Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 13, Issue, 01, pp.15875-15885, January, 2021

DOI: https://doi.org/10.24941/ijcr.40259.01.2021

ISSN: 0975-833X

RESEARCH ARTICLE

INTEGRATED PREVALENCE MAPPING OF SCHISTOSOMIASIS AND SOIL-TRANSMITTED HELMINTHIASIS UTILIZING ECOLOGICAL MODELLING AMONG COMMUNITIES IN MAYUGE DISTRICT: IMPLICATIONS FOR NEGLECTED TROPICAL DISEASES ELIMINATION PROJECT 2019-2021

[1]Muhumuza, R., [2]Ock, M.S., [3]Yu, H.S.,[4]Sohn, W.M., [5]Kong, H.H., [6]Cha, H.J., [7]Lee, J.H., [8]Koh, I.Y., [9]Kim, Y.M., [10]Musasizi, B., [11]Nakacwa, I., [12]Kim, E.S, [13]Byarugaba, P., [14]Natukunda, I., [15]Kabarangira, C., [16]Igga, C., [17]Opeto, L., [18]Mutumba, A., [19]Wandira, J., [20]Adriko, M. and [21]Tukahebwa, E.

[1]Living Goods Uganda- Field Operations team; [2]Department of Parasitology and Genetics, Kosin University College of Medicine; [3]Department of Parasitology, College of Medicine, Pusan National University; [4]Department of Parasitology and Institute of Health Sciences, Gyeongsang National University School of Medicine. [5]Dong-A University; [6]Department of Parasitology and Genetics, Kosin University College of Medicine; [7]Department of Parasitology, College of Medicine, Pusan National University; [8]World Bank; [9]Department of Preventive Medicine, Hanyang University college of Medicine; [10]Options UK; [11] UNICEF Uganda; [12] World Vision, London School of Hygiene and Tropical Medicine; [13]UN Women Uganda; [14,15,16,17,18,19]World Vision Uganda; [20]Vector Control Division Ministry of health Uganda; [21]The Task force for Global Health. - International Trachoma Initiative (OITI)

ARTICLE INFO

Article History:
Received 10th October, 2020
Received in revised form
14th November, 2020
Accepted 08th December, 2020
Published online 30th January, 2021

Key Words:
Schistosomiasis,
Soil-Transmitted Helminths,
Ecological Modelling,
Prevalence.

ABSTRACT

Background: Neglected Tropical Diseases are a group of 13 major disabling conditions commonest among the world's poorest people (Hotez, *et al*. 2007). Together, they contribute to a disease burden that is halfof all Malarias(Peter J. Hotez 2009). The diseases affect 2.7billion people that mainly live on less than $2 a day, are common in Sub-Saharan Africa, Latin America and Asia (Tchuente 2011). In the last fifteen years, Uganda's Ministry of Health (MOH) has conducted Mass Drug Administration (MDA) in NTD infected communities with the support of various agencies such as WHO, USAID, ENVISION/RTI, SCI, DFID and Carter Center (RTI 2011). MDA against Schistosomiasis using PPraziquantel (PZQ) and mass education on prevention has been conducted in schools and communities. The prevalence of Schistosmiasis reduced between 2003 and 2007, however the prevalence has increased since 2007 due to unsafe hygienic environment (MOH-UG 2017). The Mayuge district has trained about 1,384 teachers and 1,536 Community Medicine Distributors to support the NTD program. However little success has been realized today. This has been attributed to several challenges including shortage of medicines, lack of behaviour change, failure to reach the most at-risk population, failure to adhere to drug compliance among others. Further still, there has been limited documentation of prevalence studies conducted in Mayuge to ascertain the impact of the program and inform better programming. World Vision in collaboration of Korea International Agency (KOICA), designed a three-year project to address Soil Transmitted Helminthe (STH) and Schistosomiasis using WHO recommending mass drug administration(MDA) integrated control through WASH, and health education and increase awareness. The project will conduct prevalence studies before project implementation to understand magnitude of the diseases and use results for targeted implementation. Given that assumption of environment factors affect to SCH prevalence, the project uses ecological modelling for the prevalence study. After the project, another prevalence study shall be conducted to assess its impact on the reduction of the disease prevalence and make recommendations to MoH. **Methods:** We used an ecological modelling approach to determine the prevalence of SCH depending on the risk of exposure to potential vectors since it varies depending on natural environments such as temperature (Brown 1994); (Moodley, *et al*. 2003), precipitation ((DeWitt 1995); (O'keeffe 1985), soil type(Ekpo, *et al*. 2008) level of vegetation cover (Brown 1994), (O'keeffe 1985) land-use change and water availability (Xing-jian, *et al*. 1999), suitable elevation (Kloos, *et al*. 1998)and slope (Zhu, *et al*. 2015) are the main factors that are associated with the prevalence of schistosomiasis where considered. The approach was preferred to provide important information on identifying risk populations to enable an increase in the efficiency of schistosomiasis disease control (Magalhães, *et al*. 2014). **Results:** A total of 1167 children were selected from thirty schools across Mayuge district. The final sample included 1123 children, 49% boys and 51% girls. 863 samples (76.8%) were from students and 260 (23.2%) were non-school children. Age was classified into 5 groups; 7-10, 11, 12, 13, and 14-17 years. The mean age of the sample was 11.9 ± 1.4 years. The district was divided into four infection risks categorized as Very low, low, high and very high according to climate and geographic information. Student hookworm infection was 15.5% (*p=0.5074*) while control (non-school) was 13.9% *(P=0.1706)*. Prevenances for *S. Mansoni* were 28.2% and 23.9%, for Students and Control groups respectively (p = 0.1706), while STH was 15.8%. The results on regional risk category indicated a higher prevalence in low or very low-risk regions than in high or very high-risk regions. Prevalence's of all parasites were higher among boys than girls. Hookworm prevalence was 4.9% higher, *S. Mansoni* 3.4%, and any STH 5.5%. The infection prevalence tended to increase with age. The intensity of infection among children with *S.Mansoni* was mainly light (12.7%). Moderate (7.3%) and heavy (7.2%) infections were almost the same. A similar pattern was observed for hookworm infection with 14.8% of 15.1% infections light. There were significant differences between infections for children that lived near the lake or river (44.7%) compared to those that didn't (15.2%, *P=<0.0001*) for *S. Mansoni* and any infections. Awareness and knowledge of infection route, hand washing behaviour with soap and lack of proper drinking water sources were all associated with reduced infections. However, incoherence was observed among infections of children that had anthelmintic and shoe protection as they had higher hookworm infection compared those without. **Conclusions:** There is a continued need for preventive chemotherapy forSTH and *S. mansoni* across Mayuge district, despite not being high-risk to achieve elimination and also because the district is predominately high risk. Slight differences in hookworm, STH and *S. Mansoni*pr evalence between children that do and do not report school attendance were observed during the study. This suggests the importance of not implementing targeted intervention but blanket for all children in the target age category if resources allow.

Citation: ***Muhumuza, R., Ock, M.S., Yu, H.S., Sohn, W.M., Kong, H.H., Cha, H.J., Lee, J.H., Koh, I.Y., Kim, Y.M. et al.* 2020.** "Integrated prevalence Mapping of Schistosomiasis and Soil-transmitted helminthiasis utilizing ecological modelling among communities in Mayuge district: Implications for Neglected Tropical Diseases elimination project 2019-2021.", *International Journal of Current Research*, 13, (01), 15875-15885.

