

# Malaria and intestinal parasite infections and co-infections in Tach Gayint District, South Gondar Zone, Amhara Regional State 2010

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**Abstract:** To assess the level of intestinal parasite and malaria infection, a total of 806 consenting individuals were randomly selected from Tach Gayint District. The prevalence of malaria, intestinal protozoa and helminth infections and co-infections in the area were determined. The study was conducted in two seasons, November/December, 2008 (after the big rains) and April/May, 2009 (after the small rains). Blood film determination, direct wet mount and concentration techniques were respectively used for diagnosis of malaria and intestinal parasites. The overall prevalence of intestinal parasites was the same in the two seasons, 67.28% (November/December) and 67.20% (April/May), indicating lack of variation in intestinal parasite burden during the two dry periods of the year. However, the prevalence of hookworm, *S. mansoni* and *A. lumbricoides* were significantly higher in the age groups below 14 years ( $P < 0.05$ ). The prevalence of *T. trichiura* in school children was much higher (21.08%) than in the adult population (3.33%) ( $P < 0.001$ ) and the cumulative prevalence of *H. nana* in school children (7.98%) was also significantly ( $P = 0.003$ ) higher than in the adult population (3.30%). These findings indicated that the hygienic condition of the children is much worse than that of the adults and requires extra attention for improvement. On the other hand, the prevalence of malaria showed the typical seasonal pattern, with high peak transmission (11.17%) in November/December and low transmission (5.46%) in April/May. Malaria prevalence in the two seasons was at levels that are of public health concern ( $> 5\%$ ). This indicates that malaria control program in the study area was inadequate or was not being properly implemented. Furthermore, the double, triple and quadruple co-infections involving malaria and intestinal parasites were indications of high burden of parasite infection in the study area. On the whole, the findings of the present study have provided an empirical evidence for the need to implement effective malaria and intestinal parasite control measures in Tach Gayint District.

**Keywords:** Malaria, Parasite, Co-Infections, Tach Gayint

## 1. Introduction

Intestinal helminth and protozoan infections are among the most common infections worldwide. Every year, nearly one million deaths result from malaria infection [1]. The prevalence of intestinal parasites in children varies in different regions of the world. It is particularly high in poor and developing countries due to use of contaminated drinking water, inadequate sanitary conditions, and poor personal hygiene [2]. Ethiopia has one of the lowest quality drinking water supply and latrine coverage in the world. As a report from 2000 study shows Ethiopia had only 12% latrine

coverage while Kenya had 87% [3].

The World Health Organization (WHO) reported that *Ascaris lumbricoides* and invasive amoebiasis are the most common public health problems in Africa [4]. Several studies indicated that the prevalence of parasitic infections were high in the lower altitudes including southwestern Ethiopia [5, 6, 7]. Many reports illustrated that *A. lumbricoides* is the most prevalent intestinal parasite in different communities usually occurring together with Trichuris infections. The prevalence of taeniasis alone ranges from 1- 48%. Schistosomiasis is common in northern region as compared to south and south west regions of Ethiopia. Amoebiasis and giardiasis are common causes of intestinal protozoal infections throughout

the nation [5].

The prevalence of amoebiasis ranges from 0-4% and that of giardiasis is 3-23% [6]. Over one billion of the world's population is chronically infested with soil-transmitted helminthes and 200 million are infested with schistosomiasis. Schistosomiasis is more common in the northern regions as compared to the south and south west regions of Ethiopia [7]. In spite of the number of measures taken to control parasites, parasitic infections are still prevalent and cosmopolitan especially in the tropical regions. Among tropical diseases, malaria has been identified as one of the most important public health problems and is the most important human parasitic disease, affecting over 200 million people and causing more than one million deaths each year [8].

South Gondar, like many malarious regions of Ethiopia, is prone to unstable and epidemic malaria. In the region, malaria is seasonal and follows the rain with the highest incidence in November and December [9]. Accurate information is needed not only to improve our knowledge of malaria epidemics, but also to assess progress of malaria control initiatives that aim to decrease deaths from malaria worldwide by 50% by 2010 [10].

