Prevalence and intensity of Schistosomiasis in adjacent human communities along the River Kochi, West Nile region of Uganda

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ABSTRACT

Aim: To assess the prevalence of Schistosomiasis in adjacent human communities along the River Kochi, West Nile region of Uganda in relation to the presence of infected *Biomphalaria* snails

Study design: A combination of cross sectional field survey and laboratory analysis

Place and duration of study: This study was conducted between October 2007 and March 2008 along the River Kochi in the West Nile Region, Uganda.

Methodology: Five sites along this river that were approximately 20km apart were selected. Stool samples were collected from 40 randomly selected families, 20 living within 3km from the river banks and 20 beyond 3km. Four hundred and eighty nine stool samples (157 from children, 159 from adolescents and 173 from adults) were analysed and examined using standard methods for the presence of *Schistosoma mansoni* cercariae on a monthly for a period of six months. *Biomphalaria* species snails living in the river were collected using a sweep net and screened for the presence of *S. mansoni* cercariae. A generalised Linear Model was used to establish associations between human parasitic infections with age and gender. Spearman's rank correlations coefficient was used to explore the relationship between infected *Biomphalaria* snail numbers and infection incidence in humans.

Results: Percentage infection of 24.1% (118/459) was recorded**.** Prevalence of Schistosomiasis was lower in children than in adolescents (P=.001) and adults (P=.013), and was overall slightly higher in males than females (P=.014). A Spearman's rank correlations coefficient of ($r_{s=}$.710) revealed that there was a link between infected *Biomphalaria* snail numbers and infection incidence in humans.

Conclusion: From the results it appears that Schistosomiasis is still present in West Nile region and is associated with the presence of infected *Biomphalaria* snail species. Male adolescents and adults are more prone to infection than the females. There is need for regular surveys and continuous Schistosomiasis education to the communities.

Keywords: Schistosomiasis, cercariae, Biomphalaria, River Kochi, West Nile, Uganda

1. INTRODUCTION

Schistosomiasis (often known as Bilharzia) is one of the major causes of morbidity in endemic areas of Asia, Africa and South America [1]. In Africa alone, about 192 million cases of schistosomiasis have been reported; with Nigeria ranking the highest (15% of the cases) followed by the United Republic of Tanzania (about 10% of the cases) and the Democratic Republic of Congo and Ghana with 7.8% of the cases each [2]. In Uganda it is estimated that four million people are infected with schistosomiasis especially in areas of high risk to the disease by 2004 [3] for instance schistosomiasis is endemic in the West Nile region and studies have reported the prevalence in certain areas to be over 80% [4]. The disease is wide-spread among poor populations living in conditions that favour transmission, for instance fishing communities living along shores of lakes and rivers, and those that do not have access to clean and safe water sources that are free from contamination with faecal material [5]. Chemotherapy is known to reduce morbidity of this disease and a mass chemotherapy programme had been conducted in the west Nile region to de-worm communities in the preceding year of this study. Post intervention surveys are however very important because they are a key element in monitoring and evaluation. Understanding the current prevalence of this disease within this region will inform all stakeholders so that they can work together to design long-term control measures of this disease.

In Uganda, schistosomiasis is mainly caused by a human blood fluke *Schistosoma mansoni* whose host is an aquatic snail *Biomphalaria*. The disease rarely results in death but burdens and reduces the quality of life of those people infected [6]. For example, the disease has a long term effect on the society as it impairs childhood growth and cognitive development, prevents children from attending school and adults from being productive members of their communities [2]. Regardless of the burden it causes, the disease often receives little attention by healthcare providers, national governments and international agencies compared to malaria, HIV/AIDS and tuberculosis, childhood diseases and diarrhea, simply because not every individual infected shows clinical signs [7,8].

With its many lakes, rivers, streams, swamps and ponds, Uganda has a diverse fresh water environment that offers numerous and suitable habitats for the *Biomphalaria* species of aquatic snails that carry the parasite *S. mansoni* [9]. In Uganda there have been several studies on the prevalence of Schistosomiasis [3,4,9,10,11,12,13,14,15, 16]. However, most of these studies appear to have primarily focused on determining the prevalence and control of the disease in humans and less on relating disease levels with snail incidence. This study therefore set out to assess both the incidence of the disease in the vectors that transmit the parasite and its prevalence in human communities living adjacent to this river. It is hoped that the findings of this study will result in an integrated approach to controlling this disease.

