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Prevalence of intestinal protozoan parasites in school children and its associated risk factors at Grawa town, eastern Ethiopia

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Abstract

Background: parasitic infections are one of the major public health problems in developing countries including Ethiopia. The objective of the present study was to assess and determine the prevalence (magnitude) of major intestinal protozoan parasites and associated risk factors among schoolchildren in Grawa town, Eastern Ethiopia. **Methods:** The design of the study was a cross-sectional investigation involving a sample population of 384 primary school children at Grawa primary school who were voluntary during May-July 2018. 384 fresh stool samples of children were examined using direct wet-mount, Formal-Ether concentration and Modified Ziel-Neelsen methods. Of the 384 faecal samples examined, 222 (57.8%) were male and 162(42.2%) were female children.

Results: It was found that 41/222 (18.5%) male and 35/162 (21.6%) female children were infected with intestinal protozoan parasites. The overall prevalence of infections with different types of intestinal protozoan parasites was (19.8%). From the prevalence of protozoan parasites, *E. histolytica*, *G. lamblia* and *Cryptosporidium* infection was 9.1%, 7.3% and 3.4%, respectively. The risk factors that are most associated with intestinal protozoan parasites were eating unwashed fruits, drinking, washing and utilization of unprotected water and because of latrine quality problem ($p<0.05$). Infection of children with protozoan parasite leads to underweight because it shares nutrients that needs for the development of child.

Conclusion: The findings suggested that, personal hygiene, environmental sanitation, water treatment and health education are needed to reduce the prevalence of intestinal parasitic infections among schoolchildren in the study area.

Keywords: anthropometric measurement, Grawa, prevalence, protozoan, primary school children, risk factors

Introduction

Intestinal parasitic infections constitute one of the most significant public health challenges in tropical and subtropical regions, particularly among economically disadvantaged populations.[1] These infections are responsible for considerable morbidity and mortality worldwide and remain especially prevalent in developing countries, including Ethiopia.[2] Their distribution is closely linked to poverty-related conditions such as inadequate personal hygiene, limited access to safe drinking water, poor environmental sanitation, unfavorable climatic conditions, contamination of soil and water by human excreta and animal waste, malnutrition, reduced host immunity, and large household size.[3,4]

Intestinal protozoan parasites are found globally; however, their prevalence is markedly higher in low-income countries where sanitation infrastructure, water supply systems, healthcare services, and health education are insufficient.[5] Children are particularly susceptible to intestinal parasitic infections because their immune systems are not fully developed and because they frequently engage in behaviors that increase exposure, such as playing in fecally contaminated environments.[6] In addition to causing direct morbidity, intestinal protozoan infections have been shown to adversely affect children's cognitive development, learning ability, physical growth, and overall fitness, while also increasing susceptibility to other infectious diseases.[7,8]

Globally, it is estimated that approximately 3.5 billion people are infected with intestinal parasites, and about 450 million individuals suffer from clinical illness associated with these infections.[9,10] While extensive research has been conducted on the epidemiology of intestinal helminths, comparatively fewer studies have focused on intestinal protozoan parasites, despite their significant contribution to diarrheal disease burden.[11]

Among the most important protozoan pathogens, *Entamoeba histolytica* and *Giardia lamblia* are estimated to infect about 60 million and 200 million people worldwide, respectively.[12] A study conducted in 2010 among children under five years of age reported prevalence rates of 20% and 60.1% for *Giardia duodenalis* using microscopic and PCR diagnostic methods, respectively, demonstrating the substantial burden of infection and the influence of diagnostic approaches on prevalence estimates.[13]

Giardiasis, caused by *Giardia lamblia*, is one of the most common causes of protozoan-related diarrhea and can have serious consequences for the growth and development of children.[14] It affects approximately 200 million people worldwide[15] and is widely distributed across all major regions of Africa.[16] Giardia cysts have been identified during investigations of diarrheal outbreaks, such as those reported in Offoumpo village in the Abbeville area.[17] Similarly, high prevalence rates of *E. histolytica* have been documented in several settings,[18] and the presence of blood in stool has frequently been associated with amoebiasis.[19]

