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School Water, Sanitation, and Hygiene to Reduce the Transmission of Schistosomes and Soil-Transmitted Helminths

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The life cycles of schistosomes and soil-transmitted helminths (STHs) suggest that water, sanitation, and hygiene (WASH) might reduce their transmission. However, the level of impact of WASH is likely to vary with the location (in school, at home, or elsewhere), the type of WASH, and the parasite in question.

Targets for the control of schistosomes and STHs are increasing in ambition, with elimination of the parasites now under discussion [1,2]. In this context, there is a growing appreciation of the need for environmental control of the parasites to reinforce the reductions achieved with preventive chemotherapy (PC), in particular by slowing reinfection with the parasites following PC. This is particularly apparent in the case of *Trichuris trichiura*, against which single doses of mebendazole and albendazole, the drugs most frequently used in PC campaigns against STHs, have been estimated to lead to faecal egg count reductions of only 63.1% and 64.5%, respectively [3]. Furthermore, the possibility of the parasites evolving resistance to albendazole, mebendazole, and praziquantel, the drug most frequently used against schistosomes, has raised concerns about the sustainability of control programmes relying solely on PC [4]. The interventions that might slow reinfection with these parasites include: potential vaccines [5]; WASH, which might be used in households, schools, health centres, or other places, and associated health education [5,6]; and environmental management to reduce the survival of schistosomes and their intermediate snail hosts in fresh water and of STHs in the soil [7,8].

Little is known about the effectiveness of environmental interventions against these parasites, despite the fact that such knowledge is vital to the integration of these approaches into control programmes [9]. One reason for this is that studies of such interventions are frequently expensive, requiring both large scales and costly interventions. These large scales arise in part from the consideration of the relationships at the level of the community rather than of the individual. Community-level analyses are frequently appropriate since the role of WASH against these parasites is often to disrupt their transmission between inhabitants of a given community. An increase in the coverage of adequate sanitation in a community should contain infective parasite stages in the faeces and urine and prevent subsequent infection – not necessarily infection of only the same people using the sanitation, but also of adjacent community members.

Other reasons for the lack of attention paid to the environmental control of these parasites include a lack of appreciation of the public health importance of STHs until recently and the way in which anthelmintics have been the focus of control, to the exclusion of other interventions, in recent decades. The drugs albendazole, mebendazole, and praziquantel were introduced from 1975 to 1980 [4]. They are well tolerated and effective against most of the parasites in single doses [4], their prices have fallen over the years, and the pharmaceutical companies that manufacture them donate them to control programmes [1]. These drugs seemed much more powerful weapons against the parasites, and they are, in that they achieve rapid and dramatic reductions in infection intensity, thus reducing transmission and preventing much of the disease burden that would otherwise result from prolonged and heavy infections. This effectiveness of the drugs caused a lack of interest in environmental approaches until recently, when increasingly ambitious targets for parasite control, coupled with concerns over drug resistance and strong economic development in many endemic areas, has boosted enthusiasm for environmental control approaches (particularly WASH).

How well WASH can disrupt schistosome and STH transmission is likely to vary for different parasites and for different settings for the WASH provision. Differences in the location of WASH within a community (in schools, households, or other places) will affect how it is used, with implications for transmission. Other, more idiosyncratic factors may also affect the impact of WASH on the parasites. For example, schistosome transmission depends not on open defecation in general but on the input of schistosome eggs in urine or faeces into water containing intermediate-host snails. Sanitation might therefore be very effective against schistosome transmission in settings where defecation into or next to water occurs because the surrounding vegetation or banks provide the only privacy in the area [10]. Sanitation is likely to be less effective in the control of *Schistosoma japonicum*, particularly in settings where water buffaloes are providing 90% of the parasite eggs in the environment [6].

School WASH, the subject of a recent analysis of data from national mapping of Ethiopia [11], differs from WASH in households and other settings, with important implications for the control of schistosomes and STHs. For example, *Schistosoma mansoni* transmission requires both the input of eggs in faeces into a water body containing *Biomphalaria* snails and subsequent dermal contact with that water (a schematic lifecycle for

