

Full Length Research Paper

Prevalence and temporal distribution of *Schistosoma haematobium* infections in the Vhembe district, Limpopo Province, South Africa

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The aim of the present study is to determine the trend, current prevalence and contributing risk factors of *Schistosoma haematobium* infections in the Vhembe district, South Africa. A retrospective analysis of previous *S. haematobium* data at the hospitals was conducted. A survey was conducted with the use of questionnaires and urine samples collected from hospitals, university students as well as primary school children for microscopic analysis for the detection of *S. haematobium* eggs. Data from previous hospital laboratory tests indicated that *S. haematobium* infections are endemic in the region with prevalence varying between 44 and 90% among patients presenting with urinary tract infections, from 1998 to 2004 with regular peaks in January-February and July-August with an increase in percentage of infected persons during the last two years of the study (2003, 2004). The analysis of samples collected from the hospitals indicated prevalence between 78% in hospital C and 86% at the hospital A with high prevalence of heavy infections. The prevalence among university students and primary school children were 36.2 and 42%, respectively. Although females were more infected than males, the difference was not significant ($p > 0.05$). The survey indicated lack of knowledge of schistosomiasis among university students, frequent exposure to river water, a percentage of geophagy of 38.4% and low level of personal hygiene. School children are at high risk of infection and control programmes must take them into consideration. Health education is a necessity in the region to sensitise the population about these infections. Further studies are needed to identify infection foci as well as the occurrence of the intermediate hosts in different water bodies in the region. Such information will be useful in the design of control methods which will also contribute to poverty alleviation in the region.

Key words: Epidemiology; *Schistosoma haematobium*; Urinary schistosomiasis; Venda, South Africa.

INTRODUCTION

Schistosomiasis also known as Bilharziasis or snail fever is a common intravascular trematode infection most common in developing regions of Africa and Asia (Pugh and Gille, 1979). Five major species of parasitic trematodes of the family schistosomatidae including *Schistosoma haematobium*, *Schistosoma intercalatum*, *Schistosoma japonicum*, *Schistosoma mansoni*, and *Schistosoma*

mekongi, infect humans. Urinary schistosomiasis, in which the bladder is affected, is caused by infection with *S. haematobium*, while intestinal schistosomiasis is caused by *S. mansoni* both of which occur mainly in Africa. Over 200 million people, almost all of them in developing countries, suffer from schistosomiasis, which can cause hypertension, seizures, urinary obstruction, organ damage or destruction and death. At the same time, schistosomiasis is associated with economic losses, and frequently interferes with development projects, particularly water resource development projects such as dams, irrigation schemes, planned and unplanned forestry (Gryseels et al., 2006). In 1993, the World Health

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Organization (WHO) noted that the prevalence and intensity of the disease have been increased in areas undergoing water resource development, especially irrigation (WHO, 2004). The disease is endemic in most African countries where up to one-third of school age children may be actively infected although not always aware of their status (Chidozie and Daniyan, 2008). Schistosomiasis is a neglected disease and very few studies have described its epidemiology in the Vhembe district of South Africa. Thus studies are needed to understand the epidemiology of these infections in order to implement measures necessary for their control in this region.

The distribution of schistosomiasis varies considerably with regions. In developing countries, the true epidemiological picture is not clear because of inadequate research on this infection despite its relevance in planning schistosomiasis control in any locality (Nmorsi et al., 2005). In South Africa, research on schistosomiasis has been conducted mostly in Mpumalanga and Kwa-Zulu Natal provinces where up to 85% of children were infected in some rural areas. Studies in Kwa-Zulu Natal have shown that prevalence varied from 8 to 92% in four different localities (Schutte et al., 1981) and in 22.3% amongst school children in 2001 (Jinabhai et al., 2001). Schistosomiasis is considered endemic in the northern and eastern parts of South Africa. Studies by Moodley et al. (2003) have indicated that both urinary and intestinal schistosomiasis occur widely among the human residents of South Africa.

However, within the context of the spatial methodology used and the limitations of the available disease data, it has not been possible to predict the prevalence of schistosomiasis. The Limpopo province is mostly rural and well irrigated with rivers such as Muchindudi, the Crocodile River, the Limpopo River, the Nzhelele River and others. However, the actual prevalence and epidemiology of schistosomiasis have not been studied in the Limpopo Province.

