# Prevalence and intensity of the schistosomiasis situation along the Zimbabwean urban and peri-urban shoreline of Lake Kariba

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## Abstract

***Objective:*** To determine the prevalence and intensity of schistosomiasis in urban and peri-urban Kariba.
***Design:*** A cross sectional schistosomiasis survey involving screening people for infection and searching for intermediate host snails.
***Setting:*** Lake Kariba Research Station, Zimbabwe.
***Subjects:*** One thousand and seventy three people living in four residential areas of Kariba were screened for both *Schistosoma haematobium* and *Schistosoma mansoni*. Seventeen water contact sites along the shoreline close to the residential areas were surveyed for snails.
***Main Outcome Measures:*** Prevalence and intensity of both *S. haematobium* and *S. mansoni* and abundance of intermediate host snails at potential transmission sites.
***Results:*** The prevalence of *S. haematobium* and *S. mansoni* were 7.2% and 2.1% respectively. More males (8.4%) were infected with *S. haematobium* than females (5.7%). There was no difference in prevalence of *S. mansoni* between males (2.2%) and females (2.0%). Most infections of *S. haematobium* were in the age group of 15 to 19 years while the age distribution pattern for *S. mansoni* was patchy. Most of the infections detected were light i.e. one to 100 eggs per gram of faeces or less than 50 eggs per 10ml of urine. Few intermediate host snails for schistosomiais were collected and none of them were infected with human schistosomes.
***Conclusion:*** Prevalence and intensity of schistosomiasis were low and therefore, the disease was not considered to be a major public health problem.

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## Introduction

The potential health impacts of Lake Kariba were recognised before the construction of Kariba Dam.[1] A medical team that assessed health impacts associated with the construction of the dam did not consider schistosomiasis as a major problem around the dam site because the incidence of the disease in the population living along the Zambezi River was low. Furthermore, it was believed that transmission would not take place at the proposed dam site because it was rocky and therefore unsuitable for snail colonisation. It was, however, realized that most dam construction employees were drawn from distant areas in Malawi, Zambia and the then Rhodesia where schistosomiasis was endemic. Thus, all immigrants were screened for *S. haematobium* and those found infected were treated.[1] The medical report, however, did not mention *S. mansoni* nor the intermediate host snail (*Biomphalaria pfeifferi*) involved in its transmission.

A study conducted, following completion of the dam wall, showed that snail populations were increasing and that prevalence of schistosomiasis infection was also increasing.[2] Hira reported for the first time the presence of *S. mansoni* in Lake Kariba.[3] Subsequent studies by Mungomba[4,5] and Mungomba and Kalumba[6] demonstrated a reversed trend in which *S. mansoni* was more prevalent than *S. haematobium*. Similar observations were made on the Zimbabwean side but only up to 1987 (Blair, unpublished). An assessment made in 1999, on behalf of the World Commission on Dams, suggested that there was a general decline in prevalence of both *S. haematobium* and *S. mansoni* on the Zimbabwean side (Chimbari, unpublished).

The reasons for the apparent decline in prevalence of schistosomiasis in Kariba, only 20km from Siavonga, Zambia where prevalence is high were not clear. It was, however, noted that Health Centre records used in the analysis could have been misleading because of prevailing poor attendance at Health Centres due to a general shortage of drugs in Zimbabwe. The present study was conducted to determine the prevalence and intensity of infection of schistosomiasis on the Zimbabwean shoreline of Lake Kariba in order to validate the analysis done using Health Centre data. The study involved screening of 1 073 people for *S. haematobium* and *S. mansoni* and conducting a cross sectional snail survey along the shores of Lake Kariba.

## Materials and Methods

### Study Area.

Kariba town, which is 20km from Siavonga town, Zambia by road has a population of 32 000 based on the 1992 census figures adjusted for growth rates.[7] Its major industries are tourism and fishery. There are four distinct residential areas in Kariba namely, Nyamhunga, Mahombekombe, Heights and peri-urban settlements. All residential areas except Heights are situated along the lake shore with most of the homesteads within one km of the lake. All residential areas in Kariba except some peri-urban areas rely on a reticulated water supply system for domestic use. Most homesteads have household toilets but some share communal toilets. Few do not have access to toilets. The major water contact activities that involve Kariba residents are fishing and recreation (mostly swimming among children).

### Parasitology Survey.

One thousand and seventy three people aged between two and 67 years participated in the study. The participants comprised 700 school children aged between six and 18 years, 13 children below 10 years but not in school and 360 workers aged between 14 and 67 years. The workers were employed by different organizations located along the lakeshore. They included boat coxwains, fishermen, employees at Lake Harvest (an aquaculture farm), employees at Crocodile Farm, farm workers at Charara Estate and Municipality of Kariba employees. All workers present in their work places on the planned day of the survey were included in the study and children below 10 years but not in school were voluntarily presented by their parents. For school children, 10 pupils were randomly selected from each class using the class register.

