



Prevalence of Intestinal Parasitosis and Its Associated Factors Among Children Aged 6 to 59 months Attending Mekane Eyesus Primary Hospital, Northcentral Ethiopia

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Abstract

Background. Intestinal parasites are still a serious public health problem and important cause of morbidity and mortality all over the world, particularly in developing countries. Unfortunately, pre-school children are more susceptible to infection. However, information is scarce in the study area. Thus, this study aimed to assess the prevalence of intestinal parasitosis and associated factors among children aged 6 to 59 months in Northcentral Ethiopia. **Methods.** An institutional-based cross-sectional study was carried out at Mekane Eyesus primary hospital from June 10 to November 30, 2020. Stool samples were collected from 322 children and examined by using direct wet mount and formal ether concentration techniques. The data were entered and analyzed using EPI Info v7 and SPSS v23 statistical software, respectively. Both bivariable and multivariable logistic analysis was carried out and potential associated factors were identified based on adjusted odds ratio with 95% confidence interval and *P*-value <.05. **Results.** The prevalence of intestinal parasitosis was 18.0% (95% CI: 14.0%-22.0%). A total of 4 parasites were examined and the dominant parasite was *E. histolytica/dispar* (8.1%) followed by *A. limbricoide* (4.7%). Children with irregular trimming of fingernails (AOR = 3.14, 95% CI: 1.59-6.21), and child who have habit of eating unwashed fruits/vegetables (AOR = 3.80, 95% CI: 1.14-12.82) were strongly associated with IPIs. **Conclusions.** Protozoa parasites are most common cause of diseases in children. The study identified some preventable and modifiable factors to address the prevalence of IPIs. Additionally, improving mothers/guardians awareness about source of infection and mode of transmission is necessary.

Keywords

intestinal parasitic infections, soil-transmitted helminths, protozoa parasites magnitude, children aged 6 to 59 months

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Background

Intestinal parasitic infections (IPIs) are still a serious public health problem and distributed almost throughout the world.¹ They are an important cause of morbidity and mortality all over the world, particularly in developing countries. They affect the poorest and most deprived communities, where poor environmental sanitation, and personal hygiene are common.² In tropical and sub-tropical regions, where the climate is suitable for the spread of intestinal parasites (IPs) and 100s of 1000s of preventable deaths are happened each year.³

Worldwide estimation showed that around 4.5 billion people are live in IPI endemic areas and more than 2 billion people are affected. Of these 450 million people develop clinical morbidity. Many of these are children

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from developing countries.^{4,5} IPIs are associated with 39 million disability-adjusted life year loss globally.⁶ According to the World Health Organization (WHO)⁷ fact sheet on Soil-transmitted helminths (STHs), universally over 267 million preschool-age children and over 568 million school-age children live in areas where IPIs are intensively transmitted.

Every year 1.4 billion children were infected globally with an IPI throughout the world. Preschool children were attributable to the prevalence between 10% and 20% of the total people with helminthiasis.⁸ Intestinal parasites infections caused by helminths like *Ascaris lumbricoides*, *Trichuris trichiura*, and Hookworm accounts 122 million, 86 million, and 21 million preschool children infection respectively. And also, protozoan parasites like *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium species* are the most common parasite species that affect children in the world.⁸⁻¹² According to a WHO report, STHs are the second leading cause of mortality in <6 years old children of Africa.¹³

There is a high burden of IPIs in Ethiopia. The overall national prevalence of any helminth infection was 29.8% with variable degree of prevalence and species distribution among regions because of some geographical, environmental, and social factors. Amhara and Southern regional states account for the highest-burden of the disease.^{14,15} Different researches conducted in our country showed that the prevalence of IPIs among under-5 children were ranging from 15.5% to 85.1% and has been associated with adverse outcomes including growth deficits malnutrition and anemia.^{9,16-18}

Children below the age of 5 years were more susceptible to IPIs. This is because of low immunity and children's behavior like playing with soil, suck their fingernails, and soil eating habit. Specifically, children living in developing countries with limited or no access to safe drinking water, poor personal hygiene, inadequate sanitation, open field defecation, and substandard housing are the most affected peoples.^{5,15}

Different studies have been conducted on the prevalence of IPIs among under-5 children in Ethiopia. However, information on the prevalence and distributions of IPIs are incomplete and not updated periodically. On the other hand, there is no epidemiological information in many parts of the country on the prevalence of IPIs among more prone groups like children aged 6 to 59 months. Among those areas, Este wereda is the one which is located in the South Gondar zone, Northcentral Ethiopia. Therefore, this study is designed to assess the magnitude and associated risk factors of intestinal parasitosis among children aged 6 to 59 months attending Mekane Eyesus Primary Hospital.