Associated with chronic diarrhea and malnutrition, the intestinal parasites often compromise the physical and intellectual development, especially among the youngest age groups in a population [11]. Severe parasites can lead to blood loss, tissue damage, spontaneous abortion, and death. The distribution of protozoan and helminth infection depends on conditions such as suitable climate and human activities such as population movement and poor sanitation [12]. Therefore the aim of the study was to assess the prevalence of malaria, intestinal protozoa and helminths and co-infections with them in Tach Gayint District, Amhara Region with the view of identifying plausible strategy for reducing the prevalence of malaria and parasitic infections and the associated morbidity and mortality. Hopefully, the study provides baseline data to assist policy makers in developing appropriate evidence-based strategies.

## 2. Methods and Materials

### 2.1. Study Area, Design and Period

Tach Gayint is one of the 105 districts in Amhara National Regional State of Ethiopia. The major town of the District is Arb Gebeya. It is located at 780km to the North of Addis Ababa and at 130 45' N latitude, and 350 46' to 400 25' E longitude and the altitude of the district range from 1800 masl-3000masl. The district contains the three climatic zones: Dega, Woina-dega and Kolla zones. According to the district's natural hazardous management and control office report the majority of the district's population is engaged in mixed agricultural activities that make them vulnerable for different infection diseases. A community based cross sectional study was employed from November 2008 to May 2009.

### 2.2. Study Population and Sample Size

The study population was from selected kebeles of the

district. Based on figures published by the Central Statistical Agency in 2007, this district has an estimated total population of 114,326, of whom 57,132 were males and 57,194 were females; 4,610 (4.03%) of its population are urban dwellers, which is less than the Zone average (8.3%). Tach Gayint has an estimated population density of 137 persons per square kilometer, which is less than the Zonal average of 169.21 persons per Km<sup>2</sup>. Totally 806 consent study participants were examined for malaria, intestinal protozoa and Helminth parasite infections in two seasons. The sample size to this study was estimated by taking the prevalence 50% as there was no study reported in the area. Then the sample size was determined following the formula  $n = \frac{Z_{\alpha/2}^2 P (1-P)}{d^2}$ . Where,  $Z = 1.96$ ,  $P =$  prevalence of the diseases (50%) and  $d =$  precision (0.05) [13]. From the total of 16 kebeles in the district, the study includes a randomly selected people in eight kebeles; all ages and sex of the people were included in the study area. The mean age of the total study population was 20.88 ± 14.3 (ranging from 1 to 72).

### 2.3. Laboratory Methods

The choice of diagnostic techniques depends on available equipment and reagents, experience, and considerations of time and cost. The techniques used in this study are: Direct Wet Mount Microscopic Examinations and Formalin-Ether concentration techniques. Throughout the study the techniques used to diagnose malaria, intestinal protozoa and helminthes were the same.

#### 2.3.1. Diagnosis for Malaria Parasites

##### *Blood Film determination for malaria parasites*

Laboratory technicians collected the samples and malarial infections were determined from thick and thin films of finger-prick blood fixed and stained with Giemsa stain. Thick and thin blood smear were prepared for each subject from capillary blood by finger prick using sterile lancet. The thick smear was stained with Giemsa solution and the thin smear was fixed with methanol before stained with Giemsa solution. Each blood smear was observed under the oil immersion objective of the microscope. The thick smear was used to determine whether the malaria parasite was present or not after observing 100 fields of vision. The thin smear was used to identify the type of Plasmodium species.

#### 2.3.2. Diagnosis for Intestinal Parasites

##### *Direct Wet Mount Microscopic Examinations for Detection of Intestinal parasites*

A drop of saline was placed on slides and a small amount of faeces were placed on the microscope slide using tooth pick, or applicator stick, and mixed in drop and covered by cover slip. Finally the samples were examined microscopically at high power magnification.