INTRODUCTION

Neglected tropical diseases (NTDs) are a group of ~~13~~communicable diseases prevalent in tropical and sub-tropical areas among world poorest people (Hotez, et al. 2007) Together, they contribute to disease burden is that's half that of all malaria's (Peter J. Hotez 2009). The diseases affect 2.7billion people that mainly live on less than $2 day, are common in Sub-saharan Africa and Latin America and Asia. They include; soil-transmitted helminth infections (ascariasis, hookworm infection, and trichuriasis), lymphatic filariasis, onchocerciasis, dracunculiasis, schistosomiasis, Chagas' disease, human African trypanosomiasis, leishmaniasis, Buruli ulcer, leprosy, and trachoma (Peter J. Hotez 2009). Schistosomiasis and SHT are among most public health in Uganda because they are the most prevalent and little or support has previously targeted them for elimination. Last fifteen years, MOH-Uganda has practiced mass drug administration (MDA) in NTD infected areas with various agencies such as WHO, USAID, ENVISION/RTI, SCI, DFID, Carter center (RTI 2011). Schistosomiasis, MDA using praziquantel (PZQ) and prevention education has been practiced in schools and community areas. Schistosomes prevalence rates reduced between 2003 and 2007, however, prevalence has increased since 2007 due to unsafe hygienic environment (MOH-UG 2017). Schistosomiasis is a neglected tropical disease caused by blood flukes of the genus Schistosoma. It afflicts approximately 240 million individuals in the tropics and subtropics. It affects more 78 countries and nearly 800 million people are exposed to the disease. In 2017, Schistosomiasis was the third most devastating tropical disease globally and is a major cause of morbidity and mortality in Africa, South America, the Caribbean, the Middle East and Asia (Thao N 2017)

Chronic intestinal schistosomiasis has been noted to result in severe organ pathology such as hepatosplenomegaly, periportal liver fibrosis and portal hypertension which progress from abdominal pain and bloody diarrhoea (Fiona 2012). Urogenital schistosomiasis leads to haematuria, dysuria, hydronephrosis and calcification of the bladder. The early symptomatic stages of *S. mansoni* infection such as bloody stool, diarrhoea, abdominal pain and discomforts can also be associated with other infections and are non-specific indicators of infection. The late stages of chronic schistosomiasis infection such as ascites and bleeding from gastro-oesophageal varices are also unreliable indicators because they are seen in a relatively small number of infected individuals (Fiona 2012). Schistosomiasis control aims to reduce the transmission of parasites and reduce the level of infection in individuals, to minimize the pathological effects. The predominant intervention for control is annual treatment with one dose of PZQ (at 40mg/kg) where the number of tablets received is determined by a dose pole. Annual treatment is supported by improved access to safe water, adequate sanitation and, where feasible, snail control. Mass chemotherapy campaigns with PZQ are targeted at school-age children (SAC), as they harbour the heaviest worm burden in a population, and to reach at least 75% therapeutic coverage of SAC at risk of infection (Tchuente 2011). During this exercise WHO recommends that high-risk, for example, fishermen and women who frequently visit contaminated water sources, are also be targeted for mass treatment (Parker and Allen 2011).

Infection is caused by four main species of worms commonly known as roundworms (Ascaris lumbricoides), whipworms (Trichuris trichiura) and hookworms (Ancylostoma duodenale and Necator americanus). STH primarily affects the world's deprived populations (WHO n.d.). The disease has major health and socio-economic repercussions and constitutes an important public health problem in developing countries. World health organization (WHO) estimates that STH affects more than 2 billion people worldwide, and the greatest numbers of infections occur in sub-Saharan Africa. Treatment is either with a single tablet of ALB (400mg) or MEB (500mg). ALB can be safely co-administered with ivermectin (IVM) for the treatment of lymphatic filariasis and ALB or MEB can be safely co-administered with PZQ for the treatment of schistosomiasis. Mass treatment should be delivered once or twice a year depending on the underlying endemicity with therapeutic coverage of 75% and above in SAC (Fiona 2012). The current global strategy for control and elimination of SCH by WHO is Mass drug administration utilising a single oral dose of 40 mg/kg of praziquantel (PZQ).

The Uganda NTD Master plan (2017-2022), highlights the high burden of the diseases mainly affecting poor communities with limited access to health care, inadequate information and means of prevention and control measures. The plan further categories NTDs as of public health into two; those amenable to preventive chemotherapy (PC-NTDs) and those that are controlled through case management (CM-NTDs). Schistosomiasis (SCH) and Soil-transmitted helminthiasis (STH) among others have been highlighted as under PC-NTDs. Furthermore, the Uganda government is a signatory to the international treaties and conventions for the elimination of targeted diseases and is committed to control and eliminate targeted NTDs by the year 2020. With a vision to have Uganda free of NTDs by the year 2020, which the MoH revised to cover the period 2017-2022 (MOH 2017-2022). Historically Uganda, Ministry of Health, Vector Control Division (VCD) and development partners have been implementing several programs, namely Bilharzia and worm control program (BWCP) geared towards the reduction and elimination of SCH and STH in several districts in the country. MDA was introduced in 2003 in high prevalence (≥50%) endemic districts (MOH 2017-2022). The integrated program for NTD control commenced in 2007 with support from various partners including RTI/USAID, SCI and WHO. Following mapping refinement in 2013, mass treatment of school-age children was scaled up to include 34 low endemic districts with support from SCI. The objective of the interventions is morbidity control in high and moderate (10-49%) prevalence districts. In low endemic districts (<10%), the target is to eliminate the disease by 2020. Health education is carried out concurrently with treatment to raise awareness about the risks of the disease and the benefits of regular MDAs (MOH 2017-2022). After 3 years of interventions, data seemed to show a significant decline in the disease prevalence and morbidity between 2003 and 2007. Even though people continued to live in unsanitary conditions, reduction of prevalence and intensity was being achieved. However, morbidity began to increase again thereafter and in most of the high transmission areas, it is currently back to the pre-treatment level. Hence, despite the many years of control, schistosomiasis remains a serious public health problem in high and moderate transmission districts (MOH 2017-2022).

Mayuge district is one of the districts in with a high prevalence of NTDs. Some areas in Mayuge have a prevalence rate of 98% and 69.5% of each schistosomiasis and STH (WorldVision. 2019). Out of 13 sub-counties, 9 sub-counties either have landing sites or are distinguished as schistosomiasis-infected areas. The access rate to safe water is 48.4%, and the access rate to safe latrines is 67.9% this makes the district more susceptible to NTD (WorldVison 2017). Moreover, since 2007 the district has participated in NTD control interventions specifically MDA coupled with mass sensitization. The District has also trained about 1,384 teachers and 1,536 Community Medicine Distributors to support the NTD program. However little success has been realized today. This has been attributed to several challenges including shortage of medicines, lack of behaviour change, failure to reach the most at-risk population, failure to adhere to drug compliance among others. Further still, there has been limited documentation of prevalence studies conducted in Mayuge to ascertain the impact of the program and inform better programming. World Vision in collaboration of Korea International Agency (KOICA), designed a three-year project to address STH and Schistosomiasis MDA + integrated control through WASH, health education. The project will conduct prevalence studies before project implementation to understand the extent to the diseases and use results for targeted implementation. After the project, another prevalence study shall be conducted to assess its impact on the reduction of the disease prevalence and make recommendations to MoH.

METHODS

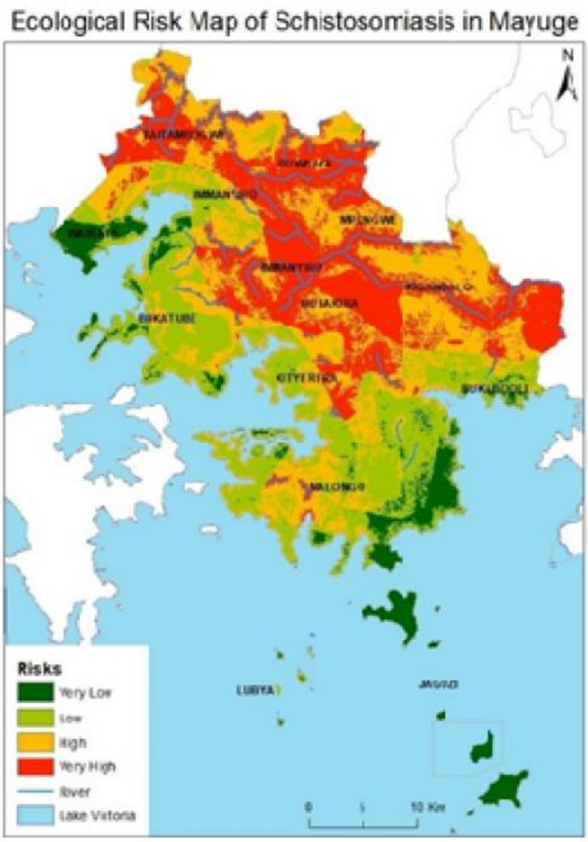
Study Area: Mayuge is located in the south-eastern part of Uganda and borders on Jinja, Iganga, Namayingo, and Bugiri. It is situated next to Lake Victoria and also boarders Tanzania in the South. From Uganda's capital Kampala, Mayuge is 146 km away. It has 13 sub-counties; Jaguzi sub-county, one of Mayuge's sub-counties, is consisted of only six islands. Mayuge's population number is 524,061; the number of children under five is 89,614, and the number of children between 5-14 is 158,266. It has a total of 446 primary schools, 41 health center (HC), and one hospital (HC II-34, HC III-5, HC IV-2). There are 1,536 health workers, and they work to raise awareness for MDA (WorldVision 2017). Out of 13 sub-counties, 9 sub-counties either have landing sites or are distinguished as schistosomiasis-infected areas. The access rate to safe water is 48.4%, and the access rate to safe latrines is 67.9% (Bennett, et al. 1991). Formative research by world vision further confirmed that there were no other methods used to control NTDs especially schistosomiasis other than MDAin Mayuge district (WorldVision 2017).