Methods and Materials

Study Area

This study was conducted in Mekane Eyesus primary hospital. The hospital is found in Mekane Eyesus town which is the capital of Este wereda located in the South Gondar zone, Amhara regional state. It is located 114 km far from Bahir Dar (the capital city of Amhara Regional State) and 678 km far from Addis Ababa in the north direction. Mekane Eyesus has a latitude of 11°37'60"N and a longitude of 38°4'0"E with an elevation of 2616 m above sea level. The mean annual rainfall is 1301.29 mm and ranges from 759.8 to 1675.80 mm with the mean annual temperature ranges between 15.6°C and 18.7°C¹⁹

According to the population projection of Ethiopia in 2017, an estimated total population of Mekane Eyesus town is 20 601 of whom 10 719 were males and 9882 were females.²⁰ The town has 1 primary hospital, 1 health center, and 6 private clinics. Mekane Eyesus primary hospital was established in 2015 with a total of 47 staff and currently, the hospital has a total of 168 staff.

Study Design, Period, and Study Subjects

An institutional-based cross-sectional study was carried out at Mekane Eyesus primary hospital from June 10 to November 30, 2020. All children who were attending a pediatric clinic at Mekane Eyesus primary hospital were considered as a source population while those children aged 6 to 59 months who visited the hospital with gastrointestinal symptoms and clinically suspected for IPIs during the data collection period were considered as a study population.

Sample Size Determination and Sampling Procedure

The required sample size was calculated using single population proportion formula; $(n = [(Z\alpha/2)^2 \times P(1-P)]/d^2)$, where; n is the required sample size, $Z\alpha/2$ is the level of confidence, P is the estimated prevalence of the IPI, d =tolerated margin of error. The following assumptions were used to determine sample size; 95% level of confidence, 5% margin of error, 25.4% prevalence of IPI among under-5 years' children on the recent study in Ethiopia²¹ and with a 10% non-response rate. Hence, a total of 322 study participants were included in this study. Study participants were selected using systematic random sampling and every second child was recruited to the study based on their order of arrival.

Inclusion and Exclusion Criteria

Children aged 6 to 59 months who attended a pediatric clinic with gastrointestinal symptoms and clinically suspected for IPIs during the study period, those who were willing to provide stool samples and whose parent/guardian can give consent were included in the study. However, children aged 6 to 59 months who were taking anti-helminths within the last 2 weeks and whose parents or guardians did not consent to participate in the study had to be excluded from the study.

Data Collection Procedure

Data were collected using a structured questionnaire through face-to-face interviews with the parents or guardians of the children. The questionnaire was developed after reviewing relevant literature. Socio-demographic characteristics of study participants and associated factors for IPIs were collected. During the interview, the cleanness, fingernail status, and shoe wearing habits of the child were collected through direct observations of the study participants.

Sample Collection and Laboratory Analysis

First clear orientation was given to each child's parent or guardian on how to collect sufficient and appropriate specimens. After that, a clean, dry, leak-proof plastic container which is labeled with a unique ID number was given for each parent or guardian of the children to collect the sample. A 5 g of stool specimen was collected from each study participant and all specimens were examined by the direct wet mount method with in 30 minutes. The remaining sample was preserved with 10% formalin and processed by the formol-ether concentration method as per the standard operating procedures. All specimen processing and examination takes place at Mekane Eyesus primary hospital laboratory. Two medical laboratory technologists perform both wet mount and concentration techniques for the identification of IP through a light microscope. All standard procedures were strictly followed from specimen collection up to the reporting and recording of results.