##### *Formalin-Ether Concentration technique for stool Examination*

This concentration procedure is efficient in recovering protozoan cyst, helminth egg and larva including operculated and schistosome eggs. The formalinized specimen was

thoroughly stirred and a sufficient quantity was strained through gauze in to a 15ml. pointed centrifuge tube to get the desired amount of sediment. Then saline was mixed and thoroughly mixed and centrifuged at 2000-2500 rpm for 1 minute. The supernatant was decanted and washed again with tape water if desired. 10ml. of 10 percent formalin was added to the sediment and mixed thoroughly. Then 3ml. of ether was added and shaken vigorously in an inverted position for a full 30 seconds, and then the stopper was removed carefully. The resulting solution was centrifuged at 1500 rpm for about 1 minute, and four layers were produced. The three top layers were decanted carefully, and adhering debris were removed from the top with a cotton swab. The remaining sediment was mixed with the small amount of fluid that drains back from the slides of the tube or a small drop of formalin or saline was added. Finally iodine and unstained mounts were prepared for microscopic examination [14]

### 2.3.3. Data Analysis

Statistical analysis was carried out using SPSS Version 15 Software. A significance level of 0.05 was used for all tests.

### 2.4. Ethical Considerations

Diagnosis was done using sterile and disposable materials. Only a laboratory technician took the blood sample and all activities in clinical examination as well as diagnosis were supervised by health personnel. Individuals diagnosed positive for malaria intestinal protozoa and/or intestinal helminth infections were treated free of charge. Those individuals who were positive for malaria (chloroquine and coartem) were provided. (Metronidazole; 750 gm t.i.d for 5-7 days Tinidazole; 2 gm p.o. for 3 consecutive days) were provided for those diagnosed positive for intestinal protozoa. Those positive for helminth infections were provided with anti-helminthic drug (Albendazole; 400mg single dose for Ascaris, Trichuris, and Hookworm. As alternative Mebendazole; 500mg single dose /Niclosamide/Praziquantel 600mg single dose for *Taenia spp.*), were provided as per Ethiopian Ministry of Health guideline. Only volunteer individuals were included in the study. Ethical clearance was obtained from the ethical clearance committee of Department of Biology, Addis Ababa University.

## 3. Results

In November/December, 2008 the percentage of males and

females infected by at least one parasite was 152 (70.05%) and 123 (66.13%), respectively. In the study conducted on April/May, 2009 the percentage of males and females infected at least by one parasite was 146 (67.28%) and 125 (67.20%), respectively.

The overall prevalence of the parasites in November/December, 2008 and in April/May, 2009 was 275 (68.24%) and 271 (67.25%), respectively. Except malaria, the other parasitic diseases did not show significant difference in between the two study seasons. The prevalence variations in most parasitic diseases were detected in different age groups of the study population; among these *T. trichiura*, *H. nana*, *Plasmodium spp.* hookworm and *A. lumbricoides* were the parasites that showed significant differences in age groups in the study population. Some of these parasites were highly prevalent in children than young and adult population. Generally from all the detected parasitic diseases (in November/December, 2008 and April/May, 2009) only *Plasmodium spp.* had showed significant difference in the study seasons.

### 3.1. Malaria

In November/December, 2008, from a total of 403 study participants, 45 (11.17%) were found to harbor one species of *Plasmodium* parasites in their blood, in the second season (April/May, 2009), the prevalence of malaria had decreased to 22 (5.46%). In both study seasons, *P. falciparum* 41 (61.19%) and *P. vivax* 26 (38.80%) were the only malaria parasites detected in the study area. The difference in the prevalence of malaria after the big rains (11.17%) and after the small rains (5.46%) was statistically significance ( $P = 0.003$ ). In the study conducted from April/May, 2009 the prevalence of malaria had been decreased to 5.46%.

### 3.2. Intestinal Protozoa

Intestinal protozoa are more prevalent in the district; among these giardiasis and amoebiasis are the two major intestinal protozoa that are more prevalent in the study area. The prevalence of *G. lamblia* in the study conducted on November/December, 2008 had showed statistically significant difference in different age groups of the study population. The difference were observed between the age groups 15-19 and  $> 19$  ( $P = 0.04$ ).

### 3.3. Intestinal Helminth

**Table 1.** The prevalence of malaria, intestinal protozoa and helminthes in selected kebeles of Tach Gayint District, South Gondar Zone, Amhara National Regional State, in November/December, 2008 and April/May, 2009.

