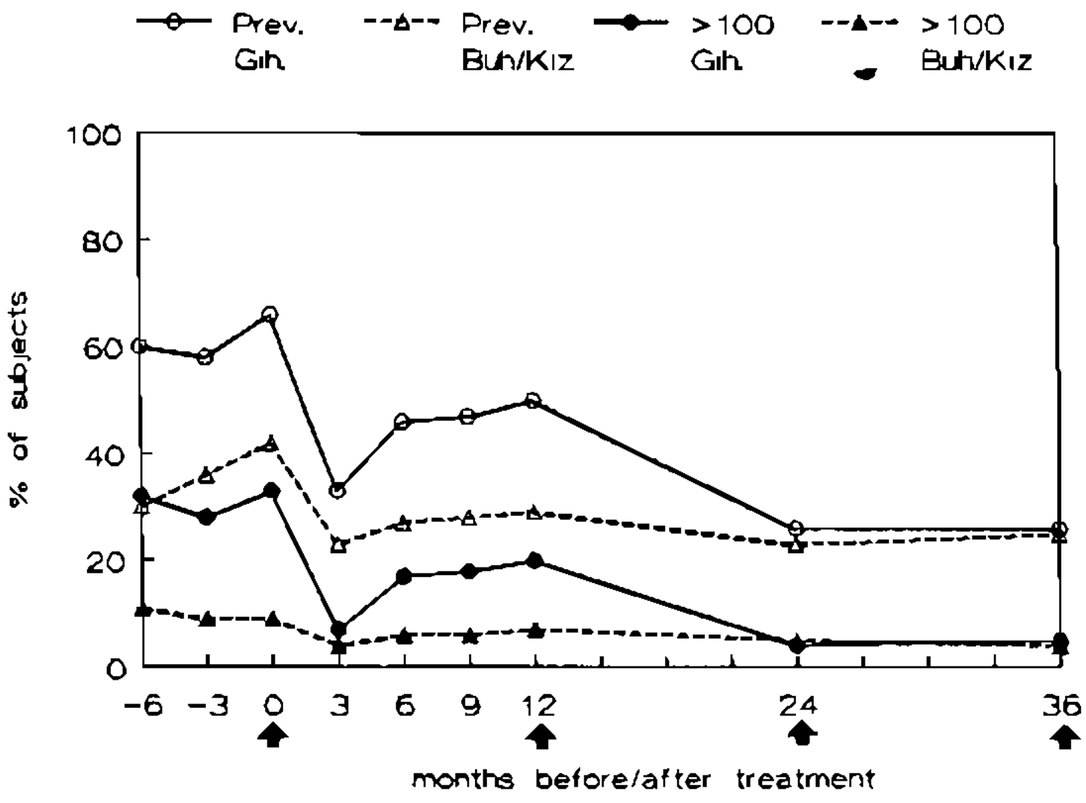


Fig. 6: impact of repeated selective chemotherapy on prevalences and prevalences of infection over 100 epg in two village groups in Burundi. Arrows indicate timing of treatment campaigns. Gih = high prevalence (60%); Buh/Kiz = low prevalence (30%).

