Prevalence and associated risk factors of intestinal parasitic infections among primary school children at Bure town, north-west Ethiopia

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ABSTRACT

The burden of intestinal parasitic infections (IPIs) has been a common problem on children in Ethiopia. While communities in Bure town, northwest Ethiopia, are presumed to be exposed to IPIs, no study has been conducted before. The aim of this study was therefore to assess the prevalence of IPIs and associated risk factors among school children in Bure town by conducting a cross-sectional study from January to June 2019. A total of 430 students were selected using stratified systematic random sampling technique. Direct wet-mount and formal-ether concentration techniques were used for parasitological analysis from stool samples taken from each student. Information about the risk factors was collected using structured questionnaire. Data were analyzed using SPSS version 24. The overall prevalence of IPIs among the children involved in the study was found to be 40% (172/430). Some 37.7% of the students exhibited single parasite infection, 2.1% double and 0.23% triple parasite. Seven species of intestinal parasites were detected, and *Entamoeba histolytica/dispar* was the most prevalent parasite (22.1%) followed by *Giardia lamblia* (8.6%), hookworms (6.75%) and *Ascaris lumbricoides* (3.7%). *Hymenolepis nana, Trichuris trichuira* and *Taenia species* were rare (<1% prevalence each). Knowledge about personal and food hygiene as well as environmental sanitation were the most important predictors for IPIs (P<0.05). Primary school children in Bure town are at high risk of IPIs. Awareness creation on personal hygiene and environmental sanitation is strongly recommended.

Keywords: Intestinal parasitic infections, Prevalence, Primary school children, Risk factor, Bure town
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INTRODUCTION

Intestinal parasitosis caused by one or more species of protozoa, cestodes, trematodes and nematodes has been a public health burden globally (Ojha *et al*., 2014). Several of such infectious diseases have already been identified as Neglected Tropical Diseases (NTDs) (Collier, 2007; Hotez *et al.*, 2009; WHO, 2010; Hotez *et al.*, 2014), and they have recently received attention. Accordingly, eradication of NTD through the control of the transmission of IPIs and the mitigation of possible risk factors is one of the sustainable development goals of the United Nations (2030 Agenda; Goal 3.3). As a result, diagnosis of these parasitic diseases has improved a lot. Despite these efforts, most parasitic diseases continue to pose major public health problems, particularly in tropical and subtropical regions (Collier, 2007; Hotez *et al.*, 2009; Hotez *et al.*, 2014).

The high prevalence of IPIs in developing countries depends on several factors (Alum *et al.*, 2010). Poverty linked factors such as poor sanitation, scarcity of potable water, unsafe human waste disposal systems, open field defecation, the prevailing bad climate, and local environmental conditions are the most important risk factors identified. In addition, insufficient health services, as well as lack of the required awareness, due probably to the absence of effective health education are among the contributing factors for the elevated IPIs among poor communities (Sady *et al*., 2015; Alganesh Gebreyohanis *et al.,* 2018; Palmeirim *et al.,* 2018).

Many studies elsewhere indicated that young children were disproportionately affected by IPIs compared to adults due to a less developed immune system, poor personal hygiene and the habit of playing on contaminated soil. IPIs could result in reduced growth, increased risk of protein-energy malnutrition, iron deficiency anemia and reduced cognitive/psychomotor development in young children (Sackev, 2001; WHO, 2010). Millions of pre-school and school children are living in areas where the intestinal parasites are widely transmitted and in need of urgent treatment and preventive interventions (WHO, 2010).

Globally, IPIs caused by pathogenic protozoan species have been reported to be high. Amoebiasis caused by *E. histolytica* is one of the severe diseases, infecting 48 million individuals. The global prevalence of giardiasis is also high (WHO, 2010). Moreover, parasitic worms such as roundworm (Ascaris), hookworm and whipworm remain a global burden in low-income countries (Hotez *et al*., 2009; WHO, 2010; Mascarini-Serra, 2011; Hotez *et al*., 2014). The protozoan parasite and the soil-transmitted helminths are thus the most prevalent intestinal parasites, resulting in high morbidity and mortality particularly in developing nations such as in sub-Saharan African countries (WHO, 2010). Many reports

have shown that the frequency of IPIs in the region is extremely high, affecting nearly all inhabitants at some point during their lives.