Kebeles		A/Gebeya	Agat	Aduka	Anseta	Bettelheim	Eskenderawi T	Gedoda	Quit-Mender
No. Examined		50	51	51	50	51	50	50	50
<i>P. falciparu</i>	Nov/Dec	0(0.0%)	2(3.9%)	7(13.7%)	4(8.0%)	8(15.7%)	2(4.0%)	4(8.0%)	0(0.0%)
	April/May	0(0.0%)	2(3.9%)	4(7.8%)	2(4.0%)	3(5.9%)	1(2.0%)	2(4.0%)	0(0.0%)
<i>P. vivax.</i>	Nov/Dec	0(0.0%)	1(1.96%)	6(11.8%)	2(4.0%)	6(11.8%)	1(2.0%)	2(4.0%)	0(0.0%)
	April/May	0(0.0%)	1(1.96%)	2(3.9%)	1(2.0%)	2(3.9%)	1(2.0%)	1(2.0%)	0(0.0%)
<i>G. lamblia</i>	Nov/Dec	3(6.0%)	4(7.8%)	11(21.6%)	4(8.0%)	16(31.7%)	8(16.0%)	9(18.0%)	3(6.0%)
	April/May	4(8.0%)	3(5.9%)	10(19.6%)	8(16.0%)	14(27.5%)	4(8.0%)	11(22.0%)	2(4.0%)
<i>E.histolytica/</i>	Nov/Dec	11(22.0%)	9(17.7%)	12(23.5%)	9(18.0%)	11(21.6%)	8(16.0%)	7(14.0%)	9(18.0%)

Kebeles		A/Gebeya	Agat	Aduka	Anseta	Bettelheim	Eskenderawi T	Gedoda	Quit-Mender
No. Examined		50	51	51	50	51	50	50	50
<i>dispar</i>	April/May	12(24.0%)	9(17.6%)	11(21.6%)	7(14.0%)	11(21.6%)	9(18.0%)	7(14.0%)	8(16.0%)
<i>S. mansoni</i>	Nov/Dec	2(4.0%)	3(5.9%)	8(15.7%)	3(6.0%)	9(17.6%)	2(4.0%)	3(6.0%)	0(0.0%)
	April/May	1(2.0%)	3(5.9%)	8(15.7%)	2(4.0%)	7(13.7%)	3(6.0%)	4(8.0%)	0(0.0%)
<i>Taenia spp</i>	Nov/Dec	13(26.0%)	6(11.8%)	3(5.9%)	8(16.0%)	2(3.9%)	5(10.0%)	9(18.0%)	3(6.0%)
	April/May	14(28.0%)	4(7.8%)	5(9.8%)	4(8.0%)	3(5.9%)	6(12.0%)	9(18.0%)	4(8.0%)
<i>H/worm</i>	Nov/Dec	1(2.0%)	3(5.9%)	14(27.5%)	11(22.0%)	16(31.7%)	8(16.0%)	10(20.0%)	1(2.0%)
	April/May	1(2.0%)	2(3.9%)	17(33.3%)	10(20.0%)	19(37.3%)	16(32.0%)	14(28.0%)	0(0.0%)
<i>T. trichiura</i>	Nov/Dec	3(6.0%)	6(11.8%)	8(15.7%)	13(26.0%)	2(3.9%)	5(10.0%)	9(18.0%)	0(0.0%)
	April/May	1(2.0%)	6(11.8%)	7(13.7%)	13(26.0%)	2(3.9%)	5(10.0%)	8(16.0%)	1(2.0%)
<i>A. lumbricoides</i>	Nov/Dec	7(14.0%)	12(23.5%)	14(27.5%)	11(22.0%)	10(19.6%)	17(34.0%)	19(38.0%)	4(8.0%)
	April/May	8(16.0%)	13(25.5%)	16(31.7%)	13(26.0%)	11(21.6%)	15(30.0%)	18(36.0%)	5(10.0%)
<i>H. nana</i>	Nov/Dec	1(2.0%)	3(5.9%)	4(7.8%)	4(8.0%)	2(3.9%)	4(8.0%)	4(8.0%)	0(0.0%)
	April/May	1(2.0%)	4(7.8%)	4(7.8%)	3(6.0%)	4(7.8%)	2(4.0%)	3(6.0%)	0(0.0%)

**Table 2.** The age related prevalence of malaria and some intestinal helminths in Tach Gayint District, South Gondar Zone, Amhara National Regional State, in November/December, 2008 and April/May, 2009.