Amoebiasis may manifest in acute forms, characterized by frequent dysentery, necrotic intestinal mucosa, and abdominal pain, or as a chronic disease with recurrent episodes of bloody and mucoid diarrhea. In some cases, *E. histolytica* invades extraintestinal organs, including the liver, lungs, and brain, resulting in abscess formation and severe complications such as liver dysfunction, pneumonitis, and encephalitis.[9]

Cryptosporidium species were first described in 1907, but comprehensive understanding of their biology, epidemiology, and clinical significance in humans has been achieved only in recent decades. During the 1990s, *Cryptosporidium parvum* emerged as one of the most important pathogenic contaminants of drinking water, largely due to its low infectious dose and high resistance to commonly used disinfectants such as chlorine, as well as its ability to survive under adverse environmental conditions, including low water temperatures. As a result, *C. parvum* has been implicated in numerous waterborne diarrheal outbreaks affecting both adults and children exposed to contaminated drinking water.[20] Furthermore, intestinal protozoan infections often exhibit marked seasonal variation, influenced by climatic factors and changes in water availability and sanitation practices.[21,22]

Giardiasis and cryptosporidiosis are particularly common among children, and transmission frequently occurs through close contact with infected individuals. School-aged children are at increased risk due to overcrowded classrooms, inadequate sanitation facilities, and shared water sources.[23] In Ethiopia, the high prevalence of intestinal protozoan infections is largely attributable to low socioeconomic status, characterized by poor personal hygiene, inadequate environmental sanitation, low household income, overcrowding, and limited access to clean and safe water supplies. Currently, *Giardia duodenalis* (syn. *Giardia intestinalis*, *Giardia lamblia*) is recognized as the most prevalent intestinal protozoan parasite worldwide, with East Africa considered one of the most endemic regions.[13]

Human intestinal protozoa are classified as either pathogenic or non-pathogenic. While pathogenic species cause overt clinical disease, non-pathogenic protozoa are epidemiologically important as indicators of fecal–oral transmission, poor hygiene, and inadequate sanitation within a community.[24] Ethiopia remains among the countries with the lowest coverage of safe drinking water and latrine facilities.[25] Despite this, information regarding the prevalence and associated risk factors of intestinal protozoan infections is limited in several parts of the country, including the present study area, Grawa town.

Moreover, data on community knowledge regarding parasite transmission, personal and environmental hygiene practices, sanitation, proper latrine utilization, health-seeking behavior, and the influence of family size on intestinal protozoan infections among school children are scarce. Therefore, this study aims to determine the prevalence of intestinal protozoan parasites and to identify associated risk factors among school children using different water sources in Grawa town, eastern Ethiopia.

Materials and methods

The study area

Grawa town is found in East Hararghe, located at 9°7'59"N and 41°4"E with an elevation of 2328 m.a.s.l in Eastern part of Ethiopia that is 75Km from Harar city or 600Km from Addis Ababa city. It was founded in 1868 E.C and has the population of more than 15,337 nowadays. The Grawa town receives an average annual rain fall of 550-1100mm and have bimodal pattern. Grawa's weather condition is temperate and has the monthly average minimum and maximum temperature of 8°C and 20°C, respectively. Grawa town get water mainly from Pipe water, stream and rivers (source from the Grawa agricultural office and Grawa town administration office).

The study design

The study design was a cross-sectional survey on intestinal protozoan parasitic infections and associated risk factors in school children and drinking water sources at Grawa town. It was conducted from April to July, 2018.

The study participants

The study participants were voluntary Grawa primary school children.

Exclusion criteria

All children who started anti parasitic drugs and completed treatment were not included in this study.

Sample size determination and sampling techniques

The sample size was calculated using the formula for cross-sectional survey:[26]

$$n = Z^2.p\left(1-P\right)/d^2$$

$$n = 384$$

Where: n= sample required

z= 95% confidence interval (1.96)

d= margin of error (5%)

p= prevalence rate.

Since the overall prevalence rate (p) of intestinal parasites is not known for the study area, prevalence will be taken to be 50%. Hence, the required sample sizes were 384.

Method of data collection

Clinical examination

The study participants were examined physically for variables such as the presence or absence of hygienic conditions, consistency of feces, physical condition and symptoms such as abdominal discomfort, nausea, vomiting loss of appetite and other body abnormalities with the help of health technician.

