Prevalence of Parasitic Infections amongst Children in Primary Schools in Tharaka South Sub County, Kenya

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Abstract

Parasitic infections-soil transmitted helminths (STHs) and protozoan infections are among the most prevalent infections in developing countries. The health effects of these infections include; poor nutritional status, appetite, gastrointestinal morbidity, cognitive disability and iron deficiency anemia among others. The aim of this study was to investigate the prevalence of parasitic infections amongst children in primary schools in Tharaka South Sub County. A cross-sectional study was conducted among 481 children in five primary schools selected from three different age groups and classes in Tharaka Nithi Sub-County. To investigate intestinal helminths and protozoa, a single stool sample was examined from each child, and both thick and thin blood smears of each participant examined for malaria parasites. Statistical analysis was done using STATA 13 MP®. Prevalence was calculated and reported per 1000 persons. The risk of infection with protozoa and/or STHs by school, gender and age was analyzed using logistic regression for Odds Ratio (OR). Risk of infection with infectious parasitic infection and risk of polyparasitism was analyzed using multivariate logistic regression for OR. Results showed the prevalence of any parasitic infection was 548.86/1000persons. Prevalence of STHs was 83.16/1000persons, most prevalent STHs was *Schistosoma mansonii* 33.26/1000persons, while prevalence of protozoa was 466/1000persons and the most prevalent protozoa was *Entamoeba hystolytica* 235/1000persons. Bivariate analysis indicated a statistically significant positive association between Giardia lamblia and gender, (*p=0.014*), Giardia lamblia and being in age group (7 -10 years (*p=0.041*), it was found that a positive association between infection with EC and being in the age group of 7-10 years, p=0.037). Risk of infection was positively associated with being male, *p=0.029* and being in class five, *p=0.017*. Polyparasitism was negatively (protective) associated with belonging to Kamatungu primary school, p=0.029 and Tunyai primary school, *p=0.007*. The study concludes that Protozoan infections were more common than soil transmitted helminths. Improved water sanitation and hygiene are essential in eradication of intestinal parasitic infection. Mass drug administration and health promotion interventions should also target protozoal infections of medical importance.

Keywords: *Soil transmitted helminths, Prevalence, Protozoa, Polyparasitism, Infection*

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Introduction.

Parasitic infections attributed to soil transmitted helminths (*Schistosoma mansoni, Ascaris lumbricoides, Enterobius vermicularis, Hymnolepsis nana, Hymenolepis diminuta,* Hook worm) and protozoan parasites (*Giardia lamblia, Hymenolepis nana, Iodomeba bustchilii, Entamoeba coli*), are among the most prevalent infections among populations in developing countries (Haque, 2007). The disease burden attributed to parasitic infections is about 3.5 billion persons with about 50 million people falling ill as a result of these infections, the majority being children (Committee, 2002; Freeman, Clasen, Brooker, Akoko, & Rheingans, 2013).

Protozoa and Helminths are a major public health challenge in developing countries especially in rural and informal settlements (Dawaki et al., 2016).

The health effects of parasitic infections include poor nutritional status, appetite , gastrointestinal morbidity, cognitive disability (Sandoval et al., 2015), iron deficiency anemia, growth retardation in children, physical, mental health disability, and mortality in some cases (Halliday et al., 2012; Votano et al., 2012).

Very little is known on the epidemiology of intestinal protozoa in sub-Saharan countries. Protozoan infections e.g.-*Entamoeba histolytica* and *Giardia intestinalis*-are very high among school-aged children (Speich et al., 2013). Studies have typically investigated health and educational consequences of protozoan infections especially malaria among school-aged children in areas of high transmission, but few have investigated these issues in moderate and low transmission settings (Halliday et al., 2012).