Federal Ministry of Health of Ethiopia (FMHE) launched the Health Extension Program (HEP) in 2003, made operational since 2004, by training thousands of Health Extension Workers (HEW) and assigning them in villages. The HEWs focus on disease prevention and health promotion at the village level, which is the health policy of the Ethiopian government since the turn of the 21st century. The program was meant to accelerate the country's progress in meeting some of the Millennium Development Goals (MDGs). Despite the efforts, a significant segment of the Ethiopian population is still under high burden of IPIs due to the risk factors linked to poverty and lack of awareness on ways of disease prevention and control (Ashenafi Abosie and Mohammed Seid, 2014; Alganesh Gebreyohannis *et al.,* 2018). Thus, in the different regions of Ethiopia, elevated prevalence of IPIs (up to 84%) was reported among high-risk groups such as primary school children (Ashenafi Abosie and Mohammed Seid, 2014; Merem Abdi *et al*., 2015; Tamirat Hailegebrael, 2017; Baye Sitotaw et al., 2019).

According to reports from clinics and health centers in Bure town, many people visit health centers mainly due to IPIs. However, there was no previous study conducted on the prevalence of IPIs and associated risk factors in Bure town. Therefore, this study was conducted to estimate the prevalence of IPIs and associated risk factors among primary school children in Bure town.

MATERIALS AND METHODS

Study design and study area

A school based cross-sectional parasitological study was conducted from January to June 2019 to determine the prevalence of IPIs and associated risk factors among students of Bure primary schools, north-west Ethiopia. Bure town is located 410 km north-west of Addis Ababa (the capital city of Ethiopia). Bure town is the capital of Bure district and is located at the geographical location of 10°42' N and 37°04' E and an elevation of about 2091 meters above sea level. Agro-ecologically, most parts of the area around the town (about 82%) is intermediate altitude. The annual mean temperature of the town is about 22 °C, and the average annual rainfall ranges from 1400 to 2200 mm. Based on the 2015 national housing and population census, the total population of Bure town was 76,368, of whom 37,820 were male and 38,548 were female. The main source of income for the population in the area is agriculture and trade. The area is one of the consistently surplus producer districts of the region. Relatively, the

district has better road density, connected by all-weather roads to the neighboring districts and regions, that improved market access for agricultural inputs and farm products to different regions.

In Bure town administration, there are two hospitals (one government owned, one private), one health center, two private clinics and eight health posts that provide routine health services for the population of the town. In 2018/19, five thousand students were enrolled in the 6 general primary schools (1-8) and 5 first cycle primary schools (1-4). According to secondary data obtained from Bure town health office and water service management office, the health coverage in the town was 97%, while water coverage was 57% in the rural area and 63% in the town. Water supply and latrines were available for the students in the four selected schools. According to the information obtained from Bure town health office, mass de-worming campaign was practiced in the area once a year with full coverage of school children. Mass de-worming was conducted at the end of June (2019), right after we completed our sampling.

Study population, sample size and sampling procedures

The study population was all school children enrolled in Bure general primary Schools (from grades 1 to 8). The total number of enrolled students in the 2018/19 academic year was 5820. Since there was no similar study previously conducted in the area, a 50% prevalence rate of IPIs was taken, assuming that IPI is significantly prevalent among Bure primary school children. Accordingly, the minimum number of sample size (n) required was determined using single population proportion formula for cross-sectional surveys (Naing *et al*., 2006), i.e., $n = Z^2 p (1-p)/d^2 = 1.96^2*0.50*0.50/.05^2 = 384$ students. To compensate for the non-respondents and to minimize errors probably arising from the likelihood of non-compliance, 12% of the calculated sample size was added giving a final sample size of 430 study participants. Four primary schools were purposely selected (two from rural and two from urban) for this study. Study participants were then selected using systematic random sampling from the students stratified into grade levels (Grades 1 to 8) according to the standards in Williams *et al.* (2012) to include 430 school children.