Each participant was asked to submit urine and stool specimens in plastic bottles. Some failed to submit both specimens, thus a total of 705 stool specimens and 985 urine specimens were collected. Ten mls of each urine sample were filtered through a membrane with a pore size of 12um and examined under a microscope (x 10 objective) to detect *S. haematobium* eggs.[8] A portion of each stool sample was pressed through a seive. The sieved material was passed onto a slide through a template that took 0.05g of stool and covered with a cover slip before being examined for *S. mansoni* eggs using x 10 objective.[9] All people found infected during the survey were treated with praziquantel at a dose of 40mg per kg body weight.

### Snail Survey.

A total of 17 sites were surveyed for snails in January 2001. A scoop made of a kitchen sieve mounted on a 1.5m long rod was used to sample for snails. For every metre along the length of a site one scoop was taken following the method described by Shiff and Clarke.[10] Contents of scoops taken at each site were put in labelled trays and taken to the laboratory for sorting. At the laboratory, intermediate host snails for schistosomiasis were measured (shell height for *Bulinus globosus* and shell diameter for *Biomphalaria pfeifferi*) and classified according to sites. They were put, singly, in small glass tubes and exposed to light for one hour to determine infection rates. Other snails were classified according to sites before being returned to their sites. Intermediate hosts were not returned to their sites for ethical reasons.

### Data Analysis.

Comparisons of prevalence of infection among different age groups and among different residential areas were done using the Chi-squared test. Comparisons of prevalence of infection between males and females; and between children and workers were done using a logistic regression model that controlled for age effects.

Intensity of infection based on egg output was compared between different age groups and different residential areas using One-way Analysis of Variance (ANOVA) on log transformed egg counts for positive cases only. However, in the case of *S. mansoni* comparison of log-transformed eggs was done by t-test since there were only two residential areas with infected people. Intensity of infection between males and females was also done using the t-test on log-transformed egg counts. Statistical significance of all analysis was based on a p value less or equal to 0.05. Analysis of snail data determined total snail densities at sites sampled and distribution of intermediate host snails at the different sites. No statistical comparisons were made because the snail densities were very low and patchy.

## Results

### Overall Prevalence and intensity of *S. haematobium* and *S. mansoni.*

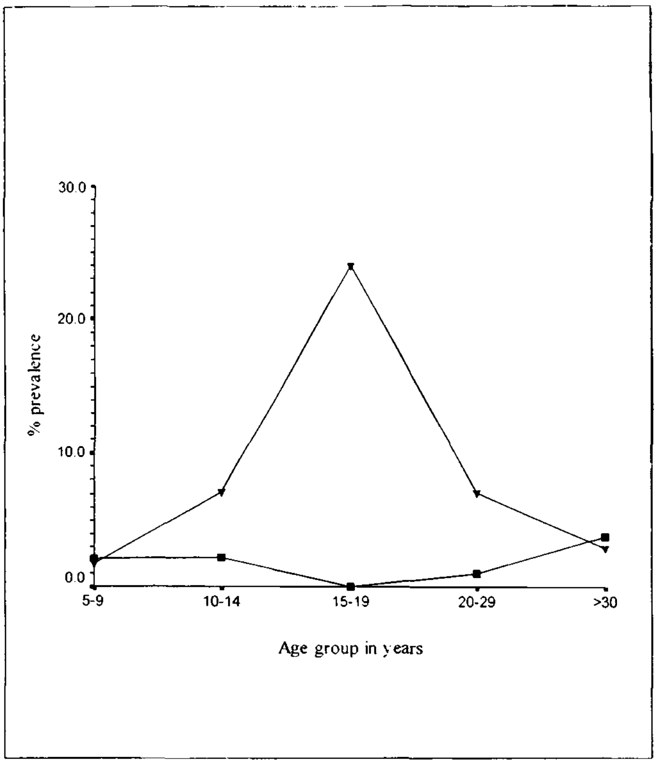
Overall prevalences for *S. haematobium* and *S. mansoni* were 7.2% and 2.1%, respectively; 8.4% males compared to 5.7% females were infected with *S. haematobium* while 2.2% males compared to 2.0% females were infected with *S. mansoni*. The differences, after adjusting for age effects, were not statistically significant for both *S. haematobium* and *S. mansoni*. *Schistosoma haematobium* prevalences among school children and workers were 7.1% and 7.4% respectively while for *S. mansoni*, prevalences for the two groups were 2.1% and 2.2%, respectively. For both infections, the differences between workers and school children, after adjusting for age effects, were not statistically significant.