The most common method of diagnosis of schistosomiasis in epidemiological surveys carried out in Africa is the identification of eggs in the stool for *S. mansoni* or in the urine for *S. haematobium*. Drug treatment is still the principal method of control and the drug of choice is praziquantel, however the degree of recovery from the infection depends on the extent of the damage caused by the infection. Single dose praziquantel (40 mg/kg) is effective in reducing prevalence and in curtailing the disease (King and Dangerfield-Cha, 2008; Danso-Appiah et al., 2008). The present study determined the occurrence of *S. haematobium* infections in the Vhembe district as well as the risk factors that could be associated with the transmission of urinary schistosomiasis in the region.

MATERIALS AND METHODS

Ethical considerations

Ethical clearance was obtained from the Ethics and Research

Committee of the University of Venda, Thohoyandou and the study was also approved by the Department of Health and welfare and the Department of Education Polokwane, Limpopo Province, South Africa. Before the onset of the study, information meetings were held with the staff and parents of the schools in the study area. At these meetings, informed consent was obtained from consenting parents and children as well as university students. Informed consent was also obtained from the children directly before specimen collection.

Study site

The study was conducted in the Vhembe district previously known as Venda. The study sites included the University of Venda, two primary schools in the Vuwani village, and the three main hospitals, in the Venda region of the Limpopo province, South Africa. The population may be roughly estimated at 1.2 million.

Retrospective survey

To have an idea of the occurrence of schistosomiasis in the region, a retrospective survey was conducted. Briefly, records on all the tests conducted on urine microscopy from the three major hospitals in the region for the period 1998 - 2004 were consulted.

Risk factor identification by questionnaires administration

A set of questionnaires was distributed to consenting students of the University of Venda to determine their knowledge on schistosomiasis. In the questionnaires, the students also indicated age and sex. Information in the questionnaires included type of toilet used, source of drinking water, if they had water treated before drinking, whether at times they ate soil, if they washed fruits before eating, whether they had taken anthelmintic or diarrhoeal drugs in the past two weeks, if they wash their hands with soap after toilet usage. They were also asked if they knew how schistosomiasis was transmitted, whether they had been exposed to any water-related activity and for how long they had been exposed to water, how large body areas were exposed to the contagious water in every exposure type and lastly if they have had symptoms of schistosomiasis before. The fully completed forms were brought back and analysed for the survey report.

Sample collection

The urine samples were collected from different communities. These included: patients attending three major hospital centres in the Venda region, pupils attending two different primary schools in the Vuwani sub-region 20 km from the University of Venda and students of the University of Venda. Each student was given a 50-ml container and advised to take the last few ml of the urine that was passed, as they usually yield the most ova. Then all the urine samples were brought to the University of Venda Microbiological Laboratory for examination. Demographic information such as sex and age was also collected. The collection of all the urine samples took place between 10:00 h in the morning and 14:00 h in the afternoon because the sensitivity for the detection of *S. haematobium* eggs is optimal for samples collected during this period of the day.

