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PREVALENCE AND INTENSITY OF *SCHISTOSOMA MANSONI* BEFORE AND AFTER CHEMOTHERAPY IN SCHOOL AGED CHILDREN

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Abstract

Aims: To determine prevalence rate and intensity of *Schistosoma mansoni* infection in School Aged Children before and after chemotherapy

Methodology: This study was carried out in Mwea Division of Kirinyaga County. Stool samples were collected from children in Mianya primary school. The samples were collected from each child and analysed for the presence or absence of *S. mansoni* eggs. Stool analysis was done at the Kimbimbi County Hospital- Division of Vector Borne Disease laboratories. The positive cases were treated with Praziquantel. Stool samples were again collected from the treated children at 6 and 12 week post treatment and analysed for the presence of *S. mansoni* eggs. Eggs were quantified per gram of the feacal sample.

Results: Baseline prevalence for the selected pupils in the school was above 60% before chemotherapy with most children having heavy infections ≥400epg/feaces. The prevalence reduced significantly after treatment at six weeks (20%) but increased slightly at twelve weeks (50%) indicating re-infection. However most of the positive children had light infections during this period.

Conclusion: The prevalence rate in the study area remains high but after intervention there is a reduction but only for a limited time. Reinfection is also high which thought to be a contributing factor to the continuous cycle of the disease in the area**.** This calls for a more integrated approach for control of the disease in the area. Drug administration alone is not adequate in alleviating the burden of diseases.

Keywords: Schistosomiasis, prevalence, chemotherapy

1. Introduction

Schistosomiasis remains a serious neglected tropical disease especially in School Aged Children (SAC) who carry the most burden of the infection. Control interventions as recommended by World Health Organization, have primary focus upon provision of free treatment with Praziquantel to SAC, 5–14 years old, as well as, adults (⩾15 years old), who reside within disease endemic regions (Fenwick *et al.* 2009). In a study carried out in Kenya on school-based deworming program, there was a 7.5% point average gain in primary school participation in, reducing overall school absenteeism by at least one-quarter (Miguel & Kremer, 2001).

The overall prevalence of schistosomiasis in Kenya ranges from 5% to over 65% which contributes to significant morbidity countrywide with the highest infection rates being found in adolescents aged 10–19 years, and adult workers in rural areas who are employed in activities associated with water contact are also affected (Ouma *et al.,* 2001). A pilot control program initiated in Mwea District in Central Kenya region in 2004, where 86 schools and a total of forty thousand (40,000) school age children were examined found a 50% mean prevalence of Schistosomiasis (Kihara *et al.,* 2007; MOPHS, 2011). Additionally, a study carried out in the Kenyan coast noted that local physical features and age-related factors play a predominant role in *S. haematobium* transmission in this setting (Satayathum *et al*., 2006). Lack of awareness and water contact habits such as frequent swimming in the open water source, agricultural activities on bare foot, and washing clothes were also associated with high risk of *S. mansoni* infection (Essa *et al.,* 2013).

2. Materials and methods

Study site

This study was carried out in Mwea Division of Kirinyaga County. The Kenya Population and Housing Census 2009 report stated that the population of the county stood at 528,054 persons with an annual growth rate of 1.5 percent. The population distribution pattern is in form of individual household and cluster of villages (Kennenni, 2002). Several perennial rivers flow through the flat terrain of the poorly drained Mwea division. These kinds of conditions have formed swamps that have led to the development of the largest rice irrigation area in Kenya, known as the Mwea Tebere Rice Irrigation Scheme. The first case of schistosomiasis in the region occurred in 1959, and within 10 years after the implementation of the irrigation system, 12 percent of the adult population and 60 percent of school children were found infected with *S. mansoni* and by 1972 the prevalence was up to 80 % (Waiyaki, 1987).

Ethical approval, consideration and inclusion of school children

The study was conducted with the approval of the Ethics and Research Committee of the Kenyatta National Hospital/University of Nairobi (KNH/UoN-ERC) Protocol no. P111/03/2015. The inclusion criteria was children aged 7-14 years positive for *Schistosoma mansoni* and who have no severe medical condition or existing disease. Children who have had PZQ treatment in the last 6 months were excluded from the study.

Sample size determination

Baseline data was obtained from the medical records of surveys and previous studies done in the area in the past six months by the Division of Vector Borne Diseases department under the MOH prior to the study. Based on this, Mianya primary school children were surveyed and selected. Sample size determination was based on the formula adopted from WHO 2013 guidelines (WHO, 2013).

Recruitment Strategy and subject approach

A letter of introduction was sent in advance to the head teacher of the school to inform the principles of the proposed study and explain to them that stool samples would be collected from the pupils to check for the presence of *S. mansoni* eggs and their intensity. After the initial visit and logistical arrangements, a date for collecting the specimens was set and the head teacher convened a meeting with the parents of the children involved in the study and explained to them about the procedures to be undertaken before signing the consent forms. On agreement the parents signed the consent forms willingly.

