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Prevalence of Protozoan Pathogens Among Diarrheic Children Under 5 Years in Public Hospital of Ethiopia During the Global COVID 19 Pandemic

Tesfaye Gobena, PhD[1], Dinaol Belina, DVM[2], Tine Hald, PhD[3], and Sara M. Pires, PhD[3]

Abstract

Acute childhood diarrhea is one of the leading causes of childhood morbidity and mortality in sub-Saharan African countries. *Entamoeba histolytica* and *Giardia lamblia* are the common cause of childhood diarrhea in the region. However, there are only few studies on protozoa causing diarrhea in sub-Saharan African countries. This study was conducted to investigate the relative prevalence and explore risk factors of *E. histolytica* and *G. lamblia* among diarrheic children of under 5 years in a public hospital of Ethiopia. A retrospective study was conducted among diarrheic children at Hiwot Fana hospital, Ethiopia. Records of all diarrheic children less than 5 years who had sought medical treatment in the hospital from September 1, 2020 to December 31, 2022 were included. Data were collected from 1257 medical records of the children using a structured data-collection format. Data were entered into an Excel sheet and exported into SPSS version 22 for data processing and analysis. Descriptive statistical tests, Chi-square, and logistic region analysis were applied to determine predictors of protozoa infections. Of the 1257 cases, 962 (76.5%) had watery diarrhea and the remaining 239 (19.0%) had dysentery. The combined prevalence of *E. histolytica and G. lamblia* among diarrheic children was 11.8% (95% CI: 9.6-13.4). As the age of children increased, the frequency of these two protozoan infections was significantly increased compared to children with other causes. There were more diarrhea cases during the summer season including those associated with *E. histolytica* and *G. lamblia*. This study revealed that 1 in 10 causes of diarhhea among young children in the study area was likely caused by *E. histolytica* and *G. lamblia*. These findings call for community-based safe water and food safety interventions in order to reduce childhood diarrhea caused by protozoan infections in resource-poor settings.

Keywords

children, *Entamoeba histolytica*, *Giardia lamblia*, prevalence, Ethiopia, diarrhea, dysentery, foodborne disease, food safety, protozoan infections

What do we already know about this topic?
The diarrheal causes of foodborne intestinal protozoan parasites is one of the major public health issues, particularly in low and middle-income countries. It is the main causes of child morbidity and mortality in resource-poor settings.

How does your research contribute to the field?
This study contributes to fill the data gap on the occurrence of foodborne intestinal protozoan parasites among diarrhea-diseased young children in Ethiopia.

What are your research's implications toward theory, practice, or policy?
This information provides additional insights for developing intervention strategies for foodborne intestinal protozoa in young children in the stud area and in other similar settings.

Background

Acute childhood diarrhea remains as one of the leading causes of childhood morbidity and mortality in low and middle income countries.[1] The Demographic and Health Survey of 34 sub-Saharan countries indicated that the overall prevalence of diarrhea was 15.3%.[2] Diarrheal disease agents being the most important contributor to overall foodborne disease (FBD) burden in African,[3,4] including Ethiopia.[5,6] In Ethiopia, The prevalence of diarrhea among children under 5 years ranges from 12%[7] to 20.8%.[8]

The protozoan parasites *G. lamblia* and *E. histolytica* are extremely common and are estimated to be responsible for about 28[9] and 50[10] million human cases of diarrhea every year, respectively. The 2010 global etiology-specific burden estimate indicated that *G. lamblia* was responsible for one of the highest diarrheal causing pathogens in children <5 years of age.[11] In Ethiopia, the prevalence of *E. histolytica and G. lamblia among under 5 children were* 14.09% and 10.03%, respectively.[12] These parasites are primarily transmitted by the fecal-oral route by consuming food or water contaminated with the protozoan cysts. The disease severity of these parasites is higher in developing countries[13] with the greatest burden in sub-Saharan Africa and Southeast Asia, where children under 5 years bear 63% of the FBD burden of infection and 50% of the FBD-associated mortality.[14]

Still, these estimates rely on very limited data, as there are only few studies on protozoa causing foodborne diarrhea in developing countries, including in sub-Saharan African countries,[3] which hampers the implementation of targeted food-safety measures and thus, the achieving of several of the Sustainable Development Goals (SDGs).[15]

This facility-based retrospective study characterizes causes of diarrhea among diarrheic children under 5 years of age, who sought medical treatment in public hospital and found positive for *E. histolytica* and *G. lamblia*. The findings can be used by national, regional and international stakeholders to assess the burden of pathogens causing diarrhea among young children and to design community-based intervention strategies.