Sample collection and processing

A structured questionnaire based on known risk factors was developed in English and translated into Amharic (local language). The participants of the study (parents in the case of younger children) were interviewed to obtain socio-demographic data, hygienic practices and knowledge of the participants about personal hygiene, food hygiene, and environmental sanitation. For the assessment of the level of knowledge, participants were asked whether the

following factors could be means of intestinal parasitic infections or not: untrimmed fingernails and dirty fingernails, not washing hands after toilet use, not washing hands before and after a meal, eating uncooked meat and or unwashed fruits and vegetables, drinking water from unprotected sources (streams, rivers or unprotected springs) without treating (boiling or adding chemical), disposing of wastes, as well as defecating in the open field. Those participants who said "no" for more than 75% of the questions were rated as having poor knowledge while those who replied "yes" for more than 75% of the questions were rated as having good knowledge. Then, the responses were translated back into English. The questionnaire was pre-tested using forty individuals outside the study area in a non-study sample population.

For parasitological analysis, fresh stool samples were collected. The children were instructed properly and given clean labeled collection cups along with applicator sticks, and from each student, about 2 g of fresh stool was collected. At the time of collection, date of sampling, the name of the participant, age and sex were recorded for each subject in a recording format. Stool sample was transported to Bure Health Center Laboratory. A portion of each of the stool samples was processed and examined microscopically using direct wet-mount, while the other portion was processed and examined using formal-ether concentration techniques following the procedures in the WHO guidelines (WHO, 2000). All developmental stages of the parasites, i.e., cysts, eggs, larvae and adults were recorded.

Data analysis

Statistical Package for Social Science (SPSS) software version 24 was used to analyze the data. Chi-square (χ^2) test was performed to verify the possible association between the prevalence of IPIs and socio-demographic characteristics, behavioral factors, hygienic practices, and environmental sanitation factors. Logistic regression was used to measure the strengths of the association between the infection and the risk factors using odds ratio. In the modeling process, a bivariate analysis was first done with a 0.25 level of significance to select the candidate variables for multivariate analysis. The variables, significant in the bivariate analysis were then included in the multivariate analysis (Lemeshow *et al.*, 2013). Values were considered statistically significant at $P<0.05$.

Limitation of the study

The study was limited to the presence or absence of infections without quantifying the parasite load, a situation that might not mean that students

developed the disease. *Entamoeba histolytica* and *E. dispar* were not differentiated due to lack of the required reagents. In addition, a self-reported data collection method was used which may also be a source of potential bias.

Ethical approval and consent to the participants

Before collecting the data, the ethical review committee of Science College, Bahir Dar University cleared the study, and a letter describing the objective of the research was written to Bure town Administration Educational Office and the four Elementary Schools. Consent was obtained from the children's parents/guardians selected for the study after explaining the purpose and the procedures of the study. The study subjects who were positive for intestinal parasites were treated free of charge at the Health Center with drugs prescribed by a physician.

RESULTS

Socio-demographic characteristics of the study participants

All the 430 students selected for this study gave a stool sample for intestinal parasitic examination and filled the questionnaire about risk factors. One hundred ninety (44.20%) students belonged to grades 1 to 4 and 240 (55.80%) to grades 5 to 8. The age of the participants ranged from 6 to 18 years; 47.4% were 6 to 11 years old and 52.6% were 12 to 18 years old (Table 1). More than half of the participants were urban dwellers (66.5%); the number of male and female students was almost equal; 63% had literate father, while a little more than half (54.7%) of them had illiterate mothers (no formal education); the fathers of some 65% of the students were engaged in farming and 71% of students had mothers who were housewives; and most were from a family size of 5 and above (69.1%) (Table 1). Regarding hygienic, behavioral and environmental sanitation factors, 93.7% of the participants had latrine and 90% of them used the latrine for defecation. Some 74% of the participants used tap water for drinking. In contrast, 63% of the participants used to dump household waste in open fields, and a considerable proportion, i.e., 47.7%, of the participants had a low level of knowledge about personal and food hygiene and about environmental sanitation (Table 2).

Prevalence of intestinal parasitic infections

The prevalence of infection was significantly higher in rural (48%) than in urban (35%) participants, and the difference was a statistically significant. Rate of intestinal parasitism was similar between the sexes.

