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Authors: Gebru, Heroda, Deyissia, Negussie, Medhin, Girmay, and Kloos, Helmut

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Heroda Gebru[1], Negussie Deyissia[2], Girmay Medhin[3] and Helmut Kloos[4]

[1]Ethiopian Institute of Water Resources, Addis Ababa University, Addis Abeba, Ethiopia. [2]School of Public Health, College of Health Sciences, Addis Ababa University, Addis Abeba, Ethiopia. [3]Aklilu Lemma Institute of Pathobiology, Addis Ababa University, Addis Abeba, Ethiopia. [4]Department of Epidemiology and Biostatistics, University of California, San Francisco, San Francisco, CA, USA.

ABSTRACT

BACKGROUND: Intestinal parasitic infections (IPIs) are neglected tropical diseases. Sanitation and hygiene are vital components for achieving sustainable control of intestinal parasitic infections. Children are the most vulnerable to intestinal parasitic infections because of their immature immune systems and frequent exposure to unsanitary environments. The aim of this study was to assess the magnitude of IPIs and associated risk factors, including sanitation and hygiene practices, among under-14-year-old children in rural Dire Dawa, eastern Ethiopia.

METHODS: This community-based cross-sectional 'study included 778 subjects aged 1 to 14 years. Data were collected using questionnaires and stool examinations. The direct wet-mount method and formol-ether concentration techniques were performed to identify IPIs. Data Analysis: A descriptive statistic was used to show the prevalence of IPIs. Bi-variable and multivariable analysis using the logistic regression model was carried out.

RESULTS: The outputs are presented using an adjusted odds ratio (aOR) with 95% confidence intervals (CIs). The prevalence of 5 intestinal parasites was 33.7% (95% CI = 30.4%-37%). *Giardia intestinalis* (15.2%) and *Hymenolepis nana* (11.6%) had the highest prevalence. The odds of IPIs among children of illiterate mothers were 13.1 times higher when compared with children of mothers with secondary education (aOR = 13.1, P = .02), and the odds of IPIs among children from households that have unclean latrines were 1.8 times higher when compared with children from households that have clean latrines. (aOR = 1.8, P = .03). Children from households that discard solid waste in open fields had 1.7 times higher odds of having a positive result than children from households that burn their waste (aOR = 1.7, P = .03). However, children without a swimming habit (aOR = 0.4, P = .000) and asymptomatic children (aOR = 0.3, P = .000) were protective against IPIs.

CONCLUSIONS: IPIs continue to be a public health problem in rural parts of Dire Dawa. The prevalence of *Giardia intestinalis* and *H. nana* could be of public health importance in this setting. Solid waste management, latrine cleanliness, mothers' level of education, and child swimming habits in unclean accumulated water were significantly associated with IPIs. Therefore, efforts should be made to ensure intervention, considering such risks.

KEYWORDS: Helminths, prevalence, protozoa, risk factors, and Ethiopia

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CORRESPONDING AUTHOR: Heroda Gebru, Ethiopian Institute of Water Resources, Addis Ababa University, P.O.Box 150461, Addis Ababa, Ethiopia.
Email: herodagebru13@gmail.com

Introduction

The public health impacts of parasitic infections are still high and difficult to reduce in developing countries. Globally, about 3.5 billion people (the majority of whom were children) were infected with intestinal parasites. Intestinal helminthic and protozoan infections are among the most prevalent IPIs in humans.[1] In Ethiopia, a systematic study from Legese reported that the prevalence of IPIs was 48%.[2] Intestinal protozoa contribute significantly to the burden of infectious diseases worldwide, and diarrhea is more commonly caused by intestinal parasites and bacterial pathogens than viruses in developing countries.[3] The second and third most common intestinal protozoa identified in Mozambique children with diarrhea were *Giardia intestinalis* and *Entamoeba histolytica*, respectively.[4]

Soil-transmitted helminths (STHs) and schistosomiasis are among the 17 neglected tropical diseases (NTDs) identified by the World Health Organization (WHO).[5] Worldwide, more than 1.5 billion people are infected with soil-transmitted helminths, most of them in sub-Saharan Africa, Central and South America, China, and East Asia.[6] Ending the epidemics of NTDs is 1 of the Sustainable Development Goals (SDGs) of the United Nations (UN).[7] Ethiopia comprises a significant proportion of the global burden of disease resulting from NTDs, and prioritization for intervention was made by the country. According to the Ministry of Health, *Schistosoma*, and soil-transmitted helminth infections rank as the fourth and fifth priority areas for its intervention, respectively.[8]

