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Prevalence and determinants of intestinal parasitic infections among primary schoolchildren in Gurage zone, South central Ethiopia

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Abstract

Background: Intestinal parasitic infections (IPI) in Ethiopia are a significant health problem and vary in different regions and with age. We examined associations between IPI and local risk factors at the age 7-19 years in primary schoolchildren, Gurage zone.

Methodology: In 2014-2015, a study on 680 primary schoolchildren (school based cohort) was conducted at Enemorena-Ener and Abeshege Districts of Gurage zone, South central Ethiopia. Fresh stool samples were collected and processed by Kato-Katz and formol-ether concentration methods. Socio-demographic and economic factors were assessed through a questionnaire, observation, interviews, focus group discussions and document review. SPSS statistical software version 16 was used and P-value <0.05 was reported as statistically significant.

Result: The overall prevalence of IPI was 40% (180/450) in Enemorena-Ener and 38.7% (89/230) in Abeshege Districts. The prevalence of the respective parasites in the two Districts was comparable, except for the few cases of *S. mansoni* in Abeshege.

Female (AOR 2.93, 95% CI 1.59 - 5.37, p < 0.001), not washing hands after defecation (AOR 1.91, 95% CI 1.25 - 2.92, p < 0.001), not hand washing practice before meal (AOR 2.57, 95% CI 1.45 - 4.56, P < 0.001), using unprotected water (AOR 3.94, 95% CI 2.84 - 5.45, P < 0.001), lack of latrine (AOR 0.11, 95% CI 0.06 - 0.21, P < 0.001), and family size more than five (AOR 3.73,95% CI 2.04 - 6.8, P < 0.001) had significant association with IPI.

Higher age category ≥ 15 years (AOR 1.69, 95% CI 1.01 - 2.84, P = 0.048), lack of latrine at home (AOR 2.16 95% CI 1.17 - 3.97, P = 0.01), not wearing shoes (AOR 0.03, 95% CI 0.02 - 0.06, P < 0.001) had significant association with hookworm infection. Not washing hands before eating (AOR 6.80, 95% CI 3.87 - 11.97, P < 0.001) and after defecation (AOR 0.33,95% CI 0.22 - 0.49, P < 0.001), lack of latrine at home (AOR 0.40, 95% CI 0.25 - 0.68, P < 0.001), illiterate mother (AOR 1.65 95% CI 1.09 - 2.49, P = 0.02) and use of unprotected water (AOR 20.00, 95% CI 10.14 - 43.64, P < 0.001) showed a significant association with giardiasis. Children use of unprotected water (AOR 0.51,95% CI, 0.33 - 0.79, P = 0.002), children who did not wash hands before eating (AOR 6.52, 95% CI 3.69 - 11.54, P < 0.001) and after defecation (AOR 0.59, 95% CI 0.39 - 0.88, P = 0.01) and children whose age ten to fourteen years old (AOR 1.83, 95% CI 1.17 - 2.86, P = 0.01) and lack of latrine at home (AOR 1.03, 95% CI 0.61 - 0.93, P < 0.001), had significant association with *ascaris* infection.

Conclusion: A high prevalence with an average low IPI was found among schoolchildren, *Ascaris lumbricoides*, hookworm and *Giardia* infections were being most common. Low personal hygiene, use of unprotected water, lack of latrine, not wearing shoes and large family size were important predictors for IPIs.

Keywords: *Children; Health; Helminths; Risk Factors; Intestinal Parasitosis; Prevalence; Southwest Ethiopia*

Introduction

Parasitic infections are closely associated with low household income, poor personal and environmental sanitation, overcrowding, limited access to clean water, tropical climate and low altitude [1,2]. People of all ages are infected by the prevalent parasitic infections; although, children are the worst affected [3,4], and the main transmission route is fecal-oral, through contaminated food or water [5,6].

