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Original Paper

Schistosoma Mansoni Infections Occurring in School Children in a Non-Endemic Area as a Result of Associated Activities in a Neighboring Endemic Area in Kenya

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Abstract

Schistosomiasis, a chronic parasitic disease is caused by a blood fluke (Schistosoma). 200 million people are infected worldwide, 85% in sub-Saharan Africa. In Kenya coastal region and irrigation schemes are endemic. Mwea irrigation scheme is endemic with 47% prevalence. Close proximity of Kagio area to the irrigation scheme offers labor opportunities to the population including school children posing a transmission threat. This study investigated Schistosoma mansoni infections among school children aged 8-15 years. Kagio and Kang'aru schools (Kagio area) and Kandongu (Mwea irrigation scheme) were selected. 322 pupils were tested for the presence of S. mansoni eggs by direct wet smears and Karto Katz. 263 questionnaires were administered to pupils from Kagio and Kang'aru schools. Data was analysed using Chi square and t-test statistics. Results showed that 7.2% of pupils from Kagio area had Schistosoma mansoni compared to 22% sampled from Mwea irrigation scheme. Mean number of eggs was 56 epg and 104 epg for the pupils who had light infection and those with moderate infection respectively. No pupils had heavy infestation. Pupils from Kagio area who worked in the farms in Mwea irrigation scheme were more prone to infection. 7.9% of those infected worked in rice paddies compared to 4% of infected pupils who did not. There was a significant relationship between labor migration and occurrence of Schistosoma mansoni infection among school children in

Kagio area (x^2=1.267; df=1; P=0.2604). There was no significant difference in infection rates between pupils from Kagio and Mwea areas (t=5.33, cl=95%, df=1, P=0.118). Schistosoma mansoni was present in both endemic and non-endemic areas. Labor migration was a significant transmission risk factor. The results indicate a need for the policymakers to institute programs that are designed to eliminate or minimize child labor migration from non-endemic to endemic areas as a way of preventing spread of Schistosoma mansoni, regular testing and treatment of the entire population and extend control interventions to neighboring non endemic area.

Keywords

*Schistosoma mansoni***,** *infection, endemic, Non-endemic, transmission risk*

1. Introduction

Shistosomiasis is second to malaria as the most devastating tropical disease in the world (WHO, 2010) and remains the most prevalent parasitic infection with significant economic and public health consequences (Chitsulo et al., 2000). The two forms of schistosomiasis, intestinal and urinary schistosomiasis, occur in Africa. Worldwide, intestinal schistosomiasis occurs in 52 countries, most of which are in Africa. Species causing Asian intestinal schistosomiasis include *Schistosoma mekongi* that occurs in several districts of Cambodia and the Lao People's Democratic Republic and *Schistosoma japonicum* that occurs in China, Indonesia and the Philippines. Urinary schistosomiasis is caused by *Schistosoma haematobium* and occurs in Africa and the Middle East (John et al., 2008).

The prevalence and intensity of *Schistosoma* infections in humans follow a characteristic pattern of variation with age, being generally low in young children up to 10 years of age but rises to a peak during the second decade of life (10-14 years) due to complex immune mechanisms that lead to slow acquisition of immune resistance. The prevalence declines to low levels among the older individuals though re-infection can occur at the same rate among individuals of different age groups (WHO, 2010). Schistosomiasis occurs worldwide and is responsible for morbidity and mortality. An estimated 200 million people are infected worldwide with both urinary and intestinal schistosomiasis in about 74 countries, with 85% infections occurring in sub-Saharan Africa (WHO, 2014). Both intestinal and urinary schistossomiasis are prevalent in tropical and sub-tropical areas, especially in communities with poor access to safe drinking water and poor sanitation (WHO, 2014). In Kenya, an estimated 5 million people are infected and about 12 million are at risk of infection (Kariuki, 2011).

The extent of spread of schistosomiasis to populations in non-endemic areas has not been studied despite the potential transmission risks from interactive activities in endemic areas. The aim of this study was to establish the occurrence of schistosomiasis in school children aged 8-15 years in non-endemic area of Kagio, which borders an endemic area, Mwea irrigation scheme located in Kirinyaga County, Kenya where a prevalence of 47% has been reported (Kihara et al., 2007) Inadequate hygiene and contact with infected water make children more vulnerable to infection hence the age group of 8-15 years who are pupils of class 4 to class 8 was selected for the study. The relationship between visiting the irrigation scheme for labor export and infection with *Schistosoma mansoni* was established among the study population.