Access to poor sanitation and inadequate hygiene are significant contributors to IPIs.[9] Globally, 2 billion people lived without basic sanitation services, of which 709 million lived in sub-Saharan Africa. Worldwide, 673 million people practice open defecation, with 229 million of them in sub-Saharan Africa.[10] According to the 2016 Ethiopian Demographic and Health Survey, 94% of the households in Ethiopia use unimproved sanitation, 9% share facilities, 53% use unimproved facilities, and 32% have no facilities.[11] Moreover, 43 million people had no handwashing facilities.[10]

The clinical manifestations of IPIs include gastrointestinal disorders, including vomiting, diarrhea, dysentery, anorexia, abdominal distension, and mental health problems.[12] Children (the most critical time for physical and cognitive development) are the most vulnerable to intestinal parasitic infections[13] because of their immature immune systems and frequent exposure to unsanitary environments. Since the adverse effects of IPIs extend to nutritional problems, they are susceptible to physical, and cognitive impairment.[14] As a result, the study's goal was to assess the prevalence of IPIs and associated factors, including sanitation, and hygiene practices, among under-14 children in rural Dire Dawa. Results may assist planners and health administrators in developing appropriate interventions in the study area. And fill the void left by the lack of data on the IPIs in the area, as highlighted by 1 systematic review study.[2]

Materials and Methods

Study area: This study was conducted in rural areas of Dire Dawa City, which is one of the 2 administrative cities in Ethiopia. Located between 9°27′N and 9°49′N latitudes and41 038′ and 42°19′E longitudes and bounded by Oromiya Regional State to the south and Somalia Regional State to the north, Dire Dawa City is accessible by airplane, train, and car. It is about 500 km east of Addis Ababa. The total area of Dire Dawa is 155 861 ha, out of which 152 937 ha (98%) are in the rural area. It has a total of 38 rural and 9 urban kebeles (the smallest local government administrative unit in Ethiopia).

Study design: The study employed a community-based cross-sectional design from April to May 2021.

Source and study population: The source population consisted of 1 to 14 children who were residents of rural Dire Dawa, and the study population consisted of under- 14 children recruited randomly from the 9 kebeles.

Inclusion criteria:

1. Participants who were able to give stool samples
2. Children who had parental consent to participate in the study

Exclusion criteria

1. Those children whose families lived less than 6 months in the area
2. Children treated for IPIs within 3 months prior to the data collection period

Sample Size Determination

The total sample size was estimated using the single population proportion formula ([$Z\alpha/2]2 \times P$ [1-P])/d2, where Z = the standard normal distribution at the 95% level of confidence interval, P is 36% based on the prevalence of intestinal parasitic infection from a previous study,[15] at 5% marginal error, and 1-P is the non-observed value. A design effect of 2 was used for the multi-stage sampling technique. To minimize errors arising from the likelihood of non-compliance, 10% of the estimated value was added, giving a sample size of 778.

Sampling Technique

Out of the 38 rural kebeles in the area, 9 were selected randomly using the lottery method. The sampling fraction from each kebele was determined proportionate to the population size of under 14 children. The list of households was obtained from the health extension workers, and a number was given for each household. After identifying the proportion of children who were participants in the study from each kebele, a simple random sampling method was used to identify study subjects.

And before the data collection process commenced, the validity of the information provided by the health extension workers was cross-checked. When the selected household was closed during the data collection process, the interviewers revisited the household at different time intervals, and we were able to visit them on the following day. When interviewers failed to get the members of that household, the household was excluded from the study and another nearby household was included. One child was selected randomly from households that had more than 1 under-14-year-old child.

Data Collection Procedures

An interview-based, pre-tested structured questionnaire was used to collect socio-demographic, sanitation, and hygiene-related behavioral data from parents or primary caretakers. Six diploma nurses collected the questionnaire-based data, and stool specimens were collected by 2 laboratory technicians. Ethical approval to conduct the study was received from Ethics Review Board of Addis Ababa University—Ethiopian Water Resource Institute (EIWR). A letter of support was sent from Dire Dawa Health Bureau to the health facilities in the study area, and the leaders of the kebeles were contacted for permission to conduct the study. Prior to the distribution of consent forms, the purpose of the study was explained to the children and their parents. The questionnaires were first prepared in English, translated into "Amharic," and "Afaan Oromoo," and then back into English to ensure consistency of the questions. To ensure reliable information, the participants were interviewed in their mother tongues.