Intestinal parasitic infections (IPIs) are globally endemic and constitute the greatest worldwide cause of illness and disease wherever there is poverty [3], Schistosomiasis, amoebiasis, ascariasis, hookworm infection and trichuriasis are among the ten most common infections worldwide. The low socio-economic development favors the wide distribution of intestinal parasites in Ethiopia [7]. Warm climate and adequate moisture, poor personal and environmental hygiene, walking barefoot, and poor nutritional status are known to increase the risk of intestinal parasitic infections [8,9].

In Ethiopia the prevalence of hookworm, *A. lumbricoides* and *T. trichiura* estimated as 16%, 37% and 30% respectively and the prevalence of taeniasis alone ranges from 1 - 48% and the infection rate with *Hymenolopis nana* is 3 - 61% [10]. Intestinal parasitic protozoa, amoeba and giardia commonly cause diseases like amoebiasis and giardiasis respectively in Ethiopia. Although, the prevalence rate varies in efficiency of different diagnostic method, microscopy method shows 0 - 4% amoebic disease and 3 - 23% giardiasis [5]. In general, the prevalence rate varies considerably: rates are lowest in the low land and dry areas of the country than in more humid high lands [11,12]. This wide distribution of intestinal parasites in Ethiopia might be related to differences in altitude that favor the growth of parasite, low socio-economic status and poor sanitation, absence of safe drinking water supplies and inadequate medical care.

Children are at more risk to intestinal parasitic infection due to their frequent contact with contaminated soil and less awareness of hand washing practice before eating. Infection is peaked between 4-8 years due to increased exposure with age and maintained constant possibly due to host resistance development and habit modification i.e. less exposure. But there is no development of permanent protective immunity to re-infection [13,14].

The level of harm caused by intestinal parasite infection to the health of individual and communities depend on the parasite species, the nature of the interaction between the parasite and the concurrent infections, the intensity and course of infection and nutritional and immunological status of the population [15,17]. The common consequences of intestinal parasitic infections have been shown to affect nutritional status, physical development, mental function, verbal ability and cognitive behavior in children [16,17]. The risk factors of intestinal parasitic infections in primary schoolchildren was not assessed in the study area. We present data on prevalence of intestinal parasitic infection among schoolchildren in a rural area of Ethiopia using a school based cohort to define the prevalence of intestinal parasitic infection and identify amenable to intervention.

Materials and Methods

Study area and study population: A school based cohort study was conducted from September 2014 to June 2015 to assess the magnitude of IPI among elementary schoolchildren in two purposively selected Enemorena-Ener and Abeshege districts, Gurage zone. Gurage zone is found at 7044’5’’-8028’5’’N latitude and 37025’5’’-38042’5’’ E longitude. Gurage zone is located 155km from Addis Ababa on the road to Jimma, central Ethiopia. 680 primary schoolchildren participated in study. The study participants were children aged 7-19 years in randomly selected kebeles of Enemorena-Ener and Abeshege districts. Children of the two districts live under similar socio-cultural characteristics and low socio-economic condition of rural villages.

Sample size and sampling method

The study populations were residents of the two purposively selected districts. Then sample size was estimated using Daniel’s formula $n=Z^2 P (1-P)/d^2$ [18]. Where P = prevalence of intestinal parasites from previous studies, d = margin of error and Z = standard score corresponds to 1.96. This would give a sample size of 326. The prevalence rate (p) of intestinal parasites from previous similar study was 69.4% in primary school children [19], a 95% confidence interval and a 5% margin of error were added. Due to the use of multistage sampling of which cluster sampling was used, a design effect of 2 was added. To compensate for non-response and incompleteness, additional 5% was added. Therefore, a total population of 680 children was included in the study. The study participants were selected from the school lists using stratified random sampling methods from the eleven schools of two districts after informed consent/assent.

Sampling method

A multistage sampling was used to select the sample. It was a two-stage sampling. The first stage was stratified cluster sampling with proportional allocation to size, and the second stage was simple random sampling.

Fecal collection and examination

Kato-katz method

From each child, about 2 grams of fresh stool samples were collected using sterilized cups. A portion of the specimen was processed using Kato technique [20]. It was examined for *Ascaris lumbricoides, Trichuris trichiura*, hookworm and other intestinal helminths. The number of eggs per slide were counted and multiplied by 24 to obtain the number of eggs per gram (epg) of feces [21].

