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Infection prevalence of intestinal helminths and associated risk factors among schoolchildren in selected kebeles of Enderta district, Tigray, Northern Ethiopia

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Lack of sanitary facilities and associated poor personal and environmental hygiene predispose people to the risk of intestinal parasite infections Thus, the objective of this survey was to assess the prevalence of intestinal helminth infections and associated risk factors among primary school children in selected kebeles of Enderta district, Tigray, northern Ethiopia. A cross sectional parasitological study consisting of 480 school children was conducted between February and March, 2011. Interview and microscopic examination of stool specimens of the children were made. Data was entered and analyzed by statistical packages for social sciences (SPSS) version 16.0 soft ware. The overall prevalence for at least one intestinal helminthic infection was 41.46% (199/480). The most dominant helminths were *Schistosoma mansoni* (23.13%), *Hymenolepis nana* (11.46%), *Ascaris lumbricoides* (5.83%) and *Enterobius vermicularis* (5.42%). Male children were at high risk for intestinal helminth infection than females (P < 0.014). Hand washing habit before meal (P = 0.0001), cleanness of fingernails (P = 0.0001) and swimming habit of the children (P = 0.0001) were significantly associated with intestinal helminth infections. Provision of health education, improving personal hygiene, potable drinking water supply as well as school based deworming should be the major focus area of the regional as well as Federal Health institutions.

Key words: Intestinal helminths, prevalence, risk factors, school children, Tigray.

INTRODUCTION

In developing countries, epidemiological determinants including lack of sanitary facilities and associated poor personal and environmental hygiene predispose people to the risk of intestinal parasite infections (Brooker et al.,

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2008). Soil-transmitted helminths (STHs) and schistosomes are among the most prevalent helminth infections of humans worldwide. In Ethiopia, both STHs and *Schistosoma mansoni* are widely distributed among school children (Mengistu and Berhanu, 2004; Girum, 2005; Tadesse and Beyene, 2009; Tadesse and Tsehaye, 2010). Both *S. mansoni* and *Schistosoma haematobium* species are endemic in Ethiopia. However, infection caused by *S. mansoni* has a wide geographical distribution in the country (Berhanu et al., 2002).

Although, various studies have tried to address the problems encountered by intestinal helminthes in Tigray, northern Ethiopia (Tadesse and Beyene, 2009; Tadesse and Tsehaye, 2008, 2010; Tadesse et al., 2009, 2010), none of them tried to correlate the prevalence of the parasitic infections with associated risk factors.

Neglected tropical diseases are still a major public health concern for developing countries such as Ethiopia. Soil-transmitted helminthiasis and schistosomiasis are among the five most common neglected diseases (Hotez et al., 2006). However, with the development of more effective treatments in the past 20 years, several implementation strategies have attempted to control, eliminate and even eradicate these diseases with varying degrees of success (Hotez et al., 2006). Key determinants of success have been how effectively these treatments and strategies have been integrated into health systems of endemic countries, and the existence, reach, and quality of health systems. Most neglected tropical disease interventions use community-directed mass drug administration as a strategy where formal health systems are weak or absent. The evidence from the success story of community-directed treatment in the control of neglected tropical diseases (NTD), such as lymphatic filariasis and schistosomiasis, were effective (Gyapong et al., 2001; Massa et al., 2008). Thus, such survey could contribute in collecting baseline data to be used for mass drug administration strategy in Tigray Region.

In addition, to our knowledge, no parasitological study, was conducted in Enderta. The objective of this study was, therefore, to assess the prevalence of major intestinal helminth parasites of human (*S. mansoni* and soil transmitted helminths) and associated risk factors among primary school children in selected Kebeles of Enderta district, northern Ethiopia.