Stool Specimen Collection and Laboratory Examination

Stool specimens were collected from 778 participants using properly labeled, clean, dry, and wide-mouthed 5 ml plastic containers with applicator sticks. All study participants were instructed on how to collect the stool samples. On the field examination, a portion of each stool specimen was processed immediately after collection using the saline wet mount technique and examined by microscope.[16] The other portion of the remaining specimen was preserved in 10% formalin and transported to the laboratory at Dire Dawa Dil Chora Hospital in a cooled box (kept at 2°C -8°C), where it was processed and examined using the formol-ether concentration technique.

For direct stool examination, a drop or drops of saline were placed on a slide. Approximately 0.05 g of stool specimen was placed using an applicator stick, mixed with a drop of saline, and covered by a cover slide. Finally, the specimen was examined under the microscope at low power (×10 objective) and high power (×40 objective) magnifications for the identification of intestinal parasites.

And for formol-ether concentration, an estimated pea-size amount of stool was emulsified in 4 ml of 10% formol water. Then 4 ml of 10% v/v formol water were added and thoroughly mixed by hand shaking. Four milliliter of diethyl ether were added after sieving the emulsified stool. Then the content was mixed for 1 minute and immediately centrifuged at 750 to 1000*g* for 1 minute. After centrifuging, the parasite sedimented at the bottom of the tube, and the stool debris was collected from the layer between the ether and formol. Then, slide smears were prepared from each processed stool specimen and examined using an Olympus microscope (using 10× and 40× objectives) for the presence of intestinal parasites.[16] To ensure the quality of the data, 10% of all positive samples were randomly chosen and reexamined by 2 skilled lab technicians who were unaware of the previous results.

Data Management and Analysis

Data were entered using the EPI-Info version 3.5.3 statistical package and exported to the Statistical Package for the Social Sciences (SPSS) version 23 for analysis. A descriptive statistic was used to show the prevalence of intestinal parasitic infections. Tables were formed to present the data. The bivariable logistic regression method was used to select candidate variables. Independent variables with a P-value of less than .05 on the bivariable analysis were considered in the multivariable logistic regression analysis for further analysis. Multivariable logistic regression was carried out to identify factors associated with IPIs. The degree of association between the dependent and independent variables was measured using the odds ratio with a 95% confidence interval. The level of statistical significance was set as $P < .05$, the final model was interpreted with adjusted odds ratios (aORs), a P value of $<.05$, and 95% CIs.

Results

General characteristics of the study subjects and socio-demographic information

A total of 778 individuals were included in the study (100% response rate). The high response rate was obtained because we collected and examined stool by moving from village to village. When the participants were unable to provide a sample on the first day, we were able to visit them on the following day. Four hundred eighty-seven (62.6%) individuals were males. Nearly half (48.8%) and 355 (45.6%) of the study, participants were found in the age groups 10 to 14 and 5 to 9 years, respectively. The mean age was 9.3 (±2.62) years. More than two-thirds (69.8%) of mothers were illiterate. Of the total 262 positive children for intestinal parasitic infection, 185 (70%) were born to illiterate mothers. Four hundred twenty-seven (54.9%) mothers were housewives. Less than half of the respondents (46.3%) knew how intestinal parasitic infections can be contracted. Nearly three-quarters of the respondents (73%) had knowledge about the symptoms of IPIs, and 94 (12%) children were experiencing some symptoms of IPIs at the time of data collection. Almost none of the mothers (0.4%) have knowledge about IPIs complications (Table 1).

Sanitary condition

In this study, the great majority of households (83.7%) followed the safe disposal method for child feces. While 70.8% of the respondents did own latrines, only 14.2% of the households kept them clean. And 89.5% of children with IPIs were diagnosed in households with unclean latrines. About 1 in 8 households (13.2%) practiced open defecation, and 32.0% of the households used open fields to manage their solid waste (Table 2).