Formol-ether concentration method

Stool samples of approximately one gram from all subjects were collected into test tubes containing 8 ml of 10% formol-ether and transported to Aklilu Lemma Institute of Pathobiology, Addis Ababa University. A portion of each fresh stool sample was processed as described by Ritchie [22]. Infected cases were treated by medical personnel from respective health institution.

Statistical Analysis

The data was initially checked for completeness and consistency, coded and entered in to the computer and validation was performed in Microsoft Excel 2010 spreadsheets. The data was then exported to SPSS version 16 program for analysis. Chi-square was used to verify possible association between intestinal parasitic infection and exposure to different factors. Univariate analysis were used to identify the possible confounders. Variables that were associated with both exposure and outcome variables in the crude analysis using statistical significance at p-value < 0.2 were considered to be possible confounders. Multivariate logistic regression analysis was used to measure the strength of association of socio-demographic factors and intestinal parasitic infections. Ninety five percent confidence interval (CI) was calculated for the odds ratio value. Values were considered significant when p < 0.05.

Ethical Consideration

The study was reviewed and approved, and ethical clearance was obtained from the Ethical Committee of College of Natural Sciences, through the Department of Microbial Cellular and Molecular Biology, Addis Ababa University. Informed verbal consent or permission was also obtained from Southern Nation and Nationalities of People Regional State Health Bureau, Gurage zone Education and Health Departments. Each of these zonal departments was passed the message of permission to their respective districts including schools and health centers. Participation in the study was on a voluntary basis. Privacy and confidentiality of the information was ensured. The ethical considerations were addressed by treating positive children using standard drugs under the supervision of a local nurse. The objective of the study was explained to school communities, kebele leaders and parents; and written consent was obtained from every participant's parent or guardians of the selected children before conducting the survey and the children also gave their assent before collecting the samples.

Results

A total of six hundred eighty (680) students, from grade 1 to 8, were enrolled in each two seasons in the study (Table 1). The mean age of the total study population was 14.2 (range: 7 - 19 years) and the male to female proportion was 51.2% and 48.8% of Abeshege, and 57% and 43% Enemorena-Ener district respectively (Table 2). Stool samples were collected and examined in two consecutive seasons from 680 children.

Prevalence of intestinal parasitic infection

Out of the 680 schoolchildren examined seven (7) species of intestinal parasites were identified with an overall prevalence of 180 (40%) in Enemorena-Ener and 89 (38.7%) in Abeshege (Table 1). The most prevalent intestinal parasites identified were *Ascaris lumbricoides* 43 (9.6%), hookworm 41 (9.1%), *Giardia lamblia* 40 (8.9%), Enemorena-Ener and hookworm 22 (9.6%), *Ascaris lumbricoides* 40 (8.7%), *Giardia lamblia* 40 (8.7%), in Abeshege respectively (Table 1). Out of these 105 (23.3%) were single infection, and 51 (8.4%) were double infection in Enemorena-Ener while 53 (23%) were single infection and 18 (7.8%) were double infection in Abeshege (Figure 1).

Type of parasites	Enemorena-Ener N = 450 No (%)	Abeshege N = 230 No (%)	P-value
Hookworm	42 (9.3%)	23 (10%)	0.84
Ascaris lumbrioides	43 (9.6%)	21 (9.1%)	0.71
Trichuris trichiura	25 (5.6%)	9 (3.9%)	0.42
E.histolytica/dispar	26 (5.8%)	10 (4.3%)	0.50
Taenia spp	7 (1.6%)	4 (1.7%)	0.76
Schistosoma mansoni	0 (0%)	4 (1.7%)	0.005*
Giardia lamblia	40 (8.9%)	21 (9.1%)	0.93
Any IPI	183 (40.67)	92 (40%)	0.74
Single infection	105 (23.3%)	52 (22.6%)	
Double infection	53 (11.8%)	18 (7.8%)	
Triple infection	24 (5.3%)	19 (8.3%)	

