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Prevalence and Intensity of Schistosomiasis in School Children in a Large Sugar Irrigation Estates of Zimbabwe

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Abstract: A schistosomiasis prevalence and intensity survey was carried out among school children in three schools of Hippo Valley one of the largest irrigated sugar estates in Zimbabwe from April-June 2004 and December 2004-February 2005. The estates have a long history of schistosomiasis that had been successfully reduced to less than 10% prevalence in 2001. In the current study the mean prevalence of schistosomiasis per school was 22.74 and 24.36% in the wet and dry seasons, respectively. There was a positive correlation between school and schistosome species. Nyawagi had the highest *S. haematobium* prevalence (24.43%) and Chikomo had the highest *S. mansoni* prevalence (26.08%). *S. haematobium* infections were light with a mean infection intensity of 13.07 eggs 10 mL^{-1} urine whereas *S. mansoni* infections were moderate to heavy with a mean infection intensity of 123.58 eggs g^{-1} of stool. Mean prevalence of schistosomiasis was significantly different in the 5-8 years and 13-15 years age groups and in the 9-12 years and 13-15 years age group ($p<0.05$). Chikomo had the highest number of infected *B. pfeifferi* while Nyawagi had the highest infection rate for *B. globosus*. The increase in the prevalence of *Schistosoma* at Hippo Valley Estates schools is attributed to poor sanitation and a breakdown in the snail control program. Schistosomiasis that had been brought under control 4 years ago is currently a major health problem in the irrigated Hippo Valley estates.

Key words: Schistosomiasis, *Schistosoma haematobium*, *Schistosoma mansoni*, irrigation, Zimbabwe

INTRODUCTION

In Zimbabwe schistosomiasis is considered to be the major source of morbidity among children of school going age[1]. The disease is often associated with water development projects such as dams and irrigation schemes where snail intermediate hosts breed[2].The Hippo Valley Estates (HVE.) has a long history of schistosomiasis control in Zimbabwe[3]. Between 1972 and 1998 the HVE embarked on schistosomiasis control program using niclosamide to control the snails. The Estates also embarked on a program that aimed at providing safe water points and toilets per family so as to reduce human contact with potentially infected water and to reduce faecal contamination of water bodies. Environmental control measure included devegetation of dams, drains and night storage ponds in order to desiccate the snails. The prevalence of *Schistosoma haematobium* was 52% in 1980 but had decreased to about 9.53% in 2001 while that of *S. mansoni* was 62% in 1985 but had decreased to 6.91% in 2001[4]. This was achieved through systematic treatment of infected children as well as organised surveillances between 1984 and 1998. However, from the year 2000 onwards there have been massive changes in land tenure. A great deal of the Estates's farm has been acquired by the government for land redistribution to the marginalized communities. In most of the small holder irrigation schemes, little if any effort is made to address the schistosomiasis problem. Currently HVE has no planned curative control program in operation but symptomatic cases that avail themselves at the health centres get treated. The aim of the present study was to evaluate the current prevalence and intensity of schistosomiasis in Hippo Valley Sugar Estates schools; to do snail surveys to assess their infection rates and to assess the environmental control measures.

MATERIALS AND METHODS

Hippo Valley Estates is situated in the Lowveld region (altitude 592 m) of Southeastern Zimbabwe. The area has a single rainy season (November to March) and receives less than 400 mm of rain per annum. Temperatures range from 18 to 30°C for most of the year, occasionally rising to over 40°C for short periods[5]. The main agricultural activity in HVE is sugarcane irrigation. Irrigation water for the estates is drawn from Mtirikwi river

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via Bangala dam and Esquilingwe weir. The estates are divided into separate farms and sections of varying sizes in terms of human population and area under cultivation. Workers and dependants in each section or farm live in compounds located within the estates. HVE has 13 primary schools.

Within the HVE three study sites were identified. Nyawagi school is located within a farm compound approximately 6 km south east from HVE sugar cane mill plant. The school is close to a fallow marshy cane field. Canals are close to the school yard. Chikomo school is located about 4 km from the cane mill plant and is on a high ground at the bottom of a small kopje. Cement lined canals pass just near the schoolyard (less than 20 m from the play grounds). Mlemi school is located approximately 4 km to the west of the sugar mill plant on a relatively flat ground and a canal runs across one side of the schoolyard.

Three hundred and sixty school children aged between five and fifteen years participated in the study. Dry season sampling was done from end of April-June 2004 and wet season sampling was done from December 2004 to February 2005. For each age class, 20 pupils were selected randomly using a class register. Each participant was asked to submit urine and stool specimens in screw-capped plastic bottles. A total of 360 stool and 360 urine specimens were collected. The urine filtration method was used to detect any *S. haematobium* eggs in the urine samples[6]. Each stool sample was processed following the Kato Katz procedure[7] to detect any *S. mansoni* eggs.