Study Design: The study employed an ecological modelling approach to determine the prevalence of SCH and STH depending on the risk of exposure to potential vectors since it varies depending on natural environments such as rivers, slope, elevation, land surface temperature, land use/cover and rainfall. Modelling for schistosomiasis risk was conducted using the spatial modelling approach (Ajakaye, Adedeji and Ajayi 2017); (Ekpo, et al. 2008); (Moodley, et al. 2003); (Navas, et al. 2018) based on the ecological environments of the study area. Ecological conditions such as temperature (Brown 1994); (Moodley, et al. 2003), precipitation ((DeWitt 1995); (O'keeffe 1985), soil type (Ekpo, et al. 2008) level of vegetation cover (Brown 1994),(O'keeffe 1985) land-use change and water availability (Xing-jian, et al. 1999), suitable elevation (Kloos, et al. 1998)and slope (Zhu, et al. 2015)are the main factors that are associated with the prevalence of schistosomiasis are where the ones considered during the study. This approach provides important information on identifying risk populations to enable an increase in the efficiency of schistosomiasis disease control (Magalhães, et al. 2014). Data to represent the ecological conditions that best represent the risk of schistosomiasis was collected. Climate data including temperature was downloaded from the European Centre for Medium-Range Weather Forecasts (ECMWF) and precipitation data was acquired from Tropical Applications of Meteorology SATellite (TAMSAT). Elevation and slope data were processed from the Advanced Spaceborne Thermal Emission Radiometer (ASTER) Digital Elevation Model (DEM) provided by the National Aeronautical and Space Agency (NASA). Land use data was obtained from the Global Land Cover Facility (GLCF), a satellite data-based center for land cover science that providesaccess to land cover change for local to global systems. The normalized difference vegetation index (NDVI) was generated by using Landsat 7 satellite image data's red band and near-infrared (NIR) band. Since Mayuge district has lots of cloud cover due to Lake Victoria, we selected a satellite image with less percentage of land cloud cover. The Landsat image captures the contrast between the two bands' reflectance of vegetation as shown in equation

$$N = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})}$$

The index provides the surface greenness information which is an indicator for detecting the level of photosynthetically active vegetation. Lastly, the proximity to a water body was generated using the river shapefile data downloaded from the Energy Sector GIS Working Group. Next, a different level of buffer zones ranging from 0m to 2000m (Ajakaye *et al.*, 2017) was created using ArcGIS software. All variables were converted into raster format at 30m spatial resolution for analysis. Using ArcGIS, each variable was reclassified into four levels including very low, low, high, and very high risk based on the existing literature' (Appleton, 1978; Brown, 1994; Clennon *et al.*, 2006; Kloos *et al.*, 1988; O'keeffe, 1985a; Patz *et al.*, 2000; Xing-jian *et al.*, 1999b) suitability level. Each variable's, as well as the overall level of risk, was visualized in a separate map.

After analyzing each variable's level of risk, the overall risks that consolidate all variable risks where assessed at the 30m raster pixel resolution across the study region. However, as variables may not have equal weight in constructing the overall risk, we applied Saaty's analytical hierarchy process (AHP) (Wind and Saaty 1980) as a method. AHP is a tool for multi-criteria decision making that helps decision-makers to elicit both subjective and objective aspects of a decision. Using the pairwise comparison matrix, a relative vector of criteria weights for each variable was computed. The higher the score, the higher the magnitude of the variable expected. Next, the option score matrix that corresponds to weight was computed. The last step of AHP was to multiply the criteria weight vector and the score matrix to generate the global score.



Map of Mayuge district indicating overall variable (Temperature, Slope, precipitation, Elevation, NDVI and Proximity) level of risk

This score identifies the overall risks for each pixel and helps us to stratify the regions with the highest and the lowest risks. In the study, we used R statistical software to generate AHP and prioritize scales to assess the risks. The equation to generate the overall risk is suggested is shown below.

$$O \quad r_i = (B1 * T \quad _i) + (B2 * P \quad _i) + (B3 * E \quad _i) + (B4 * L \quad _i) + (B5 * N \quad)_i + (B6 * S \quad _i) + (B7 * P \quad _i)$$

Where overall risk is the outcome of ecological conditions in pixel *i* and B1 through B7 are the weights for each ecological condition. After the overall risk was generated, a risk map of schistosomiasis is created. The map visualizes the study region with very low to very high risks so that the regions. The mapping provides a guideline for fieldwork and is validated by the samples we collected from various locations within the study region. While separating the areas of Mayuge district into a different level of risk areas, the GPS record for all the schools in Mayuge were recorded. After that, each school in Mayuge was identified in which risk area it belongs to.

Study population: The study population was selected from children 9-10 years in school and community following WHO guidelines for the evaluation of STH and SCH at the community level.

Sample size determination: Sample size determination was based on an estimated prevalence of schistosomiasis in Mayuge district. A response rate is 90%, the confidence interval was 95% and a margin of error of 5%.

n= 3.84 x p x (1-p) /(e^2 x RR)

Estimated prevalence of schistosomiasis: 23%
e = precision (margin of error): 5%
Confidence interval: 95%
RR (Response rate) : 90%

Based on this equation, the total number of a sample size from a risk area will be 273. A sample of 8 randomly selected classes of 30 children should be included in the study. Of 63 remaining samples were chosen from the villages located around the target schools. Mayuge district consists of four ecologically different zones (Very low, Low, high and very high). We applied the same equation for each region to arrive at a final sample size of1092 children.

Sampling procedure: After applying ecological modelling, school lists in Mayuge district were made by risk area. The sample frame was sorted within each sampling stratum by size. The required number of schools were selected by probability proportional to size (PPS). The measure of size (MOS) used for sample selection was the number of students. From each risk area, samples were selected randomly and independently from each stratum according to the sample allocation using probability proportional to size selection. A class 40-50 children were selected among the P4 and P5 classes (9-10-year-old schoolchildren) using a table of random numbers. In cases where only one class of the required aged group was present, it was selected.
In cases where present children where fewer than 35 a second class would be selected and all children in both classes examined.

Quality Assurance: Quality assurance measures including comprehensivetraining of research assistantsbefore data collection, drawing special attention to interviewing techniques, recording of responses, probing, and ethics and data handling/management, Pretesting data instruments on a ‘real-life’ situation, Appropriate supervision of the entire data collection process by the team lead and supervisors and use of Field diaries will be kept by the study team to record any events deemed important for the interpretation of the results.

Data management and analysis: WHO recommends the Kato-Katz quantitative method as the standard methods for evaluating the prevalence and intensity of soil-transmitted helminthiasis and schistosomiasis in endemic communities.

The same procedure was adopted for the study. The data from the laboratory analysis was recorded on data entry sheets and later transferred in to excel for cross-reference before analysis. Statistical analysis was performed in accordance with WHO guidelines for STH and schistosomiasis at the community level. Data Analysis was done using SAS software Version 9.4. All statistical tests were two-sided at the 5% level of significance (p values were provided for exploratory purposes only).