Table 1. Socio-demographic characteristics of school children attending at Bure town primary schools, Ethiopia, 2019. (N=430).

Variables	Categories	Frequency (%)
Grade level	1-4	190(44.2)
	5-8	240(55.8)
Residence	Urban	286(66.5)
	Rural	144(33.5)
Age in year	6-11	204(47.4)
	12-18	226(52.6)
Sex	Male	212(49.3)
	Female	218(50.7)
Mothers' educational status	Literate	195(45.35)
	Illiterate	235(54.65)
Mothers' occupation	Employee	56(13)
	Merchant	69(16)
	Housewife	305(71)
Fathers' educational status	Literate	271(63)
	Illiterate	159(37)
Fathers' occupation	Employee	80(18.6)
	Merchant	70(16.3)
	Farmer	280(65.1)
Family size	3 and below	32(7.44)
	4	101(23.5)
	5 and above	297(69.1)

The age group 12-18 years old (42%) had higher overall infection rate than the age group 6-11 years (36%), though not significant (P>0.05). Intestinal parasitic infection was not significantly associated with educational status of mothers and fathers, with occupations of mothers and fathers and with family size (P>0.05) (Table 2). Rate of IPI was significantly higher among participants who washed clothes at the river (45.4%) than those who did it at home (31.6%), and participants who had poor knowledge about personal and food hygiene, and environmental sanitation (48.3%) than those who had good knowledge (31.1%) (P<0.05). The rest of the risk factors did not show significant association.

Some 40% (172/430) of the study participants were infected by at least one intestinal parasite. The prevalence of protozoan infection was 128(29.8%), helminths was 51(11.9%) and mixed infections was 10(2.3%) (Table 3). Seven species of intestinal parasites (IPs) were detected, of which *Entamoeba histolytica/dispar* (22.1%) was the most prevalent, followed by *Giardia lamblia* (8.6%), Hookworms (6.8%) and *Ascaris lumbricoides* (3.7%). *Hymenolepis nana, Trichuris trichuira* and *Taenia species* were rare (<1% prevalence). Some

162 (37.7%) of the participants were found infected by single parasite, 9 (2.09%) by two parasites and 1(0.23%) by three parasites (Table 3).

Table 2. Prevalence of Intestinal Parasitic Infections (IPIs) among Bure primary school children by the different risk factors, Ethiopia, 2019.

Variables	Categories	Total Number (%)	Negative No. (%)	Positive No. (%)
Residence[a]	Urban	286(66.5)	186(65.0)	100(35.0)
	Rural	144(33.5)	75(52.1)	69(47.9)
Age (year)	6-11	204(47.4)	130(63.7)	74(36.3)
	12-18	226(52.6)	131(58.0)	95(42.0)
Grade level	1-4	190(44.2)	121(63.7)	69(36.3)
	5-8	240(55.8)	137(57.1)	103(42.9)
Sex	Male	212(49.3)	129(60.8)	83(39.2)
	Female	218(50.7)	131(60.1)	86(39.9)
Mothers' education	Literate	195(45.4)	117(60.0)	78(40.0)
	Illiterate	232(54.0)	144(62.1)	88(37.9)
	Other	3	0	3
Mothers' occupation	Government employee	30(7.0)	16	14
	Merchant	68(15.8)	41(60.3)	27(39.7)
	Others	5	2	3
	Private sector	22	11	11
	Housewife	305(70.9)	191(62.6)	114(37.4)
Fathers' education	Literate	271(63.0)	162(59.8)	109(40.2)
	Illiterate	159(37.0)	99(62.3)	60(37.7)
Fathers' occupation	Government employee	79(18.4)	44(55.7)	35(44.3)
	Merchant	70(16.3)	44(62.9)	26
	Others	60(14.0)	42(70.0)	18
	Farmer	221(51.4)	130(58.8)	91(41.2)
Family size	2	3	1	2
	3	29	15	14
	4	101(23.5)	59(58.4)	42(41.6)
	5 and above	297(69.1)	186(62.6)	111(37.4)
Source of drinking water	Tap water	318(74.0)	198(62.3)	120(37.7)
	Unprotected spring/stream	112(26.1)	63(56.3)	49(43.8)
Drinking water treatment practice	Treated	31(7.2)	20(65.5)	11(35.5)
	Untreated	399(92.8)	238(59.6)	161(40.4)
Ways of disposing household wastes	Burning	133(30.9)	91(68.4)	42(31.6)
	Bury under ground	26	17	9
	On open field	271(63.0)	153(56.5)	118(43.5)
Hand washing habit before a meal	Always	383(89.1)	236(61.6)	147(38.4)
	Sometimes	47(10.9)	25(53.2)	22(46.8)