Five sentinel points (secondary, tertiary canals, drop structure, offtakes and Duckbill weirs) were surveyed for snails in March and May 2005 using the scoop method[8]. Recovered snails were identified and enumerated. Twenty *Bulinus globosus* and twenty *B. pfeifferi snails* were put singly in small glass tubes and left in sunlight for approximately one hour to determine infection rates.

Visual assessment of maintenance of irrigation structures and sanitation was done concurrently with scooping.

Univariate Analysis of Variance (ANOVA) was used to test the effect of school, age sex and season on prevalence and intensity of infection. Multiple comparison tests (Least significant difference and Bonferroni) were used to detect between subjects effects on prevalence and intensity.

RESULTS

Prevalence and intensity of *Schistosoma*

Prevalence and school: School has a significant effect on the prevalence of schistosomiasis. There was a positive correlation between school and schistosome species prevalence (Table 1 and 3). Mean prevalence in Mlemi (13.24%) was significantly less than that of Nyawagi and Chikomo ($p<0.05$).

Prevalence and season: There was no correlation between *Schistosoma* sp. prevalence and season (Table 2 and 3).

Prevalence and age groups: There was a significant difference in the prevalence of schistosomiasis between age groups 5-8 years and 13-15 years and between age groups 9-12 years and 13-15 years ($p<0.05$). There was no significant difference between the mean prevalence in the age groups 5-8 years and 9-12 years (Table 2).

Intensity, age and species: There was a significant difference in the intensity of infection and species of *Schistosoma* ($p<0.05$) (Table 2 and 3). *S. haematobium* infections were light with a mean intensity of 13.07 eggs/10 mL urine during the entire study period. However, *S. mansoni* infections were heavy (>100 eggs/g of stool) with extreme cases having >500 eggs/g of stool. There were no significant differences in the intensity of *Schistosoma* infection and age, season and sex (Table 2 and 3).

Snail data: Four snail species were recovered from sentinel points around the study sites; *Bulinus tropicus*, *Melanoides turberculata*, *Bulinus globosus* and *Biomphalaria pfeifferi*. Nyawagi school had the highest percentage of *Bulinus globosus* that were shedding cercaria whereas Chikomo had the highest percentage of *Biomphalaria pfeifferi* that were shedding cercaria (Table 4).

Environmental assessment: The three schools had no safe drinking water and canal water was used for domestic purposes. Flush toilets in Chikomo had no water and cane fields were used as toilets. The canals in the three schools had overhanging vegetation. Organic debris was found in canals in Nyawagi and Mlemi schools (Table 5).

DISCUSSION

The above 20% prevalence of both *S. haematobium* and *S. mansoni* not at the heavy infections of >100 eggs/g of stool for *S. mansoni* indicates that schistosomiais is currently a problem in Hippo Valley Estates.

The high prevalence of *S. mansoni* at Chikomo is due to poor sanitation. The school had very few latrines and it is possible that most of the pupils used the bush as an alternative. However, considering that the other two

Table 1: Prevalence of schistosomiasis in the three schools during the study period

	Nyawagi	Chikomo	Mlemi
Per age class	8.91[a]	10.05[a]	4.60[b]
Overall per school	26.73[a]	30.15[a]	13.80[b]
S. haematobium	24.43[a]	13.24[b]	11.38[b]
S. mansoni	14.89[a]	26.08[b]	11.02[a]

Superscripts a and b denote differences between schools at $p<0.05$

Table 2: Overall prevalence and intensity of schistosomiasis in the estates according to age, season, species and sex

	Prevalence	Intensity
Age		
5-8 years	24.21[a]	40.67[a]
9-12 years	32.58[a]	102.34[a]
13-15 years	13.92[b]	61.96[a]
Season		
Dry	24.36[a]	83.01[a]
Wet	22.74[a]	53.64[a]
Species		
S. haematobium	23.50[a]	13.07[a]
S. mansoni	22.33[a]	123.58[b]
Sex		
Males	27.30[a]	85.04[a]
Females	19.38[a]	51.61[a]