Direct microscopic examination using normal saline and iodine preparation. About 1 to 2 mg of stool was emulsified in 1 to 2 drops of 0.85% normal saline or Lugol's iodine solution. A cover-slip was then placed and the slide was scanned under 10× and 40× objective of a light microscope. Saline wet mount smear preparation was done to detect protozoal trophozoites and helminthic eggs or larvae. Iodine direct smear allows the examination of the characteristic features of the protozoa and

the identification of the *E. histolytica/dispar* cyst from the commensal *E. coli*. In the iodine mount, the cytoplasm of the cyst will stain yellow or light brown and nuclei will stain dark brown.^{22,23}

Formol-ether concentration technique. It is the most frequently used technique to concentrate a wide range of parasites with minimum damage to their morphology and it is important to increase the chance of detecting parasites. One gram of each sample was emulsified in 7 ml of 10% formalin solution into a centrifuge tube. Sieve the emulsified feces and collected them in to test tube. Add 3 to 4 ml of diethyl ether and mix for 1 minute. Then centrifuged immediately at 750 to 1000g (3000 rpm) for 1 minute. After centrifuging, the parasites were sedimented to the bottom of the tube. The centrifuged tube inverted to decant off the supernatant and allow a few drops of the deposit to remain. Then, after mixing the sediment was transferred to a slide and covered with a cover slip. Finally, the preparation was examined under 10× and 40× objective of a light microscope.^{22,23}

Data Quality Control

Primarily, the data collection tool was prepared in the English language. Then, it was translated to the local (Amharic) language. Lastly, it was retranslated back to English to maintain its accuracy and consistency. It was pre-tested at a nearby hospital (Debre Tabor General Hospital) on 5% of calculated samples for the study to improve the quality of the data collection tool. After the pretest, the tool was modified for proper utilization. To ensure the quality of the investigation, appropriate training was given for data collectors. For each slide preparation, the 2 different laboratory technologists read the slides independently and their readings were compared. Discordant were immediately fixed by cross checking the slide by a senior medical parasitologist. Furthermore, all standard operating procedures were strictly followed during stool sample examination to ensure the quality and sensitivity of the test result.

Data Processing and Analysis

The data were checked for its completeness and coded manually before data entry. Coded data were entered using Epi-info version 7 statistical software and then exported to SPSS version 24 for analysis. Socio-demographic characteristics of the study participants and the overall magnitude of IPIs were analyzed using descriptive statistics of the sample. Based on the obtainable evidence, the least contributing factor to the dependent variable was used as a reference category. Associations between dependent and independent

Table 1. Intestinal Parasite Infections in Relation to Socio-Demographic Characteristics of Children Aged 6 to 59 Months and Their Parents/Guardians in Mekane Eyesus Primary Hospital, Northcentral Ethiopia, 2020 (n = 322).

Variables	Category	IPI		χ^2 -test	P-value
		Number of positive (%)	Total number (%)		
Sex	Male	25 (17.7)	141 (43.8)	0.014	.908
	Female	33 (18.2)	181 (56.2)		
Family residence	Urban	11 (9.6)	114 (35.4)	8.359	.004*
	Rural	47 (22.6)	208 (64.6)		
Age in months	<24	17 (15.2)	112 (34.8)	0.985	.611
	24-36	23 (19.0)	121 (37.6)		
	>36	18 (20.2)	89 (27.6)		
Mother's (guardian's) educational status	Illiterate	18 (22.2)	81 (25.2)	3.705	.295
	Able to read and write	17 (20.0)	85 (26.4)		
	Primary school	10 (20.0)	50 (15.5)		
	Secondary school and above	13 (12.3)	106 (32.9)		
Mother's (guardian's) occupational status	Housewife	17 (18.3)	93 (28.9)	7.885	.019*
	Farmer	26 (26.0)	100 (31.0)		
	Other ^a	15 (11.6)	129 (40.1)		
Religion of mother's (guardian's)	Orthodox	50 (18.2)	275 (85.4)	0.037	.848
	Muslim	8 (17.0)	47 (14.6)		
Family size	≤3	7 (12.1)	58 (18.0)	6.895	.032*
	3-5	29 (15.8)	184 (57.1)		
	>5	22 (27.5)	80 (24.9)		

^aGovernment employee and merchant.

* $P < .05$.