2. MATERIAL AND METHODS

2.1 Study area

The study took place in Kochi River and its human catchments in Koboko, Yumbe and Moyo districts of West Nile region. Kochi River has its origin in Koboko district near Uganda – Congo boarder at an altitude of above 1000m as a small stream; it gradually widens downstream with decrease in altitude through Yumbe district and finally joins the Albert Nile in Moyo at an altitude of about 600m above sea level. This river stretches all the schistosomiasis infection belts of the region [11] and transcends a range of geographical conditions. Anecdotal evidence has suggested that the prevalence of the disease decreases as one travels westwards from the river.

2.2. Study design

A combination of cross sectional research design and laboratory analysis was used and data were collected over a period of six months between October 2007 and March 2008. Five sites namely: Koboko, Yumbe (two locations), Moyo (two locations) were selected adjacent to the river and these were approximately 20 km apart. Points on the river marking the central positions of each community living at the sites were recorded by a GPS. To be able to test for the effect of distance from the river on disease prevalence, we collected data from two families living within 3 kilometers (km) either side of this reference point, and also from four families situated more than 3km away from the river to serve as controls. A list of all families was provided by the local leaders from which random samples were chosen. The researcher chose a total of 40 families, 8 from each site to perform stool examinations. Areas for sampling the snails living in the river were also defined. These measured 30 m along the bank and 3 m into the main body of the water. The corners of these rectangular sampling areas were marked by pegs so that successive samplings could be performed across the same area. Each site was sampled weekly from 0800 – 0900 hours over a period of six months.

2.3 Stool examination

Stool examinations were conducted once every month for *S. mansoni* eggs in each member of a family over the age of four years, except where a family member had not consistently stayed in the family over the previous year. Bottles for collecting stool samples were distributed prior to their collection and families notified that bottles should be ready for collection by 0800 hours the following morning. Each specimen bottle bore the site name, the number allocated to the family and the name, age and the gender of the family member. Screening of the stool was done in Yumbe Hospital, Koboko, Midigo and Ukumi Health Centre laboratories using the direct smear (wet mount) technique to prevent distortion of parasites and to be able to see live trophozoites.

2.4 Collection and screening of *Biomphalaria* snails for cercaria

Areas measuring 30m along the river and 3m into the water were designated for snail sample collection. These areas were searched for a period of 30mins and all snails found floating or attached to vegetation were collected using a scooping net with a long handle and placed on white plastic trays in order to be able to rapidly identify the different species. Snails of the *Biomphalaria* species, responsible for the transmission of Bilharzia, were transferred into large plastic buckets filled with water from the snail sampling areas and containing appropriate aquatic plants to simulate natural environmental conditions. These were taken to the field centre to screen for the microscopic presence of *S. mansoni* cercariae. With assistance from experienced lab technicians we screened the snails and the procedure involved placing individual snails in transparent 20ml glass beakers containing 10ml of filtered river water. Snails were examined for cercarial shedding by exposing them to natural light individually in glass tubes. After two hours of exposure to natural light, the glass tubes were inspected for the presence of cercariae using a dissecting microscope. Sunlight induces the snails containing the infective cercariae to shed them into the water in a wave of current observable by the naked eye. Snails that were not shedding cercariae were kept for a week to allow subsequent development of cercariae arising from early stages of infection. Snails that did not shed cercariae in either screening were considered to be uninfected. These and the other snail species were taken 1 km downstream and returned to the river. This was to maintain similar proportions of snails within the sampling areas and to avoid sampling the same snails on subsequent days.

2.4. Data analysis

Descriptive statistics was used to illustrate the variation in the number of people infected by site, age, gender and distance from the river. Inclusion of any of these variables in subsequent analysis depended on any visible significant effects on diseases prevalence. Although there was repeated sampling of the same individuals every month, we did not encounter any new infections and all the people that we found infected are the ones that consistently gave positive signs over the data collection period. A Generalized Linear Model was then used to establish the effect of age and gender on disease infection rates in people living in villages along this river. Spearman's rank correlations coefficient was used to establish if there was any association between infected *Biomphalaria* snail species and number of humans infected with *S. mansoni*. Although preliminary results indicate that the distribution of *Biomphalaria* snails and other related snail species vary with altitude [17], we did not test the effect of altitude on the prevalence of the disease because of the limited data set. Genstat version 3 was used as a tool for analyzing data.

