

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

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

13 1. INTRODUCTION

14

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

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

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

51

52

53 2. MATERIAL AND METHODS

54

55 2.1 Study area

56 The study took place in Kochi River and its human catchments in Koboko, Yumbe and Moyo
57 districts of West Nile region. Kochi River has its origin in Koboko district near Uganda –
58 Congo boarder at an altitude of above 1000m as a small stream; it gradually widens
59 downstream with decrease in altitude through Yumbe district and finally joins the Albert Nile
60 in Moyo at an altitude of about 600m above sea level. This river stretches all the
61 schistosomiasis infection belts of the region [11] and transcends a range of geographical

62 conditions. Anecdotal evidence has suggested that the prevalence of the disease decreases
63 as one travels westwards from the river.

64 2.2. Study design

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

80 2.3 Stool examination

81 Stool examinations were conducted once every month for *S. mansoni* eggs in each member
82 of a family over the age of four years, except where a family member had not consistently
83 stayed in the family over the previous year. Bottles for collecting stool samples were
84 distributed prior to their collection and families notified that bottles should be ready for
85 collection by 0800 hours the following morning. Each specimen bottle bore the site name,
86 the number allocated to the family and the name, age and the gender of the family member.
87 Screening of the stool was done in Yumbe Hospital, Koboko, Midigo and Ukumi Health
88 Centre laboratories following prescribed standard procedure.

89 2.4 Collection and screening of *Biomphalaria* snails for cercaria

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

108 2.4. Data analysis

109 Descriptive statistics was used to illustrate the variation in the number of people infected by
 110 site, age, gender and distance from the river. Inclusion of any of these variables in
 111 subsequent analysis depended on any visible significant effects on diseases prevalence.
 112 Although there was repeated sampling of the same individuals every month, we did not
 113 encounter any new infections and all the people that we found infected are the ones that
 114 consistently gave positive signs over the data collection period. A Generalized Linear Model
 115 was then used to establish the effect of age and gender on disease infection rates in people
 116 living in villages along this river. Spearman's rank correlations coefficient was used to
 117 establish if there was any association between infected *Biomphalaria* snail species and
 118 number of humans infected with *S. mansoni*. Although preliminary results indicate that the
 119 distribution of *Biomphalaria* snails and other related snail species vary with altitude [18], in
 120 press), we did not test the effect of altitude on the prevalence of the disease because of the
 121 limited data set. Genstat version 3 was used as a tool for analyzing data.

123 3. RESULTS AND DISCUSSION

124 3.1. Results

125 3.1.1 Prevalence of schistosomiasis

126 Overall, 489 stool samples were examined for eggs of *S. mansoni* in 40 families giving total
 127 percentage infections of 24.1% (118) in the study area. There was a variation in the
 128 prevalence of schistosomiasis among the people living at the different sites. Based on the
 129 overall site means there was less than 1% of samples infected in Koboko, whereas between
 130 4% and 5.3% of people were infected in the other four sites (table 1). However, these
 131 figures are so close for any significant differences to occur between them.

133 **Table 1. Average number of individuals found to be infected by gender and age at the**
 134 **different sites**

Age Site	Children	Mean Adolescents	Adults	Mean
Koboko	0.000	1.215	1.042	0.752
Yumbe1	2.783	5.345	4.028	4.052
Yumbe2	2.569	7.330	5.010	4.970
Moyo1	3.447	6.473	5.208	5.043
Moyo2	3.438	5.556	6.852	5.282
Mean	2.447	5.184	4.428	4.020

135

136 A Generalized Linear Model indicates that were significant variation in prevalence in
 137 schistosomiasis among age groups and gender (Table 2). Fewer female children and
 138 adolescents tended to be infected more than their male counterparts, but that infection rates
 139 in adults were similar (table 3). Generally infection rates were higher among males than
 140 females (Figure 1). Percentages in adolescents (5.2%) and in adults (4.4%) were higher
 141 than in children (2.4%) (table 3, and figure 2). However disease prevalence was not
 142 dependent on how far one lived from the river (table 4).

143

144 **Table 2. Effect of age and gender on infection rates of schistosomiasis in people**
 145 **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

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

147

148 **Table 3. Average number of individuals found to be infected by gender and age**

	Mean	
Gender	Male	Female
Age		
Children	3.004	1.891
Adolescents	6.492	3.875
Adults	4.613	4.243
Mean	4.703	3.336

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

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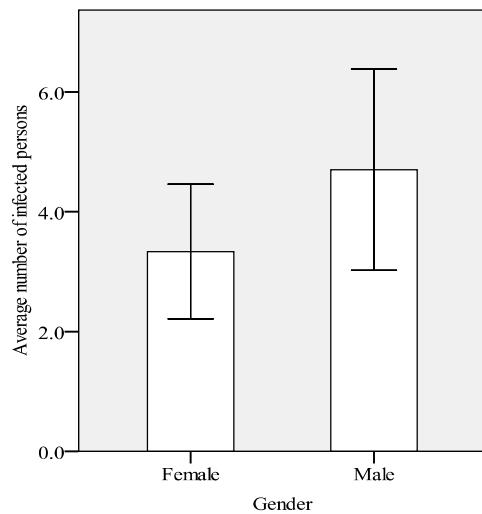
151 **Table 4. Average number of individuals found to be infected by age and location**