In Tanzania's Pemba Island nearly half of the children were infected with at least one of the three (potentially) pathogenic intestinal protozoa (Speich et al., 2013). Soil-transmitted helminthiasis (STH) is confirmed as endemic in Kenya. All three types (roundworms, whipworms and hookworms) are widely distributed across Kenya with more than 16.6 million people believed to be at risk of infection with one or more of the three types of worms (Ministry of Health [MOH], 2016). Soil transmitted helminths occur singly or in combination in certain individuals or communities living in geographical areas where more than 1 STH is co-endemic. Schistosomiasis is confirmed as endemic to Kenya.

The pattern of occurrence involves some sub counties within the Lake Victoria region, parts of Central Kenya, Lower Eastern and the Coast regions. Approximately 6 million people are estimated to be at risk of infection with Schistosomiasis in Kenya (MOH, 2016). Descriptive epidemiology of intestinal parasites by gender is important in understanding their distribution. There has been a gradual decline in the prevalence of STH and other parasitic infections in Kenya over the years. This has been attributed to school health programs implemented since 1998, improved living conditions, access to potable water, sanitation and hygiene (Ngonjo et al., 2016; Okoyo et al., 2016).

Soil transmitted helminths- *A. lumbricoides, T. trichiura* and hookworm- are commonly observed (Okoyo et al., 2016) among pre-school and school age children including adolescents (Davis et al., 2014; Ngonjo et al., 2016; Nxasana, Baba, Bhat, & Vasaikar, 2013). Intensity of soil transmitted helminths always peak in the age group of 5–14 years (Gyorkos, Maheu-Giroux, Blouin, & Casapia, 2013).

Differences in prevalence of Soil Transmitted Helminths due to gender is often not statistically significant (Ngonjo et al., 2016; Okyay, Ertug, Gultekin, Onen, & Beser, 2004). Prevalence of intestinal protozoa by gender however presents mixed results where some studies show that females present a higher prevalence compared to males (Mohammed Mahdy et al., 2009; B Speich et al., 2012), some studies show no difference by gender while others show that males present with a higher prevalence.

Prevalence of Soil transmitted helminths especially Schistosoma is significantly higher among participants aged below 18 years compared to those aged ≥ 18 years; with the highest prevalence rate (27.4%) reported among those aged 11-20 years, while children aged 10 years and below had the lowest prevalence (10.7%) compared to other age groups (Dawaki et al., 2016). Nearly similar results were reported by Teresia Ngonjo *et al.* where the mean intensity of STHs combined was high in the age groups 6-7 years and 12-13) years, at 10,752 epg and 9,217 epg, respectively (Ngonjo et al., 2016).

The most common forms of polyparasitism are; *A. lumbricoides*/*E. coli* and *E. coli*/*H. nana* both at 8.5%; followed by *A. lumbricoides*/*E. coli*/*H. nana* at 6.8% (Nxasana et al., 2013). Participants with a history of schistosomiasis are 2.87 times more likely to be infected with any other soil transmitted helminth compared with individuals that do not have history of schistosomiasis.

This could be partially attributed to the clustering of communities with high infection rates around infested water sources, exposing the residents to a higher risk of re-infection (Dawaki et al., 2016). Polyparasitism in schools is attributed to environmental conditions, Water Sanitation and Hygiene (WASH) socio-economic conditions and existing infection levels (Okoyo et al., 2016). Polyparasitism may impact nutritional status of children because combined effect of multiple parasites in one individual leads to increased nutritional demand from the host (Ngonjo et al., 2016).

The main aim of the study was to understand the epidemiological prevalence of protozoa and intestinal helminths in the study area. The specific objectives were; (i) to describe the sociodemographic characteristics of the participants, (ii). to determine the prevalence of protozoa and helminths by school, age and gender respectively (iii) to assess the risk of infection with a parasitic infection and (iv) to assess the risk of polyparasitism among the study participants.

Materials and Methods.

The study was carried out in Tharaka South Sub-County, which is made up of five administrative divisions. Five primary schools were selected, each representing one of the five divisions. In selecting these schools, spatial diversity was considered to cover different geographical zones in the Sub-County. The study design was a cross sectional survey of soil transmitted helminths and protozoa among children in primary schools in Tharaka Nithi Sub-county in 2014. The study targeted children considered to be at a high risk of infection, aged between 8 - 12 years and in classes 4, 5 and 6.