MATERIALS AND METHODS

Study area description

The study was conducted in selected Kebeles of Enderta district which is located in the south-eastern zone of Tigray. According to central statistical agency of Ethiopia (2005), the population of the district is 123,421 (62,039 males and 61,382 females). The district has about 25,751 households in 17 Tabia and 68 Kebeles. This cross sectional survey intestinal helmint parasite infections was carried out among primary school children found in three primary schools (Merb-Miti, Maykeyah and Romanat) between February to March, 2011. The study population consisted of all children attending their class in these primary schools. In 2011, the total student population in the selected schools was 3,202 (1,613 males and 1,589 females). The primary schoolchildren population is expected to represent the community because schoolchildren were used as an index for assessing community prevalence (Guyatt et al., 1999).

Sample size and sampling technique

Sample size was estimated using the statistical formula of sample size calculation $n = p (1 - p) z^2 / d^2$, where, n = required sample size, z = confidence level at 95% which is standard value of 1.96, p = estimated prevalence of intestinal parasite and d = marginal error at 5%, standard value of 0.05 (Daniel, 1995). Since the overall prevalence of intestinal helminths was not known for this study area, prevalence (p) was taken to be 50% and this gave the minimum sample size of 384. In order to minimize the likelihood of non compliance or possible drop out, 25% of the sample size was added to the normal sample size. The selected total sample size was only 15% of the total student population in the selected schools. Thus, 480 schoolchildren were selected for this study. To select the study subjects, the students were first stratified according to their educational level (grade 1 to 8). The sample size was then proportionally allocated and the required numbers of students from each class were then drawn using systematic random sampling technique.

Ethical considerations

The objectives of the study were explained to the school teachers and students at the time of sample collection. They were also briefed on impact of helminths, mode of transmission and related issues at the time. Prior to sample collection, informal consent was sought from the school directors, and ethical approval were obtained from Institutional Research Ethics Review Committee of the college of Health Science, Mekelle University (HRERC: Ref.No: CHS/1679/Dn/16; Date: 17/01/2011). Positive individuals were treated with appropriate doze of anthelminthic drugs.

Data collection

A pre-tested questionnaire, which was developed and modified based on known potential risk factors, was used to gather demographic, socio-economic and behavioral data. During the time of interview, children were also checked for condition of their finger nails. Interview questionnaire were administered to the children in their mother tongue, Tigrinya. Finally, accuracy and completeness of all the questionnaires were checked at the end of each data collection day. Prior to stool sample collection, children were guided on how to bring their stool samples not to mix with soil and urine. Then immediately after interview, each child was provided with a dry, clean and leak proof stool cup, labeled with the identification number of each child and applicator stick. Samples were preserved in 8 ml of 10% formalin solution, and transported to the Microbiology and Parasitological Laboratory of the department of Biology, Mekelle University, for processing and parasitic examination.

Table 1. Gender related prevalence of intestinal helminths among schoolchildren in selected Kebeles of Enderta district, Tigray, northern Ethiopia, 2011.

Helminths infection	Gender		Total (n=480) [No. (%)]
	Males (n=252) [No. (%)]	Females (n=228) [No. (%)]	
A. lumbricoides	9 (3.57)	19 (8.33)	28 (5.83)
Hookworm	2 (0.78)	-	2 (0.42)
T. trichiura	1 (0.40)	-	1 (0.21)
S. mansoni	70 (27.77)	41 (17.98)	111 (23.13)
E. vermicularis	10 (3.99)	16 (7.02)	26 (5.42)
S. stercoralis	1 (0.40)	-	1 (0.21)
H. nana	28 (11.11)	27 (11.84)	55 (11.46)
Taenia Spp	-	3 (1.32)	3 (0.63)

A. lumbricoides = Ascaris lumbricoides, T.trichiura = Trichuris trichiura, S.mansoni = Schistosoma mansoni, E.vermicularis = Enterobius vermicularis, S.stercoralis = Strongyloides stercoralis, H.nana = Hymenolepis nana

Formalin-ether concentration technique was used for laboratory examination of the collected samples (World Health Organization (WHO), 1991). The results were properly recorded in the table form prepared for the purpose. Stool examination was conducted by the help of experienced medical laboratory technicians.