Microscopic analysis

About 20 ml of urine were centrifuged at 1000 rpm for 10 min to

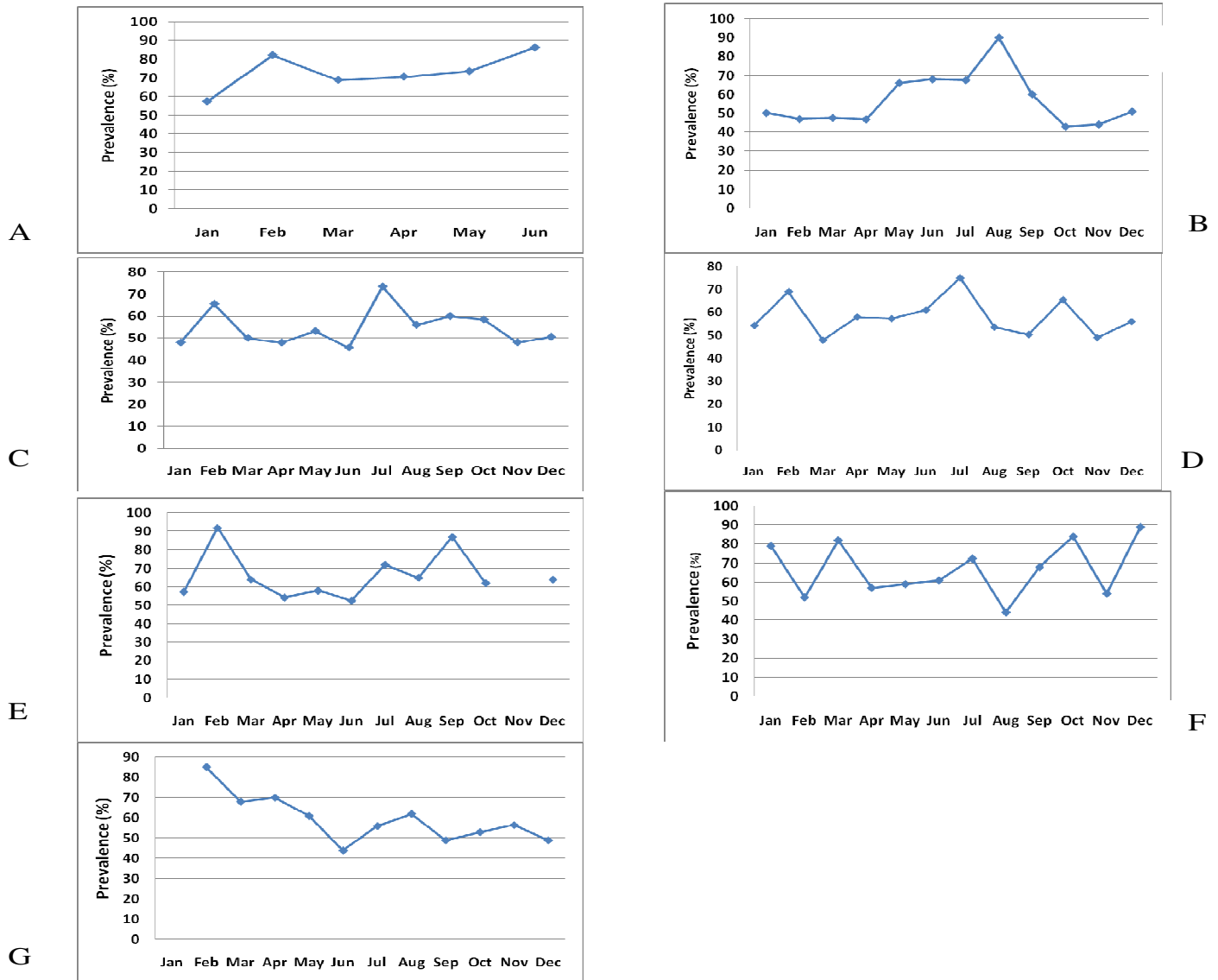


Figure 1. Occurrence of *Schistosoma haematobium* in urine samples submitted for urinary tract infections to the laboratory of the major hospitals in the Vhembe district, between 1998 and 2004. A, 2004; B, 2003; C, 2002; D, 2001; E, 2000; F, 1999; G, 1998.

obtain the sediment. The supernatants were discarded and the sediment (pellet) re-suspended for *S. haematobium*. A drop of the sediment was transferred to the slide, covered with a cover slip and examined using $\times 40$ objective lens. *S. haematobium* eggs were recognised by their large size and the presence of a terminal spine. The urine samples were also observed for red blood cells and deposits that might contain proteins.

Egg counting

Positive urine samples were used for egg counting. This method is correlated to intensity of infection. Hemocytometer was used for egg count determination. Infections were graded as light, and heavy on the basis of the number of ova per 10 ml urine. Light infection was less than 50 ova per 10 ml urine and heavy infection means that more than 50 ova per 10ml urine gram were counted (WHO, 2004).

Statistical analysis

All the data obtained were captured in statistical package SPSS version 13.0 and analyzed for statistical significance. The chi-square test was used and the difference between two different parameters was considered significant if the p value was less than 0.05.

RESULTS

Retrospective survey of schistosomiasis 1998 - 2004

The survey of the number of infections identified at the hospitals indicated that schistosomiasis occurs the whole year round with prevalence varying between 43% (October, 2003) and 92% (February, 2000) (Figure 1).