Bold: statistically significant association.

variables were analyzed by binary logistic regression. Firstly, bivariate analysis was done, and then variables with P -value $< .25$ in the binary regression were selected and analyzed by multivariable analysis to avoid the confounding effect. Adjusted odds ratio (AOR) with 95% confidence interval (CI) was considered to ascertain the significance of the association between dependent and independent variables. In all cases, P -value $< .05$ was considered as a statistically significant association.

Results

Socio-demographic Characteristics

A total of 322 children within the age of 6 to 59 months who fulfilled the inclusion criteria's and visited Mekane Eyesus primary hospital within the study period was included in this study. Among the total study participants, 56.2% were females while the remaining 43.8% were males. The mean age of the study participants was 28.86 months with a standard deviation of 12.516 months. The age distribution of children showed that the majority (37.6%) were in the age group of 24 to 36 months.

Children from parents or guardians with illiterate, Able to read and writing, primary school, and secondary

school and above education level were accounted 81 (25.2%), 85 (26.4%), 50 (15.5%), and 106 (32.9%), respectively. A majority of the children were rural dwellers, 64.6% and more than half of children (57.1%) had families with 3 up to 5 members (Table 1).

Prevalence of Intestinal Parasitic Infections

The overall prevalence of IPIs among children aged 6 to 59 months was 18.0% (95% CI: 14.0%-22.0%) which is detected in 58 suspected children. The prevalence of IPIs was significantly highest among children who were rural dwellers (22.6%), whose mothers (guardians) are farmers in occupation (26.0%) and had a family size of greater than 5 (27.5%). There was no significant difference of IPI with regard to sex ($P = .908$), Age group ($P = .611$), educational background of the parent ($P = .295$) and religion of the mothers (guardians) ($P = .848$) (Table 1).

Among the observed parasites, protozoa parasites, 40 (12.4% [95% CI: 9.1%-16.1%]), were the most dominant parasitic infections among the children. Only *E. histolytica* and *G. lamblia* were the pathogenic protozoan parasites found with a prevalence of 26 (8.1% [95% CI: 5.3%-11.2%]) and 14 (4.3% [95% CI: 2.2%-6.8%]), respectively. On the other hand, 18 (5.6% [95%