Data analysis

The data collected through interview based questionnaires and parasitological examinations were initially fed into Microsoft Excel 2003 software and then copied to SPSS software, version 16 for analysis. Chi-square test was performed to assess the presence of any significant differences between age, gender and location. Logistic regression was performed to determine the independent effect of the variables by calculating the strength of the association between infection and risk factors using odd ratio (OR) at 95% confidence interval (CI). Crude OR was estimated by univariate analysis and adjusted OR was then estimated by multivariate logistic regression analysis. P-value less than 0.05 (5%) was considered to be statistically significant.

RESULTS

Prevalence of intestinal helminth infections

From a total of 480 stool samples examined, 41.46% (199) were positive for one or more of intestinal helminths. Eight species of intestinal helminths were identified with variable prevalence: *S. mansoni* (23.13%), *Hymenolepis nana* (11.46%), *Ascaris lumbricoides* (5.83%), *Enterobius vermicularis* (5.42%), *Taenia* species (0.63%), hookworm (0.42%), *Trichuris trichiura* (0.21%) and *Strongyloide stercoralis* (0.21%). The prevalence of soil transmitted helminths (STHs) was 6.67%. Among 199 positive individuals, 109 (22.71%) were males and 90 (18.75%) were females. The majority (172; 35.83%) of infected individuals had single infection and 27 (5.63%) were infected with more than one intestinal helminth parasites. The most frequent combinations of helminths infection identified were co-infection of *S. mansoni* and *H. nana* (1.46%; 7/480), followed by *S. mansoni* and *E. vermicularis* 1.25% (6 out of 480). Gender related difference in prevalence rate of intestinal helminthic infections was observed in *S.mansoni* (χ^2 = 6.46, P = 0.011), where male children were found to be more infected (27.77%) compared to females (17.98%) (Table 1).

Age related intestinal helminthic infections were only observed in *S.mansoni* infection (χ^2 = 23.48, P = 0.0001). The age group 15 to 19 years was the most affected (32.97%) followed by the age group 10 to 14 years old (24.68%) (Table 2). The prevalence of intestinal helminthic infections showed significant difference among the selected schools (χ^2=41.25, P=0.0001). The least intestinal helminth parasitic infection was recorded in Mykeiya (26.19%) and the highest was in Romanat primary school (58.60%). The pattern of *S. mansoni* was also similar to intestinal helminthic infection and significantly varied among the three schools (χ^2 = 80.63, P = 0.0001) (Figure 1).

Risk factors associated with intestinal helminths infection

The distributions of socio-demographic and behavioral risk factors of the subjects are shown in Tables 3 and 4. In univariate analysis, significant association were seen between intestinal helminth infection and gender (COR = 0.652; 95%CI: 0.500, 0.851; P = 0.002), family occupation (COR = 0.776; 95%CI: 0.682, 0.883 agriculture versus non agriculture; P = 0.0001), availability of latrine (COR = 0.473; 95%CI: 0.374 to 0.597; P = 0.0001), family size (COR = 0.834; 95%CI: 0.725 to 0.961 for

Table 2. Age related prevalence of intestinal helminths among schoolchildren in selected kebeles of Enderta district, 2011.

Helminths infection	Age groups				Total (n=480) [No. (%)]
	5-9 (n=80) [No. (%)]	10-14 (n=308) [No. (%)]	15-19 (n=91) [No. (%)]	20-24 (n=1) [No. (%)]	
A. lumbricoides	7 (8.75)	15 (4.87)			28 (5.83)
Hookworm	-	2 (0.65)			2 (0.42)
T. trichiura	1 (1.25)	-	-	-	1 (0.21)
S. mansoni	4 (5.00)	76 (24.68)	30 (32.97)	1 (100)	111 (23.13)
E. vermicularis	6 (7.50)	15 (4.87)	5(5.50)	-	26 (5.42)
S. stercoralis	1 (1.25)	-	-	-	1 (0.21)
H. nana	15 (18.75)	33 (10.71)	7 (7.69)	-	55 (11.46)
Taenia Spp	-	3 (0.97)	-	-	3 (0.63)