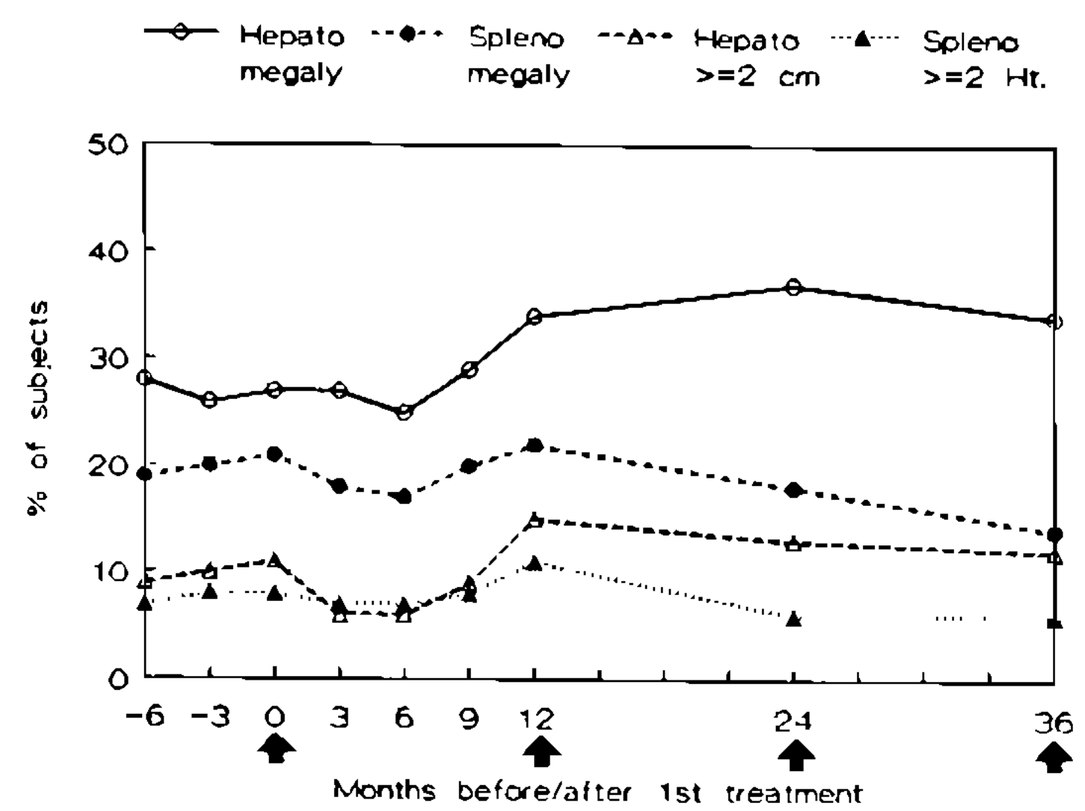


Fig. 8: impact of repeated selective chemotherapy on intestinal (top) and hepatosplenic (bottom) morbidity due to schistosomiasis mansoni in one study village in Burundi (initial prevalence 60%). Arrows indicate timing of treatment campaigns.

period plays a confounding role (Gryseels, 1990).

In the large-scale control programme in rural areas, complete coverage has now almost been reached. Mobile teams have examined 120,000 people, and treated over 40,000, between 1985 and 1990. In rural communities, prevalences have been reduced by 50-60% one year after treatment, and generally they remain low in the following years (Fig. 9); so far, no re-treatment has been necessary. The

impact on morbidity is apparent mainly from a five-fold reduction of symptomatic cases in health centers. The annual selective treatment campaigns in the Bujumbura schools, covering over 10,000 children, has resulted in a progressive, but rather slow reduction of prevalences and intensities (Fig. 10). Most members of the mobile teams have now been integrated in the staff of regional health centers, reinforcing local diagnostic capacities. One central team remains assigned to surveillance, training, and special intervention in problem zones. Undoubtedly, re-treatment campaigns will at some point become necessary; at that moment, mobile teams can be reconstituted if necessary.