2. Materials and Methods

2.1 Study Area and Population

The study was conducted in Kagio area (non-endemic for *Schistosoma mansoni*) and Mwea irrigation scheme (endemic) located in in Kirinyaga County, within central Kenya. This cross-sectional study involved school children aged 8-15 years (class 4-8) and in three schools; Kang'aru and Kagio which were purposively sampled due to close proximity to the irrigation scheme and Kandongu school was selected on the basis of preliminary data obtained from questionnaires which indicated the area within the irrigation scheme where pupils frequently visited. Three hundred and twenty two pupils who agreed to take part in the study and whose parents gave informed consent were enrolled as study participants.

2.2 Data Collection

Each of the participating pupils provided a stool specimen in provided clean Elkay specimen cup. They were advised to put 30-50 grams (up to a particular marked level of the container) of morning fecal specimen directly into the cup without contaminating with urine. Pupils from Kagio and Kang'aru primary schools were guided in filling structured questionnaires to collect data on their interaction with Mwea irrigation scheme. The collected samples were placed in a cool box and transported to Sagana Sub-County Hospital laboratory for analysis. Direct wet smears and karto katz was done to check for the presence of eggs and for intensity of infection respectively.

All data collected were entered into the computer using Microsoft Excel software and analyzed using SPSS version 16 for Windows. The data collected from stool examination including the number of positive samples from each school sampled and all the schools sampled were analyzed using t-test to check the difference in occurrence of schistosomiasis in the two schools located in non-endemic Kagio area and that located within the Mwea irrigation scheme. The data collected using questionnaires were tabulated and analyzed using Chi-square statistics to test the relationship between labor migration from non-endemic Kagio area to Mwea irrigation scheme and the occurrence of *Schistosoma mansoni* infections at $P< 0.05$ and 95% confidence level.

3. Results

3.1 Overall Schistosoma Mansoni Infection Rates in Kagio and Mwea

Figure 1 shows that pupils from the two primary schools sampled from Kagio had schistosome eggs in their stool where Kang'aru primary school pupils had 9.1% (8 pupils out of 88) positive for *Schistosoma mansoni* eggs while Kagio primary pupils had 6.3% (11 out of 175) positive for *S. mansoni* eggs.

The occurrence of *Schistosoma mansoni* infection in Kagio was found to be 7.2% (19 out of 263) while in Mwea was 22% (13 out of 59). The overall occurrence of *S. mansoni* infection was 9.9% in all the pupils studied. Statistical analysis using t-test indicated no significant difference in *Schistosoma mansoni* infection rate between Mwea irrigation scheme and Kagio area at P=0.05 (t=5.333, Cl=95%, df=1, P=0.118).

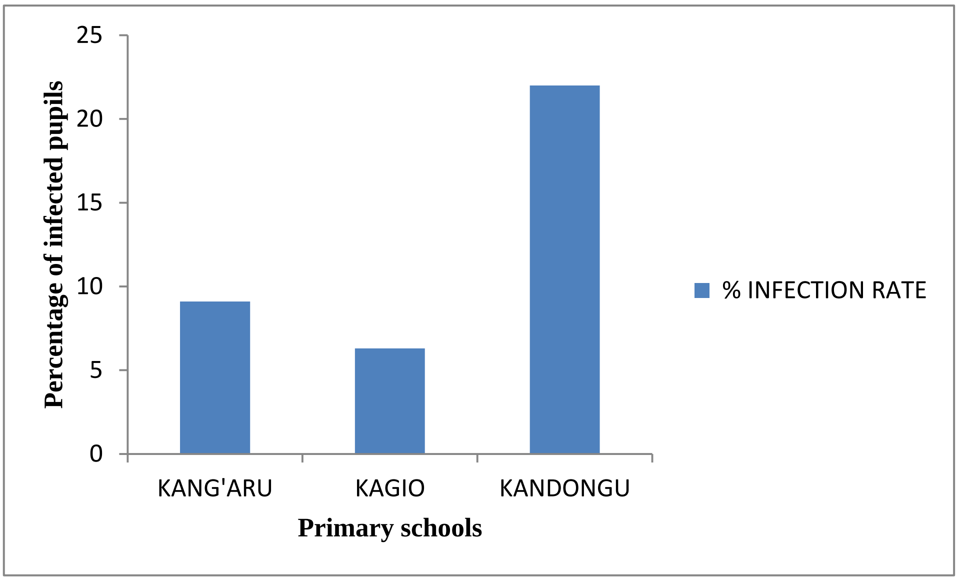

Figure 1. Percentage Infection Rate in All the Study Schools

3.2 Intensity of Infection

Quantitative stool examination results revealed that 28 pupils out of 32 had light infection (1-100 eggs per gram) representing 87.5% of the infected pupils. Those who had moderate infestation (101-400 eggs per gram) were 4, representing 12.5% of the infected pupils. There were no pupils with heavy worm egg load according to WHO,1994 classification of intensity of infection as either being light (1-100 epg), moderate (101-400 epg) and heavy (≥400). There was no significant difference between the percentage of children with light infection and those with moderate infection (χ^2=0.0057, 95%Cl, P=0.9387) (Table 1). The P value is 0.9387 hence the results are not significant at P<0.05.