Latrine availability	Present	403(93.7)	243(60.3)	160(39.7)
	Absent	27	18	9
Hand washing habit after using toilet	Always	196(45.6)	121(61.7)	75(38.3)
	Sometimes	194(45.1)	122(62.9)	72(37.1)
	Not at all	40(9.3)	18(45.0)	22(55.0)
Place of defecation	Open field	44(10.2)	30(68.2)	14(31.8)
	Latrine	386(89.8)	231(59.8)	155(40.2)
Habit of eating uncooked vegetables and unwashed fruit	Yes	375(66.0)	227(60.5)	148(39.5)
	No	55(34.0)	34(61.8)	21(38.2)
Habit of eating raw/uncooked meat[a]	Yes	306(71.2)	178(58.2)	128(41.8)
	No	124(28.8)	83(66.9)	41(33.1)
Habit of swimming in river	Yes	219(50.9)	135(61.6)	84(38.4)
	No	211(49.1)	126(59.7)	85(41.3)
Practice of crossing river	Yes	333(77.4)	205(61.6)	128(38.4)
	No	97(22.6)	56(57.7)	41(42.3)
Bath	Stream	187(43.4)	113(60.4)	74(39.6)
	At home	243(56.5)	148(60.9)	95(39.1)
Washing clothes[a]	At home	190(44.2)	130(68.4)	60(31.6)
	At river	240(55.8)	131(54.6)	109(45.4)
Consistency of wearing shoes	Always	316(73.5)	196(62.0)	120(38.0)
	Sometimes	112(26.0)	64(57.1)	48(42.9)
	Not at all	2	1	1
Dirty in fingernails	Yes	237(55.1)	139(58.6)	98(41.4)
	No	193(44.9)	122(63.2)	71(36.8)
KPFHES[a,b]	Good	225(59.3)	155(68.9)	70(31.1)
	Poor	205(47.7)	106(51.7)	99(48.3)

[a]=Significant at P value ≤0.05; [b]=Knowledge about personal & food hygiene, and environmental sanitation.

Logistic regression analysis of risk factors

The most important risk factors for IPIs among Bure primary school children were identified using logistic regression analysis (Table 4). A bivariate analysis was first conducted with a 0.25 level of significance to select the candidate variables for multivariate analysis. Ten out of 25 variables were significant in the bivariate analysis (Table 4) and included in the multivariable analysis (Lemeshow *et al*., 2013). Of these risk factors, KPFHES (knowledge about personal and food hygiene, and environmental sanitation) and place of defecation were found to be predictors of IPIs (Table 4).

Accordingly, the risk of being infected by IPIs was increased two times (*AOR=1.986, CI=1.288-3.060, P=0.002*) in participants who had poor knowledge than those who had good knowledge about personal and food hygiene, and environmental sanitation. Regarding the place of defecation, participants who practiced open field defecation were 55.6% less likely to be infected by IPIs than those who used the latrine (Table 4).

Table 3. Prevalence of parasites detected on school children in primary schools at Bure town, north- west Ethiopia, 2019.

