



Effects of Soil- Transmitted Helminths and *Schistosoma* Species on Nutritional Status of Children in Mwea Irrigation Scheme, Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. Authors NM, JAS and EK designed and supervised the study, wrote the protocol and reviewed the manuscript. Author JMN managed the literature searches, carried out the data collection and analyses and wrote the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Soil- transmitted helminths (STH) and schistosomiasis are a major public health problem in Kenya as well as in many other tropical countries. Intestinal parasite infections have been associated with malabsorption and nutrient losses that can lead to malnutrition. Malnutrition is considered one of the most prevalent conditions among children in rural population. The aim of this study was to investigate the effects of STH and *S. mansoni* parasite infections on nutritional status of school children in Mwea rice Irrigation Scheme.

Study Design: The study was descriptive cross-sectional in design.

Methodology: The study was carried out in selected schools within Mwea Irrigation Scheme. The sample size comprised 236 children at the baseline with 78 pupils from Kandongu, 89 from Kirogo and 69 from Nyangati primary schools. A sub-sample of 103 pupils was randomly selected from the sample population and used to assess the prevalence of anaemia. A sub-sample was necessary in this case due to economic and logistic problems.

Results: Overall prevalence rate of geohelminths and *Schistosoma* infections was found to be 26%. There was a strong relationship between infection and malnutrition with the number of pupils

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infected and underweight being 59% compared to 17.9% of non infected underweight. Helminth infections were also associated with anaemia, with 65.7% of anaemic cases suffering from various types of helminth infections.

Conclusion: The study has indicated that intestinal helminth infections, including soil transmitted helminths and *Schistosoma mansoni* cause malnutrition and anaemia among the school children in Mwea Irrigation Scheme, having been associated with severe, moderate to mild malnutrition as well as anaemia.

Keywords: Soil- transmitted helminthes; *Schistosoma mansoni*; malnutrition; prevalence of infection; irrigation.

1. INTRODUCTION

Soil transmitted helminth infections (STH) and schistosomiasis constitute major public health challenges among school age children in sub Saharan Africa [1]. These helminthic infections are among the leading neglected tropical diseases affecting millions of people worldwide. Current estimates indicate that globally, an estimated 4.5 billion individuals are at risk of STH infections while 207 million are infected with schistosomiasis [2-3].

Soil-transmitted helminth (STH) and schistosomiasis are diseases of poverty, delaying social and economic development in endemic areas [4-6]. These parasites consume nutrients from their hosts, causing malnutrition and retarded physical development. They also destroy tissues and organs in which they live, cause abdominal pain, diarrhoea, intestinal obstructions and iron deficiency anaemia among other health problems [2,7,8]. STH infections contribute to perpetuation of poverty by impairing the cognitive performance and growth of children, and also by reducing the work capacity and productivity of adults [9].

Mwea Irrigation Scheme is an area whose drainage and environmental conditions, in addition to farming activities, are conducive for the transmission of soil-transmitted helminths and schistosomiasis in the community [10,11]. There are no toilet facilities in the vast open area in the paddies and since farmers spend most of their time in the field during the day, secondary canals are the most likely places for defecation [12]. The faecal matter reaches the paddies through the feeder canals. School-age children are an important high risk group for STH infections. A study conducted in all primary schools in the Division by Eastern and Southern Africa Center for International Parasite Control (ESACIPAC), indicated an overall prevalence of 36% in *Schistosoma mansoni* with more than

50% of schools within the irrigation area demonstrating infection rate of 50% and above in *S. mansoni* infection. This ranged from 4% in Kimbimbi Primary School to 94% in Kirogo Primary School [13]. Overall prevalence for STH was 16%. There is need to establish any chronic association of parasitic infections and the nutritional status in children in this area.

The children are continuously exposed to contaminated soil and water and probably lack awareness of the need for good personal hygiene. Children get exposed to helminths; both in school and at home by consuming parasite contaminated food and water, eating with contaminated hands and by walking bare foot through contaminated soil and water. Reducing the intensity of infection significantly reduces both the morbidity attributed to these infections and the occurrence of severe complications developing in adult hood [14].

2. MATERIALS AND METHODS

The study was conducted in Mwea irrigation scheme located in Kirinyaga County, central Kenya. Administratively, the new upgraded Kirinyaga County has two districts (Mwea East and Mwea West). The county is located about 100 km north east of Nairobi, Kenya. It covers an area of 513 km² and it is estimated to have 51,444 households and a total population of 176,261 persons [15]. There are 58,970 school age children (5–19) in Mwea [15]. The mean annual rainfall in this area is in the range of 1200–1600 mm per year and varies by the time of year.