Seasons	November/December, 2008				April/May, 2009			
Age category	1-5	6-14	>15	P. value*	1-5	6-14	>15	P. value*
No Examined	31	144	228		37	138	288	
<i>Plasmodium spp</i>	2 (6.5%)	6 (4.2%)	37 (16.2%)	P < 0.001	0 (0%)	2 (1.5%)	20 (8.7%)	P < 0.001
<i>S. mansoni</i>	2 (6.5%)	16 (11.1%)	12 (5.5%)	P < 0.041	1 (2.7%)	15 (10.87%)	11 (4.82%)	P < 0.05
<i>Hookworm</i>	2 (6.5%)	38 (26.4%)	24 (10.4%)	P < 0.001	5 (13.51%)	46 (33.33%)	28 (12.3%)	P < 0.001
<i>T. trichiura</i>	8 (25.8%)	24 (16.7%)	14 (6.1%)	P < 0.001	20 (54.05%)	22 (15.94%)	1 (0.44%)	P < 0.001
<i>A. lumbricoides</i>	12 (38.7%)	52 (36.1%)	30 (13.2%)	P < 0.001	22 (59.46%)	41 (29.71%)	36 (15.8%)	P < 0.001
<i>H. nana</i>	5 (16.1%)	10 (6.9%)	7 (3.1%)	P < 0.032	6 (16.22%)	9 (6.52%)	6 (2.63%)	P < 0.001

\*= Any P-value less than or equal to 0.05 is statistically significant

**Table 3.** Prevalence of malaria co-infection with different intestinal protozoa and helminths and types of co-infection in Tach Gayint District, South Gondar Zone, Amhara National Regional State, in November /December, 2008 and April/May, 2009.

Prevalence of parasites			
Co-infections	Prevalence in November/December, 2008 (n=403)	Prevalence April/May, 2009 (n=403)	P. value*
<i>Malaria/ A. lumbricoides</i>	6(1.49%)	5(1.24%)	P = 0.76
<i>Malaria/ Hookworm</i>	6(1.49%)	6(1.49%)	P = 1.00
<i>Malaria/ S. mansoni</i>	4 (0.99%)	1(0.25%)	P = 0.18
<i>Malaria/ T. trichiura</i>	4 (0.99%)	1(0.25%)	P = 0.18
<i>Malaria/ Giardia lamblia</i>	10(2.48%)	2(0.50%)	P = 0.02
<i>Malaria/E. histolytica/dispar</i>	11(2.73%)	5(1.24%)	P = 0.13
<i>Malaria/Taenia spp.</i>	8(1.99%)	4(0.99%)	P = 0.25
<i>Malaria/ H. nana</i>	2 (0.50%)	1(0.25%)	P = 0.56
<i>Single</i>	150 (37.22%)	134 (33.25%)	P = 0.24
<i>Infections/Co-infections</i>			
<i>Double</i>	70 (17.37%)	86 (21.34%)	P = 0.18
<i>&gt;Triple</i>	55 (13.65%)	51(12.66%)	P > 0.05

\*= Any P-value less than or equal to 0.05 is statistically significant

Many of study subjects were infected either with hookworm, *Ascaris lumbricoides*, *Taenia spp.* *T. trichiura* or *H. nana*. The most prevalent infection was *A. lumbricoides* followed by hookworm and *Taenia spp.* infections. *T. trichiura* was the least prevalent in the study population. The prevalence of malaria, intestinal protozoa and helminths in November/December, 2008 and April/May, 2009 is depicted in Table 1.

In the study conducted in November/December, 2008 and April/May, 2009, the prevalence of malaria in different age groups had showed statistically significant difference (P < 0.001). The prevalence of malaria showed statistical difference in the age groups between 6-14 and > 19 (P < 0.001). The study has also revealed that *Plasmodium spp.* hookworm *T. trichiura* and *A. lumbricoides* had showed statistically

significance differences in different age groups (P < 0.001). The prevalence difference in *T. trichiura* was mainly observed in between the age groups 1-5 and > 19 (P = 0.02) and in between the age groups 6-14 and > 19 (P < 0.001) as shown in table 2. In *E. histolytica/dispar* the statistical difference appeared in between the age groups 6-14 and 15-19 (P = 0.02), and in between the age groups 6-14 and > 19 (P < 0.001).