Form the data, prevalence of infections and intensity of infections was computed by calculating the prevalence/intensity of each parasite species, the prevalence/intensity of infection with at least one STHs, the prevalence/intensity of infection with at least one schistosomas and the prevalence/intensity of infection with at least one STHs or schistosomas. According to the study soil-transmitted helminthiasis was defined as- *Ascaris lumbricoides, Trichuris trichiura, Necator americanus* (hookworms) While schistosomiasis- *Schistosoma haematobium, Schistosoma mansoni*

Prevalence of community infection was calculated using the below

$$\text{Prevalence} = \frac{N \quad o \quad s \quad t \quad p}{m \quad o \quad s \quad in} \times 100$$

The intensity of infection in a community was calculated by

Eggs per gram of faeces (epg)

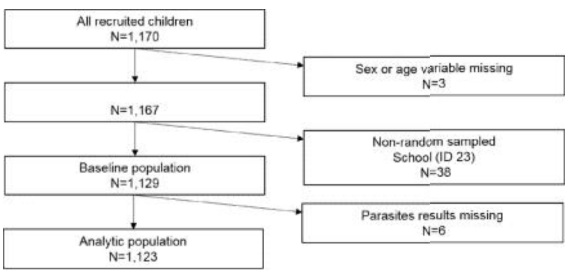
With the Kato-Katz technique, the measure of epg is obtained by multiplying the number of eggs counted on the slide. Considering the slide template holds 41.7 mg of faeces, the multiplication factor to obtain epg is 24.

The arithmetic mean epg

$$\text{arithmetic mean} = \frac{\sum e_i}{n}$$

RESULTS

The analytic Population selection process



Analytic Sample distribution (N=1123)

A total of 1123 children was used for analysis. 863 student samples (76.8%) and 260 (23.2%) were non-school children. The community samples were recruited on a scale of one-third. Climate and geographic information were used to divide Mayuge district into 4 by infection risk as categorized as Very low, low, high, and very high. Sampling ratios for sex and regional risk categorization was 1:1. The mean age of the sample was 11.9 ± 1.4 years. The mean age of the student sample group was slightly high than the community sample group (*p*-value by independent t-test <0.001).

Table 1. Distributions of the analytic population (N=1,123)

Risk categories	Student samples				Control Samples				Total			
	Boys		Girls		Boys		Girls		Boys		Girls	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Very low	104	(49.8)	105	(50.2)	32	(50.8)	31	(49.2)	136	(50.0)	136	(50.0)
Low	121	(51.1)	116	(49.0)	32	(45.1)	39	(54.9)	153	(49.7)	155	(50.3)
High	101	(48.8)	106	(51.2)	30	(47.6)	33	(52.4)	131	(48.5)	139	(51.5)
Very high	103	(49.1)	107	(51.0)	27	(42.9)	36	(57.1)	130	(47.6)	143	(52.4)
Total	429	(49.7)	434	(50.3)	121	(46.5)	139	(53.5)	550	(49.0)	573	(51.0)

Prevalence of each Parasite: *Hookworm* infection prevalence was 15.1% (15.1 infected cases per 100 children, 170 infected cases among 1,123 children). *S. Mansoni* infection prevalence was 27.2% (27.2 infected cased per 100 children, 605 cases). S. Mansoni seemed to be most prevalent.
Only 7 cases (0.6%) of*Trichuris triciura* were found andno infection of *Ascaris lumbricoides* and *S.Haematobium.*

Table 2. Prevalence of each parasite species in the total analytic population

		N	(%)
Ascaris lumbricoides_U	(-)	1123	(100.0)
	(+)	0	(0.0)
Ascaris lumbricoides_F	(-)	1123	(100.0)
	(+)	0	(0.0)
Trichuris triciura	(-)	1116	(99.4)
	(+)	7	(0.6)
Hookworms	(-)	953	(84.9)
	(+)	170	(15.1)
S. Mansoni	(-)	818	(72.8)
	(+)	305	(27.2)
S.Haematobium	(-)	1123	(100.0)
	(+)	0	(0.0)

Prevalence of each Parasite according to sample categories: There was no statistical difference in across all parasite infection between student and control areas. Student hookworm infection was 15.5% (*p=0.5074*) while control was 13.9% *(P=0.1706).* Prevenances for *S. Mansoni* were 28.2% and 23.9%, for Student and Control groups respectively (p = 0.1706), while STH was 15.8% (15.8 infected cases per 100 children, 177 infected cases among 1,123 children). Children that were positive to any infection were 427 (38%).

Prevalence of each Parasite according to Sex: Generally, prevalence's of all parasites were higher among boys than girls. Hookworm prevalence was 4.9% higher, *S. Mansoni* 3.4% any STH 5.5% and 6% for any infection.

Prevalence of each Parasite according to regional risk category: The results did not seem to be coherent with the regional risk category. The prevalence was higher in low or very low-risk regions than in high or very high-risk regions. However, there were significant differences among the infected and none infected with *S. Mansoni,* and *any STH.*

Prevalence of each Parasite according to Age: Age was classified into 5 groups; 7-10, 11, 12, 13, and 14-17 years. The infection prevalence tended to increase with age.P-value for trend test by Cochran-Armitage trend test indicated a significant difference in the infection prevalences. Any STH had the strongest trend difference *p=0.0018* followed by any infection *p = 0.0021*. Hookworm *was at p=0.004.*

Intensity of Infection

The intensity of infection among positive cases: The majority (27.2%) of the infected children presented with S.Mansoni, of these, the majority (n=146) 12.7% had light-intensity infections. Moderate (7.3%) and heavy (7.2%) infections for S.Mansoni were almost the same. Hookworm infections were (15.1%). Of these, majority (n=166) 14.8% were light.

Table 3. Infection prevalence according to sample category

		Total		Student sample		Control sample		p-value
		N	(%)	N	(%)	N	(%)	
1	(-)	953	(84.9)	729	(84.5)	224	(86.2)	0.5073
	(+)	170	(15.1)	134	(15.5)	36	(13.9)	
2	(-)	818	(72.8)	620	(71.8)	198	(76.2)	0.1706
	(+)	305	(27.2)	243	(28.2)	62	(23.9)	
3	(-)	946	(84.2)	722	(83.7)	224	(86.2)	0.3336
	(+)	177	(15.8)	141	(16.3)	36	(13.9)	
4	(-)	696	(62.0)	524	(60.7)	172	(66.2)	0.1135
	(+)	427	(38.0)	339	(39.3)	88	(33.9)	
Total Total		1123	(100.0)	863	(76.9)	260	(23.2)	

1-*Hookworms*, *2-S mansoni*, *3-STHs*, *4*-Any infection

Table 4. Infection prevalence according to sex

		Boys		Girls		p value
		N	(%)	N	(%)	
Hookworm	(-)	453	(82.4)	500	(87.3)	0.0221
	(+)	97	(17.6)	73	(12.7)	
S.Mansoni	(-)	391	(71.1)	427	(74.5)	0.1965
	(+)	159	(28.9)	146	(25.5)	
Any STH	(-)	448	(81.5)	498	(86.9)	0.0121
	(+)	102	(18.6)	75	(13.1)	
Any Infection	(-)	324	(58.9)	372	(64.9)	0.0380
	(+)	226	(41.1)	201	(35.1)	
Total		550	(49.0)	573	(51.0)	