Sample collection

Each child was given a sample collection container and asked to bring a feacal sample after the purpose of sample collection was explained to them. Each child who returned a faecal specimen was identified on a form that clearly stated the name and the serial number that is on the container in order to identify the specimen. Liquid or diarrhoeic stool samples were discarded because the condition interferes with standard evaluation of faecal egg counts. The health teacher in the school assisted in data recording and in managing the flow of children where necessary. The faecal specimens were analysed by the Kato- Katz method (Katz *et al.,* 1972) and quantification done as Egg per gram of feacal sample (EPG) classified as either light (≤ 100 EPG), moderate (≥ 101-399 EPG) or heavy (≥400 EPG).

Drug administration

A qualified nurse helped in administration of the Praziquantel (Prazitel®- Cosmos Ltd) according to the prescribed dose of 40mg/kg weight using a WHO dose pole to all the positive cases. The drug was administered as a single dose. This was done under supervision to ensure that the children took the drugs. The information was recorded in a data form. No case of adverse drug reaction/ side effect was observed or reported. All the children responded positively. Drugs were left at school to be given to the absent pupils who were positive by the health teacher who has been trained on the administration of Praziquantel.

Prevalence at six and twelve weeks post treatment

Stool samples were collected from the same pupils in Mianya primary school who had been selected for a follow up in the study at six and twelve weeks. Sample collection was done (as previously described) and analysed by the Kato- Katz method (Katz *et al.,* 1972) at six and twelve weeks. Quantification was again done as EPG of the faecal sample as previously described

Egg Reduction Rate (ERR)

The ERR was calculated for the parasitological data obtained from the pupils. It was used as a basis for

evaluation of the efficacy of the treatment. The following formula was used:-

(ERR = [(mean egg $count_{pre\text{-}treatment}$ − mean egg $count_{post\text{-}treatment}$) / mean egg $count_{pre\text{-}treatment}$] x 100)

Data analysis

Data collected on the parasitological parameters that included the age distribution (7-14years), prevalence and intensity of infection was analysed statistically (P≥0.05) using the statistical package SPSS and presented as tables and graphs.

3. Results

Baseline prevalence

A total of 112 pupils were initially sampled. From the data obtained based on egg/gram of faeces (EPG) from all the participants surveyed, the infection prevalence was 67.85%. From the parasitological data obtained of individual positive pupils, the intensity of infection was 28 % light infection (<100eggs/g), 30% moderate (>100 eggs/g) and 42% having heavy infections (> 400eggs/g) (Fig 1).

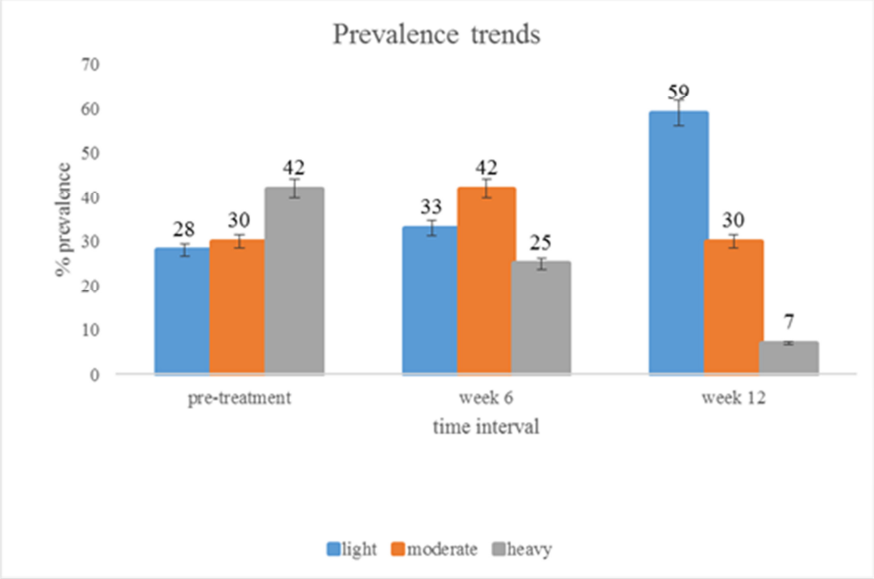

Fig. 1 Prevalence trends of the infection intensity

Prevalence at six weeks and twelve weeks

The prevalence rate was evaluated at six and twelve weeks post treatment. At six weeks 61 pupils from the initial pool of the 76 treated children were assessed and 11 turned out to be positive for *S. mansoni.* Out of this with 33% of them had light infections, 42% moderate and 25% heavy infection (Fig. 1). At eleven weeks only 58 pupils provided stool samples and out of this 59% of the pupils had light infections, 30% moderate infection and 7% heavy infection (Fig. 1).