Methods

Study Setting and Period

A retrospective study was conducted in Hiwot Fana Comprehensive Specialized Hospital, Ethiopia from September 1, 2020 to December 31, 2022. The hospital is located in Harar town, which is 526 km east of Addis Ababa. The hospital serves about 5.8 million people from the Harari region, Dire Dawa administration, Oromia region, and Somali region, and it is a teaching center in Eastern Ethiopia, providing various healthcare services, including pediatric outpatient and inpatient services.[16]

Study Population and Inclusion Criteria

Medical records of all diarrheic children less than 5 years that sought medical treatment in Hiwot Fana hospital from September 1, 2020 to December 31, 2022 were eligible for being included in the study. Records with incomplete data, particularly with regard to the diarrhea status of the case, were excluded from the study. Children whose stool samples were examined at the hospital laboratory were referred from pediatric out-patient clinics or inpatient of the hospital.

Sample Size and Sampling Technique

The sample size was estimated using a single population proportion sample size estimation formula. Assuming of proportion of protozoa 10.03%,[12] 0.02 margin of error and 95% confidence level, and 10% nonresponse. A minimum of 953 children fulfilling the inclusion criteria were thus planned to be included.

Data Collection

Data were retrieved from medical records of acute diarrheic children under 5 years who sought medical treatment from Hiwot Fana Hospital. Stool samples was examined at the hospital laboratory using direct wet mount, microscopically. Two trained nurses and 1 public-health professional under the supervision of a senior public-health professional conducted the data collection from January 1, 2023 to April 30, 2023. Data were collected using a structured data-collection format containing socio-demographic information, characterization of the diarrhea and other symptoms, and the microscopic results of the stool sample.

Data Quality Control

Before commencement of data retrieval, the data collection format was developed based on the medical record formats

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of the institution. The data-collection format was then checked for its clarity, sequence, and applicability. The completeness and consistency of the data were checked daily by the supervisor. The medical records number was used to avoid redundancy and for further cross checking of inconsistency. Finally, the collected data were cleaned and cross-checked to ensure the quality of the data.

Data Processing and Analysis

Data were entered into an Excel sheet and exported to the Statistical Package for the Social Sciences (SPSS) version 22 for data processing and analysis. To identify potential risk factors for finding protozoa among the children with diarrhea, univariate analysis was computed using the Pearson Chi-square test followed by logistic regression. A *P*-value of .05 was considered as the cut-off point for statistical significance. In the statistical analyses, a case was defined as a diarrheic child with a stool sample positive for either *E. histolytica* or *G. lamblia*, whereas the comparison group consisted of diarrheic cases with no findings of *E. histolytica* or *G. lamblia.*

Results

Socio-Demographic Characteristics

In this survey, 1257 under 5 diarrheic children records were included in the descriptive analysis. Of these, 990 (78.8%) were urban residents, while the remaining were from rural settings. Three fourth of the children were under 2 years. Three hundred thirty-four (26.6%), and 923 (73.4%) of the diarrheic children were enrolled from September 1, 2020 to August 31, 2021, and from September 1, 2021 to December 31, 2022, respectively. The mean and median age of the children were 16.48 (±SD = 12.81) months, and 12 months, respectively. The mean weight and height of the children were 9.1 kg and 73.6 cm, respectively (Table 1).

Prevalence of E. histolytica and G. lamblia in Diarrheic Children

Of the total 1083 diarrheic children, whose stool samples were examined, the overall prevalence of protozoa was 11.5% (95% CI: 9.7, 13.3%), where *E. histolytica* was found in 86 (7.9%) and *G. lamblia* in 39 (3.6%) of the samples. No children was found positive for both protozoa. Thirty-six (28.8%), and 89 (71.2%) of the protozoa cases were diagnosed from September 1, 2020 to August 31, 2021, and from September 1, 2021 to December 31, 2022, respectively. Additionally, there was highest protozoa infections during summer 54 (43.2%) and lowest in Spring 20 (16.0%).