Parasite groups	Parasite species	Total number (%)
Protozoa	*E. histolytica/dispar*	95(22.1)
	G. lamblia	37(8.6)
Helminths	Hookworm	29(6.7)
	A. lumbricoides	16(3.7)
	Hymenolepis nana	3(0.7)
	Trichuris trichuira	2(0.5)
	Taenia species	1(0.2)
Single infection	-	162(37.7)
Double infections	-	9(2.1)
Multiple infections	-	1
Overall infections	-	172(40)

DISCUSSION

Developing countries continue to suffer from the persistent burden of IPIs (Kebede Derbie *et al*., 2012). Eradication efforts of these neglected diseases were largely unsuccessful due to multiple factors. Lack of information about local risk factors of IPIs from different localities is one constraint for effective intervention. The current study was, therefore, an effort to contribute for generating information about the occurrence of intestinal parasites in the study area. The overall prevalence of IPIs among primary school children in Bure town was high (40%), corroborating previous reports on school children (30-44%) elsewhere in Ethiopia (Aschalew Gelaw *et al.*, 2013; Alemneh Abera and Endalkachew Nibret, 2014; Admasu Haile *et al*., 2017; Megbaru Alemu *et al.*, 2015). A number of other studies identified high risk communities, i.e., 55 to 81% rate of IPIs (Abdi *et al*., 2015; Tilahun Alehegn *et al*., 2015; Tamirat Hailegebrael, 2017; Baye Sitotaw *et al*., 2019), who concluded that intestinal parasitosis continued to be a nationwide public health concern. In order to improve public health services and meet some of the Millennium Development Goals, the community-based accelerated expansion of health facilities in Ethiopia was launched and operated since 2004. With the current pace, however, it may be difficult for Ethiopia to achieve the 2020 strategic goals.

Table 4. Bivariate and multivariate logistic regression analysis of potential risk factors associated with IPIs among school children at Bure primary schools, north-west Ethiopia, 2019.

Variables	Categories	Total No. (%)	Positive No. (%)	COR (95% C.I.)	AOR (95% C.I.)
Grade level	1-4	190(44.2)	69(36.3)	0.76(0.51-1.12)	-
	5-8	240(55.8)	103(42.9)	1	-
Residence	Urban	286(66.5)	100(35.0)	1	-
	Rural	144(33.5)	69(47.9)	1.86(1.28-2.79)[a]	-
Age group	12-18	226(52.6)	95(42.0)	1	-
	6-11	204(47.4)	74(36.3)	0.74(0.50-1.09)	-
Hand washing habit after toilet	Always	196(45.6)	75(38.3)	1	-
	Sometimes	194(45.1)	75(38.7)	1.02(0.67-1.52)	-
	Not at all	40(9.3)	22(55.0)	1.97(0.99-3.91)	-
Place of defecation	Latrine	386(89.8)	158(40.9)	1	-
	Open field	44(10.2)	14(31.8)	0.67(0.35-1.31)	0.42(0.20- 0.89)[a]
Place of washing clothes	At home	190(44.2)	60(31.6)	1	-
	At river	240(55.8)	109(45.4)	1.90(1.27-2.82)[a]	-
Disposal of household wastes	Burning	133(30.9)	42(31.6)		-
	Bury under ground	26(6.0)	9(34.6)	1.15(0.47-2.8)	-
	Open field	271(63.0)	121(44.6)	1.75(1.13-2.7) [a]	-
Dirty finger nails	No	193(44.9)	71(36.8)	1	-
	Yes	237(55.1)	98(41.4)	1.28(0.86-1.88)	-
KPFHES[b]	Good	225(59.3)	70(31.1)	1	-
	Poor	205(47.7)	99(48.3)	1.95(1.31-2.87)[a]	1.94(1.26-3)[a]
Habit (eating uncooked meat)	Yes	306(71.2)	128(41.8)	1.52(0.97-2.34)	-
	No	124(28.8)	41(33.1)	1	-

Note: 1= reference value; [a]=statistically significant at p≤0.05,COR=crude odds ratio; AOR=adjusted odds ratio; multivariate regression model for grade level, residence, age, place of defecation, hand washing habits after toilet use, uncooked meat eating habits, place of washing clothes, ways of disposing household wastes,dirty things in finger nails and knowledge about personal & food hygiene and environmental sanitation for intestinal parasitic infections; [k]nowledge about Personal &Food hygiene, and Environmental Sanitation.

Poverty related variables such as unsafe and inadequate water supply, unhygienic food consumption and overcrowded settlements are generally considered as the leading risk factors for intestinal parasitosis. However, Bure town is located in a moderate agro-ecological area and with surplus agricultural products. Therefore, the problem related to the prevalence of such diseases of poverty is likely due to a lack of awareness about the basics of prevention and control of parasitic diseases. Lack of knowledge could lead to a low level of personal hygiene and environmental sanitation.