Table 1. Intensity of *Schistosoma Mansoni* Egg Infection (EPG) in Sampled Pupils

Intensity (EPG) *	No. of subjects	Percentage (%)
1-100	28	87.5
101-400	4	12.5
>400	0	0
Total	32	100

*Light (1-100 epg), moderate (101-400 epg) or heavy (>400 epg) (WHO, 1994). The mean number of eggs in subjects with light infection was 56 epg while those who had moderate infection had a mean of 104 epg.

3.3 Labor Export to the Irrigation Scheme

The results revealed that 213 pupils out of 263 representing 81% pupils from Kagio area worked in the irrigation scheme with the majority working for payment during the school holidays. Majority (170) of the pupils mainly worked in Kandongu area representing 80% of child labor exported to the irrigation scheme.

The results showed that, 7.9% of the pupils exporting their labor to the irrigation scheme were found to be infected with schistosomes compared to 4% of those who did not export their labor but were infested with *Schistosoma mansoni* (Table 2). There was a significant positive correlation between pupils working in the irrigation scheme and infection rate with *S.mansoni* (r=0.99; cl=95%; P=0.01).

Table 2. *Schistosoma Mansoni* Infection in Pupils from Kagio Area Working in the Irrigation Scheme

Test results	No. of pupils who worked in the irrigation scheme	No. of pupils who did not work in the irrigation scheme	Total
Positive	n=17 (7.9%)	n=2 (4%)	19
Negative	n=196 (92%)	n=48 (96%)	244
Total	n=213 (99.9%)	n=50 (100%)	263

3.4 Association between Labor Export and Infection with Schistosoma Mansoni

The overall schistosome infection rate in Kagio area was 7.2. A total of 213 pupils sampled from Kagio area worked in the Mwea irrigation while 50 did not work in the irrigation scheme. From the data, 15 pupils who worked in the Mwea irrigation scheme were expected to have schistosome eggs while 4 pupils who did not work in the Mwea irrigation scheme were expected to have schistosme eggs (Table 3). Statistical analysis indicated that there was a significant association between labor migration by children from Kagio area to Mwea irrigation scheme and the infection rate with *Schistosoma mansoni* of the school children of ages 8-15 years (χ^2=1.267; CI=95%; df=1; P=0.2604).

Table 3. Association between Labor Export and Infection with *Schistosoma Mansoni*

	Observed	*Expected*	*Difference*	*Difference Sq.*	*Diff. Sq. / Exp Fr.*
No.of infected pupils who worked in the irrigation scheme	17	15	2.00	4.00	0.27
No. of infected pupils who did not work in the irrigation scheme	2	4	-2.00	4.00	1.00

3.5 Other Activities Carried out by Pupils Who Worked in the Irrigation Scheme

The results revealed that the pupils from Kagio area who exported their labor to the irrigation scheme also carried out other activities. The 213 pupils who exported labor to the irrigation scheme reported also performing other activities such as swimming in the canals, washing clothes, washing their legs while a vast majority (159 pupils) performed all the three activities (Table 4).

Table 4. Other Activities Carried out by Pupils Who Worked in the Irrigation Scheme

Activity	Frequency	No. infected
Swimming	10	2
Washing clothes	21	1
Washing legs	23	4
Washing clothes, swimming and washing legs	159	12
Total	**213**	**19**

4. Discussion

4.1 Overall Schisosoma Mansoni Infection Rate in Kagio Area

The study established a 7.2% *Schistosoma mansoni* infection rate in school children (age 8-15 years) in two schools in Kagio area which neighbours Mwea irrigation scheme; an endemic area for the infections. Rice farming is the major activity in Mwea irrigation scheme and is labor intensive and often requires laborers from the neighboring regions. This may potentially introduce schistosomiasis in previously non-endemic areas. The study revealed majority of pupils (81%) from Kagio area worked for pay in the rice irrigation scheme hence were exposed to infection with *S. mansoni* as pupils who were associated with the irrigation scheme were more infected than those who were not. The infection rate of 7.2% established for Kagio area was lower compared to previous study conducted in the same region (Kihara et al., 2007). However, the present results are in agreement with earlier findings reported in Zimbabwe that showed at risk population living in close proximity to the irrigation scheme and often visited the irrigation scheme were prone to infection (Mathys et al., 2007).