Table 3 shows hygienic practices in relation to IPIs. Seven hundred seventy-three (99%) of the 778 mothers of the study participants practiced hand washing after toilet use, and of this percentage, 39.7% (307) of them washed their hands only with water. Of the total 43 mothers who fed their child, 37 washed their hands before feeding. Of these 37 mothers, 31 used only water for hand washing. Similarly, of the 658 mothers who washed their hands after caring for animal waste, only 157 (8.7%) of them used soap or ash during hand washing. Of the children of 9 mothers who washed their hands only with water after taking care of their child's feces, 4 (44%) tested positive for IPI. Seven (22.6%) of the 31 children whose mothers washed their hands only with water before feeding them were diagnosed with IPI. These results show that hand washing at critical times was practiced by a majority of the participants, but using agents like soap or ash was not, and hand washing with soap or ash is crucial in preventing IPI.

Table 1. The prevalence of IPIs among under-14 children (n = 778) according to different socio-demographic characteristics of the study population in rural Dire Dawa, Eastern Ethiopia, April–May 2021.

VARIABLES	FREQUENCY	INTESTINAL PARASITIC INFECTIONS	
	NO (%)	YES (%)	NO (%)
Child sex			
Male	487 (62.6)	168 (64.1)	319 (61.8)
Female	291 (37.4)	94 (35.9)	197 (38.2)
Age of children in years			
1-4	43 (5.5)	11 (4.2)	32 (6.2)
5-9	355 (45.6)	124 (47.3)	231 (44.8)
10-14	380 (48.8)	127 (48.5)	253 (49)
Mother's education			
Illiterate	543 (69.8)	185 (70.6)	358 (69.4)
Primary	217 (27.9)	76 (29)	141 (27.3)
Secondary	18 (2.3)	1 (0.4)	17 (3.3)
Father's Education			
Illiterate	298 (38.3)	91 (34.7)	207 (40.1)
Primary	406 (52.2)	147 (56.1)	259 (50.2)
Secondary	74 (9.5)	24 (9.2)	50 (9.7)
Mother's occupation			
Housewife	427 (54.9)	119 (45.4)	308 (59.7)
Farmer	250 (32.1)	96 (36.6)	154 (29.8)
Merchant	79 (10.2)	41 (15.6)	38 (7.4)
Others	22 (2.8)	6 (2.3)	16 (3.1)
knowledge of IP acquisition			
No	418 (53.7)	135 (48.5)	283 (45.2)
Yes	360 (46.3)	127 (51.5)	233 (54.8)
knowledge of IP symptom			
Yes	569 (73.1)	206 (78.6)	363 (70.3)
No	209 (26.9)	56 (21.4)	153 (29.7)
Do you currently have symptoms?			
No	684 (87.9)	207 (79)	477 (92.4)
Yes	94 (12.1)	55 (21)	39 (7.6)
Knowledge of IPI complications			
Yes	3 (0.4)	2 (0.8)	1 (0.2)
No	775 (99.6)	260 (99.2)	515 (99.8)
Swimming practices in local streams and dams			
No	354 (45.5)	95 (36.3)	259 (50.2)
Yes	424 (54.5)	167 (63.7)	257 (49.8)

Table 2. Bi-variable association of sanitary conditions and intestinal parasitic infections among under-14 children (n = 778) in rural Dire Dawa, April–May 2021.

VARIABLE		INTESTINAL PARASITIC INFECTIONS		COR (95% CI)	*P*-VALUE
Latrine ownership	No (%)	Yes (%)	No (%)		
No Latrine	227 (29.2)	61 (23.3)	166 (32.2)	1	
Have Latrine	551 (70.8)	201 (76.7)	350 (67.8)	0 0.64[0.5-0.9]	.01
Latrine cleanliness					
No	473 (85.8)	180 (89.5)	293 (83.7)	1.67 [0.98-2.84]	.06
Yes	78 (14.2)	21 (10.4)	57 (16.3)	1	
Household latrine utilization					
Sometimes	90 (16.3)	34 (16.9)	56 (16)	1.07 [0.7-1.72]	.07
Always	461 (83.6)	167 (83.1)	294 (84)	1	
Household method of child feces disposal					
Safe	36 (83.7)	8 (72.7)	28 (75)	0.83 [0.13-5.1]	.38
Unsafe	7 (16.3)	3 (27.2)	4 (25)	1	
Households without latrines					
Open field	50 (13.2)	19 (31.1)	31 (18.7)	1.98 [1.0-3.8]	.05
Designed area	197 (86.7)	42 (68.8)	135 (81.3)	1	
Solid waste management					
Buried in one place	137 (17.6)	43 (16.4)	94 (18.2)	1.2 [0.8-1.9]	.4
Burn	139 (17.9)	34 (12.9)	105 (20)	1.7 [1.1-2.8]	.02
Collected by waste collectors	252 (32.4)	95 (36.2)	157 (30.4)	0.9 [0.6-1.3]	.7
Discarded in the open field	250 (32.1)	90 (34.3)	160 (31)	1	

Abbreviations: COR = crude odds ratio.
Indicate significant at $P < .05$;1 = reference value.