Table 5. Infection prevalence according to regional risk category

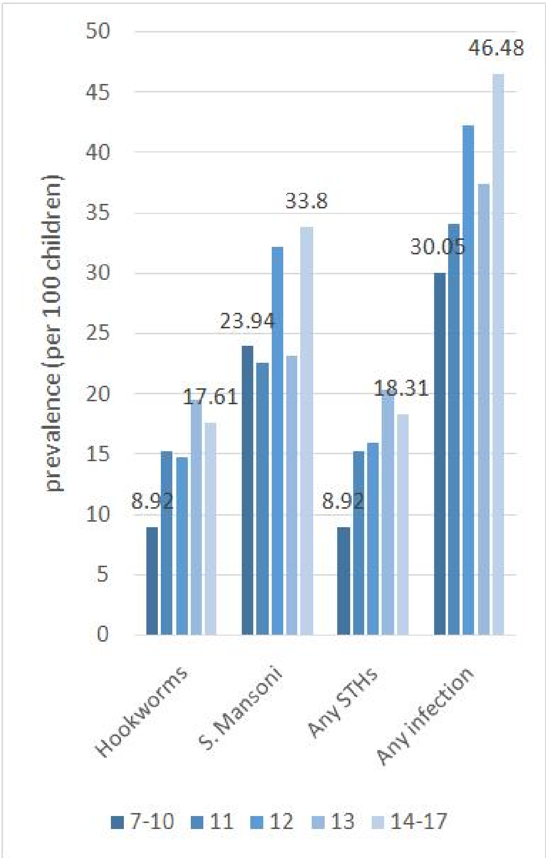
		Very low		Low		High		Very high		p value
		N	(%)	N	(%)	N	(%)	N	(%)	
Hookworms	(-)	231	(84.9)	247	(80.2)	230	(85.2)	245	(89.7)	0.0161
	(+)	41	(15.1)	61	(19.8)	40	(14.8)	28	(10.3)	
S. Mansoni	(-)	131	(48.2)	208	(67.5)	227	(84.1)	252	(92.3)	<0.0001
	(+)	141	(51.8)	100	(32.5)	43	(15.9)	21	(7.7)	
Any STHs	(-)	230	(84.6)	244	(79.2)	227	(84.1)	245	(89.7)	0.0071
	(+)	42	(15.4)	64	(20.8)	43	(15.9)	28	(10.3)	
Any infection	(-)	106	(39.0)	168	(54.6)	194	(71.9)	228	(83.5)	<0.0001
	(+)	166	(61.0)	140	(45.5)	76	(28.2)	45	(16.5)	
Total		272	(24.2)	308	(27.4)	270	(24.0)	273	(24.3)	

Table 6. Distribution of EPG among positive cases

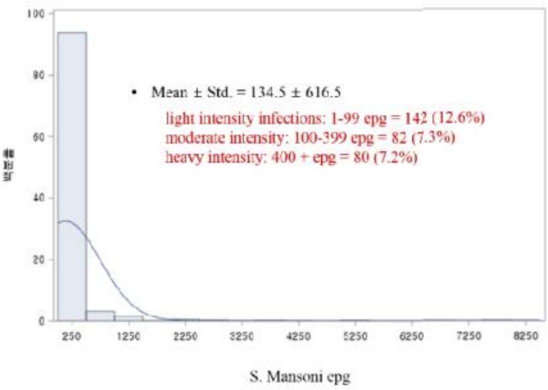
Parasite	N	Mean	Std	Min	P25	P50	P75	Max
Hookworms	170	280.0	536.6	24.0	48.0	108.0	264.0	4200.0
S. Mansoni	305	495.7	1102.2	0.0	48.0	120.0	432.0	8304.0
Any STHs	177	273.1	526.9	24.0	48.0	120.0	264.0	4200.0
Any infection	427	467.2	993.1	0.0	48.0	144.0	408.0	8304.0

Table 7. Distribution of EPG (eggs per gram) by sex

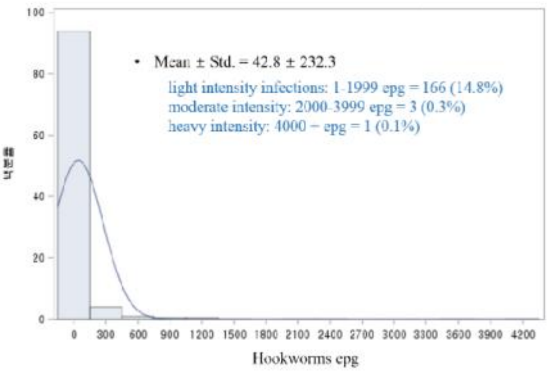
Parasite	Sex	N	Mean	Std	Min	P25	P50	P75	Max	p value
Hookworms	Boys	97	247.9	355.9	24.0	48.0	96.0	264.0	2208.0	0.4121
	Girls	73	322.5	709.7	24.0	48.0	120.0	264.0	4200.0	
S. Mansoni	Boys	159	487.3	976.8	24.0	48.0	120.0	480.0	6552.0	0.8907
	Girls	146	504.8	1227.6	0.0	48.0	120.0	408.0	8304.0	
Any STHs	Boys	102	240.5	348.6	24.0	48.0	96.0	264.0	2208.0	0.3836
	Girls	75	317.4	700.7	24.0	48.0	120.0	264.0	4200.0	
Any infection	Boys	226	451.3	860.7	24.0	48.0	144.0	432.0	6552.0	0.73
	Girls	201	485.1	1125.4	0.0	48.0	144.0	408.0	8304.0	



Whereas any infections were 38% with a mean ±Std 177.7±652.6. See a graphical representation of infection densities of different parasites below.

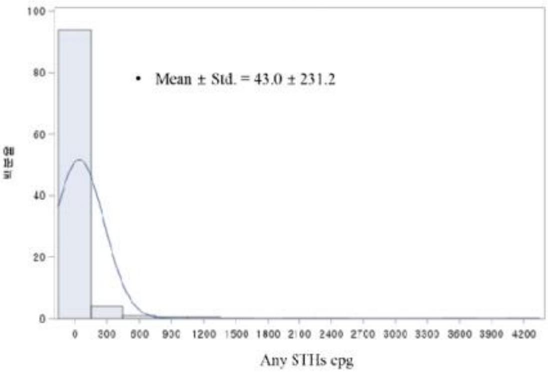


Distributions of S. Mansoni epg

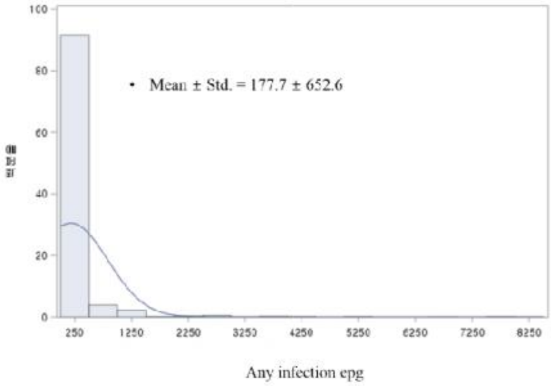


Distribution of Hookworm epg

Distribution of EPG (Eggs per gram) by sex



Distribution of Any STHs epg



Distribution of Any Infection epg

The study further indicated no significant difference in infection intensity between boys and girls. However, there were generally more infected boys by all parasites than girls.

Factors associated with the infections

Latrine use: Children who had latrines in the house showed lower *S. Mansoni* and any infection rates than without latrine.

Proximity to a Lake or River: Children that livened near the lake or river had higher infection (44.7%) rates compared to those that didn't (15.2%). Pronounced differences were observed in *S. Mansoni* and any infections.

Water and Waterfront environment: Significant differences were observed between *S. Mansoni*infection and any infection among children that lacked a clear source of drinking water. A similar trend was observed for households that were reported to be close to the lack and the children that reported bathing in lake/river at least once a week. Children with handwashing habit after going out showed slightly lower infection rates for most parasites except for hookworm infection. Infection prevalence indicators were all slightly lower among children who washed hands with soap compared to those with no soap.