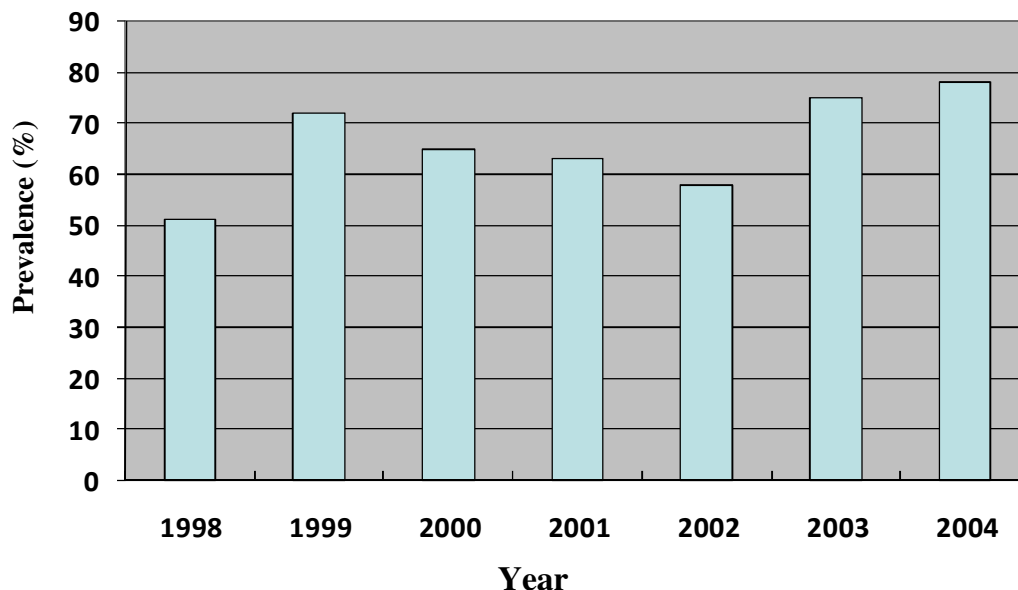


Figure 2. Overall yearly prevalence of urinary schistosomiasis amongst patients attending the main hospitals with urinary tract infection per year from 1998 to 2004.

Table 1. Occurrence of urinary schistosomiasis in different sites studied in the Venda region, South Africa.

Site	Total	Age range	<i>S. haematobium</i> positive	Hematuria	Intensity of infection	
			No (%)	No (%)	Light (%)	Heavy (%)
University of Venda	94	18 - 30	34 (36.2)	29 (30.8)	23 (68)	11 (32)
Primary schools	148	6 - 15	62 (42)	49 (33.1)	36 (58)	26 (42)
Hospital A	247	5 - 68	212 (86)	217 (88)	76 (36)	136 (64)
Hospital B	191	6 - 71	160 (84)	164 (86)	53 (33)	107 (67)
Hospital C	138	4 - 62	108 (78.2)	117 (85)	40 (37)	68 (63)
Total	818	4 - 71	576 (70.4)	486 (72)	228 (40)	348 (60)

Hematuria is the presence of red blood cells in the urine. Light infection was defined as infection with <50 ova/10 ml urine; while heavy infections were defined as >50 ova/10 ml urine.

Regular peaks occurred in February-March and in July-August and in some years in October indicating a possible seasonal high occurrence of urinary schistosomiasis in the region. The overall prevalence of schistosomiasis per year varied between 51% in 1998 and 78% in 2004 (Figure 2). It can be observed that schistosomiasis occurs the year round in the region with increasing prevalence during the last two years studied (2003 and 2004).

Occurrence of *S. haematobium* among hospital patients, university students and primary school children

The analysis of the urine samples collected from the hospitals indicated even higher prevalence of schistosomiasis among out-patients visiting the hospitals for

urinary tract infections. The prevalence at the hospitals varied from 78.2% in hospital C and 86% in hospital A among the patients tested. Haematuria was very common and varied between 85% in hospital C and 88% in hospital A. Heavy infections were common in the hospitals with more than 60% of all infections at the hospitals being heavy infection cases. In hospital B, the prevalence of *S. haematobium* infection was 84% of which 67% were heavy infections. Haematuria was also higher in these samples. In hospital C, 63% of all infections were heavy infections while at hospital A, 64% were heavy infections. Table 1 shows the results of the analysis of the samples from the hospitals as well as the University of Venda students and primary school children. The age of the patients at the hospitals varied between 4 and 71 years with more patients in the age group 10 - 20 years (Table 2) and most of the age groups tested appeared to be infected. Of all the patients from whom

Table 2. Age and sex distribution of *S. haematobium* infections amongst patients attending the three major hospitals between January and May 2005.