3. RESULTS AND DISCUSSION

3.1. Results

Overall, 489 stool samples were examined for eggs of *S. mansoni* in 40 families giving total percentage infections of 24.1% (118) in the study area. There was a variation in the prevalence of schistosomiasis among the people living at the different sites. There were fewer people infected in Koboko as compared to the rest of the sites (Table 1). However, the numbers of infected people at these four sites are so close for any significant differences to occur between them.

Table 1. Overall prevalence and intensity of *Schistosoma mansoni* infections by age, gender and site

Age	Children (5-9 years)						Adolescents (10-19 years)						Adults (20 and above years)					
	No. T	No. I	Male		Female		No. T	No. I	Male		Female		No. T	No. I	Male		Female	
			M T	M I	F T	F I			M T	M I	F T	F I			M T	M I	F T	F I
Location																		
Koboko	31	0	14	0	17	0	36	2	15	1	21	1	35	2	17	1	18	1
Yumbe 1	36	7	14	4	22	3	40	13	20	7	20	6	37	9	18	2	19	7
Yumbe 2	32	5	14	2	18	3	29	13	17	8	12	5	37	11	16	5	21	6
Moyo 1	30	6	15	5	15	1	29	11	14	8	15	3	29	9	14	6	15	3
Moyo 2	28	6	13	3	15	3	25	10	18	9	7	1	35	14	15	7	20	7
Totals	**157**	**24**	**70**	**14**	**87**	**10**	**159**	**49**	**84**	**33**	**75**	**16**	**183**	**45**	**80**	**21**	**93**	**24**

(No.T = Number total; No.I = Number infected; MT = Male total; MI = Male infected; FT = Female total; FI = Female infected)

Table 2. Mean intensity of *S. mansoni* infection in relation to age, gender and location

Age	Children (5-9 years)		Adolescents(10-19 years)		Adults (20 and above years)		Overall mean
Site	Male	Female	Male	Female	Male	Female	
Koboko	0.00 ± 0.00	0.00 ± 0.00	1.04±1.47	1.39 ±1.96	1.04 ±1.47	1.04 ±1.47	0.75±1.13
Yumbe 1	3.33±4.71	2.23±0.21	5.81±0.36	4.88±1.67	1.85±2.62	6.20±1.70	4.05±2.51
Yumbe 2	2.43±0.49	2.71±0.88	7.75±2.13	6.90±0.34	5.16±0.56	4.89±0.98	4.97±2.19
Moyo 1	2.75±3.24	0.93±1.60	9.52±3.37	3.42±1.89	7.14±3.36	3.27±1.26	5.04±3.31
Moyo 2	2.50±2.20	3.13±4.42	8.33±1.31	2.78±3.93	7.87±0.65	5.83±1.18	5.28±2.96
Mean	3.00±2.50	1.89±2.01	6.49±3.47	3.88±2.61	4.61±3.27	4.24±2.23	4.02±2.98

The numbers in each category are as shown in table 1

A Generalized Linear Model indicates that were significant variation in prevalence in schistosomiasis among age groups and gender (Table 3). Fewer female children and adolescents tended to be infected more than their male counterparts, but that infection rates in adults were similar (Table 2). Generally infection rates were higher among males than females (Figure 1).Infection rates were higher in adolescents and adults than in children (Table 3 and Figure 2). However disease prevalence was not dependent on how far one lived from the river (Table 4).