From the questionnaire study it was found that infection transmission risk of children from Kagio area was working in the rice paddies in Mwea irrigation scheme. Results from the present study revealed that the 81% of the pupils who worked in the paddy fields in different parts of the irrigation scheme had increased exposure to the infective stages of *Schistosoma mansoni* in agreement with a study done in Ethiopia which showed that frequent water contact led to increased cases of infection (Alembrhan et al., 2013). Unhygienic practices and playing in contaminated water make children vulnerable to infection (WHO, 2010). Poor sanitation and contact with contaminated water are factors that promote the transmission of schistosomiasis (WHO, 2014). Other activities including washing the body, swimming and washing clothes done by 75% of the children in the farming fields may have exposed them more to the parasite since most of the water in the irrigation scheme is infested with the *S. mansoni* worm larvae. Furthermore, results from the study in Ethiopia showed that water and reasons for water contact such as swimming, working in irrigated agricultural field and bathing were significantly associated with *Schistosoma mansoni* infection (Fekadu et al., 1992).

4.2 Schistosoma Mansoni Infection in Mwea Irrigation Scheme

The present infection rate of 22% in pupils from Kandongu primary school within the irrigation scheme is lower than previous reports of 47% by Kihara and Muhoho (2007. A study done in Mbita district in western region of Kenya neighboring Lake Victoria showed a high infection rate of 76.8% (Odiere et al., 2011) and in Kisumu town, high levels of *Schistosoma mansoni* were reported among car washers working along the shores of Lake Victoria (Karanja et al., 1997). School children in Kisumu also an endemic area near Lake Victoria were found to have a 21% infection rate (Odiere et al., 2011) which is comparable to the present study. The reduced infection rate in the current study as compared to previous findings in Mwea may be attributed to regular chemotherapy using praziquantel that has been carried out annually in the area (MOH and MOEST, 2009). Mwea rice irrigation scheme is endemic for schistosomiasis due to favorable conditions such as water bodies favoring snail development and poor sanitation in the rice paddies that favor the spread of the disease.

4.3 Relationship between Labour Migration and Infection with Schistosoma Mansoni

The identification of risk factors for the infection of *Schistosoma mansoni* contributes to a better understanding of the transmission process and for the implementation of appropriate control measures in a particular locality. Intestinal schistosomiasis is more prevalent and has high intensity in irrigated than non-irrigated areas (Mutahi et al., 2005). In the present study, *Schistosoma mansoni* infection varied by school according to the proximity to the irrigated area. The school in the irrigated area recorded higher infection rate. The results supports previous reports that distance from water bodies affects infection rates whereby individuals closer to infected water bodies have a higher infection rate compared to those who live further from the infected water (Fekadu et al., 1992). Most of the infected pupils worked in the irrigation scheme which supports earlier studies done in Ethiopia that showed that children who assisted their family in irrigated farm works were more infected than those who did not participate in irrigated agricultural activity (Mathys et al., 2007).

Kagio area is an urban set-up with the largest population seeking menial jobs in Mwea irrigation scheme. Owing to the close proximity to the irrigation scheme and high poverty levels, school children often seek menial jobs in the irrigation scheme and thereby perform other activities such as washing their body, washing clothes and swimming. The present study found that those who performed many activities combined had a higher chance of infection compared to those who performed individual activities. Performing such activities exposed the pupils more to the infected water.

In the current study most of the pupils had light infection (1-100 epg). Previous reports show that most individuals in endemic areas and its environs excrete low number of eggs (Butterworth et al., 1991). A previous study done in Central Kenya by Mutahi and Thiong'o (2005) recorded 41% of the participating pupils had significant infection; the infections have reduced possibly due to regular deworming program in school children implemented by Ministry of Health in Kenya (MOEST and MOH, 2014).

5. Conclusion

Schistosoma mansoni infection rate among the school children in Kagio area was 7.2% compared to 22% in Mwea irrigation scheme. Majority (>80%) had light infection and there were no cases of heavy infections detected. Majority of the school children aged (8-15 years) from Kagio worked for pay in the Mwea irrigation scheme. The results revealed that labor migration was a significant risk factor associated with *Schistosoma mansoni* transmission among the school children resident in the non-endemic area.

The study shows that schistosomiasis as a public health concern could easily spread to non-endemic areas like Kagio due to water related activities by people from non-endemic area. It is recommended that schistosomiasis control activities and regular surveillance be carried out regularly in endemic and neighboring non-endemic areas for effective control of the disease. Further research should be done involving identification of snail intermediate hosts in water bodies in Kagio area and establishing their infection with *Schistosoma mansoni* larvae. Wider screening of the population should be done in areas neighboring irrigation schemes to establish the levels of *Schistosoma mansoni* infections which would inform targeted control measures.

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