Table 1: *Prevalence of IPIs in Enemorena-Ener and Abeshege districts elementary schoolchildren, Gurage Zone, 2014-2015.*

** Enemorena-Ener district is non-endemic for schistosomiasis.*

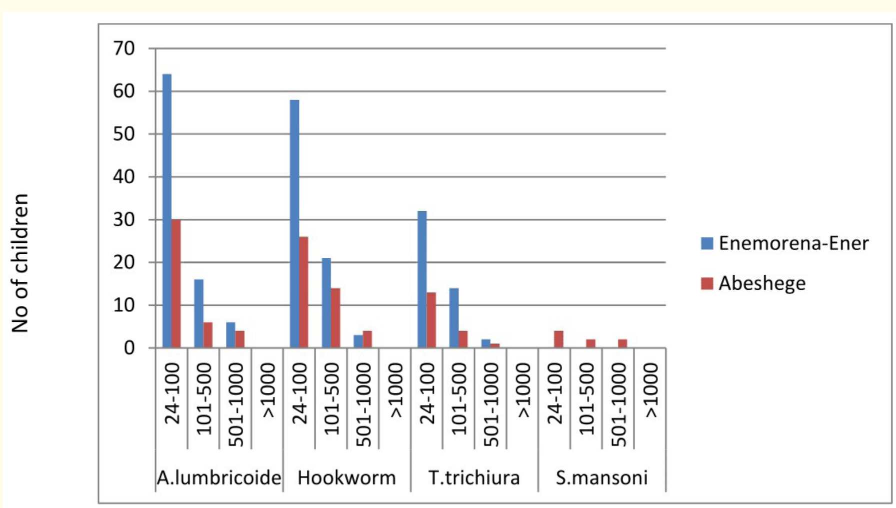

Figure 1: *Intensity of helminth infection (epg) among Enemorena-Ener and Abeshege district school children, Gurage zone, South central Ethiopia, 2014 - 2015.*

The intensity of infection for hookworm, *Schistosoma mansoni, Trichuris trichiura* and *Ascaris lambricoides* is shown in Figure 1. The highest egg count for *A. lumbricoides* was 912 eggs per gram (epg) of stool in two male and two female students in Enemorena-Ener District and 600 epg for Two male students in Abeshege District.

Analyses of the potential risk factors explored for the IPI showed, variables like Femaleness, illiterate mother, not washing hands after defecation, not hand washing practice before meal, use of unprotected water, lack of latrine, the presence of more than five family size, and not wearing shoes had significant association with the presence of IPI (P < 0.05) (Table 2).

Variable		**IPI Positive***	**P--value**
Gender	Male Female	127 (35.4) 142 (44.2)	1 0.001
Residence	Enemorena-Ener (N = 450) Abeshege (N = 230)	180 (40) 89 (38.7)	1 0.64
Age category	6 - 9 10 - 14 ≥ 15	37 (48.1) 158 (38.9) 74 (37.6)	0.08 0.49 1
Father education	Illiterate Educated	112 (40.7) 157 (38.8)	0.47 1
Mother education	Illiterate Educated	142 (42.3) 127 (36.9)	0.044 1
Water type used	UnSafe Safe	76 (59.4) 193 (35.0)	< 0.001 1
Latrine	Unavailable Available	233 (67.3) 36 (10.8)	< 0.001 1
Family size	2-5 >5	42 (14.4) 227 (58.4)	1 < 0.001
Wearing shoes	Yes No	158 (35.8) 111 (46.4)	1 < 0.001
Washing hands after defecation	Yes No	174 (36.1) 95 (48)	1 < 0.001
Washing hands before eating	Yes No	14 (3.4) 255 (94.8)	1 < 0.001

Table 2: *Socio-demographic risk factors and IPI among Schoolchildren Enemorena-Ener and Abeshege districts, Gurage zone, South Central Ethiopia, 2014-2015.*

**The percentage is calculated from the total examined for the respective characteristic*

Univariate and multivariate analysis was performed for all variables that were significantly associated with any IPI in Table 2. After adjustment, wearing shoes, and mother education were excluded from the model (P > 0.05). Variables, more than five family size and not hand washing practice before meal, not washing hands after defecation, lack of latrine at home, use of unprotected water and femaleness were remained significant positive association with any IPI (Table 3).