Table 3. Effect of age and gender on infection rates of schistosomiasis in people living in villages along the River Kochi

	Number sampled	Number infected	Parameter estimate	t	t (pr)
Children	157	24	reference		
Adolescents	159	49	3.004 ± 0.795	3.78	0.001
Adults	173	45	1.999 ± 0.770	2.60	0.013
Males	234	68	reference		
Females	255	50	-1.627 ± 0.639	-2.55	0.014

Children =5-9 years, Adolescents = 10-19 years, Adults ≥20 years

Table 4. Average number of individuals found to be infected by age and location

	Mean		
Location	**Away**	**Near**	**Mean**
Age			
Children	2.14±2.27	2.75±2.38	2.45±2.28
Adolescents	5.43±3.68	4.94±3.00	5.18±3.28
Adults	5.17± 2.39	3.67±2.97	4.43±2.73
Mean	4.25±3.14	3.79±2.85	4.020±2.98

Children =5-9 years, Adolescents = 10-19 years, Adults ≥20 years; Away=>3km from the river, Near = < 3km from the river

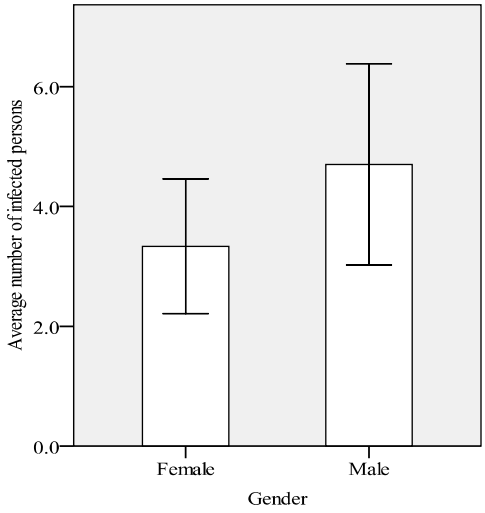

Fig 1: Variation in the mean ± SE of *S. mansoni* infections by gender.

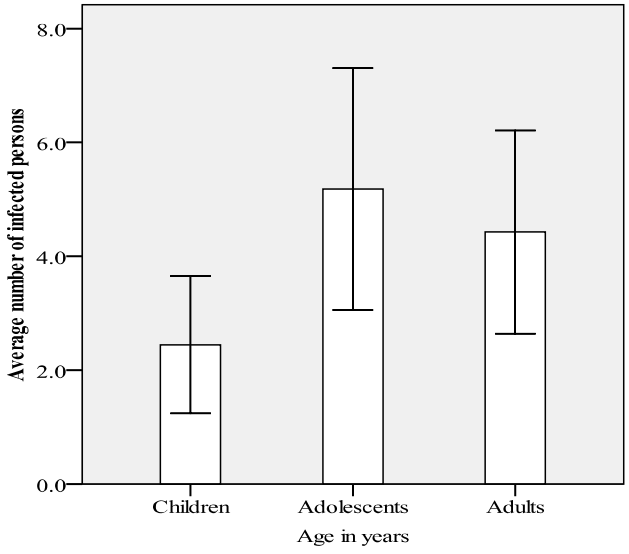

Fig 2. Variation in the mean ± SE of prevalence of *S. mansoni* among the different age groups

Children =5-9 years, Adolescents = 10-19 years, Adults ≥20 years

A total of 473 *Biomphalaria* species snails were collected and out of these 97 were infected with cercaria representing 20.5% of *Biomphalaria* species snail infections in the river. There was a strong positive correlation between the numbers of infected Biomphalaria snails with the number of humans infected (rs= 0.710). As the number of snails increased there was a tendency for the numbers of humans detected positive to increase too (Figure 3). This indicates a potential link between increases in the population of infected snails and the incidence of new infections detected in humans

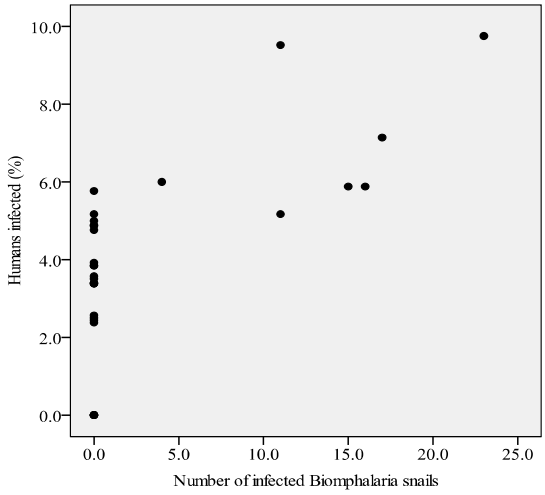

Fig 3. Relationship between the number of infected persons and infected *Biomphalaria* snails