The study population included school children from three public primary schools within Mwea Irrigation Scheme, namely Kandongu, Kirogo and Nyangati Primary Schools. All children aged 9-12 years of both gender were included in the study. The study excluded all children whose parents did not consent.

The sample size comprised 236 children at the baseline with 78 pupils from Kandongu, 89 from Kirogo and 69 from Nyangati primary schools. However, only 196 children completed the study. The rest were disqualified either due to absenteeism during data collection or transferred to other schools while the study was still going on. All pupils in this group with no infection acted as the control group. A sub-sample of 103 pupils was randomly selected from the sample population and used to assess the prevalence of anaemia. A sub-sample was necessary in this case due to economic and logistic problems.

2.1 Ethical Consideration

Permission was sought from the Ministry of Health, Ministry of Education, Kenyatta University and from the parents of the respondents. All the children whose stool contained helminth eggs during stool examination were treated. Those infected with geohelminths were treated with a single dose of albendazole while those infected with *Schistosoma mansoni* were treated with praziquantel according to the recommended doses by World Health Organization Guidelines [16].

2.2 Methods of Data Collection

To examine the rate of parasite infection stool was collected from all the children under study. The children were each given a universal bottle the previous day and instructed to put in the morning stool. The specimen was collected upon arrival in school, labeled and taken immediately to Mwea District hospital laboratory. Stool examination for evidence of soil transmitted helminths and *schistosoma* based on the presence of eggs was done using Kato Katz thick smear technique [17].

Anaemia was assessed using measurement of haemoglobin levels. This was done using Drabkin's method as used by Cheesbrough [18]. Drabkin's diluting fluid was first prepared and distributed into 10 ml bottles in quantities of 5 ml per bottle. Using a 0.02 ml pipette capillary, blood was drawn from a finger prick of each child. The outside of the pipette was then wiped and the blood washed into the bottle containing 5 ml of diluting fluid. The content of the bottle was then mixed well and left to stand for a few minutes. It was then transferred into a tube and placed on a calorimeter, (whose initial reading was zero) for reading. The calorimeter readings

of the test fluid were then used to read off the haemoglobin concentration in the test solution using the calibration curve.

The readings, done using a calorimeter were reported in grams percent. Anaemia was classified as severe if haemoglobin level was less than 5 g%, moderate if haemoglobin level ranged between 5 to 7 g%, mild if haemoglobin level ranged between 8 to 10 g% and normal if haemoglobin level was more than 11 g% [19,20].

Nutritional status of each child was examined using anthropometric measurements. These included measurement of weight and height. Weight was measured using a clinical digital scale calibrated in units of 0.1 Kilograms. The children were allowed to be in light clothing, without sweaters and shoes. Height was measured using wooden height meter ruler, calibrated in millimeters and centimeters and with a sliding headpiece.

Classification of Protein-Energy Malnutrition (PEM) was done according to National Council of Health Statistics (NCHS). Underweight, which is low weight for age, was determined using Weight for Age Z- scores (WAZ) and Height for Age Z- scores (HAZ) was used to determine stunting, which is low height for age. Malnutrition was classified as severe if Z- scores were less than - 3.0 sd, moderate if Z- scores ranged between - 2.9 sd and -2.0 sd and normal if Z- scores ranged between -1.9 to 1.9 sd [21].

Data was processed using Statistical Package for Social Sciences (SPSS) version 17 and Epi info statistical packages. Anthropac program was first used to convert raw anthropometric data into nutritional indicators and compared them with the National Center for Health Statistics (NCHS) reference figures as designed by world health organization [16] Descriptive statistics was done by running frequencies, means and cross-tabulations. Further comparative analysis between experimental groups was done using Chi-square test.

3. RESULTS AND DISCUSSION

3.1 Total Parasitic Infection Rates

Overall prevalence of geohelminths and *Schistosoma* species in the children was 26%, where *S. mansoni* was 17.3%, hookworm 5%, *A. lumbricoides* 4.6% and *T. trichiura* was lowest with 3% (Table 1). Mixed infection was also observed in a small number of cases, (4.6%)

involving combined STH or mixes of STH and *S. mansoni* (Table 1).