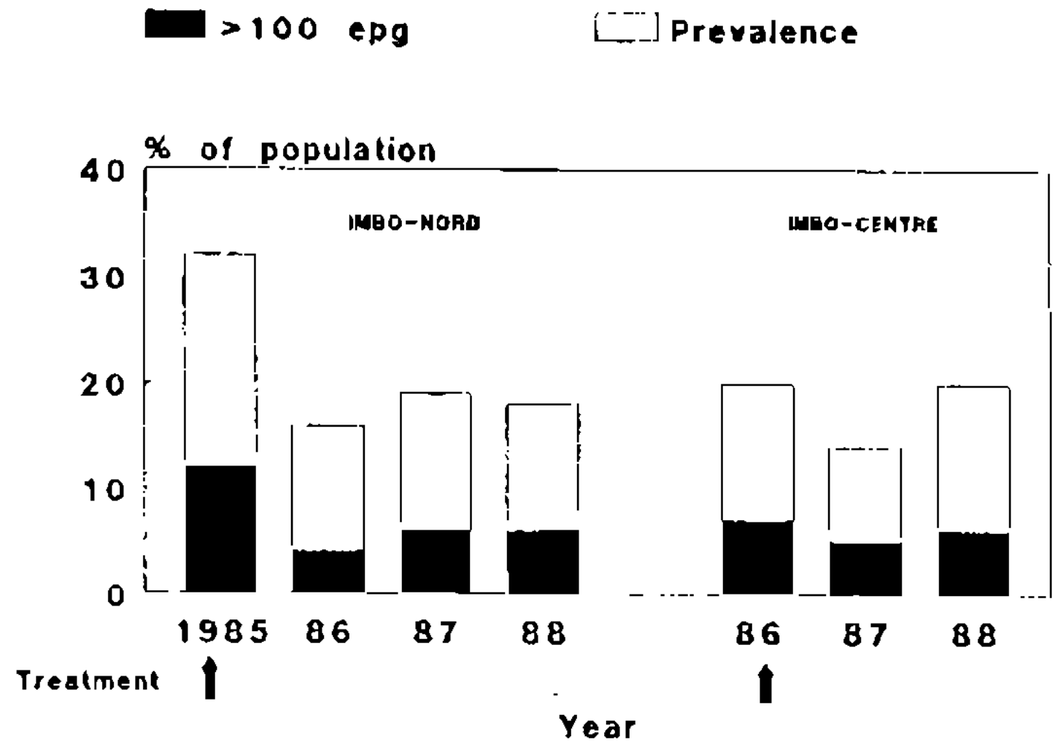


Fig. 9: evolution of prevalences and prevalences of infection over 100 epg in some of the areas submitted to large scale control (selective chemotherapy, mollusciciding, water supply and health education) in Burundi.

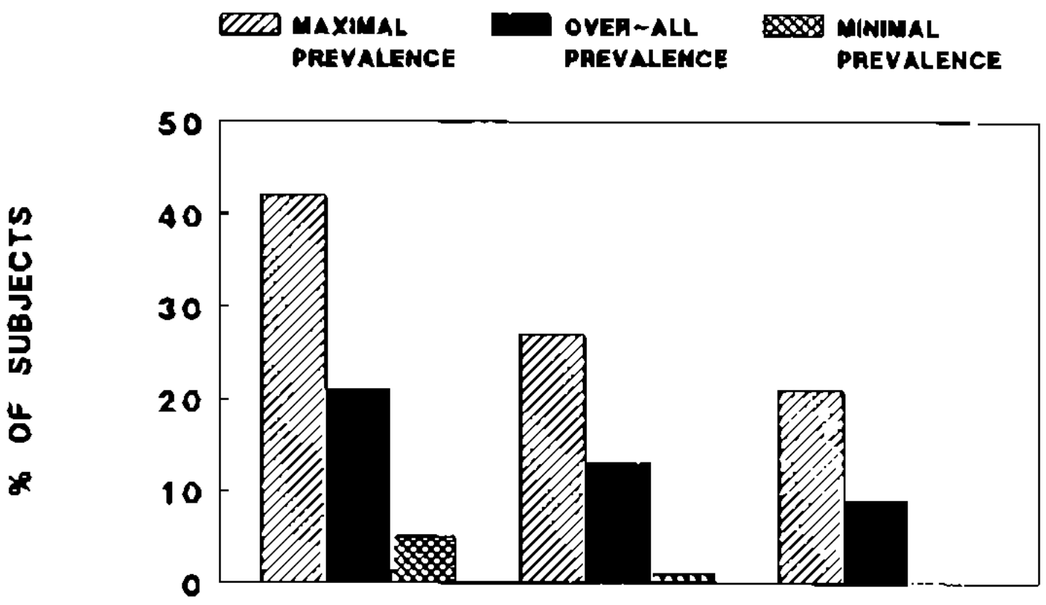


Fig. 10: evolution of prevalences of infection with *Schistosoma mansoni* in schools in Bujumbura, submitted to annual screening and chemotherapy: over-all prevalences, school with maximal prevalence, school with minimal prevalence.

From 1987 on, intersectorial cooperation including supplementary financial assistance, has led to the development of an extensive sanitary and water supply programme, including family and school latrines, provision of piped water in the villages, building of public laundry blocks, simple showers, foot bridges. A comprehensive health education programme has been launched in schools and communities, based on classic (posters, meetings) and modern (videofilms, radio messages) techniques.

The cost of the chemotherapy campaigns in Burundi is about 1$/capita/year, the cost for drugs accounting for 50%. Also snail control costs about 1$/capita/year, but is practiced only in well defined areas. The total cost of the sanitation and water supply programme is about 35$/capita, but its impact is much broader and long-lasting.