3.2. Discussion

The overall infection rate was 24.1% which on average is lower than findings obtained by earlier studies conducted in this region. For example Nelson [10] recorded a prevalence of 14% in Panyagoro community while Bukenya and Andama [13] got up to 37% prevalence in Rhino Camp area. In addition, Odongo-Aginya, Lakwo, Schweigmann, Schickerling, Linder, Mueller et al [18] recorded a prevalence of 62% near river Enyau in Arua town. It is important to note that although these studies give us an indication on the trend of prevalence of the disease in this region, they varied spatially and in methodological scope. We think that this relatively low rate of infection could be attributed to the fact that the Government conducted a mass chemotherapy programme in the region a year earlier (2006) to de-worm communities. This is likely to have influenced the results of this study. In addition, not everyone who is infected with the disease will show clinical signs.

The high level of infection among adolescents seems to indicate that that probably infections are acquired early in life, peaking at adolescent age and then moderately declining with age as one gets older. Our results seem to tally with those in the previous studies [3, 19, 20, 21]. Variations in prevalence rates among men and women of differing age groups could be attributed to the duration and frequency at which each of them gets in contact with infected water. Male children and some adolescents in this area swim in the river more than their

female counterparts. They are also engaged in fishing especially during the dry season when farming activities temporarily come to halt and grazing of animals is restricted along water bodies for easy access of water and pasture in swamps for the animals. This subjects men of all ages in this area at higher risks of infection than women of corresponding age groups. These findings seem to be in agreement with previous studies conducted in this region [3, 4, 13]. However, they differ from Butterworth, Dalton and Dunne [22] who argues that on average women have longer and more frequent contacts with infected water bodies than men during the collection of domestic water and washing of clothes.

The strong positive correlation between infections in *Biomphalaria* snails with *S. mansoni* infections in human populations is an indication that schistosomiasis infections in human populations along a water body can result into contamination of water bodies and subsequent infections of vector snails in the river available and the reverse is also true. An increase in infections in vector snails will lead to increased contamination of the water body with the infective parasites which in turn puts the humans in the surrounding at higher risk of infection. This observation is strengthened by Faust and Hoffman [23] who noted that a single *Biomphalaria* snail infected by a single miracidium resulting from the hatching of an egg of *S. mansoni* discharges an average of 3500 infective cercariae daily for a long time and that in an instance the total progeny of a single miracidium exceeded 200,000 cercariae. In other words a small number of infected *Biomphalaria* snails in a given water body could contaminate a large water body and pose a serious threat to a community's incidence with schistosomiasis

The risk of infection did not depend on how near or far away one lived from the river. The possible explanation could be due to the fact that there many small rivers, streams and swamps scattered all over the study area some of which present even more suitable conditions for harboring *Biomphalaria* vector snails than the river Kochi given their muddy sluggish nature and plenty of water vegetation growth. Such scattered water bodies could possibly have been the source of infections *S. mansoni* in members of families living beyond 3kms from River Kochi.

4. CONCLUSION

This study indicates that the prevalence of schistosomiasis was lower in children than in adolescents and adults, and was overall slightly higher in males than females. There is also a link between *Biomphalaria* snail numbers and infection incidence in humans. Considering that the variation in infection among gender and age seems to be based on gender roles which are not easy to change, there is need for health officials at the district level to conduct regular health education in rural communities and in dwellers along water bodies. The continuous presence of schistosomiasis in the study area even after intervention calls for regular surveys to inform the next steps. The association between *Biomphalaria* snail numbers and infection incidence in humans was based on a very limited data set, it is therefore important that a much more intensive study is done to clearly bring out this relation since it as serious health implications

COMPETING INTERESTS

Authors have declared that no competing interests exist.

ETHICAL APPROVAL

This study was approved by the Islamic University in Uganda research committee and permission to collect data was granted by the respective district medical officers. We adequately informed all the subjects of the aims, methods, our institutional affiliations and the anticipated benefits and potential risks of the study. We then sought their informed consent verbally, which was witnessed by a representative from the district medical officer's unit. "All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki."

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