Age range	Males			Females		
	Total	Positive	(%)	Total	Positive	(%)
0 – 10	95	69	73	48	42	88
11 – 20	237	186	78	77	58	75
21 – 30	14	9	64	13	10	77
31 – 40	8	5	63	6	2	33
41 – 50	2	2	100	2	1	50
51 – 60	1	0	0	0	0	0
61 - 70	2	0	0	0	0	0
Total	359	271	75	146	113	77

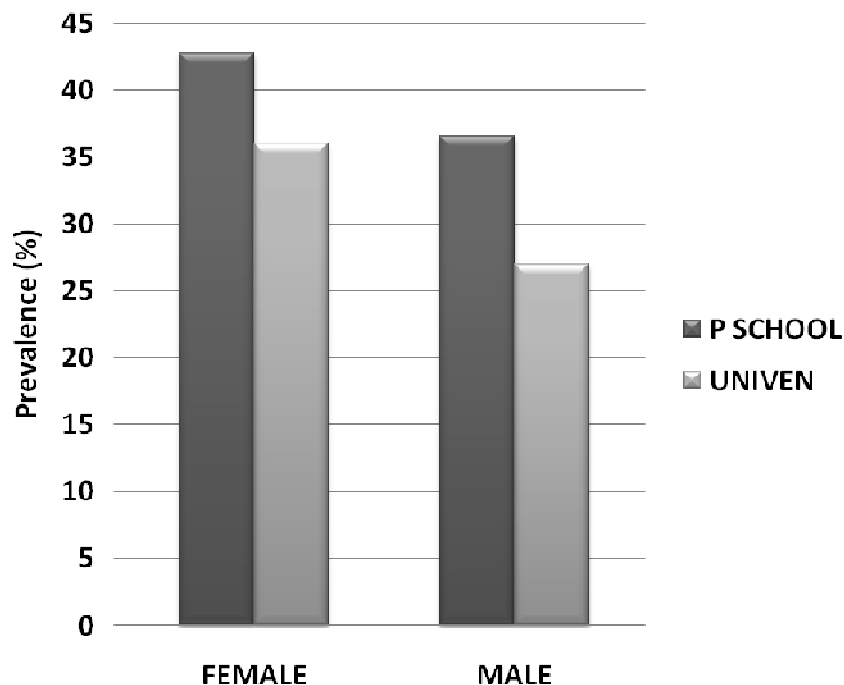


Figure 3. Prevalence of *S. Haematobium* infections by gender among primary school children aged between 6 and 15 years (P School) and University of Venda students (UNIVEN) aged between 18 and 30 years.

the samples were collected, the number of males was higher than that of females even though the prevalence of infection was higher among female patients.

At the university, the prevalence of schistosomiasis was 36% with 32% of cases being heavy infections. Haematuria was not as common as in the hospitals among schistosomiasis patients with only about 31% haematuria cases compared to 36% *Schistosoma* infections (Table 1). At the primary schools, the prevalence of schistosomiasis was 42% while haematuria was found in 33% of cases. Most infections at the schools were also light infections with 42% cases of heavy infections. At the

university as well as at the primary schools, females were more infected than males (Figure 3).

Survey on university students’ knowledge of schistosomiasis and hygienic habits

The results of the questionnaire survey indicated that most students at the University were not aware of schistosomiasis, left alone its symptoms (Table 3). Of all the participating students only 16% had good knowledge of the diseases, while 21% had some knowledge of it and

Table 3. Factors that might be associated with *Schistosoma* transmission from 448 students of the University of Venda.