Most of the infections detected were light (one to100 eggs per gram of faeces or one to 50 eggs per 10ml of urine) with very few having heavy infections ie. >500 eggs per gram of faeces or >50 eggs per 10ml of urine.

### Distribution of Schistosome Infections by Age, Residential Area and Sex.

Figure I shows prevalences of *S. haematobium* and *S. mansoni* for different age groups. Prevalence of *S. haematobium* infection increased with age and peaked in the 15 to 19 years age group, thereafter decreasing in older age groups. The differences among age groups were statistically significant. In contrast, the prevalence for *S. mansoni* was highest in the age group 30 years and above and zero in the 15 to 19 years age group, with no statistically significant differences across the age groups.

*Figure I: Prevalence of* ***Schistosoma haematobium*** *(▲) and* ***Schistosoma mansoni*** *(■) for different age groups.*




Cross tabulation done to compare prevalence of infection among different residential areas indicated statistically significant differences for both *S. haematobium* and *S. mansoni* . The peri-urban area had the highest prevalence for *S. haematobium* while Mahombekombe had the highest prevalence for *S. mansoni*. No *S. mansoni* infections were found in people residing in the peri-urban and Heights areas (Table I). There were no statistically significant differences of infection status between males and females for both *S. haematobium* and *S. mansoni*.

*Table I: Prevalence and intensity of* ***S. haematobium*** *and* ***S. mansoni*** *in different residential* areas. Mean egg counts are based on positive counts only.

| | *S. haematobium* | | | | *S. mansoni* | | | |
|---|---|---|---|---|---|---|---|---|
| Residential Area | No. Exmined | No. Positive | % Positive | Geometeric Mean Egg counts /10 ml urine | No. Examined | No. Positive | % Positive | Geometric Mean Egg counts /g stool |
| Nyamhunga | 643 | 41 | 6.4 | 9.4 | 124 | 7 | 1.8 | 4.8 |
| Mahombekombe | 143 | 13 | 9.1 | 12.2 | 442 | 8 | 5.6 | 3.2 |
| Peri-Urban | 132 | 16 | 12.1 | 20.0 | 108 | 0 | 0 | 0 |
| Heights | 67 | 1 | 1.5 | 32.0 | 31 | 0 | 0 | 0 |

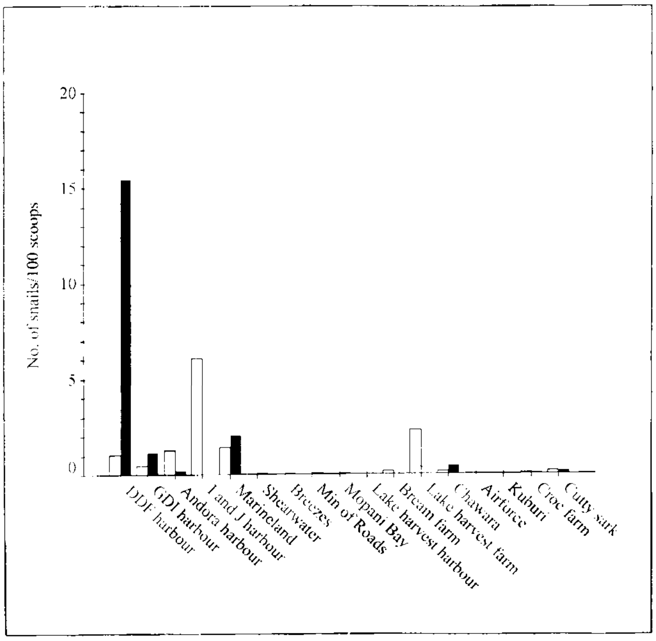
Excluding the Heights area, where there was only one infected individual, intensity of *S. haematobium* was highest among people residing in the peri-urban area while for *S. mansoni* intensity of infection was highest in Nyamhunga. In both cases the differences were not statistically significant. No *S. mansoni* infections were found in people residing in the peri-urban and Heights areas (Table I). Intensities of infection were not different between sexes and among different age groups for both infections.

**Snail Distribution.**

Eleven species of snails were collected at sites along the lake shoreline. *Melanoides tuberculata* was most abundant (190/100scoops) followed by *Lymnaea natalensis* (110/100scoops) and *Physa acuta* (70/100scoops). The rest of the snail species (*Bulinus globosus, Biomphalaria pfeifferi, Bulinus tropicus, Bulinus depressus, Bellamya capilata, Cleopatra ferruginea* and *Bivalve* sp.) were found in numbers less than 10/100scoops.