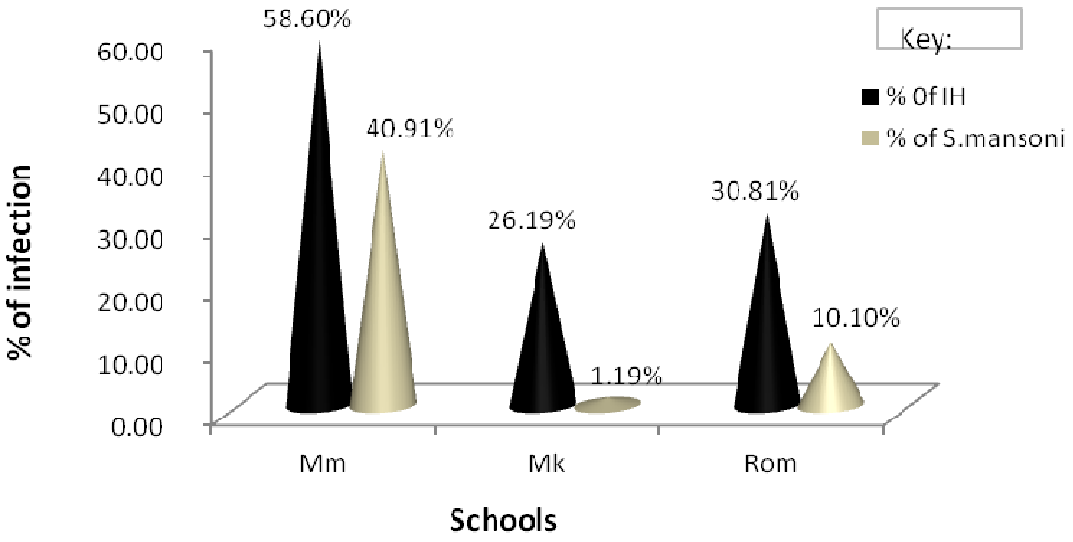

Figure 1. Prevalence rate of intestinal helminths among primary schools in selected Kebeles of Enderta district, 2011. Mm= Merb-Miti, Mk= May Keyah, Rom= Romanat.

family size > 5; P = 0.012) but no significant association with the source of water (COR = 0.879; 95%CI: 0.651 to 1.187 for pipe user versus river/stream; P = 0.401). In addition, hand washing habit (COR = 0.503; 95%CI: 0.394, 0.641; P = 0.0001), latrine usage habit (0.515; 95%CI: 0.406, 0.652; P = 0.0001), habit of swimming (COR = 1.855; 95%CI: 1.336 to 2.574; P= 0.0001), and cleanness of finger nails (COR= 1.153; 95%CI: 0.917 to 1.450; P = 0.0001) were significantly associated with intestinal helminthic infections.

Risk factors independently associated with intestinal helminth infections

The final model (multivariate logistic regression) analysis indicated that male children were at high risk of infection (AOR = 1.835; 95%CI: 1.133 to 2.971; P = 0.014). Children who had not habit of washing their hand always were more likely to be infected with intestinal helminth infections (AOR = 0.434; 95%CI: 0.277 to 0.681; P = 0.0001) than those who washed their hand always before meal. Children who had habit of swimming (AOR = 6.113; 95%CI: 3.604 to 10.368; P = 0.0001) and dirty material in their hand fingernails (AOR = 3.133; 95%CI: 1.923 to 5.104; P = 0.0001) were more likely to be infected by intestinal helminth infection. The final model analysis also indicated that there were no statistically significant association between intestinal helminth infection and family occupation (P = 0.087), latrine distribution (P = 0.427), family size (P = 0.088), latrine usage habit (P = 0.198).

Table 3. Univariate analysis for socio-economic risk factors associated with intestinal helminths infections among schoolchildren in selected Kebeles of Enderta district, 2011.