The sample size was 500 participants equally distributed from the five primary schools but the return rate was 481 participants which was satisfactory according to the original plan.(96.2%) Participants from the primary schools were stratified for school, age and sex selected using simple random sampling methods in the study while assuming a 5% margin of error and 10% non- response rate. For the intestinal helminths and protozoa, a single stool sample was examined from each child, and both thick and thin blood smears of each child examined for malaria parasites. The preparation method for stool examination was the qualitative Ritchie's formal/ether concentration method and for malaria the smears were stained using the Giemsa stain.

All analyses were performed using STATA statistical software (v. 13; SAS Institute Inc., Station Road Texas, USA) and p values < 0.05 were considered statistically significant. Chi square test was used to summarize the socio-demographic characteristics. Prevalence rates was calculated and expressed per 1000 persons. Bivariate assessment of risk of infection with protozoa and soil transmitted infection was calculated using logistic regression for reporting odds ratios. Risk of infection with Intestinal parasitic infection and risk of polyparasitism was determined using a multivariate logistic regression for reporting odds ratio.

The study was approved by the Research Ethics Board of the Kenya Methodist University and approval sought from respective school administration before collection of data.

Results.

Socio-demographic characteristics

The proportion of female children was significantly higher compared to males (RR=1.08). The proportion of females who tested negative was higher compared to those who tested positive (RR=1.87), while among males the proportion who tested negative was also higher compared to positive (RR=1.16). The proportion of males who tested positive was higher compared to the proportion of females who tested positive (RR=1.33). Gender was not independent from the test results as indicated by the direction of the rate ratios (*p=0.01*).

Primary schools were not independent of the test results as indicated in the direction of the rate ratios (p=0.036). Among the five primary schools, some children in Kamatungu and Kiorimba were in boarding facilities. The proportion of students from Kamatungu was 3.08 times that of students from Chiakariga. About 194/481-40.33% of the children tested positive with a parasitic infection while 287/481- 59.67% tested negative for any parasitic infection. The proportion of children who tested positive was higher compared to those who tested negative at Rancha Primary School (Rate Ratio=1.1). The proportion of negative tests in Chiakariga Primary School was higher compared to proportion of positives (RR=1.18), and proportion of children who tested negative for any parasitic infection at Kamatungu and Tunyai primary schools were about twice that of positive tests i.e., (RR=1.96 and 2.00 respectively).

The proportion of participants from class 4 was slightly higher compared to proportion of participants in class 5 and 6 (RR= 1.13, 1.22 respectively). Class was not independent from the test results (p=0.01). The proportion of participants in class 4 who tested negative was nearly twice the proportion who tested positive (RR=1.97), the proportion of participants who tested negative in class 5 was nearly equal that of positives (RR=1.01) while in class 6 the proportion of those who tested negative was more than one and half times compared to positives (RR=1.61)

There was no statistically significant association between age groups and testing positive or negative for any parasitic infection. The proportion of 11 to 14-year-olds was nearly ten times compared to over 14 years (RR=9.49).

Prevalence
The prevalence of any parasitic infection was 264/481-548.86/1000 persons. (Table 1)

Table 1: Prevalence of Protozoa and Soil Transmitted Helminths

Prevalence of Protozoa and Soil Transmitted Helminths		
Protozoa	***N***	**prev./1000**
EH	113	234.93
EC	55	114.35
GL	28	58.21
IB	28	58.21
Total-Protozoa	**224**	465.70
Helminths		
SM	16	33.26
AL	7	14.55
EV	6	12.47
HN	6	12.47
HD	4	8.32
HW	1	2.08
Total-Helminths	**40**	83.16
Total	***264***	***548.86***