Factors associated with intestinal parasite infections

In the multivariable analysis using the logistic regression model, 5 variables showed statistically significant associations with IPIs (Table 5). The odds of IPI among children of illiterate mothers were 13.1 times higher when compared with children of mothers with secondary education (aOR = 13.1, $P = .02$). In multivariable analysis, children who have an unclean latrine were 1.8 times more exposed to IPIs than their counterparts. (aOR = 1.8,95%CI = 1.0-3.3). The odds of acquiring IP infections among children whose household discarded solid waste in an open field were 1.7 times higher than those children whose household burned their solid waste (aOR = 1.7; 95% CI [1,2.7]). The odds of intestinal parasitic infection were lower in children who had no swimming habit than in children who had swimming habits (aOR = 0.4; 95% CI [0.27, 0.58]). Similarly, being asymptomatic had lesser odds to have positive result than being symptomatic (aOR = 0.3; 95% CI [0.2, 0.5]).

Discussions

The overall prevalence of intestinal parasitic infections among 778 children under 14 years of age in rural Dire Dawa was 33.7% (95% CI = 30.4–37%), which was lower than the result of other studies conducted in Ethiopia and other countries. A study in Sasiga District in southwestern Ethiopia found a prevalence of 62.4% among school children.[17] A much higher prevalence was reported from a community in Argentina (78.1%).[18] The prevalence in our study was comparable with a study in Haike Town in the eastern Ethiopian Highlands (30.5%),[19] and in Senegal (34.9%).[20] But the prevalence of this study was higher than the result from rural Dembiya in the Lake Tana area (25.8%).[21] The variation in findings among these studies may be due to demographic, socioeconomic, sanitation, and behavioral factors such as hygienic practices.

Double parasitic infections were found in only 2 children (Table 4). In this study, protozoan infections were more common (17.4%) than helminth infections (12.4%), similar to

Table 3. Bi-variable association of hand hygiene practice of mothers/caretakers and under-14 children (n = 778) with intestinal parasitic infections in Dire Dawa, April–May 2021.

HAND WASH AFTER DEFECATION	NO (%)	INTESTINAL PARASITIC INFECTIONS		COR (95% CI)	*P*-VALUE
		YES (%)	NO (%		
No	5 (.7)	3 (60)	2 (40)	2.9 [0.49-17.9]	.26
Yes	773 (99.3)	259 (33.5)	514 (66.5)	1	
Hand wash with					
Water only	307 (39.7)	102 (33)	205 (67)	0.98 [0.72-1.3]	.9
Use soap/ash	466 (60.3)	157 (33.6)	309 (66.4)	1	
Mother hand wash after child feces care					
No	8 (18.6)	3 (37.5)	5 (62.5)	2 [0.39-10.4]	.42
Yes	35 (81.4)	8 (22.8)	27 (77)	1	
Hands washed with					
Water only	9 (22.9)	4 (44)	5 (56)	4.4 [0.8-23.9]	.11
Use soap/ash	26 (77.1)	4 (18.5)	22 (81.5)	1	
Hand wash before cooking					
No	7 (1)	4 (57)	3 (43)	2.65 [0.59-11.9]	.22
Yes	771 (99)	258 (33.4)	513 (66.5)	1	
Hand wash with					
Water only	368 (47.7)	125 (34)	243 (66)	1 [0.77-1.4]	.7
Use soap/ash	403 (52.3)	133 (33)	270 (67)	1	
Mother hand wash before child feed					
No	6 (13.9)	3 (50)	3 (50)	3.6 [0.61-21.52]	.2
Yes	37 (86)	8 (21.6)	29 (78.3)	1	
Washing hands with					
Water only	31 (83.7)	7 (22.6)	24 (77.4)	1.45 [0.14-14.6]	.82
Use soap/ash	6 (16)	1 (16.6)	5 (83.4)	1	
Washing hands after caring of animal waste					
No	0			NA	
Yes	658	212	446		
Hands washed with					
Water only	501 (76)	164 (32.7)	337 (67.3)	1.1 [0.75-1.63]	.6
Use soap/ash	157 (23)	48 (30.5)	109 (69.5)	1	
Wash before eating					
No	0			NA	
Yes	735	251	484		
Hands washed with					
Water only	280 (38)	88 (31.4)	192 (68.6)	0.8 [0.59-1.13]	.2
Using soap/ash	455 (62)	163 (35.8)	292 (64.2)	1	