Risk factor	Intestinal helminths		COR	95%CI	P-value
	Positive [No. (%)]	Negative [No. (%)]			
Sex					
Male	109 (43.3)	143 (56.7)	0.652	0.500-0.851	0.002
Female	90 (39.5)	138 (60.5)			
Family occupation					
Agriculture	137 (43.2)	180 (56.8)	0.776	0.682-0.883	0.0001
Non agriculture	62 (38.0)	101 (61.9)			
Availability of latrine					
Present	104 (32.1)	220 (67.9)	0.473	0.374-0.597	0.0001
Absent	95 (60.9)	61 (39.1)			
Source of water					
Pipe	119 (38.5)	190 (61.5)	0.879	0.651-1.187	0.401
River/stream	80 (46.8)	91 (53.2)			
Family size					
≤ 5	142 (37.7)	235 (62.3)	0.834	0.725-0.961	0.012
>5	57 (55.3)	46 (44.7)			

COR=Crude Odd Ratio, 95%CI= ninety five percent confidence interval

Table 4. Univariate analysis for behavioral risk factors associated with intestinal helminths among schoolchildren in selected Kebeles of Enderta district, 2011.

Risk factor	Intestinal helminths		COR	95%CI	P-value
	Positive [No. (%)]	Negative [No. (%)]			
Hand washing habit					
Always	98 (33.4)	195 (66.6)	0.503	0.394-0.641	0.0001
Sometimes/not at all	101 (54.0)	86 (46.0)			
Latrine usage habit					
Present	104 (34.0)	202 (66.0)	0.515	0.406-0.652	0.0001
Absent	95 (54.6)	79 (45.4)			
Habit of swimming					
Present	102 (65.0)	55 (35.0)	1.855	1.336-2.574	0.0001
Absent	97 (30.0)	226 (70.0)			
Dirty materials in the hand fingernails					
Present	158 (53.6)	137 (46.4)	1.153	0.917-1.450	0.0001
Absent	41 (22.2)	144 (77.8)			

DISCUSSION

The present study revealed the occurrence of eight species of intestinal helminths of public health importance among school children in the study area. The overall prevalence roles of helminths observed in the present study was found to be higher than earlier reports from different parts of the region: southern and central zones of Tigray (Tadesse and Beyene, 2009), Hintalo Wejerat (Tadesse and Tsehaye, 2008) and from eastern Ethiopia (Girum, 2005). Further, the present finding was in agreement with that reported from south Wello (Assefa et al., 1998). However, the present rates were far lower than those reports from rural areas close to south east lake Langano (Mengistu and Berhanu, 2004), near Lake Tana (Melakeberhan et al., 1993), Lake Awassa (Yared et al., 2001) and Chilga district, northwest Ethiopia (Leykun, 2001). The differences in observed prevalence among the studies might be due to varied factors, including socio-economic conditions, individual behavioral habits of selected children, the methods employed for stool examination, the sample size taken as well as the time of study conducted. Further, Mengistu and Berhanu (2004) stated that the distribution and prevalence of various species of intestinal parasites also vary from region to region because of several environmental, social and geographical factors. In addition, in the present study area there was no school based deworming activity in the area. Thus, this may attribute to the observed high prevalence of helminth infections in the present study area.

In the present study, *S. mansoni* was the dominant helminth infection. The result was higher than reported from southern and central zone of Tigray (12.4%) (Tadesse and Beyene, 2009). However, the prevalence of *S. mansoni* (21.25%) was similar with the results obtained from south east of Lake Langano (Mengistu and Berhanu, 2004). High prevalence of *S. mansoni* in the present study may be attributed to the presence of irrigation schemes near to the study areas and high water contact of the children to the nearby water bodies which enhanced the transmission. Increases in Schistosomiasis transmission associated with water development projects is well documented (Tadesse and Beyene, 2009; Leykun, 1999). Similarly, Bethony et al. (2006) stated that frequent contact with contaminated water create favorable condition for the transmission and wide spread of intestinal helminths infection.