Anthropometric measurements

Anthropometric variables were measured according to standard anthropometric techniques. Height was measured to the nearest of 0.5 cm without shoes. Weight was determined to the nearest of 0.1 kg with the participant in light clothes and without shoes using pre-calibrated weighing scale. Body mass index (BMI) was calculated based on the following formula: weight (kg) divided by height (m^2).[27]

Stool collection and processing

A single fresh stool sample was collected with labeled stool cup (plastic container) from consulted study subjects and transported to the laboratory for examination within one hour of delivery (April – July). At the time of sampling date of sampling, age, sex, consistency of feces (Diarrhea or Non-diarrhea (normal), and code number were recorded for each child on the record format. The questionnaires concerning the prevalence study was filled by all the study participants' parents/caretakers during sample collection. A portion of the stool was preserved with SAF (15g Sodium acetate, 20ml glacial acetic acid, 40ml formalin and 925ml distilled water) in a proportion of 1g of stool in 3ml of Sodium Acetate–acetic acid–Formalin (SAF). The remaining part was processed following standard procedures under 2.7.[28]

Questionnaires survey

Structured questionnaires were developed in English and then translated into the local language (0romifa). These interviews with a few open-ended interviews were used to gather relevant general information on demographic and socioeconomic data on the children and their parents in the study area. The questionnaires were administered and observations on physical situations were recorded.

Laboratory parasitological procedures

Stool sample examination procedures

Direct wet mount method

A direct wet mount with normal saline (0.85% NaCl solution) were prepared at the laboratory and observed for the presence of motile intestinal parasites and trophozoite under light microscope at 10X and 40X magnification. Lugol's iodine staining was used to observe cysts of intestinal parasites.

Formol-ether concentration method

Using an applicator stick, about 1 g of preserved stool sample was placed in a clean 15 ml conical centrifuge tube containing 7 ml formalin. The sample was dissolved and mixed thoroughly with applicator stick. The resulting suspension was filtered through a sieve (cotton gauze) into a beaker and the filtrate was poured back into the same tube. The debris trapped on the sieve was discarded. After adding 3 ml of diethyl ether to the mixture and hand shaken, the content was centrifuged at 2000 rpm for 3 minutes. The supernatant was poured away and the tube is replaced in its rack. Iodine stain preparation was made from the sediments. Finally, the entire area under the cover slip was systematically examined using ×10 and ×40 objective lenses.

Modified Zeihl-Neelsen method

For detection of *Cryptosporidium* oocyst, direct and concentration, smears were prepared. Fresh faecal sample was collected from children, thin smears were prepared, dried, fixed with methanol for 5 minutes in the field and stained by Zeihl-Neelsen techniques, and the same procedure was used for smears prepared after concentration. In this technique, the slides were stained with carbol fuschine for 30 minutes and thereafter, they were washed with tap water. The slides were decolorized in acid alcohol for 1 minute and were counter stained with methylene blue for another 1 minute. Finally, the stained smears were microscopically observed using 100x magnifications.

Data analysis

Statistical analysis was done by using SPSS window Version 16.0. Anthropometry indices were computed using the calculator mode of anthropometry calculating software program. Underweight, Normal health and overweight was defined within what was expected on the base of international growth reference scale.[27] Data were summarized using frequency tables. The strength of association was measured by using the odd ratio and its associated p-value. Values were considered statistically significant when the p-value obtained is ≥ 0.05.

Ethical consideration

The study was reviewed and approved by the ethics committee of Grawa health office. At the beginning of the study, the objective of the study was explained to the households, to Grawa primary school, to Garamulata hospital administrative officer, health extension workers and Grawa town administrative officer. Institutional consent was obtained from Grawa administrative office before conducting the study.

Data quality control (DQC)

To ensure quality control, all the laboratory procedures including collection and handling of specimens were carried out in accordance with standard protocols. To ensure general safety, disposable gloves were worn and universal bio-safety precautions[29] were followed at all times. For the quality control of the concentration method, preserved stool specimens known to contain parasite oocyst, cyst and trophozozoites were included in each batch of samples to be concentrated to ensure that the procedures are precise.

Results and discussion

Prevalence of intestinal protozoan parasites in school children by sex

The result of prevalence of intestinal protozoan parasite infections among examined schoolchildren are summarized and presented in Table 1. According to the results shown in table 1, the prevalence of intestinal protozoan parasite infections (IPPI) among examined schoolchildren of both sex and all age groups was 19.8%(76/384). Of these, the prevalence of IPPI among examined male schoolchildren was 18.47% (41/222).