Variable		* IPI Positive	COR (95%CI)	P-value	AOR (95%CI)	P-value
Gender	Male Female	127 (35.4) 142 (44.2)	1 1.5 (1.16-1.80)	 0.02	1 2.93 (1.59-5.37)	 0.001
Residence	Enemorena-Ener Abeshege	180 (40) 89 (38.7)	0.95 (0.68-1.31) 1	0.74	1.02 (0.64-1.9) 1	0.71
Mother education	Illiterate Educated	142 (42.3) 127 (36.9)	0.80 (0.64-0.99) 1	0.04	1.25 (0.69-2.25) 1	0.46
Water type used	Unafe Safe	76 (59.4) 193 (35.0)	0.37 (0,28-0.49) 1	< 0.001	3.94 (2.84-5.45) 1	< 0.001
Latrine	Unavailable Available	233 (67.3) 36 (10.8)	0.06 (0.04-0.08) 1	< 0.001	0.11 (0.06-0.21) 1	< 0.001
Family size	2 - 5 > 5	42 (14.4) 227 (58.4)	1 8.31 (6.33-10.90)	 < 0.001	1 3.73 (2.04-6.8)	 < 0.001
Wearing shoes	Yes No	158 (35.8) 111 (46.4)	1 0.64 (0.48-0.89)	 < 0.001	1 1.34 (0.71-2.51)	 0.36
Washing hands after defecation	Yes No	174 (36.1) 95 (48)	1 0.61 (0.48-0.78)	 < 0.001	1 1.91 (1.25-2.92)	 < 0.001
Washing hands before eating	Yes No	174 (36.1) 95 (48)	1 0.61 (0.48-0.78)	 < 0.001	1 2.57 (1.45-4.56)	 < 0.001

Table 3: *Results from Univariate and Multivariate analysis of Socio-demographic risk factors and IPI among Schoolchildren Enemorena-Ener and Abeshege district, Gurage zone, South Central Ethiopia, 2014 - 2015.*

AOR: Ajusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

**The percentage is calculated from the total examined for the respective characteristic*

The present study had shown a high prevalence of intestinal parasitic infections, especially with hookworm, *G. lamblia* and *Ascaris lumbricoide* infections. The factors that make higher prevalence of *Ascaris lumbricoides*, hookworm and giardia are not known in the study area. The current study aimed at identifying prevalence and predictors of those intestinal parasitic infections in Gurage zone, which is vital for the effective implementation of control strategies in combating these intestinal parasitic infections (Table 4-6).

Socio-demographic risk factors multivariate analyses with hookworm infection confirmed that the prevalence of hookworm in children with no latrine at home and not wearing shoes were significantly associated with hookworm infection (P < 0.05) (Table 4).

Variable		Hookworm* Positive	P- value	COR (95%CI)	P- value	AOR (95%CI)
Age category	6 - 9 10 - 14 ≥ 15	11 (14.3) 30 (7.4) 22 (11.2)	 0.32 029	1.00 0.75 (0.44 - 1.31) 1.58 (1.05 - 2.37)	 0.99 0.048	1.00 0.99 (0.5 - 1.99) 1.69 (1.01 - 2.84)
Water type used	Safe Unsafe	42 (7.6) 21 (16.4)	 < 0.001	1.00 1.59 (1.27 - 1.98)	 0.67	1.00 0.17 (0.28 - 0.78)
Latrine	Unavailable Available	45 (13.0) 18 (5.4)	< 0.001	2.63 (1.76 - 3.92) 1.00	0.01	2.16 (1.17 - 3.97) 1.00
Family size	2 - 5 > 5	15 (5.2) 48 (12.3)	 < 0.001	1.00 2.59 (1.69 - 3.96)	 0.69	1.00 0.89 (0.49 - 1.60)
Washing hands before eating	yes no	9 (2.2) 54 (20.1)	 < 0.001	1.00 11.2 (6.72 - 18.73)	 0.32	1.00 1.24 (0.81 - 1.89)
Washing hands after defecation	Yes no	28 (14.1) 35 (7.3)	 0.02	1.00 1.6 (1.07 - 2.25)	 0.24	1.00 1.22 (0.81 - 1.72)
Wearing shoes	Yes No	5 (1.1) 58 (24.3)	< 0.001	1.00 0.04 (0.02 - 0.07)	< 0.001	1.00 0.03 (0.02 - 0.06)