Factors	Possible answers	Number	Percentage
Knowledge of schistosomiasis	Unknown	280	62.5
	Moderately known	96	21.4
	Well known	72	16.1
Source of drinking water	Pipe born	436	97.3
	Streams	12	2.7
Toilet facilities	Flush toilet	392	87.5
	Pit latrines	56	12.5
Geophagy (Soil eating habits)	Yes	172	38.4
	No	276	61.6
Hand washing after toilet visits	Sometimes	360	80
	Always	88	20
Fruit washing before eating	Yes	56	12.5
	No	92	20.5
	Sometimes	300	69.4
Water related activities	Recreational (swimming)	404	90
	Occupational (agriculture)	44	10

62.5% had no knowledge at all of this infection. Since most of the students lived on campus, almost all of them used piped water as well as flush toilet for their day to day need while only about 3% used stream water while 12.5% used pit latrines. About 40% of the responding students indicated that they ate soil some times. Soil eating habit might also be a risk factor not only for schistosomiasis but also for other intestinal parasites. In the present study, it was found that more females (24.1%) ate soil compared to males (14.2%).

Hygiene habit was approximate, with only 20% of the students indicating that they wash their hands every time they visited the toilets while 80% only washed their hands some times. The same was observed with the fruits washing habit. Most students (69.4%) indicated that they wash their fruit some times while 20% indicated that they did not generally wash their fruit before eating. Almost all the students indicated that they generally have contact with water mostly for recreational activities (90%) and occupational activities such as agriculture (10%).

DISCUSSION

The objectives of the present study are to determine the trend of the prevalence of schistosomiasis in the Venda region among patients visiting the hospitals from 1998 - 2004 and compared to the present prevalence in the hospitals and at the University of Venda and in the schools and also to identify possible risk factors that might be associated with schistosomiasis transmission in the region. The data obtained at the hospitals (1998 - 2004) shows that schistosomiasis is a public health problem in the Venda region which is mostly rural. The

inhabitants of these areas usually obtain water for domestic and other uses from springs, wells and streams (Obi et al., 2007). These water sources have been associated with high level of bacterial contamination and might be implicated in the transmission of schistosomiasis in the region as well, even though very few studies have been conducted in the region on schistosomiasis.

In the present study, females particularly at the university were more prone to infection by *S. haematobium* than males in the 21 -25 years age category even though the difference was not significant ($p = 0.142$). At this stage of life females are more involved in water related home chores such as cleaning, washing clothes and dish-washing. Similar results were found in Nigeria by Tohon et al. (2008). However, this is in contrast with results obtained in the Qena governorate in Egypt where males were more infected than females (Hamman et al., 2000).

In the present study, the prevalence of urinary schistosomiasis varied according to the group of population considered. Among patients attending hospitals, the prevalence was high which is normal since individuals seeking for health services might have experienced symptoms. However among primary school children as well as university students, a prevalence of 42 and 36% was found, respectively. This prevalence is close to that described by Taylor et al. (2004) among primary school children in two rural areas in Ugu North district in Kwa-Zulu Natal, South Africa, where a prevalence of 34.3% was found while Appleton and Kvalsvig (2006) found prevalence of up to 92% for *S. haematobium* in some areas of Kwa-Zulu Natal Province. However, lower prevalence was found in Pietermaritzburg (7.2%) among children (Johnson and Appleton, 2005). Studies on the

prevalence of urinary schistosomiasis in Ikpeshi, Nigeria showed that 195 (65%) out of 300 volunteers harboured *S. haematobium* ova in their urine with highest intensity of infection (718 +/-295.98 ova/10 ml) of urine observed among the school children while the least occurs among the farmers with 397.13 +/-304.02 (Nmorsi et al., 2005). In Ghana, of 354 children who responded and also submitted their urine sample, 297 (84%) tested positive for *S. haematobium* with intensity of infection varying between 74 and 110 ova per 10 ml.

Several risk factors have been identified for the transmission of urinary schistosomiasis in the present study. University students were targeted to identify behaviours that could be conducive for the transmission of schistosomiasis in the region. Most of the previous reported questionnaires used to identify high risk communities were conducted among school children, with questions mainly focusing on early clinical symptoms (Lengeler et al., 2002a; Stothard et al., 2002; Ramdrianasola et al., 2002). Lengeler et al. (2002b) reported that from the mid-1990s onwards, questionnaires were extended from identification of high risk communities to the individual level, with emphasis on *S. haematobium* and *S. mansoni* in different epidemiological setting across Africa. Identified risk factors include swimming and bathing in a river as a transmission route which showed significant association for higher prevalence or intensity of infection. Also, practice variables such as washing clothes and fishing in the stream were significantly associated with both high prevalence and high intensity (Wagatsuma et al., 2003). In the present study, almost all the respondents indicated that they regularly have contact with river water which constitutes a risk factor for the transmission of schistosomiasis.