Table 1. Demographic Characteristics of Children Under 5 Years With Diarrhea Illness in Public Hospital of Ethiopia, 2023.

Child characteristics/variables (N = 1257)	Category	Number (%)
Place of residence	Urban	990 (78.8)
	Rural	267 (21.2)
Sex of child	Male	609 (48.4)
	Female	648 (51.6)
Age (in months)	<6	223 (17.7)
	6-11	295 (23.5)
	12-23	433 (34.4)
	24-35	157 (12.5)
	36-47	79 (6.3)
	48-59	70 (5.6)

Demography and Clinical Symptoms of Diarrheic Children

Three-fourths of the cases were children under 2 years of age. One in 10 children had received treatment within 24 hours since the onset of diarrhea, and 375 (33.9%) had diarrhea at least for 4 days since the onset of diarrhea (Table 2). Of the total medical treatment sought diarrhea cases, 962 (80.1%) had watery diarrhea; and the remaining 239 (19.01%) had dysentery. Almost half of children had received treatment 2 to 3 days after the onset of diarrhea (Table 2).

There were more diarrhea cases 852 (78.7%) including protozoa diagnosis 94 (75.2%) among children from rural areas than urban areas (Table 3). More diarrhea cases 598 (47.6%) including protozoa diagnosis 54 (43.2%) were also observed during the summer season compared with the other seasons.

Factors Related With Protozoan Infections Among Diarrheic Children

When comparing diarrheic children positive for protozoa with diarrheic children negative for protozoa, the test for trend showed a significant difference among the age categories of the children ($X^2 = 20.76$, *P*-value = .001), where protozoa were more commonly found in older children (Table 3). The univariate analysis also indicated that diarrheic children positive for protozoa more commonly experienced fever and vomiting (Table 3).

Of the variables included in the final logistic regression model, increasing age remained a predictor for positivity for protozoa among diarrheic children. Place of residence, sex, and season were not statistically different between protozoa cases and the comparison group, although there were in general more diarrhea cases including those positive for protozoa in the summer season and in rural area (Table 4).

Table 2. Characterization of Diarrhea and Other Clinical Symptoms of the Children With Diarrhea Among Children Under 5 Years of Age in Public Hospital of Ethiopia, 2020-2023.

Child characteristics	Number (%)
Types of diarrhea	
Dysentery (bloody, mucoid)	239 (19.9)
Watery diarrhea	962 (80.1)
Number of days with diarrhea	
1 day	122 (11.0)
2-3 days	609 (55.1)
≥4 days	375 (33.9)
Vomiting	
Yes	548 (43.6)
No	709 (56.4)
Protozoa (*E. histolytica and G. lamblia*)	
Yes	125 (11.5)
No	958 (88.5)

Discussion

Acute diarrhea disease due to FBDs is one of the major public health problems among children under 5 years of age in LMICs.[3,17] In Ethiopia, *E. histolytica* and *G. lamblia* are the most common protozoa FBDs.[12] This study revealed that the prevalence of *E. histolytica* and *G. lamblia* among children seeking medical care due to diarrhea was 11.5%. This is statistically lower than the findings in other similar studies conducted in the country Hawassa,[18] Bahir Dar,[19] and Debre Birhan.[20] Similarly, it is lower than the findings of a study conducted in Mozambique.[21] This may be due to differences in the stool examination techniques used. The results of this study was based on direct wet mount, which is a less sensitive method to detect protozoan parasites.[22] Additionally, there was also differences in study periods, except for the Bahir Dar study (2020), all other studies were conducted before the global COVID 19 pandemic. During at least the first year of the COVID pandemic, hand washing and sanitization, and other hygienic practices were given more attention than before the pandemic, which may have resulted in an overall decrease in communicable diseases, particularly respiratory and diarrheal infections. A study in Ethiopia reported that there was a decrease of diarrhea during the pandemic although it was found not to be significant.[23]

The current study found that *E. histolytica* accounted for 7.9% of diarrhea cases, which is higher than the findings of previous studies reported[20] *E. histolytica* from Debre Birhan, Ethiopia, and study conducted in Mozambique.[21] But lower than the finding of a study conducted in Hawassa, Ethiopia[18] and Bahir Dar.[19]