3.2 Prevalence of Malnutrition

General Prevalence of underweight was 27.6%, with 1.1% being severely underweight and stunting prevailed in 34.7% of the study subjects, with 6.1% of them being severely stunted. There was negative interrelationship between infection and nutritional status. The number of pupils infected underweight was significantly higher (59%) than that of non-infected underweight (17.9%), ($\chi^2 = 27.961$, $df = 1$, $P < 0.05$). On stunting, the results indicated that 60% of the infected pupils were stunted compared to 25.5% of the uninfected (Fig. 1). The difference

observed attained statistical significance, $\chi^2 = 18.973$, $df = 1$, $P < 0.05$.

Underweight and stunting was observed more in pupils infected with *A. lumbricoides* at 77.8% and 66.7% respectively and least observed in pupils infected with hookworm at 45.4% in each case (Table 2).

3.3 Prevalence of Anaemia

Data on anaemia indicated that 43% of the study population had haemoglobin levels less than 11g% (Fig. 2) hence anaemic but the number of anaemic children was higher in the infected group (67.5%) compared to the uninfected group (32.5%).

Table 1. Prevalence of geohelminths and schistosomiasis

Infection	Prevalence rate (%)	Intensity of infection	
		Light (%)	Moderate (%)
<i>S. mansoni</i>	17.3	70.6	29.4
Hookworm	5.0	100	0.0
<i>A. lumbricoides</i>	4.6	100	0.0
<i>T. trichiura</i>	3.0	100	0.0
Mixed infection	4.6		
Total infection	26%		

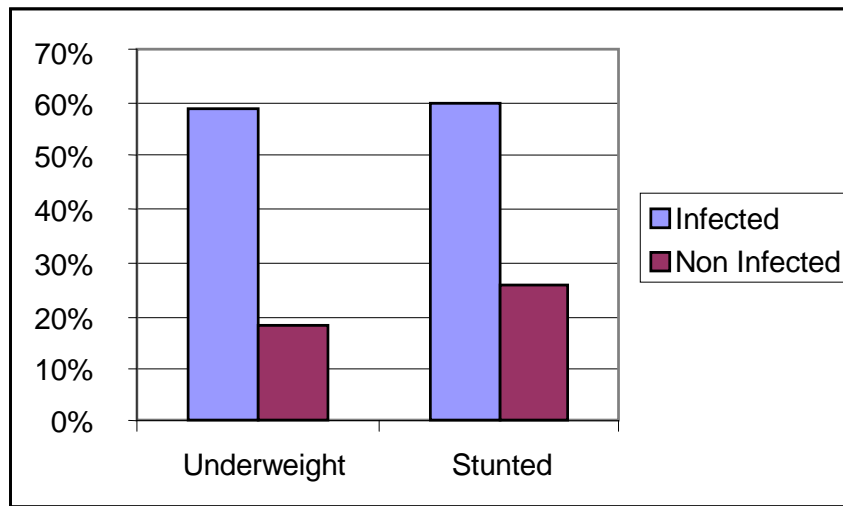


Fig. 1. Malnutrition in relation to infection

Table 2. Effects of various helminths on nutritional status

Nutritional status	Type of infection			
	<i>A. lumbricoides</i>	<i>T. trichiura</i>	Hookworm	<i>S. mansoni</i>
Underweight	77.8%	50%	45.4%	52.9%
Stunted	66.7%	66.7%	45.4%	61.8%

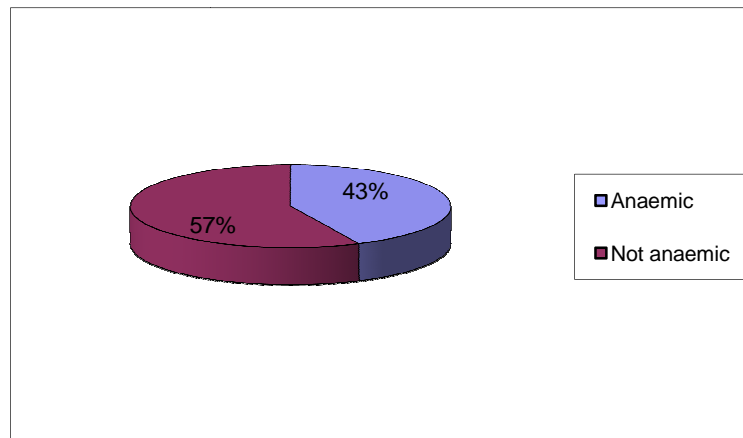


Fig. 2. Prevalence of anaemia

The infected and anaemic pupils were then grouped according to the various types of infections they suffered from (Fig. 3). The results indicated that most of the anaemic cases suffered from hookworm and *S. mansoni* infections. *Trichuris trichiura* did not appear to be associated with anaemia and infection with *Ascaris lumbricoides* was only associated with mild anaemia. Statistical test indicated that the difference between the type of helminth infection and Hb level was highly significant, $\chi^2 = 53.90$, $df = 7$, $P < 0.05$.