Only a few studies in Ethiopia have shown relatively lower prevalence rates of IPIs (9.5 to 27%) (Begna Tulu *et al.,* 2014; Girum Tadesse, 2005; Aschalew Gelaw *et al.,* 2013; Getaneh Alemu *et al.*, 2015; Habtamu Woldesenbet *et al.,* 2019). The reasons for such reduced prevalence may be that some of these studies were conducted after the mass de-worming program (Habtamu Woldesenbet *et al*., 2019) in the study population, or the study was conducted at the well-aware community such as university community schools in Gonder (Aschalew Gelaw *et al.,* 2013). In addition, the technique used to identify intestinal parasites may influence the prevalence rate. For example, Girum Tadesse (2005) used only formal-ether concentration technique that might underestimate the result.

Out of the 25 variables considered in this study, a low level of awareness about personal and food hygiene and environmental sanitation were found to be the most important risk factor for IPIs among the study participants (Table 4). In line with this, Alum *et al.* (2010) emphasized that poor hygienic practices, primarily due to lack of proper handwashing habits, could significantly increase the rate of IPIs. Regarding the place of defecation, a contradicting result was observed where participants who practiced open field defecation were 55.6% less likely to be infected by IPIs than those who used latrine. Most of the participants (89.8%) reported that they had latrines. Thus, it could likely be attributed to the quality of latrine, hygienic practices after latrine use and other factors for the infection.

Among the seven species of intestinal parasites (IPs) identified, *Entamoeba histolytica/dispar* was the predominant species (22.1%). Similarly, Abddel-Aziz *et al*. (2010) in Central Sudan, Al-Harazi (2016) in Yemen, Tamrat Hailegebrael (2017) in Bahir Dar town, Ethiopia, have also reported that *E. histolytica* was the dominant parasite detected among school children. Indeed, this intestinal parasite is the most common in tropical areas where poor sanitation prevails. In a number of other studies, however, *A. lumbricoides, Giardia lamblia* or Hookworm species were found to be the most dominant species frequently identified among school children (Megbaru Alemu *et al.*, 2015; Tilahun Alehegn *et al*., 2015; Admasu Haile *et al*., 2017; Baye Sitotaw *et al*., 2019;

Getaneh Alemu *et al*., 2019; Habtamu Woldesenbet *et al.,* 2019). *Giardia lamblia* (8.6%), Hookworms (6.75%) and *Ascaris lumbricoides* (3.7%) were also detected among the participants of this study, though they were at a lower rate compared to other similar studies (Alemneh Abera and Endalkachew Nibret, 2014; Ashenafi Abosie and Mohammed Seid, 2014; Mulusew Andualem, 2014; Tamirat Hailegebrael, 2017; Getaneh Alemu *et al*., 2018; Baye Sitotaw *et al*., 2019). The rate of multiple infections was relatively low in this study (10, 2.3%) unlike the results in many other studies (e.g., Mulusew Andualem, 2014)

CONCLUSION

In this study, we have confirmed that a significant proportion of school children in Bure town were infected with intestinal parasites (IPs). This indicates that IPIs are important public health concerns in the area, and calls for immediate action to alleviate the problem. We have also confirmed that the same range (and prevalence) of intestinal parasitic species occur as previous reports in other places in Ethiopia and elsewhere in the globe (particularly in developing countries). Of the potential risk factors considered, knowledge (about personal and food hygiene, and environmental sanitation) and place of defecation were found to be the most important risk factors for IPIs among the students in Bure primary schools. Bure town health service quality and awareness creation activities on the prevailing risk factors should thus be properly evaluated. All concerned bodies (decision-makers, mass media, health workers, religious leaders, and teachers) should work in collaboration to reduce the parasite burden. Practical action plans for effective prevention and control of IPIs in the study area should be in place. Primarily, an awareness creation campaign should be conducted on school children and their parents. In addition, coverage and frequency of the de-worming campaign should be improved to eliminate soil-transmitted helminths in the study area.

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