Superscripts a and b denote differences between groups at $p<0.05$

Table 3: Tests of between subjects effects on prevalence and intensity

	Prevalence		Intensity	
Parameters	F-value	Sig.	F-value	Sig.
Age	7.24	$p<0.05$	1.43	ns
Season	0.16	ns	0.94	ns
Species	0.20	ns	13.33	$p<0.05$
Sex	3.48	ns	1.22	ns
Age and season	0.49	ns	0.53	ns
Age and species	0.27	ns	1.60	ns
Season and species	0.06	ns	0.31	ns
Age, season and species	0.92	ns	0.59	ns
Age and sex	0.09	ns	0.64	ns
Season and sex	0.44	ns	0.01	ns
Age, season and sex	0.59	ns	0.50	ns
Species and sex	0.85	ns	1.70	ns
Age, species and sex	0.55	ns	0.53	ns
Season, species and sex	0.12	ns	0.02	ns
Age, season, species and sex	3.78	ns	0.56	ns
School	7.70	$p<0.05$		
School and species	7.81	$p<0.05$		

ns: non significant

Table 4: Number of snails caught in canals around the schools (percentage of snails shedding schistosome cercaria)

Species	Nyawagi	Chikomo	Mlemi
Bulinus globosus	22 (80%)	26 (55%)	26 (50%)
Biomphalaria pfeifferi	20 (45%)	25 (85%)	21 (70%)
Other species (*Bulinus tropicus* and *Melanoides*)	36	66	34

schools were experiencing the same situation, it is possible that other factors besides sanitation contributed to the high prevalence of *S. mansoni* at Chikomo school. Many *B. pfeifferi* snails were found around this site. The lining of the canal may be preferred for egg laying and mobility since the area is rocky and provide a habitat for the snails. Also, the presence of many weirs along the main canal reduce the water velocity and thereby promote snail colonisation. However, Nyawagi had the highest prevalence of *S. haemoatobium* infection (Table 2). In this site *S. haematobium* is predominant over *S. mansoni*, which is contrary to the situation at Chikomo school. The marshy area and the tall grass that over hangs the canals seems to provide a conducive environment for the *B. globosus* snails. Water in the canals is fast flowing, a situation that favours colonisation by *B. globosus*[9]. The significant interaction between site and species prevalence infers that transmission of schistosomiasis is focal and is also affected by human contact behaviour at a particular school/site.

Table 5: Environment assessment of schools and canals in the estates

School	Safe water	Sanitation	Vegetation/debris
Nyawagi	No taped water, use of canal water	Pit latrines	Vegetation in canals overflowing water
Chikomo	No taped water, use of canal water	Bush toilets	Vegetation and organic debris
Mlemi	No taped water, use of canal water	Pit latrines and use of canal fields	Vegetation, debris and overflowing water

Overall data indicates that more males compared to females were infected with both *Schistosoma* species (Table 2). This can be attributed to the behaviour patterns of boys and girls. Recreation such as swimming and fishing in ponds is done by boys who spend more time in contact with water. However the difference in the prevalence was not statistical significant. The finding of no significant difference between the mean prevalence of schistosomiasis during the wet and dry seasons could be due to overall warmer conditions and the permanence of water in the canals which permit all year round transmission of schistosomiasis.

Age distribution of schistosomes showed a typical age curve in which their prevalence increased with age up to a certain age and thereafter decreased. It is worth noting that in the present study the highest prevalence was found in the 9-12 years age group and then decreased thereafter with age. However, there was no significant difference between the mean prevalence of the 5-8 years and 9-12 years age group. These age groups are active and adventurous hence their water contact behaviour is more than that of the older age group (13-15 years) whose levels of water contact is lower and may be able to express acquired immunity to infection[10,11].

The prevalences for the 2004-2005 study period indicate that infections from both *Schistosoma* species have significantly increased from the prevalence of the period 1991-2000. Mean schistosomiasis prevalence per school has risen from 7.70% in the year 2000 to 23.56% during the current study period. A marked improvement in safe water and sanitation facilities in 2000 contributed

to the reduction of schistosomiasis in the Hippo Valley estates[4]. It appears that this previous success in the control program has been eroded. Schistosomiasis is actually increasing in Hippo valley schools despite chemotherapy that is provided to children that are presenting symptoms of the disease. This implies that the rate of re-infection is very high and that most water bodies are contaminated with cercaria. Snail data supports these observations since most snails that were scooped were shedding cercaria. Also, snail densities in in-field canal works were very high indicating that snail control efforts are very minimal if any. Environment assessment indicated that most sections of the estates lack safe water points. This has a bearing on the observed results. The nature of the canals is very conducive for snail breeding. The tall grasses and vegetation that grow in canals together with high debris levels provides good habitats and food for the snails. The problem is also aggravated by the poor siting of the school communities. Proximity of the schools to canals allows pupils to have access to them and this contributes to the high prevalence of schistosomiasis. Poor drainage in some parts of the study sites and poor sanitation also contribute to the high prevalence. The new small holder irrigation scheme owners should be encouraged to embark on a snail control program using molluscicides and to provide good sanitation and safe water to the communities. Health education on schistosomiasis should be intensified.

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