The trends in the infection level shows a rise in the light infections progressively at week six and week twelve which was statistically significant (P=0.007, Table 1).

Table 1 ANOVA analysis for Light infection

ANOVA					
egg count					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4735.662	2	2367.831	5.747	.007
Within Groups	15656.143	38	412.004		
Total	20391.805	40			

Further Post –Hoc analysis showed that there were no significant differences between pre-treatment infection levels and week six (P=0.44) but there were significant differences between pre-treatment levels and week 12 (P=0.002). There were no significant differences between week six post-treatment and week 12 post treatment (P=0.217, Table 2).

Table 2. Post Hoc analysis for Light infections

Multiple Comparisons						
egg count LSD						
(I) intensity of infection	(J) intensity of infection	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
pre-treatment	week 6	-8.57143	11.07340	.444	-30.9884	13.8455
	week 12	-22.82143*	6.73569	.002	-36.4571	-9.1857
week 6	pre-treatment	8.57143	11.07340	.444	-13.8455	30.9884
	week 12	-14.25000	11.34686	.217	-37.2205	8.7205
week 12	pre-treatment	22.82143*	6.73569	.002	9.1857	36.4571
	week 6	14.25000	11.34686	.217	-8.7205	37.2205
*. The mean difference is significant at the 0.05 level.						

For the moderate infections there was a small increase in week six and then a decline in week twelve but the differences were not statistically significant (P=0.690>0.05, Table 3).

Table 3 ANOVA analysis for Moderate infection.

ANOVA					
egg count					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6323.548	2	3161.774	.375	.690
Within Groups	278396.452	33	8436.256		
Total	284720.000	35			

Finally there was a progressive decline in the heavy infections as at week six and twelve respectively. This decline was statistically significant between all the sampling intervals, P= 0.002 < 0.05, (Table 4).

Table 4. ANOVA analysis for Heavy infections

ANOVA					
egg count					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5406644.443	2	2703322.222	7.295	.002
Within Groups	2.001E7	54	370565.490		
Total	2.542E7	56			

Further Post –Hoc analysis showed that there were significant differences between pre-treatment infection levels and week six (P=0.014) and similarly between pre-treatment levels and week 12 (P=0.043). There were also significant differences between week six post-treatment and week 12 post treatment (Table 5).

Table 5. Post Hoc analysis for Heavy infections

Multiple Comparisons						
egg count LSD						
(I) intensity of infection	(J) intensity of infection	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
pre-treatment	week 6	-612.81250*	2.40626E2	.014	-1095.2385	-130.3865
	week 12	379.17279*	1.82697E2	.043	12.8876	745.4579
week 6	pre-treatment	612.81250*	2.40626E2	.014	130.3865	1095.2385
	week 12	991.98529*	2.60996E2	.000	468.7208	1515.2498
week 12	pre-treatment	-379.17279*	1.82697E2	.043	-745.4579	-12.8876
	week 6	-991.98529*	2.60996E2	.000	-1515.2498	-468.7208
*. The mean difference is significant at the 0.05 level.						

Overall reduction of prevalence rate

Overall, the prevalence rate decreased at week five and then increased by week 12 (Fig. 2).

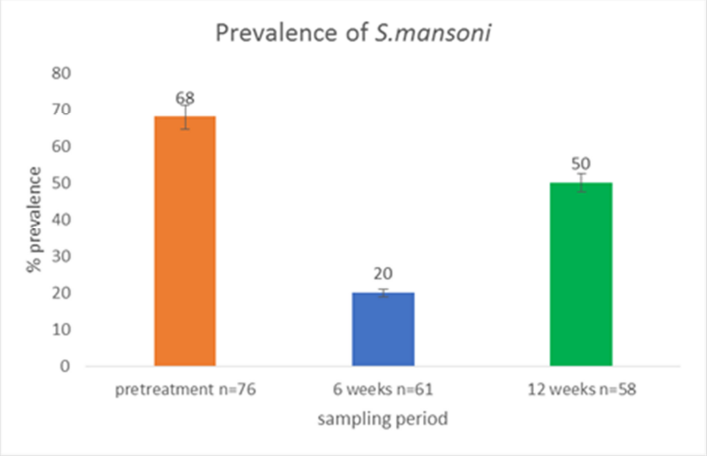

Fig 2. Overall reduction of *S. mansoni* prevalence during study period

Egg Reduction Rate (ERR)

At the end of the sampling period only 46 pupils were consistent for the three sampling intervals. This was due to absenteeism on the sampling days, some were present at week six and absent in week twelve and vice versa. At the end of week six the Egg reduction rate (ERR) for the 46 consistent pupils was 98% while at week twelve it was 91%. The parasitological indicator for evaluation of efficacy of an anthelminthic treatment is always based on the ERR.