Anthelmintic and shoe protection: *There was a reverse relationship between STHs infection and anthelmintic. Highest (21.7%).*

Table 1 Relationship between hygiene and infections

		Hookworms				p value	S. Mansoni				p value	Any STHs				p value	Any infection				p value
		(-)		(+)			(-)		(+)			(-)		(+)			(-)		(+)		
		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)	
toilet in your home	missing	14	(77.8)	4	(22.2)	0.7792	16	(88.9)	2	(11.1)	0.0007	14	(77.8)	4	(22.2)	0.5832	14	(77.8)	4	(22.2)	0.0231
	yes	843	(84.8)	151	(15.2)		737	(74.1)	257	(25.9)		836	(84.1)	158	(15.9)		625	(62.9)	369	(37.1)	
	no	96	(86.5)	15	(13.5)		65	(58.6)	46	(41.4)		96	(86.5)	15	(13.5)		57	(51.4)	54	(48.7)	
type of toilet	missing	16	(72.7)	6	(27.3)	0.7153	18	(81.8)	4	(18.2)	<0.0001	16	(72.7)	6	(27.3)	0.6638	15	(68.2)	7	(31.8)	0.0062
	flush/purt	11	(84.6)	2	(15.4)		11	(84.6)	2	(15.4)		11	(84.6)	2	(15.4)		9	(69.2)	4	(30.8)	
	pit latrine	837	(84.8)	150	(15.2)		734	(74.4)	253	(25.6)		830	(84.1)	157	(15.9)		624	(63.2)	363	(36.8)	
	composting	1	(100.0)	-	-		-	-	1	(100.0)		1	(100.0)	-	-		-	-	1	(100.0)	
	bucket	4	(80.0)	1	(20.0)		5	(100.0)	-	-		4	(80.0)	1	(20.0)		4	(80.0)	1	(20.0)	
	others	84	(88.4)	11	(11.6)		50	(52.6)	45	(47.4)		84	(88.4)	11	(11.6)		44	(46.3)	51	(53.7)	
field defecation	missing	12	(75.0)	4	(25.0)	0.3081	13	(81.3)	3	(18.8)	0.1237	12	(75.0)	4	(25.0)	0.5361	11	(68.8)	5	(31.3)	0.3577
	over 50 times	67	(88.2)	9	(11.8)		50	(65.8)	26	(34.2)		67	(88.2)	9	(11.8)		44	(57.9)	32	(42.1)	
	10-50	109	(81.3)	25	(18.7)		90	(67.2)	44	(32.8)		109	(81.3)	25	(18.7)		75	(56.0)	59	(44.0)	
	1-10	424	(84.0)	81	(16.0)		368	(72.9)	137	(27.1)		423	(83.8)	82	(16.2)		316	(62.6)	189	(37.4)	
	none	341	(87.0)	51	(13.0)		297	(75.8)	95	(24.2)		335	(85.5)	57	(14.5)		250	(63.8)	142	(36.2)	
treatment	missing	249	(88.9)	31	(11.1)	0.1651	176	(62.9)	104	(37.1)	0.0693	249	(88.9)	31	(11.1)	0.2248	157	(56.1)	123	(43.9)	0.3008
	toilet paper	249	(86.8)	38	(13.2)		216	(75.3)	71	(24.7)		246	(85.7)	41	(14.3)		189	(65.9)	98	(34.2)	
	water washing	309	(82.4)	66	(17.6)		298	(79.5)	77	(20.5)		306	(81.6)	69	(18.4)		243	(64.8)	132	(35.2)	
	others	146	(80.7)	35	(19.3)		128	(70.7)	53	(29.3)		145	(80.1)	36	(19.9)		107	(59.1)	74	(40.9)	
fertilizer	missing	20	(76.9)	6	(23.1)	0.5745	18	(69.2)	8	(30.8)	0.8238	20	(76.9)	6	(23.1)	0.5844	14	(53.9)	12	(46.2)	0.6842
	yes	21	(80.8)	5	(19.2)		20	(76.9)	6	(23.1)		21	(80.8)	5	(19.2)		15	(57.7)	11	(42.3)	
	no	912	(85.2)	159	(14.9)		780	(72.8)	291	(27.2)		905	(84.5)	166	(15.5)		667	(62.3)	404	(37.7)	

Table 2: Relationship between proximity of the house to "a lake or river with infections

		missing		1. yes		2. no		p value
		N	(%)	N	(%)	N	(%)	
Hookworms	(-)	84	(84.9)	356	(82.8)	513	(86.4)	0.1154
	(+)	15	(15.2)	74	(17.2)	81	(13.6)	
S. Mansoni	(-)	76	(76.8)	238	(55.4)	504	(84.9)	<0.0001
	(+)	23	(23.2)	192	(44.7)	90	(15.2)	
Any STHs	(-)	84	(84.9)	352	(81.9)	510	(85.9)	0.0836
	(+)	15	(15.2)	78	(18.1)	84	(14.1)	
Any infection	(-)	66	(66.7)	194	(45.1)	436	(73.4)	<0.0001
	(+)	33	(33.3)	236	(54.9)	158	(26.6)	
Total		99	(8.8)	430	(38.3)	594	(52.9)	

Table 3. Relationship between water and waterfront environment with infections

		Hookworms				p value	S. Mansoni				p value	Any STHs				p value	Any infection				p value
		(-)		(+)			(-)		(+)			(-)		(+)			(-)		(+)		
		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)	
drinking water type	missing	501	(87.3)	73	(12.7)	0.0014	446	(77.7)	128	(22.3)	<0.0001	498	(86.8)	76	(13.2)	0.0078	395	(68.8)	179	(31.2)	<0.0001
	tap	41	(93.2)	3	(6.8)		42	(95.5)	2	(4.6)		41	(93.2)	3	(6.8)		39	(88.6)	5	(11.4)	
	tube well	69	(79.3)	18	(20.7)		61	(70.1)	26	(29.9)		69	(79.3)	18	(20.7)		51	(58.6)	36	(41.4)	
	dug well	160	(87.4)	23	(12.6)		82	(44.8)	101	(55.2)		157	(85.8)	26	(14.2)		69	(37.7)	114	(62.3)	
	river	153	(75.0)	51	(25.0)		159	(77.9)	45	(22.1)		153	(75.0)	51	(25.0)		116	(56.9)	88	(43.1)	
	lake	29	(93.6)	2	(6.5)		28	(90.3)	3	(9.7)		28	(90.3)	3	(9.7)		26	(83.9)	5	(16.1)	
a lake or river near house	missing	84	(84.9)	15	(15.2)	0.1154	76	(76.8)	23	(23.2)	<0.0001	84	(84.9)	15	(15.2)	0.0836	66	(66.7)	33	(33.3)	<0.0001
	yes	356	(82.8)	74	(17.2)		238	(55.4)	192	(44.7)		352	(81.9)	78	(18.1)		194	(45.1)	236	(54.9)	
	no	513	(86.4)	81	(13.6)		504	(84.9)	90	(15.2)		510	(85.9)	84	(14.1)		436	(73.4)	158	(26.6)	
bath in lake or river per week	missing	390	(85.5)	66	(14.5)	0.0666	382	(83.8)	74	(16.2)	<0.0001	388	(85.1)	68	(14.9)	0.0682	327	(71.7)	129	(28.3)	<0.0001
	none	257	(88.0)	35	(12.0)		236	(80.8)	56	(19.2)		256	(87.7)	36	(12.3)		208	(71.2)	84	(28.8)	
	once	92	(84.4)	17	(15.6)		68	(62.4)	41	(37.6)		91	(83.5)	18	(16.5)		58	(53.2)	51	(46.8)	
	twice	83	(76.9)	25	(23.2)		63	(58.3)	45	(41.7)		83	(76.9)	25	(23.2)		45	(41.7)	63	(58.3)	
	three times	41	(87.2)	6	(12.8)		23	(48.9)	24	(51.1)		40	(85.1)	7	(14.9)		22	(46.8)	25	(53.2)	
	more than 3	90	(81.1)	21	(18.9)		46	(41.4)	65	(58.6)		88	(79.3)	23	(20.7)		36	(32.4)	75	(67.6)	