In China, major risk factors included duration of contagious water exposure due to swimming and paddling and intensity of contagious water exposure due to occupational activities and the major protective factor was the knowledge of schistosomiasis transmission (Zhaowu et al., 1993; Zhang et al., 2007). Some study showed that the contagious water contact was significantly related to *Schistosoma* infection (Utzinger et al., 2000). However, Scott et al. (2003) reported that the water contact patterns might not be related to the intensity of schistosoma infection. Our study showed that the contagious water exposure history was the most important predicting factor for *S. haematobium* infections.

Loss of blood in the urine is one of the most common signs of urinary schistosomiasis. It has been estimated that more than half of pregnant women in developing countries are anaemic (Crompton, 2000). Our findings indicated that haematuria among both male and female from all the study groups was common. In a few cases, the negative sample showed the presence of haematuria. This may be due to menstruation or other sexually-transmitted infections. Poor iron status and anaemia is closely linked to diminished education performance at

school (Sinha et al., 2008). Since schistosomiasis cause blood loss leading to iron deficiency, it is conceivable that the educational performance and achievement of infected school children will be impeded unless actions are taken to keep infection intensities low through regular deworming. A randomised evaluation of a project in Kenya suggested that school-based mass treatment with deworming drug reduced school absenteeism in treatment schools by 25% (Miguel and Kremmer, 2001; Koukounari et al., 2008).

In Morocco, the preparation of the national control programme was started in 1976 with operational phase being implemented in all provinces with endemic schistosomiasis in 1982. Praziquantel was introduced in 1987. Rigorous treatment and post-treatment follow up, coupled with environmental management has reduced cumulative incidence to <1% (Belkacemi and Jana, 2006; Yacoubi et al., 2007). Since 1985, the policy has shifted from transmission control to elimination (Tchuem Tchuente, 2003). In South Africa, there is no national program for the control of schistosomiasis in spite of the common occurrence of these infections in many parts of the country. Treatment for intestinal parasites exist in the clinics, however the percentage coverage of the population remains low (at <10%) in our region according to the survey. We therefore suggest that all patients with urinary schistosomiasis should be treated because of the high prevalence among patient having urinary tract infection symptoms.

The prevalence of urinary schistosomiasis obtained in the present study was high, indicating that the region is endemic for this infection, and there is an urgent need for an effective urinary schistosomiasis control programme in the Venda region and the Limpopo Province in general. Another major concern found in the present study was the very poor level of awareness of urinary schistosomiasis among university students. It can be expected that the level of knowledge in primary schools will be even much lower. Also, almost all the students responded positively to visiting water bodies, like streams, rivers and dams, which is known to be a risk factor as these water bodies might harbour the intermediate snail host (*Bulinus* spp.).

It has been suggested that the distribution of worms in any community is widespread but uneven and that severe disease usually follows after many years of silent or mild symptomatic infection (King and Dangerfield-Cha, 2008). This has generally led to the underestimation of the public health significance of schistosomiasis. Studies on parasitic infections in the Venda region and the Limpopo Province are scarce.

Considering the outcome of the present study, it is indispensable that a comprehensive epidemiological survey of urinary schistosomiasis be conducted in the Venda region and the Limpopo Province at large in order to further identify high-risk communities for the successful design and implementation control programmes. Community-level treatment and control of schistosomiasis in Venda region where the infection is common are to be

encouraged and is likely to improve child growth, appetite, physical fitness and activity levels and to decrease anaemia and other symptoms of the infection. School children are at high risk of infection and control programmes must take them into consideration. Health education is a necessity in the region to sensitize the population about these infections. Further studies are needed to identify infection foci as well as the occurrence of the intermediate hosts in different water bodies in the region. Such information will be useful in the design of control methods which will also contribute to poverty alleviation in the region. Such information will be useful in the design of control methods which will also contribute to poverty alleviation in the region.

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