Table 4: *Results from Univariate and Multivariate analysis of factors associated with hookworm infections among schoolchildren, Enemorena - Ener and Abeshege district, Gurage zone, South Central Ethiopia, 2014/2015.*

AOR: Ajusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

**The percentage is calculated from the total examined for the respective characteristic*

Multivariate analyses of the socio-demographic variables for the association of Giardia infections confirmed that children who did not wash hands before eating and after defecation, lack of latrine at home and use of unprotected water were significantly associated with giardia infection (P < 0.05) (Table 5).

Variable		*G. lamblia* Positive *	P- value	COR (95%CI)	p- value	AOR (95%CI)
Gender	Male female	28 (7.8) 32 (10)	 0.16	1.00 1.31 (0.89 - 1.91)	 0.43	1.00 1.18 (0.78 - 1.79)
Mother education	Illiterate Educated	34 (9.4) 27 (7.7)	0.16	1.31 (0.89 - 1.91) 1.00	0.02	1.65 (1.09 - 2.49) 1.00
Water type consumed	Safe Unsafe	48 (8.7) 12 (9.4)	 < 0.001	1.00 11.2 (6.72 - 18.73)	 < 0.001	1.00 20 (10.14 - 43.64)
Latrine	Unavailable Available	42 (12.1) 18 (5.4)	< 0.001	0.41 (0.27 - 0.63) 1.00	< 0.001	0.40 (0.25 - 0.68) 1.00
Family size	2 - 5 >5	16 (5.5) 44 (11.3)	 < 0.001	1.00 2.19 (1.44 - 3.34)	 0.87	1.00 0.96 (0.59 - 1.57)
Washing hands before eating	Yes no	14 (3.4) 46 (17.1)	 < 0.001	1.00 5.85 (3.77 - 9.07)	 < 0.001	1.00 6.80 (3.87 - 11.97)
Washing hands after defecation	yes no	26 (5.4) 34 (17.2)	 < 0.001	1.00 0.28 (0.19 - 0.40)	 < 0.001	1.00 0.33 (0.22 - 0.49)

Table 5: *Results from Univariate and Multivariate analysis of factors associated with Giardia lamblia infections among schoolchildren, Enemorena - Ener and Abeshege districts, Gurage zone, South central Ethiopia, 2014/2015.*

AOR: Ajusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

**The percentage is calculated from the total examined for the respective characteristic*

Socio-demographic risk factors multivariate analyses in schoolchildren in relation to ascaris infection confirmed that use of unprotected water, lack of latrine at home and not washing hands before eating and after defecation had a significant association with *ascaris* infection (P < 0.05) (Table 6).