3.4 Prevalence of Infections

Out of 196 children examined in this study, 51 were infected with various types of worms. This represents 26% of the sample population. Earlier studies conducted by ESACIPAC in 86 schools in Mwea Division reported an overall prevalence of 36% [13,22] The noted reduction in prevalence of infection in present study could be due to targeted mass chemotherapy by ESACIPAC and the observed infections could be due to re-infection or new infection.

3.5 General Malnutrition

The results indicated that 27.5% of the sample population was underweight, and 34.7% was stunted. Both underweight and stunting could be due to inadequate intake of food or illness and it is a reflection of chronic state of malnutrition which could result from long term inadequate food or food of low nutritional value or illness. It is important to note that in areas where human hosts are already marginally nourished, parasite-induced reduction in food intake can worsen

stunting and malnutrition in general [18]. The present data indicates that malnutrition was more prevalent amongst those infected with helminths as compared to those not infected. Among the infected, 60% were stunted compared to 25.5% of those without infection. This difference was statistically significant, ($\chi^2 = 18.973$, $df = 1$ and $P < 0.05$). Similarly underweight was significantly prevalent among the infected compared to the non- infected at the rate of 59% and 17.9% respectively, ($\chi^2 = 27.961$, $df = 1$ and $P < 0.05$). This state of malnutrition could be attributed to mal-absorption of nutrients and loss of appetite caused by helminth infection. Our findings concur with another study done in another endemic area in Kenya where many children had chronic malnutrition [21]. Earlier studies associated helminths with mal-absorption of nutrients' impaired growth loss of appetite and reduction in food intake [23,24].

3.6 Prevalence of Anaemia

The prevalence rate of anaemia was found to be 43% of the sample population. Although general anaemia was common in the study population the prevalence was higher in the infected persons. The study found that 33.3% of the pupils with severe anaemia also suffered from intestinal schistosomiasis and another 33.3% of the pupils with moderate anaemia suffered from hookworm infection. Amongst those with mild anaemia, 14.7% had *Ascaris*, another 14.7% had hookworm and 44.1% had intestinal schistosomiasis. It is important to note that in this study *Trichuris trichiura* was not associated with anaemia and that the majority of anaemic cases suffered from *Schistosoma mansoni*. These

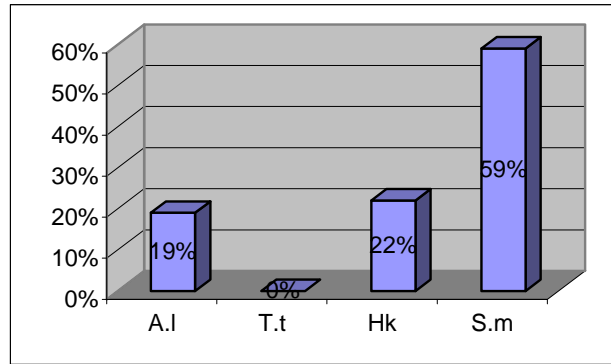


Fig. 3. Anaemia in relation to various types of infection

Key: A.I – *Ascaris lumbricoides*
 T.t - *Trichuris trichiura*
 Hk - Hookworm
 S.m. – *Schistosoma mansoni*

results support findings of other studies that attributed anaemia to schistosomias [25-27] In another study a decrease in hookworm eggs following treatment significantly led to a rise in mean Hb level between baseline and final examination [28]. In this study ascariasis is associated with mild anaemia, contributing 14.7% of anaemic cases. According to literature, iron is absorbed through the intestinal wall in the duodenum and jejunum. It is believed that iron absorption could be impaired by the presence of *Ascaris lumbricoides* leading to anaemia [26].

4. CONCLUSIONS

Geohelminths and *Schistosoma* infections are a health concern among children in Mwea Irrigation Scheme. The most prevalent infections are *Schistosoma mansoni* infections. There is a relationship between helminth infection and a child's nutritional status with infected cases suffering from severe, moderate to mild malnutrition. Anaemia is also associated with helminth infections with most infected anaemic cases suffering from *Schistosoma mansoni* and hookworm infections.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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