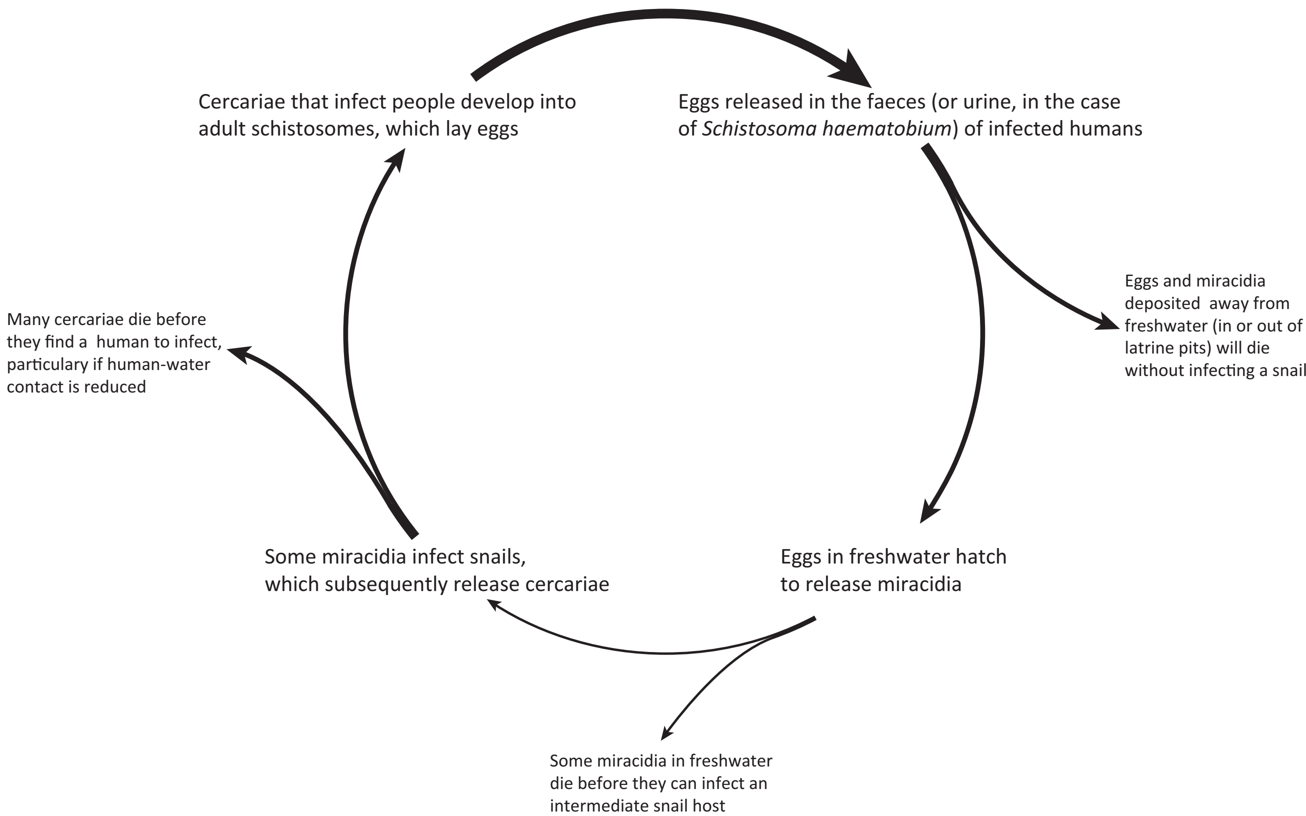

Figure 1. Schematic Life Cycle of *Schistosoma*. The diagram shows how defecation (or urination, in the case of *Schistosoma haematobium*) away from water bodies containing intermediate-host snails and avoidance of human–water contact lead to the death of miracidia and cercariae, respectively, and thus a reduction in transmission of schistosomes.

Schistosoma is shown in Figure 1). It is therefore intuitive that *S. mansoni* transmission rarely occurs within schools, since these requirements are unlikely to be met there. Students are unlikely to be able to leave the school compound during the school day to defecate elsewhere. Even in the rare case that they can, they will not necessarily defecate at water bodies where *S. mansoni* is transmitted. Therefore, school WASH might play a weaker role in the control of *S. mansoni* than household WASH, the latter being potentially closer to transmission sites and being used during non-school hours, when students have more freedom to move around and seek out private areas for defecation. Note that this is less likely to apply to *Schistosoma haematobium*, the eggs of which are released during urination. People generally seek out less privacy for urination than for defecation [10] and males in particular frequently urinate in the open. Sanitation anywhere (at school, at home, or elsewhere) would therefore seem to be less effective in the control of this parasite.

Schools' water supplies might be expected to have a stronger impact than sanitation on *Schistosoma* transmission. If water is needed at a school (most obviously for drinking, but perhaps also for hand washing, cleaning, food preparation, construction, or even watering plants), the students may be responsible for bringing it. If there are no safe and convenient water supplies in the vicinity, this water may be collected from cercaria-infested sources and its collection may cause schistosome infection. Here it should be mentioned that the collection of water is sometimes thought to be relatively unimportant in the transmission of schistosomes since it involves immersion of small areas of skin and for short durations, while recreational swimming exposes a much greater area of the body to cercariae and generally occurs for longer [6]. However, water collection does not involve the use of soap, which by virtue of its toxicity to cercariae may prevent infections that would otherwise occur during other activities such as washing or bathing [6].

The transmission pathways of the STHs differ markedly from those of *Schistosoma*; the life cycles of the STHs are summarised schematically in Figure 2.

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