The prevalence of *Plasmodium spp.* and *H. nana* was statistically significantly different in different sexes. In the first study season, the prevalence of *Giardia lamblia* (P = 0.96) and *E. histolytica/dispar* (P = 0.80) did not show statistically significant difference in different sexes. The prevalence of malaria in females was highly decreased than males. The prevalence of malaria in males and females was statistically

different ( $P < 0.001$ ). None of the intestinal helminth showed statistically significant difference in different sexes except *H. nana*. The prevalence of *H. nana* among females (8.06%) was significantly higher than males (2.76%) ( $P = 0.021$ ).

### 3.4. Malaria Intestinal Protozoa and Helminths Co-Infections

During the study, there were co-infections of malaria with intestinal helminths and protozoa. Amoebiasis, giardiasis and hookworm are the major parasitic diseases that have co-infections with malaria. *H. nana* was the least parasite that had co-infection with malaria in the two study seasons. The following tables show co-infection of malaria with other intestinal protozoa and helminthes, in the study area. During April/May, 2009 Malaria hookworm, *A. lumbricoides* and *E. histolytica/dispar* were the major parasites that had co-infections with malaria. From the overall co-infections, there were single, double, triple and quadruple infections. The amounts of infections were greater in single and double infections than triple and above infections [table 3].

## 4. Discussion

This study may be considered the first study conducted on the prevalence and association of malaria, intestinal protozoa and helminth infections and co-infections in Tach Gayint District, as no published records exist. As knowledge of the distribution extent of malaria, intestinal protozoa and helminth infections in a given community is a prerequisite for planning and evaluating health intervention programs [12], the information obtained through the present study is of vital relevance.

Tach Gayint has suitable climate and topography conducive for transmission of malaria, intestinal protozoal and helminth infections. Climate and soil type which determine the distribution of intestinal worm infections [15] are also characteristic of Tach Gayint. Although it has been shown that the infection rate of malaria, intestinal protozoa and helminths could vary from place to place due to differences in the socio-economic and educational status of the population [16], such variations would not be expected in the study area as there is no apparent variations in these conditions.

As shown by Investigators elsewhere [17], the areas which have better socio-economic status have lower prevalence of helminth, malaria and intestinal protozoal infections than the areas with low socio-economic status. Thus, the high prevalence of helminth and protozoal intestinal parasites is a reflection of the poor socio-economic condition of Tach Gayint District (personal communication: Tach Gayint Natural Disaster Management and Control Office).

The transmission of malaria in the area is seasonal and unstable and hence acquired immunity will be expected to be low [18]. This is unlike the case of year round stable transmission, where the community usually develops protective immunity.

Studies have shown that peak transmission of malaria occurs following the main rainy season and a minor

transmission peak occurs following light rainy season in the tropics [19, 20]. Therefore the relatively low peak transmission in April/May, 2009, following the light rains, was to be expected in the study area. However, it was interesting to find that the prevalence of malaria in males was significantly higher than in females ( $P = 0.001$ ) in April/May, 2009. This finding might be explained by the fact that, in Tach Gayint District males spend the early part of the night working in their farms where they might be easily infected by exophagous mosquito bites, whereas most females do not have such risk as they normally are engaged in indoor household chores. At the time where there is no much rain, the water near the residences dries up and only the adult individuals that may move far from their residences might be exposed to outdoor infection due to the presence of irrigation and other water bodies. Thus, this might explain why those under 14 years old had lower cases of malaria, particularly, in the seasons after the light rains.

In Tach Gayint most of the people use unsanitary drinking water and live under inadequate hygienic conditions, and experience poor personal hygiene that favors high prevalence of intestinal protozoal and helminth infections. The study finding of no difference in the prevalence of *G. lamblia* and *E. histolytica/dispar* in the different seasons suggests the year round transmission of the pathogens to be contaminated drinking water. The prevalence of *G. lamblia* and *E. histolytica/dispar* in the two study seasons was greater than 18% which is consistent with what was reported by [2, 21], in many tropical countries the prevalence of these may approach 50%.