Table 4. Relationship between handwash behaviours and infection

		Hookworms				p value	S. Mansoni				p value	Any STHs				p value	Any infection				p value
		(-)		(+)			(-)		(+)			(-)		(+)			(-)		(+)		
		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)	
after going out	missing	41	(82.0)	9	(18.0)	0.1069	42	(84.0)	8	(16.0)	0.7914	41	(82.0)	9	(18.0)	0.1437	35	(70.0)	15	(30.0)	0.0961
	yes	710	(86.0)	116	(14.0)		599	(72.5)	227	(27.5)		704	(85.2)	122	(14.8)		520	(63.0)	306	(37.1)	
	no	202	(81.8)	45	(18.2)		177	(71.7)	70	(28.3)		201	(81.4)	46	(18.6)		141	(57.1)	106	(42.9)	
before meals	missing	28	(77.8)	8	(22.2)	0.2167	30	(83.3)	6	(16.7)	0.2860	28	(77.8)	8	(22.2)	0.1740	25	(69.4)	11	(30.6)	0.8122
	yes	868	(84.8)	156	(15.2)		746	(72.9)	278	(27.2)		861	(84.1)	163	(15.9)		633	(61.8)	391	(38.2)	
	no	57	(90.5)	6	(9.5)		42	(66.7)	21	(33.3)		57	(90.5)	6	(9.5)		38	(60.3)	25	(39.7)	
with soap	missing	34	(81.0)	8	(19.1)	0.0008	34	(81.0)	8	(19.1)	0.0006	34	(81.0)	8	(19.1)	0.0021	28	(66.7)	14	(33.3)	<0.0001
	yes	500	(88.5)	65	(11.5)		435	(77.0)	130	(23.0)		495	(87.6)	70	(12.4)		384	(68.0)	181	(32.0)	
	no	419	(81.2)	97	(18.8)		349	(67.6)	167	(32.4)		417	(80.8)	99	(19.2)		284	(55.0)	232	(45.0)	

Table 3. Relationship between anthelmintic and shoe

		Hookworms				p value	S. Mansoni				p value	Any STHs				p value	Any infection				p value
		(-)		(+)			(-)		(+)			(-)		(+)			(-)		(+)		
		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)	
anthelmintic frequency in a year	missing	36	(83.7)	7	(16.3)	0.0041	31	(72.1)	12	(27.9)	0.0900	36	(83.7)	7	(16.3)	0.0122	26	(60.5)	17	(39.5)	0.4051
	none	178	(91.8)	16	(8.3)		137	(70.6)	57	(29.4)		175	(90.2)	19	(9.8)		126	(65.0)	68	(35.1)	
	once	292	(85.1)	51	(14.9)		236	(68.8)	107	(31.2)		290	(84.6)	53	(15.5)		203	(59.2)	140	(40.8)	
	twice	306	(84.3)	57	(15.7)		277	(76.3)	86	(23.7)		305	(84.0)	58	(16.0)		233	(64.2)	130	(35.8)	
	three times	141	(78.3)	39	(21.7)		137	(76.1)	43	(23.9)		140	(77.8)	40	(22.2)		108	(60.0)	72	(40.0)	
shoes on the outside	missing	34	(81.0)	8	(19.1)	0.0723	33	(78.6)	9	(21.4)	0.5124	34	(81.0)	8	(19.1)	0.0544	27	(64.3)	15	(35.7)	0.0389
	yes	249	(88.3)	33	(11.7)		209	(74.1)	73	(25.9)		248	(87.9)	34	(12.1)		189	(67.0)	93	(33.0)	
	no	670	(83.9)	129	(16.2)		576	(72.1)	223	(27.9)		664	(83.1)	135	(16.9)		480	(60.1)	319	(39.9)	

Table 13. Relationship between awareness and knowledge of infection route and infection

		Hookworms				p value	S. Mansoni				p value	Any STHs				p value	Any infection				p value
		(-)		(+)			(-)		(+)			(-)		(+)			(-)		(+)		
		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)		N	(%)	N	(%)	
risk of swimming	missing	53	(82.8)	11	(17.2)	0.0825	54	(84.4)	10	(15.6)	0.3454	52	(81.3)	12	(18.8)	0.1493	46	(71.9)	18	(28.1)	0.1244
	yes	525	(86.6)	81	(13.4)		444	(73.3)	162	(26.7)		520	(85.8)	86	(14.2)		384	(63.4)	222	(36.6)	
	no	375	(82.8)	78	(17.2)		320	(70.6)	133	(29.4)		374	(82.6)	79	(17.4)		266	(58.7)	187	(41.3)	
knowledge infection route	missing	43	(84.3)	8	(15.7)	0.0065	41	(80.4)	10	(19.6)	<0.0001	43	(84.3)	8	(15.7)	0.0031	35	(68.6)	16	(31.4)	<0.0001
	yes	355	(88.8)	45	(11.3)		318	(79.5)	82	(20.5)		354	(88.5)	46	(11.5)		283	(70.8)	117	(29.3)	
	no	555	(82.6)	117	(17.4)		459	(68.3)	213	(31.7)		549	(81.7)	123	(18.3)		378	(56.3)	294	(43.8)	

Hookworms prevalence was observed among children that had reported having had preventative chemotherapy (PC) at least three times.

Handwashing Behaviors: Children with handwashing habit after going out showed slightly lower infection rates for most parasites except for hookworm infection. Infection prevalence indicators were all slightly lower among children who washed hands with soap compared to those with no soap.

Awareness and Knowledge: There was a positive correlation between children with no knowledge of infection route the risk of swimming in a lake/river.

Higher infections for S. Mansoni *were observed among children that had reported not having had PC or had only taken it once. Also, children who didn't put shoes were infected more frequently than children who put shoes.*

DISCUSSION

In the district wide population -based sample of school and non-children, the prevalence of STH was (15.8%), S. mansoni (27.2%) was low and moderate respectively as classified by WHO guidelines for Helminth control in school-age children (WHO 2011). Despite the risk maps placing 50% of the subcounties in the risk under a high risk and only one (Wairasa) under very low. However, prevalence's across remain low and moderate for STH and SCH. low and moderate prevelances of parasites in Mayuge may have resulted from routine deworming under MOH- bi annual child health plus days -program were all children below 14 years are dewormed, hygine and sanitation campaigns by government and non-government organizations. Despite the moderateparasite burden overall in Mayuge,PC distribution was required across the district despite WHO guidance of targeting only school children and most at risk communities (WHO. 2017)to allow the project achieve its goal of elimination and also because the district is majorly high risk geographically and the population is constantly exposed to infection. Parasite prevalence estimates from Mayuge district werehigher ingeneral, somewhat lower than the results of previousreports from Uganda. A similar study 9 years ago estimated prevalence of STCH and SCH for districts around lack Victoria to be 14.7% and 23.5% respectively (Kabatereine, et al. 2011). Mayuge district is located next to Lake Victoria and surrounded by a number of water bodies such as swamps and rivers which harbor snails' that intermediate hosts for Schistosoma. The population is also largely rural and highly dependent on Agriculture and thus exposing it to hookworm infestation.

Prevalence of SCH shows reverse association with risk areas on ecological modelling. To create ecological modelling for Mayuge district, we borrowed an idea of formulating the equation of the ecological modelling from multiple pieces of literature. The project team expected highly association between SCH prevalence and high and very high-risk areas upon ecological modelling. After finishing prevalence survey, the team revisit four schools chosen from each risk area, and the team also reviewed more relevant articles regarding the ecological modelling and published articles describing the association between SCH prevalence and Ugandan environmental facts. Through these works, the team realized that the AHP equation utilized before conducting the prevalence survey must be modified considering the specificity in Uganda setting:

- Proximity to water is the most influent factor to SCH prevalence, so it is necessary to impose the highest weight on creating the AHP equation.
- The lowest average temperature in Mayuge district is high enough the intermediate host (Bulinus species snails) to populate, so the difference of temperature in Mayuge cannot be a factor for the AHP equation.
- Precipitation is generally proportionate to increase the number of intermediate hosts. But, in the lakeshore area in Uganda, precipitation can be a negative factor for the snail population (Odongo-Aginya *et al*., 2008).
- SCH prevalence is different between the lakeshore area and river-closing area even though both regions are as equally close to the water source. In conclusion, the newly updated AHP equation shows the highest to the lowest weight in the order of the proximity to water, precipitation, altitude and slope, and NDVI. Males and females are had slight differences in parasite prevalence and significant differences by age were observed. Not any studies withing the country were seen on the relationship of sex with parasite prevalence however, studies from elsewherereported conflicting evidence.

The observed increased in hook worm infection with increase in age has be associated to ability of the child to walk longer distances and work in gardens thus increased exposure to infection as well as fecal-oral transmission during younger ages (Andrew, et al. 2018) (Mabaso, et al. 2004)argues that the type of soils could also play part in affecting hookworm infection. The results of this survey should be considered in lightof some limitations. Mass drug administration (child days plus) using albendazole for STH had been delayed and therefore the study preceded few months after. This could have influenced observed low prevalence infections of STH and Hookworms Andew *et al*, also noted that parasitologymethods including Kato-Katz have shown a reduction in sensitivity for detecting infections in low-intensity samples like one for Mayuge.