The estimated prevalence of *G. lamblia* in the present study was 3.6%. This is at the same level as a study conducted in West Omo Zone, Ethiopia,[24] but lower than the findings in other studies conducted in Ethiopia; Bahir Dar,[19] Gondar,[18] and Debre Birhan[20]; and in Mozambique.[21] The variation in the prevalence of the protozoa among the different studies might be attributed to differences in geographical location, study period, study design, sample size, differences in method of stool examination and also the cases referral system in the health sector. Moreover, the improved hand hygiene to prevent COVID-19 and food safety measures in the country could have also had a positive effect in reducing the proportion of the protozoa among the diarrhea cases. However, the number of diarrhea cases and protozoan infection increased from 2021 to 2022. This may be the number of diarrhea cases returning to the pre-epidemic level, because of a loosening of COVID-preventive measure such as hand sanitation or washing.

The current study found an association between prevalence of protozoa and the age of the children. This study reveals that the older the children the higher risk of being found positive for protozoa. This finding was similar to the results of cross-sectional studies conducted in Mozambique[25] and Kenya.[26] This finding may be because older children through their food consumption habit and outdoor behavior in general are more exposed to protozoan cysts. However since this study only provides a relative prevalence of protozoa among diarrheic children, it may simply also be because other infectious diseases such as enteroviruses or bacterial pathogens such as diarrheagenic *E. coli* are common causes of diarrhea among infants meaning that the proportion of infections caused by protozoa is relatively smaller.

In this study, we found no statistically significant association between gender and the positivity for protozoa among diarrheic cases. This finding is consistent with other studies in Ethiopia[27] and Kenya.[26] Other studies also indicate an equal probability of protozoa infection.[28,29] Additionally, there was no statistical significant association between place of residence and protozoa infections, though more proportion of protozoa cases were reported in rural than urban children.

There were clearly more diarrhea cases including protozoa during summer. This may be due to scarcity of safe water supply in the community during summer, which exacerbate the poor hygienic practice of the mother and their young children, including unsafe food consumptions.

In general, the current study revealed that there is significant proportion (11.7%) of protozoa parasites among diarrheic children in the study area. Although other causes of the disease such as enteric virus, intestinal bacterial pathogens, or other parasites cannot be ruled out, as they were not examined for at the study hospital. Still, the results call for community based tailored water supply, sanitation and food hygiene intervention to reduce diarrhea disease in children including those caused by foodborne protozoan parasites.

Table 3. Socio-Economic and Demographic Factors, and Clinical Symptoms Associated With Protozoa Among Diarrheic Children oF Under 5 years in Public Hospital, Ethiopia.

Child characteristics	Presence of Protozoa		Total no. (%)	Chi-square test value	*P*-value
	Yes (%)	No (%)			
Place of residence					
Urban	31 (24.8)	200 (20.9)	231 (21.3)	1.01	.31
Rural	94 (75.2)	758 (79.1)	852 (78.7)		
Sex of child					
Male	53 (42.4)	470 (49.1)	523 (48.3)	1.96	.16
Female	72 (57.6)	488 (50.9)	560 (51.7)		
Age (in months)					
<6	16 (12.8)	130 (13.6)	146 (13.5)	20.76	.001
6-11	25 (20.0)	284 (29.6)	309 (28.5)		
12-23	37 (29.6)	325 (33.9)	362 (33.4)		
24-35	17 (13.6)	115 (12.0)	132 (12.2)		
36-47	14 (11.2)	56 (5.8)	70 (6.5)		
48-59	16 (12.8)	48 (5.0)	64 (5.9)		
Types of diarrhea					
Dysentery (bloody, mucoid)	29 (24.0)	226 (24.3)	255 (24.3)	0.01	.94
Watery diarrhea	92 (76.0)	706 (75.7)	796 (75.7)		
Number of days with diarrhea					
1 day	16 (14.7)	84 (10.1)	100 (10.6)	2.24	.33
2-3 days	57 (52.3)	448 (53.7)	505 (53.6)		
≥4 days	36 (33.0)	302 (36.2)	338 (35.8)		
Vomiting					
Yes	67 (53.6)	410 (42.8)	477 (44.0)	5.24	.02
No	58 (46.4)	548 (57.2)	606 (56.0)		
Fever					
Yes	23 (18.4)	74 (7.7)	97 (9.0)	15.38	.001
No	102 (81.6)	882 (92.3)	984 (91.0)		
Cough					
Yes	30 (24.8)	162 (17.5)	192 (18.3)	3.81	.05
No	91 (75.2)	764 (82.5)	855 (81.7)		
Vomiting and fever					
Yes	18 (14.4)	39 (4.1)	57 (5.3)	23.57	.001
No	107 (85.6)	917 (95.9)	1024 (94.7)		