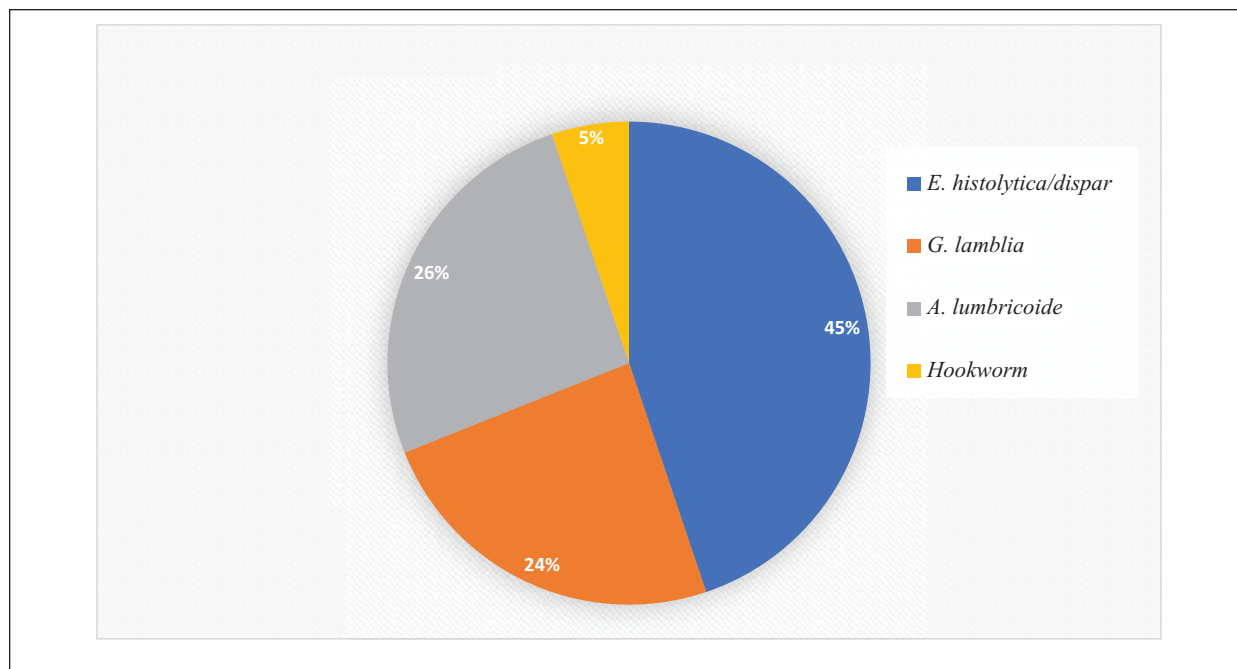


Figure 1. Types of intestinal parasites among children aged 6 to 59 months attending at Mekane Eyesus primary hospital, North central Ethiopia, 2020 (n = 58).

CI: 3.4%-8.4%]) children were infected with helminth parasites. All of the infected children had a single infection. The distribution of identified parasites among children was described in Figure 1.

Analysis of Associated Factors for Intestinal Parasitic Infections

Univariate analysis showed that child who has farmer mothers or guardians, rural resident and family size of greater than 5 are among socio-demographic characteristics which were significantly associated with an increased risk for an intestinal parasitic infection (P -value $< .05$). Similarly, from the potential associated risk factors; regular trimming fingernails, the habit of geophagy, and latrine availability at home were found to be statistically associated with IPI in univariate analysis (see Table 2).

Multivariable logistic regression was conducted after adjusting variables which were P -value $< .25$ in the univariate analysis. The multivariable logistic regression model estimated that children who had a farmer family were 2.6 times (AOR=2.60, 95% CI: 1.08-6.25; P =.033) more likely to be infected as compared with a child whose family occupation was merchant and government employee. Those children who had always eat unwashed fruits or vegetables were 3.8 (AOR=3.80, 95% CI: 1.14-12.82; P =.030) more likely to be infected with IPI than children who hadn't the habit of eating

unwashed fruits or vegetables. The odds of intestinal parasitic infection were 3 times higher (AOR=3.14, 95% CI: 1.59-6.21; P =.001) for under-5 children who had irregular trimming their fingernail as compared to those who did. Besides, participants with a habit of geophagy were 2.71 times (AOR=2.71, 95% CI: 1.31-5.59; P =.007) more likely to become infected as compared to non-geophagy (Table 2).

Discussion

In this study, the prevalence and associated risk factors of intestinal parasitic infections among children aged 6 to 59 months were determined in Mekane Eyesus Primary Hospital, Northcentral Ethiopia. Locally appropriate epidemiological data on the prevalence of IPIs and identification of possible associated risk factors is essential to make an evidence-based decisions for design appropriate intervention strategies. We report an overall prevalence of IPIs was 18% (95% CI: 14.0%-22.0%) and have identified that child whose family was farmer, the habit of eating unwashed fruits and vegetables, infrequently trim the fingernails and habit of geophagy are a potentially associated factor for IPIs. Improvements in these areas could address both short and long-term consequences of these conditions in this vulnerable population.

The prevalence of IPI in the present study corroborated the findings of different studies that have been

Table 2. Bivariate and Multivariate Binary Logistic Regression Analysis of Factors Associated With IPIs Among Children Aged 6 to 59 Months Attending at Mekane Eyesus Primary Hospital, Northcentral Ethiopia, 2020 (n=322).