The high prevalence of *G. lamblia* in preschool children was similar to the findings of [11], who reported *Giardia trophozoites* and *H. nana* to be significantly higher in preschool children. On the other hand, since adults are known to eat more raw and undercooked vegetables than children, in the study area, more cases of *E. histolytica/dispar* in adults than in children might be due to this feeding habit of adults.

Although the District Health Office had reported the existence of deworming programme, hookworm infection ranked second among the widespread intestinal helminth parasites and affected a significant proportion of the population especially in some kebeles of the District. As the age group 6 to 14 years old are known to actively make soil contact at the play around and it is to be expected that the prevalence of hookworm was significantly higher in this age group ( $P < 0.001$ ), whereas the age group under 5 are too young to play around and make soil contact activities, therefore exposure to the infective filariform larvae would be relatively low [22, 23]. A study showed [12], wearing shoes regularly has a significant contribution to the low prevalence rate of hookworm infections. Therefore, since most adults in the study area regularly wore shoes, it was to be expected that the prevalence of hookworm would be relatively low in the age group above 19 years.

Among Soil Transmitted Helminthes (STH) *S. stercoralis* and *E. vermicularies* were not common in the study area, whereas *T. trichiura*, *A. lumbricoides* and *H. nana* were the other parasites that showed statistically higher prevalence

among the age groups below 14 years. This is related to the activities of the children that more frequently play with soil and other contaminated materials exposing them to the ingestion of ova as food contaminants. Furthermore, even though infection of *H. nana* can occur in persons of any age because of exposure to infected human feces, school-age children have more risk of hymenolepiasis. According to Robert and Tolan [24], infection of *H. nana* is most common in children aged 4-10 years, in dry, warm regions of the developing world with an estimated rate of infection in various regions ranging from 0.1-58%. Therefore, the higher prevalence in the age group below 5 year old, in this study can be due to direct transmission of the parasite through fecal-oral exposure as shown elsewhere by Robert and Tolan [24]. On the other hand, as a result of protective immunity following cure from infections during early age in life infection in adults tends to clear spontaneously, and hymenolepiasis is uncommon among this age group [24].

In this study, the prevalence of *S. mansoni* infection was found to be similar in males and females even though gender-associated difference has been reported by other workers [25, 26]. This finding might be associated that, in the study area both females and males have the same activities up to they became adults. Although it was not detected in the present study, higher prevalence of *schistosomiasis* was also reported in males than in females in Northern Ethiopia [26]. The existence of more outdoor activities among the active age group (6-14) than the other age groups could be one of the reasons for the high prevalence of *S. mansoni* in this age group. This is supported by the observation in the area, that of the adults and those under 5 years old did not play or swim in local water bodies, reduces the chances for their exposure to cercariae-infested waters. In addition, the significantly reduced *S. mansoni* prevalence following the age of puberty is consistent with what was reported for the protective effects of puberty-related hormones and acquired immunity in adults [26, 27].

In the study conducted in November/December, 2008 those children under 5 were least infected by *S. mansoni* as they were too young and may not have contacts with water bodies. The prevalence of *S. mansoni* in the 6-14 year olds was higher than in other ages in the study population, due to the greater contact of these age group individuals with water bodies. It has been shown by many that the amount of exposure, such as swimming in the water bodies is a determining factor for the spread of *schistosomiasis* [28, 29, 30, 31].

In Tach Gayint District some kebeles such as Bethlehem 16 (16.00%) and Aduka 16 (15.68%) had relatively high number of *S. mansoni* cases as the kebeles are irrigated. According to Jemaneh (2000) the prevalence of *schistosomiasis* among Tach Gayint school children (Tatek Lesira primary school) was about 1.7%, which is much lower than the present finding. This discrepancy can be explained by the fact that Jemaneh had considered only one primary school, which is found in the main town of the district and did not sample other potential *schistosomiasis* endemic areas, which are included in the present study. The difference in the methods employed or

stool examination-Formalin ether concentration and direct wet mount used in this study versus the kato-katz used in the *schistosomiasis* study may have contributed to the difference observed between the two findings. In this study due to time and budget constraints the kato-katz technique was not used for *schistosomiasis* diagnosis as the result of which its prevalence may have been under estimated.