Table 1 Prevalence of intestinal protozoan parasites among school children by sex in Grawa town

Parasite identified	Sex	Number of examined	No. of positive Prev.%	No. of negative prev%	P-value
Amoeba	Male	222	22(9.9%)	200(90.1%)	
	Female	162	13(8.0%)	149(92%)	0.526
Giardia	Male	222	16(7.2%)	206(92.8%)	
	Female	162	12(7.4%)	150(92.6%)	0.941
Cryptosporidium	Male	222	4(1.8%)	218(98.2%)	
	Female	162	9(5.6%)	153(94.4%)	0.045
Total	Male	222	41(18.47%)	181(81.5%)	
	Female	162	35(21.60%)	127(78.4%)	
	Total	384	76(19.8%)	308(80.2%)	

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Similarly, the prevalence of IPPI among examined female schoolchildren was 21.6% (35/162). Although there was no statistically significant difference, the prevalence of IPPI in female schoolchildren was less than that of males (Table 1).

Out of the 384 study subjects, 222 were males and 162 were females. Among the males (22/222) 9.9% and among the females (13/162) 8.0% were positive for *Amoebiasis*. The prevalence of *Giardiasis* was 16/222(7.2%) and 12/162(7.4%) in male and female schoolchildren, respectively. The prevalence of *Cryptosporidiosis* was 4/222(1.8%) and 9/162(5.6%) in the male and female schoolchildren, respectively. The difference in the prevalence of *Cryptosporidiosis* was significant ($p<0.05$) between males and females but the difference was not statistically significant ($p>0.05$) in the case of *Giardiasis, Amoebiasis* (Table 1). As it is well known by many researchers, in children, intestinal parasitic infections, and particularly intestinal protozoan parasite infections are the causes of common health problems in tropical countries. Younger children are predisposed to heavy infections with intestinal parasites since their immune systems are not yet fully developed, and they also habitually play in fecal contaminated soil and water. In addition to considerable mortality and morbidity, infection with intestinal protozoan parasites have been found to profoundly affect a child's mental development, growth and physical fitness while also predisposing children to other infectious agents.

Major intestinal protozoan parasite species identified from examined schoolchildren by age

In this study the result of prevalence of intestinal protozoan parasite species among schoolchildren are summarized and presented in Table 2. As the result shown in table 2, the prevalence of intestinal protozoan parasite species are, *E. histolytica* 9.1% (35/384), *G.lamblia*,7.3% (28/384) and *C. parvum* which was 3.4% (13/384. The overall prevalence in the study site (19.8%) was lower when compared to the studies of[30] 34.6% in Benishangul-Gumuz, and higher compared to[31] 16.6% in Gaza, Palestine**.** The variation of overall prevalence might be due to personal hygiene and environmental sanitation, consumption of untreated pipe water and eating of uncooked vegetables and unwashed fruits.

Table 2 Major prevalence of intestinal protozoan parasite species identified from examined Grawa primary school children (n=384), Grawa town, during April-July, 2018

Age	Sex	No. of examined	IPPS			X^2	P-value
			Eh/d No. pos	Gl No. pos	Cp No. pos		
7-9	Male	94	7(7.5%)	4(4.3%)	1(1.1%)	6.389	0.09
	Female	61	6(9.8%)	9(14.8%)			
10-12	Male	107	11(10.3%)	8(7.5%)	2(1.9%)	3.639	0.303
	Female	78	5(6.4%)	4(5.1%)	5(6.4%)		
P13	Male	21	4(19%)	3(14.3%)	1(4.8%)	5.921	0.116
	Female	23	2(8.7%)		4(17.4%)		

PPS, protozoan parasitic species; Eh/d= *entamoeba histolytica/disper*; Gl, *giardia lamblia*; Cp, *cryptosporidium parvum*

As shown in Table 2, it was found that children`s age ranged between 7-9 was 27 (17.53%), 10-12 was 35(18.82%), ≥13 was 14(31.82%) were infected with human intestinal protozoan parasites. The low rate of infections was observed in aged between 7-9 years old and high rate of infections was for the children aged from ≥13 years old. Children`s in above or equal to 13 years old were highly infected with protozoa infections and indicating a risk for acquiring parasite infections. The prevalence of intestinal protozoan parasite infections and species diversity in the study site revealed that increment with age group as the age increased; particularly it was highest in age group from ≥13 years old (31.82%) (Table 2). This might be due to playing with dirty water (swimming), neglecting to wash hands after defecation, using of river or non-purified water, improper cleaning of child dinning utensils and in cause of female children, at these age they did different activity at home such as washing cloth, cleaning house, cleaning animals house (they may contact with animal feces) and they may infect with intestinal protozoan parasite oro-fecally.