The distribution of *B. globosus* and *B. pfeifferi* at human water contact sites along the shoreline are shown in Figure II. Both species were found in very low densities. *Bulinus globosus* was found at DDF harbour, GDI harbour, Andora harbour, I and J harbour which are close to Mahombekombe residential area, at Lake Harvest harbour near Nyamhunga and at Chawara close to the peri-urban residential areas. Other sites where *B. globosus* was found include Marineland harbour, Bream Farm ponds, Crocodile Farm harbour and Cutty Sark harbour. Water contact at these sites is occupationally related and involves workers at companies within the harbours. *Biomphalaria pfeifferi* was found at sites close to Mahombekombe residential area as well as at Marineland, Chawara and Cutty Sark harbours. Intermediate host snails for schistosomiasis (*B. globosus* and *B. pfeifferi*) collected at all sites were not infected with human schistosomes.

*Figure II: Distribution of* ***Bulinus globosus*** *( ) and* ***Biomphalaria pfeifferi*** *(■) at different study sites.*




## Discussion

Prevalences of both *S. haematobium* and *S. mansoni* were below 10% and the majority of infected people had light infections, suggesting that schistosomiasis is not a major health problem in Kariba town and Kariba peri-urban areas. This is in agreement with the findings of a rapid assessment made in 1999 using Health Centre statistics (Chimbari, unpublished).

The schistosomiasis situation in Kariba is very different from the situation at Siavonga, a Zambian town only 20 km from Kariba by road and less than 10km on lake. Mungomba[4] reported prevalences at Siavonga as 17% and 56% for *S. mansoni* and *S. haematobium*, respectively. In 1998 the same authors reported, for the same study area, prevalences of 35% and 60.1% for *S. haematobium* and *S. mansoni*, respectively.[5] The differences in prevalence between Kariba town (Zimbabwe) and Siavonga (Zambia) may be explained by a long history of control activities (mollusciciding and treatment) on the Zimbabwean side (Blair Research Laboratory, unpublished reports) in comparison to the Zambian side where treatment was only given to study subjects. We are, however, aware that differences in study designs and sample sizes between the Zimbabwean and Zambian studies may also contribute to the observed differences in prevalence of schistosomiasis.

Contrary to the situation at Siavonga and Matinangala, a village close to Siavonga,[6] the present study found *S. haematobium* to be predominant over *S. mansoni*. Unpublished reports of surveys conducted by Blair Research Institute in Kariba indicate that in 1967 *S. haematobium* was predominant over *S. mansoni* while in 1979, 1985 and 1986 the reverse was true. A similar shift in predominance of the schistosome species on Lake Kariba was reported by Mungomba[4,5] and Mungomba and Kalumba[6]. On the Zambian side, predominance of *S. mansoni* has persisted while in Kariba, this study indicates that another shift resulting in *S. haematobium* being predominant has occurred.

Shifts of predominance of *S. haematobium* and *S. mansoni* have been reported in other lake environments and varied explanations have been suggested.[11,12] Mungomba[5] attributed the shift in predominance of the two forms of schistosomiasis in Lake Kariba to stabilisation of the lake which tends to promote proliferation of *Biomphalaria pfeifferi*. More recently, Mubila and Rollinson[13] have suggested that the decline of *S. haematobium* in Siavonga may be "related to the presence (at ever higher prevalences) of *S. mansoni*," but did not explain why the prevalence of *S. mansoni* is ever high. We, however, are of the opinion that poor sanitation in Siavonga may be the major contributory factor. In the 1980s when *S. mansoni* was reported to be more predominant over *S. haematobium*, raw sewerage was discharged directly into the lake. This has been stopped and Kariba town now has better water and sanitation facilities than both Siavonga and Matinangala. This, together with the long history of control activities on the

Zimbabwean side, may explain the observed differences in prevalence of schistosomiasis. There is, however, need to assess the role of sanitation and water supply on transmission of *S. mansoni* involving researchers in Zambia and Zimbabwe. The contribution of improved water supply and sanitation in the reduction of schistosomiasis is well documented.[14,15,16]

Age distribution of *S. haematobium* showed a typical age prevalence curve in which prevalence increased with age up to a certain age and thereafter decreased. It is, however, noteworthy that for this study the highest prevalence was found in the 15 to 19 years age group while at Siavonga, the 10 to 14 years age group was most affected.[5] Similar age classification to that used by Mungomba[5] was used in this study. A combination of water contact activities and immunity as suggested by Dalton and Pole[17] is a possible explanation for observations made in this study but these factors were not investigated.

Between 1993 and 1998 the lake level rose gradually and from 1999 to 2001 it rose rapidly. Thus, the current lakeshore has recently been inundated by rising water and this probably explains the low numbers of snails found in this study. Surveys conducted during a recent field study training course showed that intermediate host snails were found 200m from the shoreline at depths of four to six meters where water contact does not take place. This may explain the low prevalences of both *S. haematobium* and *S. mansoni* in Kariba. The effect of lake level on distribution of snails, however, needs further investigation.

While this study has made important observations, it has raised many research questions. Studies to investigate the research questions indicated have been initiated.

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