Conclusion

There is a continued need for preventive chemotherapy forSTH and *S. mansoni*across the Mayuge district, despite not being high-risk to achieve elimination and also because the district is predominately high risk. Modelling is useful to foresee which areas are more vulnerable to SCH infection and provide a tailor-made strategy to eliminate SCH effectively.

Acknowledgement

Mayuge NTD Elimination (MANE) project operated by World Vision, and the Korea International Cooperation Agency(KOICA) finances this project.

REFERENCES

Ajakaye, O.G, O.I Adedeji, and P.O. Ajayi. 2017. "Modelling the risk of transmission of schistosomiasis in Akure North Local Government Area of Ondo State, Nigeria using satellite derived environmental data." *PLoS neglected tropical diseases* 11: e0005733.

Andrew, Nute, Endeshaw Tekola, Stewart Aisha E. P, Sata Eshetu, Belay Bayissasse, and Mulat Zerihun. 2018. "Prevalence of soil-transmitted helminths and Schistosoma mansoni among a population-based sample of school-age children in Amhara region, Ethiopia." *Parasites and Vectors* 6-9.

Bennett, S, T Woods, Liyanage W. M, and Smith D.L. 1991. "A simplified general method for cluster-sample surveys of health in developing countries ." *World Health Statistics Quarterly* 98-106.

Brown, D. 1994. "Freshwater snails of Africa and their medical importance. ." ((Taylor, Francis, Eds,)).

DeWitt, W.B. 1995. "Influence of temperature on penetration of snail hosts by Schistosoma mansoni miracidia." *Experimental Parasitology* 4: 271–276.

Dong, R, Z Zhu, R.R Rafikov, and J.M. Stone. 2015. "Observational signatures of planets in protoplanetary disks: Spiral arms observed in scattered light imaging can be induced by planets." *The Astrophysical Journal Letters* 809(1): L5.

Ekpo, U.F, C.F Mafiana, C.O Adeofun, A.R Solarin, and A.B. Idowu. 2008. "Geographical information system and predictive risk maps of urinary schistosomiasis in Ogun State, Nigeria. ." *BMC Infectious Diseases* 8, 74.

Fiona, F. 2012. "Evaluating Integrated Neglected Tropical Disease (NTD) Control Strategies: Cost, Effectiveness and Sustainability of the NTD Control Programme in Uganda."

Hotez, Peter J., David H. Molyneux, Alan Fenwick, Jacob Kumaresan, Sonia Ehrlich Sachs, Jeffrey D. Sachs, and

Lorenzo Savioli. 2007. "Control of Neglected Tropical Diseases." *The New England Journal of Medicine* 1018-1019.

Kabatereine, Narcis B, Claire J Standley, Jose C Sousa-Figueiredo, Fiona M Fleming, J Russell Stothard, Ambrose Talisuna, and Alan Fenwick. 2011. "Integrated prevalence mapping of schistosomiasis, soil-transmitted helminthiasis and malaria in lakeside and island communities in Lake Victoria, Uganda." (Springer). https://link.springer.com/article/10.1186/1756-3305-4-232.

Kloos, H., C.T Lo, H Birrie, T Ayele, S Tedla, and F. Tsegay. 1998. "Schistosomiasis in Ethiopia. Social Science & Medicine ." 26: 803–827.

M.D, Allen G.P. Ross, Thao N. Chau, Marianette T. Inobaya, Remigio M. Olveda, Yuesheng Li M.D, and Donald A. Harn. 2017. "A new global strategy for the elimination of schistosomiasis." *International Journal of Infectious Diseases* 54: 130-137. https://www.sciencedirect.com/science/article/pii/S1201971216311808.

Mabaso, M.L.H, C.C Appleton, J.C Hughes, and E. Gouws. 2004. "Hookworm (Necator americanus) transmission in inland areas of sandy soils in KwaZulu-Natal, South Africa. Tropical Medicine & International Health, 9(4), pp.471-476."

Magalhães, R.J.S, M.S Salamat, L Leonardo, D.J Gray, H Carabin, K Halton, D.P McManus, G.M Williams, P Rivera, and O. Saniel. 2014. "Geographical distribution of human Schistosoma japonicum infection in The Philippines: tools to support disease control and further elimination." *International journal for parasitology 44*, 44: 977–984.

MOH. 2017-2022. "NTD Master plan." Policy Document, Kampala, 6.

MOH-UG. 2017. "Uganda masterplan for NTDs program (2017-22)." Plan, Kampala.

Moodley, I, I Kleinschmidt, B Sharp, M Craig, and C. Appleton. 2003. "Temperature-suitability maps for schistosomiasis in South Africa." *Annals of Tropical Medicine & Parasitology* 97: 617–627.

N, Thao, Chau M, Marianette T, Remigio M, Yuesheng L, and Donald A. 2017. “A new global strategy for the elimination of schistosomiasis.” *International Journal of Infectious Diseases* 54: 130-137.

Navas, A.L.A., Magalhães, Osei R.J.S., F, R.J.C. Fornillos, L.R Leonardo, and A. Stein. 2018. "Modelling local areas of exposure to Schistosoma japonicum in a limited survey data environment." *Parasites & vectors* 11: 465.

O’keeffe, J.H. 1985. "Population biology of the freshwater snail Bulinus globosus on the Kenya coast. I. Population fluctuations in relation to climate. ." *Journal of Applied Ecology* 73–84.

Parker, M, and T., Allen. 2011. "Does mass drug administration for the integrated treatment of neglected tropical diseases really work? Assessing evidence for the control of schistosomiasis and soil-transmitted helminths in Uganda." *Health research policy and systems* 9 (1): 3.

Peter J. Hotez, Aruna Kamath. 2009. "Neglected Tropical Diseases in Sub-Saharan Africa: Review of Their Prevalence, Distribution, and Disease Burden." *PLOS Neglected Tropcal Diseases.* https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0000412.

RTI. 2011. "ENVISION, a global NTDs-control movement - Unpublished ."

Tchuente, L.T.,. 2011. "Control of soil-transmitted helminths in sub-Saharan Africa: diagnosis, drug efficacy concerns and challenges." *Acta tropica 120* 4-11.

Thao N, Chau M, Marianette T, Remigio M. Yuesheng L, Donald A. 2017 7. 2017. "A new global strategy for the elimination of schistosomiasis. International Journal of Infectious Diseases 54 (2017) 130–13."

WHO. 2011. "Helminth control in school age children." 18.

—. n.d. *Soil-transmitted helminth infections.* Accessed June 8, 2019. https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections.

WHO. 2017. "Preventive chemotherapy to control soil-transmitted helminth infections in at-risk population groups." 3. https://apps.who.int/iris/bitstream/handle/10665/258983/9789241550116-eng.pdf?sequence=1&isAllowed=y.

WHO. 2011. "Report of an informal consultation on Schistosomiasis control." 19. https://apps.who.int/iris/bitstream/handle/10665/78066/9789241505017_eng.pdf?sequence=1.

Wind, Y, and T.L. Saaty. 1980. "Marketing applications of the analytic hierarchy process." *Management science,* 26(7): 641-658.

WorldVision. 2017. "Formative research results." Brief.

WorldVision. 2019. "MANE-Project Concept."

WorldVison. 2017. "Formative research. unpublished ."

Xing-jian, X, Y Xian-xiang, D Yu-hai, Y Gui-yang, C Liu-yan, and S. Zheng-ming. 1999. "Impact of environmental change and schistosomiasis transmission in the middle reaches of the Yangtze River following the Three Gorges construction project." *Southeast Asian journal of tropical medicine and public health* 30: 549–555.

Zhu, H.-R, L Liu, X.-N Zhou, and G.-J. Yang. 2015. "Ecological model to predict potential habitats of Oncomelania hupensis, the intermediate host of Schistosoma japonicum in the mountainous regions, China." *PLoS neglected tropical diseases* 9: e0004028.

****