The higher predominance of males to *S. mansoni* in the present study is consistent with reports from elsewhere in same region and eastern Ethiopia (Girum, 2005; Tadesse and Tsehaye, 2008; Tadesse and Beyene, 2009). The difference in *S. mansoni* infection among sexes can be explained in behavioral differences among sexes in which males have high frequency of water contact habit. In the present study, assessment of sex related water contact habit (swimming habit) revealed that males do have significantly high swimming habit compared to females (X^2 = 50.78, P = 0.000). Thus, the water contact through swimming could be one reason for the observed *S. mansoni* infection difference among sexes. The age dependent prevalence of *S. mansoni* infection obtained in the present study is consistent with reports from the same region (Tadesse and Bayene, 2009). Accordingly, significantly higher infection was reported in the age group 15 to 19 and 10 to 14 compared to the 5 to 9 age group which was the least affected group. The low infection rate of *S. mansoni* among 5 to 9 age groups might be as a result of low water contact behavior of the children.

The prevalence of soil transmitted helminth infection reported in this study was comparable with reports from Hintalo Wejerat, northern Ethiopia (7.5%) (Tadesse and Beyene, 2009), but lower than result obtained from Southern and Central zone of Tigray (13.9%) (Tadesse and Beyene, 2009) and Babile town, eastern Ethiopia (14.2%) (Girum, 2005). Further, the result of this study was lower than reported from different part of Nigeria; South west Nigeria (83%) (Ibidapo and Okwa, 2008) and Ebenebe town, Nigeria (87%) (Chukwuma et al., 2009). The low prevalence of soil transmitted infection in the present study area might be as a result of the local climatic condition which is an important determinant factor for transmission of various intestinal helminth infections. In fact climate with adequate moisture and warmth temperature is very crucial for larval development of STHs in the soil (Brooker et al., 2006; Brooker and Michael, 2000). This idea was also supported by Tadesse and Beyene (2009) in that geohelminth infection was high in southern Tigray than central Tigray since the moist condition and hot temperature in the southern part was favorable for the preservation of infective helminth. In addition, the low prevalence of STHs in the present study might be because of the time of sample collection. It is well recognized that wet or damp soil favors the eggs of helminths and rainy season enables them to thrive more than dry season (WHO, 2002).

The present study also tried to assess the possible association of intestinal helminth infection with socio-demographic and behavioral risk factors among school children. The analysis in this study indicated that male children were at high risk for intestinal helminth infections compared to female children. Similar observations are found in different parts of Ethiopia and other tropical countries (Ikon and Useh, 1999; Adhikari et al., 2004; Ukpai and Ugwu, 2003; Girum, 2005, Tadesse and Bayene, 2009). This gender difference of helminthic infection might be because of the difference in gender behavior. The males are more likely to involve in outdoor activities than females because of social and religious

restriction and the outdoor environment including agricultural areas are common place for defection by males during working time, therefore contamination of soil in the areas would facilitate the transmission of intestinal helminth. But contrasting results were reported in different areas in which females had a relatively high prevalent rate than males (Adefemi and Musa, 2006; Rajini and Gurdip, 2010). Further, Adefemi and Musa (2006) stated that the influence of gender on the prevalence of helminthic infection is inconclusive since it may or may not play a role depending on the regional and environmental factors. Thus, more systematic research works are required to elucidate this.

In the present study, high degree of association between hand washing habit and cleanness of the finger nails with intestinal helminth infections is well recognized. This was in agreement with earlier reports in different parts of Ethiopia (Ali et al., 1999; Girum, 2005; Yeshambel et al., 2010). This is probably due to insufficient water supplies, poor hygienic practice, and socio-economic status. Further, Filippo et al. (1998) stated that promoting hand-washing and improvement of general personal hygiene could bring reduction in the level of intestinal helminthic infection. Thus, lack of personal hygiene might increase the probability of exposure to intestinal helminths infection. There is also evidence from Gurez valley of Jammu and Kashmir state, India that children with better personal hygiene had lower prevalence of infecting by helminthic infection than those children living in poor hygienic condition (Showkat et al., 2010).