Prevalence of protozoa

The overall prevalence of protozoa was (224/481)-466/1000 persons. The most prevalent protozoan was *Entamoeba histolytica* at (113/481)-235/1000 persons while *Iodomoeba bustichilii* was 28/481-58/1000persons. The prevalence of *Entamoeba hystolytica* was (235/58) about 4 times that of *Iodomoeba bustchilii.*

Prevalence by School
Protozoa: *Entamoeba histolytica* was the most prevalent protozoa in all five schools, followed by *E. coli*. The prevalence of *Entamoeba coli* in Kiorimba was 3.20 times compared to Chiakariga. The prevalence of *E.histolitica* in Rancha was 3.30 times compared to Tunyai. The prevalence of *Giardia lamblia* was highest in Kamatungu at 24.95/1000 persons while there was none in Chiakariga. The prevalence of *Iodomoeba bustchilii* in Kamatungu was 15.99 compared to either Kiorimba, Rancha or Chiakariga. There was no *Plasmodium falciparum* detected in any of the five schools.

Prevalence of Protozoa by Gender
There was statistically significant association between *Giardia lamblia* and male gender, (OR=2.881; 95% CI: 1.243 to 6.677, *p=0.014*). There was no statistically significant association between *Entamoeba*

coli, *Entamoeba hystolytica*, *Giardia lamblia* and *Iodomoeba bustchilii* and gender as follows *Entamoeba coli*, (OR; 1.151; 95% CI: 0.656 to 2.018, *p=0.625)*, *Entamoeba histolytica*, (O.R; 1.141; 95% CI 0.749 to 1.740, *p=0.539*), *Iodomoeba bustchilii*, (OR;1.093; 95% CI 0.509 to 2.344)

Prevalence of Protozoa by Age

There was a positive association between infection with (GL—G. lamblia) and being in the age group of 7 - 10 years, (OR: 2.268; 95%CI 1.036 to 4.966; *p=0.041*) There was a negative association between infection with *Entamoeba coli* and being in the age group of 7-10 years, (OR; 0.432; 95%CI 0.196 to 0.949, *p=0.037*). However, there was no association between prevalence of *Entamoeba coli* and being in the age group of over 14 years, (OR; 1.831; 95% CI 0.746 to 4.495, *p=0.187*). There was no statistically significant association between *Giardia lamblia* infection and age group of over 14 years old age group, (OR 0.665; 95% CI (0.085-5.226), p=0.698).

There was no statistical association between age and infection with *Entamoeba histolytica* and *Iodomoeba bustchilii*. *Entamoeba histolytica* and being in the 7-10 years age group (OR 0.617); 95%CI 0.371 to 1.025, *p=0.062*), over 14 years age group (OR 0.913; 95%CI (0.396-2.104, *p=0.83*). There was also no statistically significant association between being infected with *Iodomoeba bustchilii* and being in the age group of 7-10 years, (OR; 0.971; 95% CI (0.414-2.277), *p=0.947*), over 14 years, (OR 0.482; 95% CI 0.062 to 3.720 *p=0.484*).

Prevalence of Soil Transmitted Helminths

The total prevalence of soil transmitted helminths was (40/481)-83.16/1000 persons. The most prevalent Soil Transmitted Helminth was *Schistotosoma mansoni (16/481)-33.26/1000 persons* while the least prevalent STH was hookworm (1/481)-2.08/1000 persons. The prevalence of *Schistosoma mansoni* was 15.99 times that of hook worm.

Prevalence of Helminths by School

Table 2 shows the distribution of soil transmitted helminths, the most interesting finding was *Schistosoma mansoni*, which was only found in two schools, Kamatungu, 2 cases and Rancha, 14 cases. Rancha had the highest prevalence of STHs 21/481(4.37%), Kamatungu had 6/481 (1.25%), Kiorimba had 7/481 (1.46%), Tunyai had 6/481 (1.25%).

Table 2 : Prevalence of Helminths by schools.