Variables	Infection status		COR (95% CI)	AOR (95% CI)	P-value
	Number positive (%)	Number negative (%)			
Sex					
Male	25 (17.7)	116 (82.3)	1		
Female	33 (18.2)	148 (81.8)	1.03 (0.58-1.83)		
Family residence					
Urban	11 (9.6)	103 (90.4)	1	1	
Rural	47 (22.6)	161 (77.4)	2.73 (1.36-5.52)	1.86 (0.55-6.33)	.319
Age in months					
<24	17 (15.2)	95 (84.8)	1		
24-36	23 (19.0)	98 (81)	0.76 (0.38-1.52)		
>36	18 (20.2)	71 (79.8)	0.71 (0.34-1.47)		
Mother's (guardian's) educational status					
Illiterate	18 (22.2)	63 (77.8)	2.04 (0.94-4.46)	1.37 (0.43-4.39)	.597
Able to read and write	17 (20.0)	68 (80.0)	1.79 (0.81-3.92)	1.68 (0.49-5.70)	.409
Primary school	10 (20.0)	40 (80.0)	1.79 (0.72-4.42)	1.08 (0.29-3.93)	.911
Secondary school and above	13 (12.3)	93 (87.7)	1	1	
Mother's (guardian's) occupational status					
Housewife	17 (18.3)	76 (81.7)	1.70 (0.80-3.61)	1.82 (0.76-4.39)	.181
Farmer	26	74	2.67 (1.33-5.43)	2.60 (1.08-6.25)	.033
Other ^a	15 (11.6)	114 (88.4)	1	1	
Religion of mother's (guardian's)					
Orthodox	50 (18.2)	225 (81.8)	1.08 (0.48-2.46)		
Muslim	8 (17.0)	39 (83)	1		
Family size					
≤3	7 (12.1)	51 (87.9)	1	1	
3-5	29 (15.8)	155 (84.2)	1.36 (0.56-3.30)	1.04 (0.39-2.80)	.939
>5	22 (27.5)	58 (72.5)	2.76 (1.09-6.99)	2.88 (0.91-7.30)	.076
Hand wash after toilet before touching your child					
Always	25 (15.4)	137 (84.6)	1	1	
Sometimes	33 (20.6)	127 (79.4)	1.42 (0.80-2.53)	1.33 (0.65-2.71)	.435
Habit of eat unwashed fruits and vegetables					
Always	6 (26.1)	17 (73.9)	1.87 (0.67-5.26)	3.80 (1.14-12.82)	.030
Sometimes	29 (18.8)	125 (81.2)	1.23 (0.67-2.25)	1.68 (0.78-3.61)	.183
Nor at all	23 (15.9)	122 (84.1)	1	1	
Child meal					
Always fresh	16 (15.5)	87 (84.5)	1		
Sometimes fresh	35 (18.7)	152 (81.3)	1.25 (0.66-2.39)		
Not fresh	7 (21.9)	25 (78.1)	1.52 (0.56-4.12)		
Trimming child's nails when grown					
Regularly	16 (10.2)	141 (89.8)	1	1	
Irregularly	42 (25.5)	123 (74.5)	3.01 (1.61-5.62)	3.14 (1.59-6.21)	.001
Child playing ground					
Clean	37 (16.8)	183 (83.2)	1		
Not clean	21 (20.6)	81 (79.4)	1.28 (0.71-2.33)		
Habit of geophagy					
Yes	19 (27.1)	51 (72.9)	2.04 (1.09-3.83)	2.71 (1.31-5.59)	.007
No	39 (15.5)	213 (84.5)	1	1	

(continued)

Table 2. (continued)

Variables	Infection status		COR (95% CI)	AOR (95% CI)	P-value
	Number positive (%)	Number negative (%)			
Source of drinking water					
Tap water	34 (16.3)	174 (83.7)	1		
Well water	18 (20.7)	69 (79.3)	1.34 (0.71-2.52)		
Stream/river water	6 (22.2)	21 (77.8)	1.46 (0.55-3.89)		
Latrine availability at home					
Yes	28 (13.3)	183 (86.7)	1	1	
No	30 (27.0)	81 (73.0)	2.42 (1.36-4.31)	1.85 (0.93-3.66)	.079
Shoes wearing habit					
Yes	33 (17.3)	158 (83.7)	1		
No	25 (19.1)	106 (81.9)	1.13 (0.64-2.01)		

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio; CI, confidence interval.

^aGovernment employee and merchant.

conducted in Woreta (18.7%),¹⁷ Dessie (15.5%),¹⁶ Debre Birhan (17.4%),²⁴ Gondar (17.3%),²⁵ Ghana (17.3%),²⁶ and Saudi Arabia (17.7%).²⁷

However, the current study showed a lower prevalence of IPI than the previous studies conducted in various areas of Ethiopia such as the findings from Dembia (25.4% and 25.8%),^{21,28} Chwahit (35.2%),²⁹ Sekota (29.9%),¹ Wonji Shoa Sugar Estate (24.3%),³⁰ Butajira (27.6%),³¹ and Hawassa (26.6%).³² The possible explanation for the low prevalence of IPI in our study might be due to differences in the study period, study population, level of environmental sanitation, and geographic locations of the study participants.