Although the distributions of better toilet facilities in each individual house hold as well as in each school could have reduced effect on the prevalence of intestinal helminth infections, the logistic regression analysis in the present study indicated that the availability of toilate (latrine) and the type of latrine was not significantly associated with the prevalence of intestinal helminthic infection. Similar results were reported in different areas of Ethiopia (Girum, 2005; Tadesse and Beyene, 2009).

Tashikuka et al. (1995) described that the use of pit latrine was associated with a lower risk of acquisition of intestinal helminth compared to open bush, but where the provision of pit latrine is not accompanied with adequate supply of water, the chance of faecal contamination becomes higher. Furthermore, Ali et al. (1999) stated that improper usage and poor quality hygiene of the toilet have been shown to influence acquisition of intestinal helminths. Thus, the mere availability of a toilet, unless properly used, does not guarantee protection against intestinal helminth infection.

Conclusion

This study added to the knowledge of the epidemiology of intestinal parasitic infections in Ethiopia in general and revealed that hand washing habit before meal, swimming habit of the children and availability of dirty materials in the fingernails of the schoolchildren were found to be significantly associated with intestinal helminths infection in the study area. The information may be used in design and application of control strategies.

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Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

Adefemi S, Musa O (2006). Intestinal helminthes infestation among pupils in rural and urban communities of Kwara state, Nigeria. Afr. J. Clin. Exp. Microbiol. 7:217-228.

Adhikari M, Bomjan R, Khatri B, Joshi R, Dhakal P, Lekhak B (2004). Intestinal helminthic infections among school children in Kathmandu valley. J. Nepal Health Res. Council 5:17-21.

Ali I, Mekete G, Wdajo N (1999). Intestinal parasitism and related risk factors among students of Asendabo elementary and junior secondary school, South Western Ethiopia. Ethiop. J. Health Dev. 13:157-161.

Assefa T, Woldemicael T, Dejenie A (1998). Intestinal parasitism among students in three localities in south Wello, Ethiopia. Ethiop. J. Health Dev. 12:231-235.

Berhanu B, Medhin G, Berhe N, Abebe F, Gebre T, Michael S, Gundersen G (2002). Epidemiologic studies on intestinal Schistosomiasis in Wondo Genet, Sothern Ethiopia. Ethiop. Med. J. 41:333-44.

Bethony J, Brooker S, Albonico M (2006). Soil-transmitted helminth infections: Ascariasis, Trichuriasis, and hookworm. Lancet 367:1521-1532.

Brooker S, Michael E (2000). The potential of geographical information systems and remote sensing in the epidemiology and control of human helminth infections. Adv. Parasitol. 47:245-288.

Brooker S, Archie C, Clements A, Bundy D (2006). Global epidemiology, ecology and control of soil-transmitted helminth infections. Adv. Parasitol. 62:221-261.

Brooker S, Hotez P, Bundy D (2008). Hookworm-Related Anaemia among Pregnant Women: A Systematic Review. Plos Neglected Trop. Dis. 2:274-291.

Chukwuma C, Ekejindu M, Agbakoba R, Ezeagwuna D, Anaghaw C, Nwosu D (2009). The prevalence and risk factors of geohelminths infections among primary school children in Ebenebe Town, Anambra state, Nigeria. Middle East J. Sci. Res. 4:211-215.

Daniel W (1995). Biostatistics a foundation for analysis in the health science. In: Statistical analysis (6 thed.), New York: John Willey and sons Inc, USA. p. 155.

Filippo C, Patrizio P, Abdel L, Hamdan A, Pietro I, Youshri S, Marzio B (1998). Knowledge, perceptions and behavior of mothers toward intestinal helminths in Upper Egypt: implications for control. Health Policy Plan. 13:423-432.

Girum T (2005). The prevalence of intestinal helminthic infections and association risk factors among schoolchildren in Babile town, eastern Ethiopia. Ethiop. J. Health Dev. 19:140-147.

Guyatt H, Brooker S, Donnelly C (1999). Can prevalence of infection in school aged children be used as an index for assessing community prevalence? Parasitology 118:257-268.