Prevalence of Helminths by schools, n=481												
School	SM		AL		EV		HN		HD		HW	
	N	**Prev./1000**	N	**Prev./1000**	N	**Prev./1000**	N	**Prev./1000**	N	**Prev./1000**	N	**Prev./1000**
Kamatungu	2	4.16			1	2.079	2	4.158			1	2.079
Kiorimba			1	2.08	4	8.316	2	4.158				
Rancha	14	29.11		0.00	1	2.079	2	4.158	4	8.316		
Tunyai			6	12.47								

Prevalence of STHs by age

In a bivariate analysis of prevalence of STHs by age groups, the study found no statistically significant association between prevalence of Soil Transmitted Helminths and age group. Odds of infection with *Schistosoma mansoni* by age groups; 7-10years, (OR; 1.056; 95% CI 0.360 to 3.1, *p=0.921*), over 14 years, (OR; 1). Odds of infection with *Hymenolepis nana* by age; 7-10years, (OR; 0.576; 95% CI 0.064 to 5.206, *p=0.624*), over 14 years, (OR; 1). Odds of infection with *Hymenolepis diminuta*; by age; (7-10years, OR; 2.34; 95% CI 0.326 to 16.78, p=0.398), over 14years, (OR; 1). Odds of infection with *Ascaris lumbricoides* by age, 7-10 years, (OR; 0.382; 95%CI 0.046 to 3.203, *p=0.375*), over 14 years, (OR; 1).

Table 3: Bivariate Analysis of Prevalence of Soil Transmitted Helminths by Age group.

Bivariate Analysis Odds of Prevalence of Soil Transmitted Helminths by Age group

STH	**Age Group**	**Odds Ratio**	***p-value***	**[95% Interval]**	**Conf.**
SM					
	7 -11 years	1			
	7 - 10 years	1.055944	*0.921*	0.360	3.100
	over 14 years	1			
HN					
	7 -11 years	1			
	7 -10 years	0.5764926	*0.624*	0.064	5.206
	over 14 years	2.414064	*0.437*	0.262	22.257
HD					
	7 -11 years	1			
	7-10 years	2.338346	*0.398*	0.326	16.775
	over 14 years	1			
AL					
	7 -11 years	1			
	7 -10 years	0.3818408	*0.375*	0.046	3.203
	over 14 years	1			

Prevalence of STHs by Gender

Bivariate analysis of prevalence of STHs by Gender showed no statistically significant association between Gender and Prevalence of STHs as follows; Odds of infection with *Enterobius vermicularis* among males compared to females; (OR; 1.083; 95% CI 0.216 to 5.422, *p=0.922*). Odds of infection with *Hymenolepis nana* among males compared to females, (O.R; 5.509, 95% CI 0.639 to 47.509, p=0.121). Odds of infection with *Hymenolepis diminuta* among males compared to females, (OR; 1.083; 95% CI 0.151 to 7.751, *p=0.937*). Odds of infection with *Ascaris lumbricoides* among males compared to females, (OR; 0.428, 95% CI 0.082 to 2.228, *p=0.313*).

Risk of Infection with Intestinal Parasites
Risk factors; Male Gender (OR; 1.539; 95% CI 1.045 to 2.266, p=0.029). Being in class 5 put the students at a risk of infection compared to being in class 4. (OR; 1.769 95% CI 1.107 to 2.827, p=0.017). School and age were not statistically significantly associated with being infected with either protozoa or soil transmitted helminths. See Table 4

Table 4 :Risk of Infection with STHs or Protozoa among Participants.

Risk of Infection with STHs or Protozoa among Participants, n=481				
Variables	Odds Ratio	p-value	[95% Conf. Interval]	
Gender				
Female	1			
Male	**1.539**	**0.029**	**1.045**	**2.266**
School				
Chiakariga	1			
Kamatungu	0.638	0.194	0.324	1.257
Kiorimba	0.922	0.817	0.461	1.841
Rancha	1.351	0.421	0.650	2.810
Tunyai	0.615	0.205	0.291	1.304
Class				
4	1.000			
5	**1.769**	**0.017**	**1.107**	**2.827**
6	1.068	0.814	0.617	1.847
Age groups				
11 to14 years	1.000			
7 to 10 years	0.685	0.124	0.423	1.109
over 14 years	0.884	0.763	0.395	1.978
Constant	0.594	0.171	0.282	1.251

Polyparasitism
Polyparasitism: Protective factors; Belonging to Kamatungu primary was statistically significantly associated with protection from polyparasitism OR= 0.343, CI=0.131-0.895, p=0.029, belonging to Tunyai primary school was also significantly associated with polyparasitism OR=0.111, CI=0.023-0.544, p=0.007. Gender, age group and class were not statistically significantly associated with polyparasitism.