A much higher prevalence of IPIs was reported in different studies that have been conducted in Wondo Genet (85.1%),¹⁸ Goncha Siso Enese District (65.1%),³³ Tigray Region (58%),⁹ North Shoa (52.3%),³⁴ and Hawassa Zuria District (51.3%).³⁵ This might be due to differences in study area, environmental and socio-economic conditions of the study population. Most of the above studies are conducted in highly endemic areas for IPs. It is due to either the warmer temperature that increases the rates of parasite development, facilitates higher rates of infectivity and heavier burdens of disease³⁶ or occurrence of water bodies like river and lake around the study area also increases the chance of waterborne IPs infestation. The other possible reason for the variation might be due to diagnostic laboratory method differences. All studies with a high prevalence of IPIs have used more sensitive diagnostic techniques like the Kato-katz technique. The technique was highly sensitive as compared with wet mount and formol-ether concentration in the diagnosis of IPs was recognized.³⁷

Furthermore, the prevalence IPIs in this study was lower than the studies conducted out of Ethiopia, such as

the studies conducted in Kenya (25.6%),³⁸ Thailand (22.7%),³⁹ North Maharashtra, India (37.66%),⁴⁰ Karachi, India (68.8%),⁴¹ Pakistan (52.8%),⁴² Bogota (26.4%),⁴³ Cuba (71.1%),⁴⁴ and Brazil (27.5%).⁴⁵ This difference in this study might be due to the difference in practices of personal hygiene, level of environmental sanitation, drinking water source, season, cultural difference, educational, and socio-economic status of the study participant's parent as well as geographical distribution of the parasites. On the other hand, some of the above studies include only children with diarrhea, collection of 3 different samples from each individual and using more sensitive laboratory method may result high prevalence of IPIs as compared with this study.

Intestinal protozoa parasitic infections are the most common cause of diseases in children. Their transmission occurs by ingestion of cysts through the fecal-oral route, either via person to person contact or via contamination of surface water or food.²⁴ In the present study, the protozoan parasite accounts for 69% (40/58) of the total IPIs. Protozoan parasites were also the predominant parasites detected in studies conducted in Wereta,¹⁷ Debre Birhan,²⁴ Tigray Region (58%),⁹ Hawassa,³² Saudi Arabia 17.7%,²⁷ North Maharashtra, India,⁴⁰ and Brazil.⁴⁵ But, in some other studies like the finding from Dembia,^{21,28} Chwahit (35.2%),²⁹ Butajira (27.6%),³¹ Wondo Genet,¹⁸ and Ghana 17.3%²⁶ the most encountered parasite was helminths.

The most predominant parasite identified in this study is *E. histolytica/dispar* 26 (8.1%) with a 95% CI of (5.3%-11.2%) followed by *A. lumbricoides* 15 (26%) with 95% CI of (2.5%-7.1%). This is agreed with some studies conducted in our country and different parts of the world that indicated the major parasite among children was *E. histolytica/dispar*.^{1,9,16,32,38,45} However, in

some other studies the most encountered parasite was *A. lumbricoides*.^{21,28,29,31,33}

In this study, none of the IP infected children had double parasitic infections whereas studies conducted in different parts of Ethiopia reported the occurrence of double parasitic infections on children.^{16,24,25,32,34} Variations in the level of environmental contamination, socioeconomic factors and endemicity of parasites might be responsible for the difference in the prevalence of multiple parasitic infections. The above studies with multiple parasitic infections used either Kato-katz³⁴ or modified acid-fast staining^{16,32} techniques as additional laboratory methods that may be important for detecting double infection.