Abbreviations: COR = crude odds ratio.
Indicate significant at $P < .05$;1 = reference value.

Table 4. Intestinal parasites identified in under-14 children (n = 778) in rural Dire Dawa, April–May 2021.

INTESTINAL PARASITES	NUMBER POSITIVE	PERCENT POSITIVE
Intestinal protozoa		
Giardia intestinalis	116	14.9
E.histolytica/dispar	17	2.2
Total intestinal protozoa	133	17.1
Cestode		
H.nana	89	11.5
Pinworm		
E.vermicularis	6	0.8
Trematode		
S.mansoni	33	4.2
Total helminths	127	16.5
Total double infection	2	0.2
G. intestinalis and E. histolytica/dispar	1	0.1
G.intestinalis and H.nana	1	0.1

studies in Jawi[22] and Senegal.[20] This could be due to the ongoing deworming program in the study area. In contrast, higher helminths than protozoan infections were reported from Birbir town in southern Ethiopia.[23] The protozoan prevalence of this study was lower than the pooled prevalence of human intestinal protozoan parasitic infections in Ethiopia (25.0%).[24] Similarly, in this study, only 4.2% of the children were infected with *Schistosoma mansoni*, a lower rate than the 18.0% reported by the systematic review by Hassen.[25] The reason for the low prevalence of *Schistosoma mansoni* might be due to differences in the source of infection. *Hymenolepis nana* was the second dominant parasite, in agreement with a study conducted in Dessie City in north-eastern Ethiopia.[26]

This could be due to the absence of preventive chemotherapy with praziquantel. *Giardia intestinalis* was the most prevalent parasite, with a prevalence of 15.2%, similar to a study in Boricha District in southern Ethiopia.[27] Contrary to this finding, the study conducted in Harbo, in the north-eastern part of Ethiopia, indicated that *Giardia intestinalis* was the least identified parasite.[28] The higher rate of protozoan infection in the current study could be due to various reasons, such as geographical setting differences, hygiene dissimilarities, and the risk of farmland contamination with fecal matter and close contact with infected animals. While low prevalence of helminths could be attributed to the deworming program.

Maternal education showed an inverse relationship with the prevalence of intestinal parasitic infections. The findings of this study were consistent with a study conducted in Turkey.[29] This may be due to mothers with higher educational levels positively influencing the health behaviors of their children. In this study, asymptomatic children had lower odds (0.3) to have a positive result than symptomatic children. Similarly, a study in Nepal reported higher IPIs in symptomatic cases (66.7%) than asymptomatic cases (33.3%).[30] This could be due to IPIs manifesting with and without symptoms, increasing the probability of positivity in symptomatic cases.

The result of the current study showed that intestinal parasitic infections were associated with poor sanitation conditions. The odds of IPI among children whose household dumped waste in open fields were 1.7 times higher when compared with children whose household burned the solid waste. Similarly, 1 study showed that the odds of being infected with IPIs were eightfold and fivefold higher in students who dumped waste in open fields and buried waste, respectively, than in students who burned the waste. In the present study, only 14% of the toilets were clean. The odds of being infected with IPIs were 1.8-fold higher among children from households with unclean latrines than their counterparts. The uncleanliness of latrines favors open defecation, which favors the transmission of IPIs. A study of hygiene practices in a western Ethiopian community indicated that schoolchildren who used a latrine due to cleanliness (ie, no bad smell and no feces inside the latrine structure) were 3.4 times more likely to have good hygiene practices than those who used latrines for sex-separation purposes.[31] Poor sanitation conditions (unselective disposal of human excreta and solid waste) result in disease-causing pathogens contaminating the environment. As IPIs are transmitted by the fecal-oral route, the risk of infection will increase with such environmental contamination.[32]