Therefore, the enhancement of diarrhea intervention and collaboration among sectors and partners are utmost important in controlling of prevalence of FBD caused by protozoan parasites.

The current study considered the retrospective data collected from medical records of the children, which made us focus on some variables and limited our ability to determine the association between different risk factors and the occurrence of protozoa among the acute diarrhea cases. Furthermore, the reporting methods of the institution forced us to determine only the prevalence of *G. lamblia* and *E. histolytica*, which may not represent all foodborne pathogens including other protozoa such as Cryptosporidia spp. Additionally, some medical records had incomplete data on diarrhea status of the child and was excluded from the analysis. Nevertheless, this large sample size data gave valuable information on the proportion of the most crucial foodborne protozoan infection in the study area.

Conclusion

The current study revealed that 1 in 10 causes of diarrhea among young children in the study area could be associated with the protozoa *E. histolytica or G. lamblia*. The enhancement of food safety measures, safe water supply and improvement of environmental sanitation activities in the community are of utmost importance in controlling of protozoan parasites leading to diarrhea. Furthermore, the authors recommend the need for further community based prospective study to capture the causes of the protozoa among diarrheic children in resource-poor settings.

Table 4. Factors Independently Associated With *E. histolytica and G. lamblia* in Public hospital of Ethiopia, 2023.

	Presence of Protozoa						
Child characteristics	Yes (%)	No (%)	CORs	95% CI	*P* values	AORs	95% CI
Place of residence							
Urban	31 (24.8)	200 (20.9)	1.25	0.81,1.93	.32	1.31	0.84,2.04
Rural	94 (75.2)	758 (79.1)	1				
Sex of child							
Male	53 (42.4)	470 (49.1)	0.76	0.52,1.11	.16	0.77	0.52,1.12
Female	72 (57.6)	488 (50.9)	1				
Age (in months)							
<6	16 (12.8)	130 (13.6)	0.37	0.17,0.79	.01	0.36	0.16,0.77
6-11	25 (20.0)	284 (29.6)	0.26	0.13,0.53	.001	0.26	0.13,0.52
12-23	37 (29.6)	325 (33.9)	0.34	0.18,0.66	.001	0.33	0.17,0.64
24-35	17 (13.6)	115 (12.0)	0.44	0.21,0.95	.04	0.44	0.20,0.94
36-47	14 (11.2)	56 (5.8)	0.75	0.33,1.69	.49	0.71	0.31,1.61
48-59	16 (12.8)	48 (5.0)	1				
Seasons							
Spring	20 (16.0)	160 (16.7)	0.73	0.39,1.35	.31	0.72	0.38,1.35
Summer	54 (43.2)	465 (48.5)	0.68	0.41,1.11	.12	0.65	0.39,1.08
Autumn	24 (19.2)	176 (18.4)	0.79	0.44,1.43	.44	0.72	0.39,1.32
Winter	27 (21.6)	157 (16.4)	1				

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Authors Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Declaration of Conflicting Interests

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Ethics and Consent

The study obtained ethical clearance from the Institutional Health Research Ethics Review Committee (IHRERC) of Haramaya University and the National Research Ethics Committee with a letter written on February 11, 2020 (Ref Number: MoSHE/RD/14.1/9849/20). The IRB waived the consent due to use of secondary source of data from medical records of the hospital. Additionally, permision was obtained from the hospital and the respective units to collect the data. In this study, no personal identification information was collected to ensure confidentiality of the patient data. The data collected from the medical records are kept confidentially at all stages of the research activities using anonymous medical registration numbers.

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