Discussion

The study examined the prevalence of protozoa and soil transmitted helminths (STHs) among children in five primary schools in Tharaka Nithi County. Prevalence of protozoan infections was higher compared to helminth infections (Erismann et al., 2016). *Entamoeba histolitica* and *Schistosoma mansoni* were the most prevalent protozoa and soil transmitted helminth respectively while the least prevalent protozoan infection and soil transmitted helminths were *Iodomoeba bustchilii* and Hook worm respectively. There was a strong association between schools and the test results and one school, Rancha, had a higher prevalence of parasitic infections than other schools.

Assessment of water sanitation and hygiene conditions in the school and households may help in solving the puzzle (Freeman et al., 2015). And among children in class five the proportion of positive to negative tests was nearly equal. However, age group did not determine whether the children could test positive or negative.

Entamoeba histolytica was the most prevalent protozoa (Speich et al., 2013), in addition, when prevalence was now stratified by schools we discovered that this was highest in one of the schools, Rancha. This prevalence is like those found in a study done in Thika. Their findings were however stratified by locality (Votano et al., 2012).
There was a statistically significant positive and harmful association between being of the male gender and infection with *Giardia lamblia*.

There was a nearly threefold likelihood of being male and infection with *Giardia lamblia*. These findings are similar to those of Zylberberg et al. who did the largest study to date to assess predictors of giardiasis. Hormonal differences between the sexes may be a cause of this increased prevalence as more severe infection profiles have been found in male animal models of *E.hystolytica*, malaria and leshmaniasis (Zylberberg, Green, Turner, Genta, & Lebwohl, 2017).

There was a statistically significant association between being infected with *Giardia lamblia* and being in the age group of 7 - 10 years. There was more than two-fold likelihood of being infected with *Giardia lamblia* and being in the age group of 7 - 10 years. The findings are similar to other studies in that there was some association between at least one but a different age group (Furness, Beach, & Roberts, 2000; Lebwohl, Deckelbaum, & Green, 2003; Painter, Gargano, Collier, & Yoder, 2015; Yoder, Harral, & Beach, 2010). However, it was also found that being 7-10 years old protected participants from being infected with *Entamoeba coli* (Ochoa et al., 2009).

Malaria

Investigations did not detect any malaria case among the children in the schools. The study was done towards the end of the dry season in 2014.This may partly explain the results. Absence of malaria causing parasites may imply that Tharaka is unstable (epidemic) malaria zone, with epidemics occurring during and immediately after the rains. Assessment of the presence or absence of breeding sites for anopheles mosquitoes regardless of season could also explain this phenomenon. Absence of malaria could also mean that malaria control initiatives, principally the use of insecticide-treated bed nets by the Ministry of Health, successfully controlled malaria in this area (Garrett-Jones, 1964; John et al., 2009).

Helminthology

The prevalence of any soil transmitted helminth was slightly higher than the average reported in a study conducted in Mbita - Nyanza province that reported 6.1%, 3.0%, 6.1% and 6.8% by Mini-Parasep, Kato-Katz, modified Mini-FLOTAC FS2 and modified Mini-FLOTAC FS7 techniques respectively(Ng'etich et al., 2016). However in a different study in Western Kenya, the prevalence of any STHs was eight-fold our prevalence (Riesel, Ochieng', Wright, Vermund, & Davidson, 2010) while in a different study the prevalence was twice the figure we found (Andereck, Kipp, Ondiek, & Vermund, 2014). Prevalence of STHs differ because our prevalence figures are either higher or lower than that of other researchers and detection techniques.