Variable		Ascaris Positive*	P- value	COR (95%CI)	p- value	AOR (95%CI)
Gender	Male female	27 (7.5) 36 (11.2)	0.02	1.00 1.55 (1.07 - 2.25)	0.27	1.00 1.26 (0.84 - 1.80)
Age category	6 - 9 10 - 14 ≥ 15	6 (6.7) 41 (13) 24 (12.2)	0.004 0.79	1.80 (1.21 - 2.69) 0.93 (0.53 - 1.63) 1.00	0.01 0.88	1.83 (1.17 - 2.86) 1.05 (0.57 - 1.94) 1.00
Water type consumed	Unsafe Safe	23 (18) 40 (7.2)	< 0.001	1.00 0.36 (0.24 - 0.53)	0.002	1.00 0.51 (0.33 - 0.79)
Latrine	Unavailable Available	47 (13.6) 16 (4.8)	< 0.001	0.32 (0.21 - 0.49) 1.00	0.02	1.03 (0.61 - 0.93) 1.00
Family size	2 - 5 > 5	13 (4.5) 50 (12.9)	< 0.001	1.00 3.15 (2.02 - 4.92)	0.36	1.00 1.27 (0.76 - 2.13)
Washing hands before eating	Yes no	12 (2.9) 51 (19)	< 0.001	1.00 7.78 (4.91 - 12.32)	< 0.001	1.00 6.52 (3.69 - 11.54)
Washing hands after defecation	Yes no	28 (14.1) 35 (7.3)	< 0.001	1.00 0.48 (0.33 - 0.69)	0.01	1.00 0.59 (0.39 - 0.88)

Table 6: *Results from Univariate and Multivariate analysis of factors associated with Ascaris lumbricoide infections among schoolchildren, Enemorena - Ener and Abeshege districts, Gurage zone, South Central Ethiopia, 2014/2015.*

AOR: Ajusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

**The percentage is calculated from the total examined for the respective characteristic*

Discussion

Study on the prevalence of intestinal parasites in school age children is decisive [23,24] since they are the high-risk group for infections. Even though, there were continuous efforts made to control IPI during the past decade, infections remained high in Ethiopia [25]. This could be due to low socioeconomic status, poor hygienic conditions, impure drinking water, low literacy rate of parents and large size of the families. Due to differences in the risk factors in different localities, environmental sanitation, culture of the community among regions, the prevalence and distribution of IPI varies in Ethiopia [26, 27]. The most frequent IPI being *Ascaris lumbricoides*, hookworm, *Giardia lamblia*. The study identified key socio-demographic factors linked with these parasitic infections. Use of unprotected water, large family size, not washing hands before eating and after defecation, lack of latrine were found to be predictors of IPI in the children.

The current findings indicated that the prevalence of IPIs (39.6%) was relatively low compared to a previous study carried out on schoolchildren in which the prevalence of intestinal parasites was 83.8% in Southeast of Lake Langano [25]. Furthermore, IPI in the present study was low as compared to the previous study done in Jimma zone, that showed prevalence of intestinal parasites to be as high as 83% and 86.2% in urban and rural setting respectively [5,27], and the study done among North Gondar Delgi school children, that showed the prevalence of intestinal parasites as high as 79.8% [28]. This difference might be due to the current increase of health facilities, periodical mass deworming, differences in study subject and differences in socio-demographic conditions of the society that makes variation in factors exposing IPIs. As a result, risk factors for intestinal parasitic infection in one region may not be determinant in other regions hence contributing to the lower prevalence of parasitic infections.

In current findings seven species of intestinal parasites were identified with an overall prevalence of 39.6% (269 of 680 children). The most prevalent intestinal parasites identified were *Ascaris lumbricoides, hookworm Giardia lamblia, Entamoeba histolytica/dispar, T. tichiura, Taenia* spp, *Schistosoma mansoni*. The prevalence of these parasites are low as compared to a previous study carried out on schoolchildren in which the most prevalent intestinal parasites identified were *Ascaris lumbricoides* (48%), *Giardia lamblia* (41.9%), *Entamoeba histolytica/dispar* (27.3%), *Schistosoma mansoni* (15.9%), Hookworm (11.5%) among North Gondar Delgi school children, that showed the prevalence of intestinal parasites as high as 79.8% [28]. The present findings are in agreement with the previous study done in Assendabo where *Ascaris lumbricoides* was the leading (56.4%) followed by hookworm (25.5%) and *Trichuris trichiura* (21.6%) [27]. The present findings indicates relatively lower than infection rate that was reported from previous studies conducted in Jimma zone intestinal parasitosis (47.1%) [29], in Durbete Town, North western Ethiopia Soil-Transmitted Helminth Infections (54%) [30]. Such differences might be caused due to difference in the study population, better attention in health issues in health facilities (periodic deworming and health education) or differences in the parasitological examination techniques and time of the study.