Association of parents'/caretakers' level of knowledge, management practices and socio-demographic characteristics associated with intestinal protozoan parasitic infections of schoolchildren in Grawa town during April-July, 2018

The result of assessment paternal knowledge about and management practices of intestinal parasitic diseases of schoolchildren is summarized presented in table 3. The result revealed the existence of significant association between prevalence of intestinal parasitic infection among schoolchildren and parents /caretaker's awareness or knowledge about how the disease caused. In the study, mother/father /caretakers limited knowledge about the sign and symptoms (clinical manifestations) and mode of transmission of intestinal parasitic infections as well as impact of infections on their children (Table 3).

As the results of this study, the association between eating of unwashed fruits and row vegetables, having toilet, presence of animal around children's residence, water for drinking, washing and other utilization and intestinal parasite infections was found statistically significant ($p<0.05$)[32] in Nasiriyah reported a similar approach.

According to this research report, the rates of prevalence of human intestinal protozoan parasite infections in regions was high mainly due to direct contact and a long time staying of children in dirty areas with dust and mud and eating of unwashed fruits and raw vegetables there.

The result from Table 3 showed that the prevalence of human intestinal protozoan parasite infections in accordance to children`s family education level were illiterates, literates primary education, literates of secondary and above, 32(21.62%), 18 (15.13%), 14 (20.3%) and 12(25%), respectively. Although the association between the prevalence of human parasites infection and education level were statistically insignificant ($p > 0.05$), it was found that higher parasitic infection among school children were those had illiterate families. Because illiterate families do not know about intestinal protozoan parasite transmission.

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Table 3 Association of parents'/caretakers' level of knowledge and management practices and socio-demographic characteristics associated with intestinal protozoan parasitic infections of their school children in Grawa town during April-July 2018

Character		Freq	IPPI		OR(CI)	X^2	P-value
			Pos%	Neg%			
p.Age	20-30	140(36.5)	33(23.57)	107(76.43)			
	31-40	210(54.7)	37(17.6)	173(82.3)		1.692	0.42
	41 and above	34(8.9)	6(17.65)	28(82.35)			
PEL	Illiterate	153(39.8)	32(21.62)	116(78.38)			
	Primary	120(31.3)	18(15.13)	101(84.87)	0.435	2.78	0.42
	Secondary	68(17.7)	14(20.3)	55(79.7)	(0.385-0.484)		
	Above Grade 12	43(11.2)	12(25)	36(75)			
DUHL	Yes	367(95.6)	67(18.3)	300(81.7)	0.199	12.313	0.00S
	No	17(4.4)	9(52.9)	8(47.1)	(0.074-0.533)		
SUF	At home	382(99.5)	76(19.9)	306(80.1)	0.801		
	Restaurant	0	0	0	(0.762-0.842)	0.496	0.48
	Both	2(0.5)	0	2(0.5)			
HDUEFV	Directly	105(27.3)	19(18.1)	86(81.9)			
	Wash by drinking water	266(69.3)	47(17.7)	219(82.3)	0.0	27.675	0.00
	S.Wash with water	13(3.4)	10(76.9)	3(23.1)			
PAAR	Yes	220(57.3)	47(21.4)	173(78.6)	1.265		
	No	164(42.7)	29(17.7)	135(82.3)	(0.756-2.116)	0.802	0.05
DCWAF	Yes	76(19.8)	30(39.5)	46(60.5)	4.247	27.684	0.00
	No	308(80.2)	41(13.3)	267(86.7)	(2.413-7.475)		

Keywords: DUCW, do they contact with animal feces; HDUEFV, how do you eat fruit and vegetable; DUHL, do you have latrine; SUF, source of your food; PAAR, presence of animal around you residence; p.Age, parents' (caretakers') age; PEL, parents' education level