5. Discussion

The endemicity of schistosomiasis in Kenya over the years has contributed to recurrent infections with periodicity and the same is also seen in Mwea where the study was undertaken. The site specific baseline prevalence percentage data of 68% in Mianya obtained from this study showed a high percentage infection of *S. mansoni* parasite in the children in the school before treatment. Mwea region has been known to be endemic for *S. mansoni* dating back to 1970 where a prevalence of 60% was first recorded in the sampled children (Oomen *et al.,* 1979) and by 1972 it was up to 80% (Waiyaki 1987). The high prevalence in Mianya is in agreement with similar studies over the years that have shown high prevalence of *S. mansoni* in various schools in Mwea division (Masaku *et al.,* 2015; Kihara *et al.,* 2007). SAC are at a greater risk specifically because they are suspected to harbour the heaviest worm burdens and thus experience a high degree of morbidity from infection. In addition, SAC exhibit greater prevalence and higher infection intensity than adults due to a combination of high exposure and immunological factors (Bundy, 1988; Muchiri *et al.,* 1996).

The children at Mianya who recorded heavy infection (42%) are seen to be at higher risk of suffering from the consequences of morbidity associated with the disease condition. Heavy worm burden in schistosomiasis often is associated with poor cognitive development and short term memory (Health, 2002) and it is school age children who are most likely to suffer the consequences of infection because they are generally more likely to harbour heavy infections (Savioli *et al*., 1992). In addition as seen in this study children with the heaviest current parasitic load may show the greatest impairment because they have harboured a worm burden for the longest period of time (Health, 2002). There is strong evidence that administration of the drugs reduces worm loads, but there seems to be a disconnect of the reduced worm loads and improved life outcomes. This is crucial because for success of disease control other factors also play an important part.

In the present study there was a reduction in the overall prevalence rate at six weeks and twelve weeks after chemotherapy in Mianya School which was selected for follow up. Prevalence was reduced from 68% to 20% in the first five weeks following treatment and then slightly increased to 50 % after twelve weeks represented by the EPG faeces calculated. A decrease in the heavy infections and moderate infection was noted with the heavy

infection at very significant levels. However there was an increase in the light infections and this can be attributed to the reinfection of the children twelve weeks after treatment. In general there was a reduction in the percentage prevalence for the pupils over the period and this was also noted by Kihara et al. (2007) in a previous study.

Despite several years of Mass Drug Administration in this region, here has been no apparent reduction in the overall transmission of schistosomes in the area (Lelo *et al.,* 2014; Kihara *et al.,* 2012). Previous studies have shown that with successive rounds of treatment, prevalence has been noted to increase in this area, although not to baseline levels as had been recorded (Kihara *et al.,* 2012). Overall transmission cycles may not just be reduced through chemotherapy alone but it is worth noting that treatment should be continued in the school children at regular intervals and monitoring and surveillance intensified to ensure interruption of transmission areas (Masaku *et al.,* 2015).

There was a reduction in the worm burden which was shown after calculation of the Egg Reduction Rate (ERR). This indicated a good reduction of the parasite load in the children, a contributing factor in the reduction of morbidity especially in the children with heavy infections. This can even be brought down further as seen in a study by Ojurongbe *et al.* (2014) that showed very good ERR but this was more enhanced because there was a second round of treatment after five weeks. It was noted that the efficacy of the drug based on the ERR was good at six weeks after treatment but there was reinfection in the children by week twelve which translated to an increase the EPG/faeces. This can be attributed to several factors such as the non-treatment of community members (adults) who are potentially infected and act as reservoirs, and lack of control of the intermediate hosts (snails) leading to re-infection (Kihara *et al*., 2012; Njenga *et al.,* 2011).

Re-infection always occurs immediately because exposure to the parasite is always continuous in the area. Recovery of the eggs in stool is seen after five weeks. In addition PZQ usually does not destroy immature/juvenile worms and these may have then matured to adults. In the study this is evident because by week six eggs were recovered from the treated pupils. It is assumed that patients in high transmission areas would harbour a high number of immature schistosomes that are less susceptible to PZQ (Erko *et al.,* 2012).

5. Conclusion

In conclusion prevalence rate of *S. mansoni* in Mwea for the sampled school remained high despite the various control initiatives in the area over the past years. The reinfection rate is still high as shown in the study with a 59% light infections recorded in week 12. This may be contributing to the continuous cycle of the disease in the area. However with PZQ treatment there is a reduction in the worm loads and intensity of infection especially with children who initially had heavy infections with 7% heavy infections recorded at week 12.

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