Current findings were higher than that was reported from previous studies conducted eastern Ethiopia, intestinal helminths with an overall prevalence of 27.2% [31]. The differences in findings among the studies might be due to variations in geography, socio-economic conditions, and the time of study.

The prevalence of *ascaris* and trichuris in Abeshege destrict however, appears significantly lower than hookworm, this could be because of better awareness of the community to keep personal hygiene and environmental sanitation, increasing use of toilet towards a good means of prevention of *Ascaris lumbricoides* and *Trichuris trichiura* infections which are oral-fecal compared to hookworm infection which is via the skin. Furthermore, the prevalence of hookworm in the current study was significantly higher than the prevalence of other intestinal parasites which might be due to the fact that all children are rural and almost all did not wear shoes and played or walked over loamy soils and cultivated fields. As a result, children walking barefoot on the soil contaminated with fecal matter will be exposed to the infective larval stages of the parasite.

In the current study, the prevalence rate of *A. lumbricoides* (9.6%) was found to be higher than studies conducted in Ethiopia around lake Langano (6.2%) [25,32]. In contrast, lower in the studies conducted in Dembia plains (41.3%), South Wollo (18.3%), North Gondar Dembia District (34.4%), south Ethiopia Wondo Genet (84.3%) and Adarkay (43%) [12,33-36]. This might be due to differences in study population, socio-demographic conditions of study subject, expansion of health facilities and time of the study.

The present study also assessed the possible association of intestinal parasitic infection with potential risk factors among schoolchildren in the cohort. Several recent studies have identified a range of socio-demographic risk factors associated with IPI [5,8,28,37,38]. The odds of not washing hands before eating and after defecation, no wearing shoes, defecate in open field, presence of larger family size increases the prevalence of IPI in Enemorena-Ener and Abeshege districts, which conforms study among North Gondar Delgi school children, that showed the prevalence of intestinal parasites as high as 79.8% [28]. This might occur due to similarity in altitude, personal hygiene and environmental sanitation in study population.

Univariate and multivariate analysis was also carried out based on single infection with hookworm, *Giardia lamblia* and *Ascaris lumbricoides*. It was found that children in age category fifteen to nineteen had higher prevalence of overall hookworm infection. This might be due to higher age group children more participated in agricultural activities to help their parents that may exposed to infective larvae in the soil. The odds of hookworm infection were increased in children with no latrine at home, not wearing shoes, no washing hands before eating and after defecation. This indicated that wearing shoes, using protected water, and keeping environmental and personal hygiene might have great importance in protecting hookworm infection. This agreed with previous study done by [39].

Not washing hands before eating and after defecation, lack of latrine at home, illiterate mother and use of unprotected water showed a significant association with giardiasis. This indicated that personal hygiene and environmental sanitation could be the best alternative to protect giardiasis in the study area. This is agreed with previous study done by [40-43].

Using unprotected water, not washing hands before eating and after defecation had a significant association with ascaris infection. These result might indicated that using protected water and avoiding contamination and keeping self-hygiene could contribute to reduction of ascaris infection. This finding is in agreement with previous study done by [8,39].

Conclusions

IPI is common in schoolchildren in this locality. Our finding show that being female, not using safe water, lack of latrine, having family size more than five, not washing hands after defecation, not washing hands before eating increases the risk of IPI. Health education, personal hygiene, presence of latrine and provision of safe water could be important to reduce IPI among schoolchildren in Gurage zone. Deworming intestinal helminths and treatment of protozoa infection will have additional impact on reducing IPI among schoolchildren in Gurage zone.

Declarations

Consent for Publication

All authors confirm that they have agreed to publish this manuscript in ECMI Journal.

Authors' Contributions

MB conceived the project idea, designed the study protocol, collected the data, analyzed the data, interpreted and drafted the manuscript; BP designed the study protocol, collected the data and manuscript reviewing; KU collected the data and manuscript reviewing. All authors read and approved the final paper.

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