Children who don't have swimming practices in local streams and dams less likely (0.4) to have a positive result for IPIs than children who have the swimming practice. Likewise, a study conducted in Harbu Town in eastern Ethiopia reported that contact with water bodies carried 4.6 times higher odds of infection with IPIs than not swimming.[19]

Limitations of the study

This study had a number of strengths. Among these strengths, the community-based nature of this study is representative of all children in the age group of 1 to 14 years, which is essential to an appropriate policy strategy for effective prevention of intestinal parasites. Regardless of its strengths, this study had a few limitations. Due to the cross-sectional design, it was difficult to examine any potential temporal relationships. Due to the shortage of resource, formol ether fecal concentration technique with the direct microscopy method was applied. Which has lower sensitivity to show protozoan species compared to the polymerase chain reaction (PCR) based techniques. We recommend researchers should conduct further studies using microscopic examination with PCR technique to increase the possibility of the presence or absence of the infection.

Table 5. Factors associated with intestinal parasitic infections among under-14 children (n = 778) in rural Dire Dawa, Eastern Ethiopia, April–May 2021.

VARIABLES	INTESTINAL PARASITIC INFECTIONS		COR (95% CI)	AOR (95% CI)	*P*-VALUE
	YES	NO			
Mother's education					
Illiterate	185	358	0.95 [0.7-1.3]	13.1 [1.6-107]	.02
Primary	76	141	9.1 [1.2-66]	1.1 [0.7-1.5]	0.7
Secondary	1	17	1	1	
Latrine cleanliness					
No	180	293	1.7 [0.98-2.8]	1.8 [1.0-3.3]	.03
Yes	21	57		1	
Solid waste management					
Buried in one place	43	94	1.2 [0.8-1.9]	1.1 [0.7-1.7]	.8
Discarded in open field	34	105	1.7 [1.1-2.8]	1.7 [1 -2.7]	.03
Collected by waste collectors	95	157	0.9 [0.6-1.3]	0.8 [0.5-1.3]	.4
Burn	90	160	1	1	
Swimming practices in local streams and dams					
No	95	259	0.6 [0.4-0.8]	0.4 [0.27-0.58]	.000
Yes	167	257	1	1	
Current symptoms					
No	207	477	0.3 [0.2-0.5]	0.3 [0.2-0.5]	.000
Yes	55	39	1	1	

Abbreviations: AOR = adjusted odds ratio.
Indicate significant at $P < .05$;1 = reference value.

Conclusion

Intestinal parasitic infection is still a problem in the area, and preventive measures must target protozoan infections, especially G. lamblia, and from helminths targeting H. nana. Even though the prevalence of *schistosomes* was lower than the estimated nationwide prevalence, care must be taken to prevent its expansion. Especially in areas where water has been accumulated naturally or for farming purposes. Dealing with a child's swimming practices in ponds or in areas where water has accumulated for farming purposes can contribute to decreasing the risk of infection in the setting. Also, to prevent IPI transmission, increasing mothers' health awareness regarding sanitation and hygiene is mandatory. So, to incorporate consistent health education using local ceremonies like "Coffee ceremony" in spiritual places like churches Mosques, and to use schools where children can be easily accessed, it is vital.

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Authors' Contributions

HG: was involved in proposal development, data collection, data management, analysis, and write up of the article. ND and GM: were involved in proposal development, data analysis, and writing and editing the manuscript. HK, ND, and GM edited and finalized the manuscript.

Data Availability Statement

The authors present the data in the main paper.

Ethics Approval and Consent to Participate

Prior to the commencement of the study, ethical approval was obtained from the Institute of Ethiopian Water

Resource, Addis Ababa University. A letter of support was sent from the Dire Dawa Health Bureau to the health facilities in the study area, and the leaders of the kebeles were contacted for permission to conduct the study. Written informed consent was obtained from each parent on behalf of participants after an adequate explanation of the objective and purpose of the study. A study participant who was not willing to continue in the study had full rights to do so. Children's privacy during the stool collection was maintained, and the data obtained from them was kept strictly confidential. During the survey, individuals found to be positive for intestinal parasites were treated according to the national guideline.

ORCID iD

Heroda Gebru https://orcid.org/0000-0002-4477-1291

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