DISCUSSION

These experiences first of all show how the relevance, feasibility and strategy of disease control is highly dependent of local epidemiological, logistic, socio-cultural and economic circumstances. In Maniema, a emergency situation caused by man-made intervention and economic interest had to be confronted with limited logistic and financial means; only palliative action, targeting heavily infected individuals was possible. In Burundi, a situation with moderate endemicity and morbidity was addressed by the national government; logistic and budgetary conditions were relatively good. This allowed a more structural approach with a thorough epidemiological preparation, and comprehensive environmental and sanitary intervention besides chemotherapy and molluscicide.

The experiences further show that chemotherapy is a valid tool for morbidity control, but that in operational conditions it has no material long-term impact on transmission. Also in Egypt and Mali transmission appeared to be little or not affected by chemotherapy, even if (in Mali) indiscriminate mass treatment combined with focal molluscicide was applied (Werler, 1988; Webbe & El Hak, 1990). Chemotherapy should thus be developed in function of morbidity control; considerations about "reduction of the reservoir" may lead to little cost-efficient approaches. Probably, a strict morbidity control objective can be achieved with much less frequent treatments than necessary to keep prevalences and egg output low.

The reported results also show that the impact of chemotherapy on morbidity may be

dissociated from its effect on parasitological parameters. The relation between egg output and morbidity is well described, at least at the community level (Gryseels & Polderman, 1991); however, little is known about post-control situations. Our results appear somewhat conflicting. In Maniema, prevalences and intensities of infection have hardly been affected, but the gross organomegaly observed before intervention has all but disappeared. In Burundi, prevalences and intensities of infection and intestinal morbidity were considerably reduced by repeated selective chemotherapy, but its impact on organomegaly was unnoticeable. Confounding factors such as malaria may play a major role in moderate foci such as Burundi, and hepatomegaly may not be a valid tool for the evaluation of interventions, and perhaps not be a very relevant morbidity parameter to start with (Gryseels & Polderman, 1991). In such moderate subsaharan foci, intestinal morbidity control may be a more important objective, which has important strategic consequences; diarrhoea control is clearly a multifactorial problem in need of an integrated approach. In any case, it appears necessary to monitor the impact of schistosomiasis control interventions with direct morbidity parameters, and not with parasitological data only.

In both foci, snail control had little impact on reinfection rates. It is commonly agreed that area-wide snail control is unrealistic in most endemic areas (Fenwick, 1986; Anonymous, 1985); in foci with a large number and wide range of habitats, as those presented here, it is even unfeasible. More targeted, "focal" molluscicíding, has been presented as a valid alternative, but so far there is little hard evidence that this approach really works. Also in Egypt (Gilles et al., 1973; Webbe & El Hak, 1990) and Mali (Werler, 1988), (focal) molluscicíding appeared to have little impact on transmission, even though snail populations were successfully controlled. It has already been suggested by Bradley (1972) that schistosome populations may be regulated mainly by host-related factors, rather than transmission factors. Recent observations on the role of immunity in transmission tend to confirm this hypothesis (Butterworth & Hagan, 1987). This may imply that even a substantial reduction of transmission may only have a limited impact on reinfection. Furthermore, in practice focal molluscicíding may be a surprisingly difficult exercise: the identification and surveillance of the "where", "when", and "how" of transmission in each locality is a demanding and often unfeasible task. Finally, focal molluscicíding is often followed by rapid re-invasion by snails from upstream.

These – and other – experiences show that chemotherapy remains an expensive strategy, in spite of the reduction of the price of praziquantel in recent years. The cost differences between both projects are explained mainly by the higher operational costs in Maniema, due to the large distances and bad roads between foci and the poor logistic conditions. In both projects drugs accounted for less than half of the total cost; elsewhere, e.g. in Mali, this was even less (Brinkmann et al., 1988b). For schistosomiasis control to become possible at a tolerable cost, not only the price of praziquantel must be further reduced, but also affordable delivery strategies, which can be integrated in regular health services, must be developed. For schistosomiasis mansoni, the need for labour-intensive microscopic screening remains the main problem. The establishment of special mobile teams is generally only a temporary solution, as these mostly require external funding which tends to be shorter lived than an average schistosome generation.

In conclusion, chemotherapy is clearly a valid tool for short-term control of morbidity, even if prevalences and intensities remain high after treatment. However, in order to consolidate the results, integration in existing health services is essential, but not always possible. The easy successes of chemotherapy should not make us forget that environmental measures, domestic water supply, and health education remain the cornerstones for lasting control.

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