The most prevalent STHs was *Schistosoma mansoni,* this prevalence that was about half that was found in a study done in Central Kenya which depicted an overall rate of 6.9% (95% CI 5.0–9.5) (Masaku et al., 2017). *Schistosoma mansoni* is often likely to be underestimated as the eggs are commonly missed in the direct smear technique due to their size (Riesel et al., 2010). The focality due to Schistosomiasis in this region may be because many diseases with intermediate hosts are very sensitive to the local ecological conditions including seasonal vector build-up.A thorough surveillance in the transmission dynamics and pathogenicity of this parasite is important in understanding prevalence of *Schistosoma mansoni* at Rancha. Prevalence of *Schistosoma mansoni* may be exacerbated by the possibility of double infection with *Visceral leishmaniasis* – (if indeed it -*Schistosoma mansonii*- occurs here as indicated in the results).

There was no statistically significant association between gender and infection with the following soil transmitted infections; *Enterobius vermicularis, Hymenolepis nana, Hymenolepis diminuta, Ascaris lumbricoides* (Masaku et al., 2017). This is contradictory to other findings among elementary students in Ethiopia (Samuel et al., 2017) that found an association and higher prevalence among females.

Risk of infection

There proportion of males who tested positive for any parasitic infection was about one and half fold compared to females. There was more than one and half fold risk of infection with either protozoa or STH among males compared to the females. According to a study by Freeman et.al., found that girls may be less likely to urinate or defecate in the open than boys, thus may disproportionately benefit when latrines are new or clean, or when hand washing water and soap are available (Freeman et al., 2015; Freeman et al., 2013; Fuhrimann et al., 2016). This could also be attributed to the level of physical activity among the male school going children compared to the females. The males are more active and tend to engage in behaviors that put them at risk of infection such as playing in the mad, geophagy or biting dirty objects. There was also a two-fold risk of infection among school age children in class five as compared to school going children in class four.

Polyparasitism

Belonging to two schools of Kamatungu and Tunyai was protective from polyparasitism. This may be attributed to effectiveness of improved sanitation facilities, water supply and health hygiene educational intervention augmenting the deworming programs (Freeman et al., 2015; Freeman et al., 2013; Gyorkos et al., 2013).However, there was no statistically significant association between polyparasitism and gender, age group and class. This findings are similar to those of a study that looked at epidemiology of polyparasitism among school children in Malaysia (Al-Delaimy et al., 2014; Chin et al., 2016).

Limitations

Had we used the more sensitive Kato/Katz thick smear quantitative method, the prevalence would not only have been higher but we would also have established the intensity of infection by counting the number of eggs produced by each participant (egg load accounts for morbidity in Schistosomiasis). The study did not take care of data on the environmental and sanitation conditions that would have helped put certain prevalence into context.

Conclusions

Protozoan infections were more common than soil transmitted helminths. Improved water sanitation and hygiene are essential in eradication of intestinal parasitic infection. Mass drug administration and health promotion interventions should also target protozoal infections of medical importance.

Recommendations

Based on the study finding, it is recommended that:

i. Seasonal surveillance of *Anopheles* mosquito species and a five-year retrospective document analysis on hospital records be done in order further explain the puzzling results on malaria,
ii. A further study should be done in Rancha to confirm prevalence by collecting three consecutive stool samples from the study group (i.e. days 1, 2, 3), then examine double slides per child quantitatively, using the Kato/Katz thick smear method. It should include physical examination to elucidate for hepatosplenomegaly. This would provide information on morbidity. Organomegaly would also be useful in determining the prevalence of *visceral leishmaniasis*.
iii. A study to establish the transmission sites of snail intermediate hosts should be executed. It would also include examining the spatial and temporal variability/diversity of the snail hosts over time. The dynamics of transmission and pathogenicity of Schistosomiasis should also be investigated

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