Children born and raised from farmer family increases the odds of intestinal parasitic infestation by 2.6 times (AOR=2.60, 95% CI: 1.08-6.25) than children of merchant and government employee. Most farmers live in rural areas of the country. This area is characterized as poverty, shortages of clean potable water, a high rate of open defecation, poor environmental sanitation and personal hygiene. Additionally, most farmers use excreta as compost which is an absolute source of infection since children and their mothers often go to the farm may attribute to a high rate of infection.³

Children who have a habit of eating unwashed fruits or vegetables were 3.8 times more likely to be infected with IPI than children who haven't the habit of eating unwashed fruits or vegetables (AOR=3.80, 95% CI:1.14-12.82). This was in line with other studies conducted in Cuba (RR=8.40; 95% CI [3.69-19.12]).⁴⁴ The possible explanation may be due to the fact that contamination of fruits and vegetables through open defecation, and using night soil as fertilizer. Proper washing of fruits and vegetables before eating is very important to remove the infective stages of different parasites like cysts of protozoan species and eggs of worms as a prevention and control mechanism.⁴⁶

This institutional-based cross-sectional survey described that childhood parasitic infection was statistically associated with irregular trimming of fingernails (AOR=3.14, 95% CI: 1.59-6.21) which is congruent with the findings of other studies.^{17,25,31} This is due to the playing habits of children with soil, poor socioeconomic status and poor hygienic practice results accumulated dirt containing eggs of parasites under fingernails.^{17,26} It results in significant source and transmission of IPI.

This study demonstrated that there was a significant association between the habit of geophagy and the rate of IP infestations. Children who have a habit of geophagy were 2.71 times more likely to be infected with IPs (AOR=2.71, 95% CI: 1.31-5.59) compared with children who do not have a habit of geophagy. It is in agreement with other study conducted in India showed that eating

mud were found to be the major cause of parasitic infections.⁴¹ This finding might be due to the high rate of open defecation and poor environmental sanitation results contamination of soil and important source of infection.

Limitations

Due to budget shortage, this study did not focus on molecular assays and other techniques which are best to estimate the prevalence of IPs and differentiating different species of ameabiasis. Also, a modified acid-fast staining technique was not used to detect *Cryptosporidium* species, and it might cause to miss this species.

Conclusions

In conclusion, the overall prevalence of IPI among children aged 6 to 59 months was 18.0% and all study participants were affected by single IPs. Protozoa parasites are the most common cause of diseases in children. The dominant parasite species was *E. histolytica/dispar* followed by *A. lumbricoide*. Child habit of eating unwashed fruits or vegetables, family occupation, regular trimming fingernails and habit of geophagy were significantly associated with IPIs. Therefore, strengthening health education about the importance of washing fruits or vegetables before eating and regular trimming of fingernails is very crucial. Furthermore, protecting the children from eating soil and exposing for the farming environment is another way of preventing the occurrence of infection. As well, improving mothers/guardians awareness about the source of infection and mode of IP transmission is necessary.

List of abbreviations

AOR: Adjusted Odds Ratio, CI: Confidence Interval, COR: Crude Odds Ratio, IP: Intestinal Parasite, IPI: Intestinal Parasitic Infection, SSA: Sub-Saharan African, STH: Soil Transmitted Helminth, WHO: World Health Organization.

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Authors' Contributions

TE was the primary researcher who involved in conceptualization, data curation, formal analysis, methodology, laboratory investigation, results interpretation, involved in execution, acquisition of data, data statistical analysis, drafting the manuscript, and engaged in critically revising of the manuscript. AW

participated in overall data collection including questioner and stool specimen, laboratory investigation, execution, acquisition of data, participated in statistical analysis, result interpretations, have participated in drafting and substantially revising the manuscript. TK, TT, SD, MS, AA, ESC, and LW were involved in execution, acquisition of data, data statistical analysis, results interpretation, drafting the manuscript, engaged in critically revising of the manuscript. All authors read and approved the final manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical Consideration

The study was approved by the Debre Tabor University, College of Health Sciences, Research and Ethical Review Committee (reference number: CHS/224/2012 in Ethiopian calendar). A letter of support was secured from a woreda health office and a permission letter was obtained from the medical director of the hospital. Written informed consent was obtained from the parents or guardians of the children. Those children who were positive for IPs were linked to the responsible body in Mekane Eyesus primary hospital for treatment. All results were kept confidential and used only for research purposes. This study was conducted in accordance with the declaration of Helsinki.

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Availability of Data and Materials

The authors confirmed that all the data used in this research article are presented within the manuscript.

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