	Mean	
Location	Away	Near
Age		
Children	2.143	2.752
Adolescents	5.430	4.937
Adults	5.169	3.687
Mean	4.248	3.792

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

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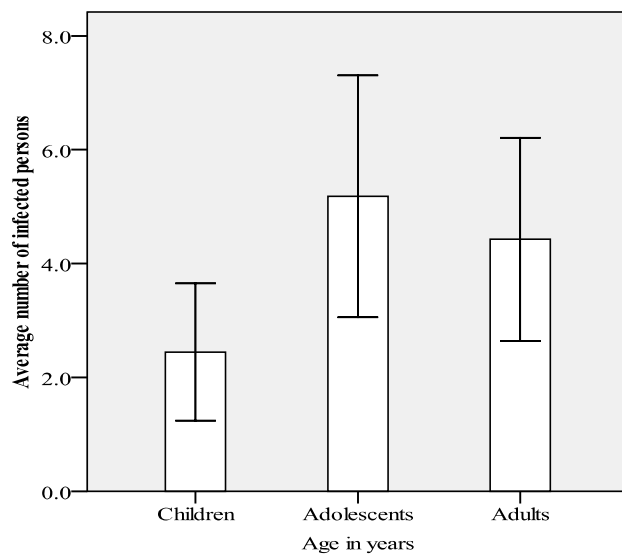
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157

158 **Fig 1: Variation in the mean $\pm$ SE of *S. mansoni* infections by gender.**

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160

161 **Fig 2. Variation in the mean $\pm$ SE of prevalence of *S. mansoni* among the different age**
 162 **groups**

163 *Children =5-9 years, Adolescents = 10-19 years, Adults $\geq$ 20 years*

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3.1.2. Relationship between infected *Biomphalaria* snail and infected people

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 ($r_s = 0.710$). 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

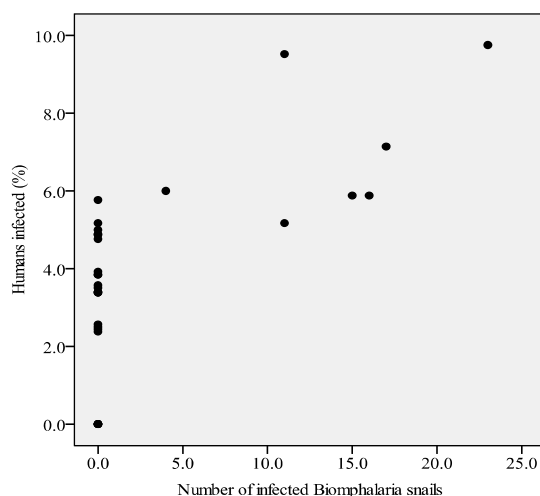


Fig 3. Relationship between the number of infected persons and infected *Biomphalaria* snails

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 [10] recorded a prevalence of 14% while [13] got up to 37% prevalence in Rhino Camp area, [18] reported a prevalence of 50% for [19] 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 in spatial scales and 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 earlier studies done by [3, 20, 21, 22]. 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

196 when farming activities temporarily come to halt and grazing of animals is restricted along
197 water bodies for easy access of water and pasture in swamps for the animals. This subjects
198 men of all ages in this area at higher risks of infection than women of corresponding age
199 groups. Our results with previous studies conducted in the same region [3,4,13]. However,
200 they differ from [23] who argues that on average women have longer and more frequent
201 contact with infected water bodies than men during the collection of domestic water and
202 washing of clothes.

203 The strong positive correlation between infections in *Biomphalaria* snails with *S. mansoni*
204 infections in human populations is an indication that the number of *S. mansoni* infections in
205 human populations along a water body can result into infections of vector snails in the water
206 body provided the vector snails are available and the reverse is also true. An increase in
207 infections in vector snails will lead to increased contamination of the water body with the
208 infective parasites which in turn puts the humans in the surrounding at higher risk of
209 infection. This observation is strengthened by [24] who noted that a single *Biomphalaria* snail
210 infected by a single miracidium resulting from the hatching of an egg of *S. mansoni*
211 discharges an average of 3500 infective cercariae daily for a long time and that in an
212 instance the total progeny of a single miracidium exceeded 200,000 cercariae. In other
213 words a small number of infected *Biomphalaria* snails in a given water body could
214 contaminate a large water body and pose a serious threat to a community's incidence with
215 schistosomiasis

216 The risk of infection did not depend on how near or far away one lived from the river. The
217 possible explanation could be due to the fact that there many small rivers, streams and
218 swamps scattered all over the study area some of which present even more suitable
219 conditions for harboring *Biomphalaria* vector snails than the river Kochi given their muddy
220 sluggish nature and plenty of water vegetation growth. Such scattered water bodies could
221 possibly have been the source of infections *S. mansoni* in members of families living beyond
222 3kms from River Kochi.

223

224 4. CONCLUSION

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

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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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