As shown from Table 3, the prevalence of human intestinal parasite infections in schoolchildren at the study site in relation to source of water for drinking, washing and other utilization was 2/3(66.7%) from river water, 22/63 (34.9%) from *'bishanmiskina'*, 27/94(28.7%) from *'bishandobi'* and 25/224(11.2%) from pipe water. The association between the source of water for different facility and prevalence of human protozoan parasites with schoolchildren in Grawa town was statistically significant ($p < 0.05$). Table 3 showed that the prevalence of human intestinal protozoan parasite infections among school children in relation to having their own toilet was, 67(18.3%) of the respondents are positive and 9(52.9) 0f the positive respondents had no their own toilet. The association between the prevalence of parasitic infections and toilet (latrine) facilities in the research site was statistically significant ($p < 0.05$). This result was similar to the studies reported by[33] this indicated that toilet facilities are highly risky to the prevalence of human intestinal parasite infections.

Associated risk factors for intestinal protozoan parasitic infections of school children in Grawa town

The study participants were examined physically for variables such as children hygienic condition, children physical condition, stool type (consistency of feces), nausea, abdominal discomfort, vomiting and other abnormalities, by the physician and investigator (Table 4). The result of prevalence of intestinal protozoan parasite infections among examined Schoolchildren are summarized and presented in Table 4. As the result shown in table 6, the prevalence of intestinal protozoan parasite infections among examined schoolchildren of both sex and all age group and clinical manifestation like abdominal discomfort, consistency of feces(stool type), loss of appetite, increased gas (flatulence), vomiting and nausea were highly significant ($P \leq 0.05$) (Table 4).

As shown from Table 4, the prevalence of human intestinal parasite infections in children at the study site in relation to personal hygiene and children health and physical condition was highly associated with the prevalence of intestinal protozoan parasitic infections and revealed greater significant. As shown from Table 4, the prevalence of human intestinal parasite infections in children at the study site in relation to clinical manifestations like child's hygienic condition 37%(17/46), poor child physical condition 50%(9/18), diarrheic stool type 66(39/53), Nausea 49.4%(42/85), abdominal discomfort 53%(62/117), increased gas 59.5%(25/42), loss of appetite 36.1% (13/36) and vomiting 41.7%(15/36). In this study all the clinical manifestation was found significantly associated with intestinal protozoan parasite infection.

Several factors like climatic conditions, poor sanitation, unsafe drinking water, and lack of toilet facilities are the main contributors to the high prevalence of intestinal parasites in the tropical and sub-tropical countries. Further, lack of awareness about mode of transmission of parasitic infections increases the risk of infection. Children who had poor personal hygienic conditions were more likely to acquire intestinal protozoan parasite infections 17(20.6%) compared to children who had good personal hygiene 59(19.7%). For example, hand washing after defecation is one of the most effective ways to prevent intestinal parasitic infection.[34] The high prevalence of intestinal protozoan parasite infections in poor personal hygienic condition of children may be due to their poor knowledge about the spread of parasite. This finding was supported by[35] infection with protozoan parasite may show clinical manifestation or symptoms. As shown from the Table 4 children 39(66.1%) parasitic positive had diarrheic consistency of feces (stool type), excessive gas (often flatulence or a foul or sulphuric-tasting belch 25(59.5%), which has been known to be so nauseating in taste that it can cause the infected person to vomit possible (but rare) vomiting which is often violent,15(41.7%), epigastric pain (abdominal discomfort) 62(53%),, nausea 42(49.4%), diminished interest in food13(36.1) and weight loss.[36]

Table 4 Observed clinical signs and symptoms among examined school children (N= 384) and its relationship with intestinal protozoan parasitic infections, during April-July, 2018