Although it may be argued that in highly contaminated environments, focal transmission in defecation grounds may not be the single most important site for geo-helminth infection, it is a significant univariate risk factor for infection of many geo-helminths (*Ascaris*, *hookworms* and *Trichuris*) [32]. In the community of the present study, children were particularly at high risk as they were defecating in sites that are already polluted by faeces and therefore can be exposed to more frequent and heavy infection than adults.

Eventhough the prevalence and distribution of intestinal helminths varies from place to place because of several environmental, social and geographical factors [12,33,34,35,36] the prevalence of *Taenia spp.* (12.16%) was within the same range reported from other parts of Ethiopia [5]. This can be accounted for by the ubiquitous tradition of raw beef consumption in Ethiopia.

In the study area the intestinal protozoa *Giardia* and *E. histolytica/dispar* had considerable co-infections with malaria in Nov/Dec, 2008, which is characteristic of a wet season where both malaria and the intestinal protozoa are highly prevalent [32]. In November/December, 2008 study, co-infection of malaria and *G. lamblia* was significantly higher than that in April/May, 2009 ( $P = 0.02$ ). According to a study conducted by Ayalew [37], high number of giardiasis cases result during high rain fall months. This finding may be associated with the presence of flood storm that may wash fecal materials into drinking water bodies. *Giardia lamblia* have been implicated in many water-born diarrheal out-breaks both in adults and children that are exposed to contaminated drinking water and swimming in lakes and rivers [38].

Overlapping distributions of intestinal helminths and malaria result in high rate of malaria and helminth co-infections [39]. In many regions of Sub-Saharan Africa, intestinal helminth infections particularly hookworm disease overlaps geographically with falciparum malaria [40]. The co-infection of malaria and hookworm were relatively common in Aduka and Bethlehem in Tach Gayint District. Aduka and Bethlehem, two of the malarious kebeles of the district had the major co-infection of malaria and intestinal helminths resulting from favorable physical environment and ecology. In most tropical regions hookworm has high co-infection with malaria [41, 42]. The basis for this was explained by Hotez [43] who hold that hookworms have a wider thermal tolerance than *A. lumbricoides* and *T. trichiuria*, adapting them to tropical temperature that increases the chances of co-infection with malaria.

Poor environmental sanitation and climatic conditions (hot, wet and humid) favor the persistence of mosquito vectors of malaria and the free living infective stage of hookworm larva [19, 20]. In Africa over a quarter of school aged children are at

high risk of coincidence infection and consequently at enhanced risk of clinical diseases. On the whole, the high co-incident infections detected in Tach Gayint District is consistent with what was reported for much of Sub-Saharan Africa [44].

## 5. Conclusion and Recommendation

The findings of the present study showed that malaria, intestinal protozoa and helminthes were more prevalent in children than in adults in Tach Gayint District. Malaria was seasonal and relatively more prevalent in November/December, 2008 than in April/May, 2009. The prevalence of *S. mansoni* was higher in the age group 6-14 years than in other age groups of the study population. The prevalence of *Taenia spp.* (most probably *Taenia saginata*) was very low in children under 5, whereas the prevalence of *H. nana* was very high in children under 5 years of age. The prevalence of hookworm was very high in the age group 6-19 years but very low in children under 5 and in those above 19 years of age. *Trichuris trichiura* and *A. lumbricoides* were more prevalent in children under 5 than in other age groups of the study population. Multiple infections with malaria, intestinal protozoa and helminthes were common.

Therefore public education program on personal hygiene, proper use of latrines, and improved sanitation should be provided to prevent and reduce the rate of worm infections. The existing deworming programme must be redesigned for more coverage and efficiency to address the health problems in Tach Gayint District, particularly in the kebeles where intestinal helminthes are more prevalent. Improvement in the malaria control measures such as chemical, biological, and environmental management techniques that are being implemented must be instituted in the district. Further detailed investigation by using the Kato-katz method should be conducted to determine the intensity of *schistosomiasis* in the area would be recommended.

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