Gyapong M, Gyapong JO, Owusu-Banahene G (2001). Community-directed treatment: the way forward to eliminating lymphatic filariasis as a public health problem in Ghana. Ann. Trop. Med. Parasitol. 95:77-86.

Hotez PJ, Ottesen E, Fenwick A, Molyneux D (2006). The neglected tropical diseases: the ancient afflictions of stigma and poverty and the prospects for their control and elimination. Adv. Exp. Biol. Med. 582:22-33.

Ibidapo C, Okwa O (2008). The prevalence and intensity of soil transmitted helminths in a rural community, Lagos Suburb, South west Nigeria. Internet J. Agric. Biol. 10:89-92.

Ikon G, Useh C (1999). Epidemiology of gastrointestinal helminthosis among pupils in urban and sub-urban communities of, Nigeria. J. Med. Lab. Sci. 8:1-6.

Leykun J (1999). Intestinal helminth infections in schoolchildren in Gonder town and surrounding areas, northwest Ethiopia. Ethiop. J. Sci. 22:209-220.

Leykun J (2001). Soil-transmitted helminth infections and *Schistosomiasis mansoni* in schoolchildren from Chilga District, Northwest Ethiopia. Ethiop. J. Health Sci. 11:79-87.

Massa K, Magnussen P, Sheshe A, Ntakamulenga R, Ndawi B, Olsen A (2008). Community perceptions on the community-directed treatment and school-based approaches for the control of schistosomiasis and soil-transmitted helminthiasis among school-age children in Lushoto District, Tanzania. J. Biosoc. Sci. 41:89-105.

Melake-Berhan D, Wondwossen H, Tsefaye W, Elis G, Sissay Y, Tariku A, Tibabu D (1993). Intensity of intestinal parasite infection in a small farming village near Lake Tana, Ethiopia. Ethiop. J. Health Dev. 7:27-31.

Mengistu L, Berhanu E (2004). Prevalence of intestinal parasites among schoolchildren in a rural area close to the southeast of Lake Langano, Ethiopia. Ethiop. J. Health Dev. 18:116-120.

Rajini K, Gurdip S (2010). Epidemiology and control of Schistosomiasis and other intestinal parasitic infections among school children in three rural villages of south Saint Lucia. J. Vector Borne Dis. 47:228-234.

Showkat AW, Fayaz A, Showkat AZ, Ayesha A, Zubair A, Pervaiz A (2010). Intestinal Helminthiasis in Children of Gurez Valley of Jammu and Kashmir State, India. J. Global Infect. Dis. 2:91-94.

Tadesse D, Beyene P (2009). Irrigation practices and Intestinal helminth infections in Southern and Central Tigray. Ethiop. J. Health Dev. 23:48-56.

Tashikuka J, Scott M, Gary-Donald K (1995). *Ascaris lumbricoides* infection and environmental risk factors in an urban African setting. Ann. Trop. Med. Parasitol. 89:505-514.

Ukpai O, Ugwu C (2003). The prevalence of gastro-intestinal tract parasites in primary school children in Ikwuano Local Government Area of Abia State, Nigeria. Nig. J. Parasitol. 240:129-36.

World Health Organization (WHO) (2002). Prevention and Control of Schistosomiasis and Soil-Transmitted Helminthiasis. World Health Organization, Technical Series Report 912. Geneva.

World Health Organization (WHO) (1991). Basic laboratory methods in medical parasitology. Geneva, Switzerland.

Yared M, Mamdouh H, Girma M, Shiferaw T (2001). Intestinal helminthic infection among children at Lake Awassa Area, South Ethiopia. Ethiop. J. Health Dev. 15:31-38.

Yeshambel B, Girmay M, Alemayehu A, Berhanu E, Charloette H, Atalay A, Andrea V, John B, Gail D (2010). Prevalence and risk factors for soli transmitted helminth infection in mothers and their infants in Butajira, Ethiopia: A population based study. BioMed Central Public Health 2:10-12.