Clinical manifestations		Number examined (%)	IPPI		OR (CI)	X²	P-value
			№. Pos. (%)	№. Neg. (%)			
CHC	Poor Good	46 338	17(20.6) 59(19.7)	29(79.4) 799(80.3)	2.772(1.431-5.370)	.9.700	0.002S
CPC	Poor Good	18(4.7) 366(95.3)	9(50) 67(18.3)	9(50) 299(81.7)	4.268	5.777	0.000S
Stool type	Diarrheic Nodiarrheic	59 325	39(66.1) 37(11.4)	20(33.9) 288(88.6)	15.178(8.015-28.744)	94.178	0.000S
Nausea	Yes No	85 299	42(49.4) 34(11.4)	43 (50.6) 265(88.6)	7.613(4.369-13.264)	60.332	0.000S
Abdominal discomfort	Yes No	117 267	62(53) 14(5.2)	55(47) 253(94.7)	20.371(10.644-38.989)	1.168E2	0.000S
Increased gas	Yes No	42(10.94) 342(89.1)	25(59.5) 51(14.9)	17(40.5) 291(85.1)	8.391(4.233-16.633)	46..896	0.000s
Loss of appetite	Yes No	36(9.4) 348(90.4)	13(36.1) 63(18.1)	23(63.9) 285(81.9)	2.557(1.229-5.321	6.664	0.000s
Vomiting	Yes No	36(9.4) 348(90.4	15(41.7) 61(17.5)	21(58.3) 287(82.5)	3.361	11.974	0.000s

Keywords: S, significant; CHC, child health condition; CPH, child physical condition

Anthropometric measurement of the schoolchildren (BMI)

The Body Mass Index (BMI)-for-age of the students was calculated according to the Quetelet's Index nutritional evaluation tools used for adults that were adopted to adolescents by[37] the prevalence of underweight (BMI value below the 5th percentile) in the area was 197(51.3%) in all age group, 185(48.2%) of them had normal weight (BMI between the 5th and 85th percentile), 2(0.5%) of them were at risk-of-overweight (BMI between 85th and 95th percentile) (Table 5).

Table 5 Distribution of BMI and percentiles values of the students among Grawa town school children, April-July, 2018

Age (years)	Under weight		Normal		Over weight		Total	
	M	F	M	F	M	F	M	F
7-9	59(37.8%)	26(16.7%)	35(22.4%)	34(22.4%)	-	1(0.6%)	94(60.3%)	61(39.7%)
10-12	61(33%)	33(17.8%)	46(24.9%)	44(23.8%)	-	1(0.5%)	107(57.8%)	78(42.2%)
>=13	9(20.5%)	11(25%)	12(27.3%)	12(27.3%)	-	-	21(47.7%)	23(52.3%)
Total	129(33.6%)	70(18.2%)	93(24.2%)	90(23.4%)	-	2(0.5%)	222(57.8%)	162(42.2%)

In older children, i.e. above 10 years, weight-for-age is not a good indicator as it cannot distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight (by weight-for-age) when in fact they are just tall. BMI-for-age is the recommended indicator for assessing thinness, overweight and obesity in children above 10 years.[27]

Therefore, in the present study, the prevalence of BMI-for-age under 5thpercentiles which were an indication for being underweight for 7-9 years of age were 54.8%. Of which, 37.8% was for males and 16.7% was for females. In addition, BMI-for-age percentiles of 5th - 85th, and > 85th were calculated for analyzing the status of normal growth and to assess risks for overweight and/or obesity, respectively. There was no risk for overweight among the study school children (Table 5).

The prevalence of underweight among age group above 10 years in the present study was (29.7%) much lower than the prevalence of underweight (36%) reported from Southern Ethiopia[38] and the prevalence reported from Abchikeli and Ayalew Mekonnen Elementary school children (30.7%).[39] The high variations may be probably due to differences in family living standard that is due to difference in adequate nutrition or staple food types.[40]

Conclusion

The major intestinal protozoan parasite species diagnosed among schoolchildren of Grawa town were *E. histolytica/dispar*, *G. lamblia, C. parvum*. The findings reported in the present study was that intestinal protozoan parasitic infections represent a health problem among school children of Grawa town. Most intestinal protozoan parasitic infections represent a schoolchildren health threat because of their contaminated water-borne transmission. *E. histolytica/dispar*, *G.lamblia*, were found as a dominant species of intestinal protozoan parasites diagnosed in the stool samples of the school children.

Association was observed between prevalence of human intestinal protozoan parasite infection and schoolchildren eating unwashed fruits and uncooked vegetables and their source of drinking water. Providing of washed fruits and cooked vegetables, proper hygienic condition, well protected and treated drinking water, proper education on hygienic and environmental sanitation would help in reducing the prevalence of intestinal parasites infection and need more medical attention to avoid the intestinal parasites consequence.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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