Prevalence of *Entamoeba histolytica* and *Giardia lamblia* among schoolchildren in Um-Asher Area, Sudan

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Research note

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Abstract

Objective: Infections with *Entamoeba histolytica* and *Giardia lamblia* are widely prevalent and responsible for serious public health issues among school-aged children in developing countries. This study was conducted to determine the prevalence of these parasites among children from two primary schools in Um-Asher area, Khartoum, Sudan. A total 170 fresh stool specimens were collected from November 2017 to June 2018. The samples were examined by microscopy for the presence of the two parasites.

Results: The overall prevalence of both parasites among the 170 children was 20%, with 13 children infected with *E. histolytica* (7.6%) and 23 with *G. lamblia* (13.5%). Most of the positive cases were single infections. Only two children (1.2%) had mixed infections. This indicates that these gastrointestinal parasites remain a challenging public health concern wherever sanitation and health measures are limited.

Introduction

Intestinal parasites are a serious medical problem that significantly affects public health and results in considerable morbidity and mortality in developing countries (1), including Sudan (2, 3), where many conditions, including climatic, ecological, socioeconomic and hygienic, favour their transmission. In addition, infection with these pathogenic parasites can be associated with gastrointestinal diseases and malnutrition, particularly among young children (4). Several pathogenic intestinal parasites may be responsible for the above health problems, two parasites, *Entamoeba histolytica* (*E. histolytica*) and *Giardia lamblia* (*G. lamblia*) being the commonest and have been reported and associated with significant illnesses in developing countries. *E. histolytica*, the etiologic agent of amoebiasis, is an important parasite of the human gut. Among parasitic diseases, amoebiasis is considered the third most common cause of death after malaria and schistosomiasis (5). The parasite causes amoebic dysentery, amoebic colitis and amoebic liver abscess and leads to almost 100 thousand deaths annually (6). *G. lamblia* is another common cause of gastrointestinal diseases in humans throughout the world, and approximately 5–10% of the global population is at risk of giardiasis, which is considered one of the main nonviral causes of diarrhoeal diseases in humans (7).

In Sudan, the two parasites are widely distributed and pose significant challenges to health authorities due to insufficient health education, poor sanitation and improper disposal of human excreta, which lead to the contamination of food and drinking water, and poverty (1, 8). In this regard, Sudanese children are at risk of infection (9); the infection rate of *Entamoeba* spp. is predicted to increase. Meanwhile, schoolchildren are the primary victims of *Giardia* spp. infection in both developed and developing countries. Accordingly, prevalence surveys of both parasites are a prerequisite for developing effective control strategies. However, only few studies have been conducted in different parts of Sudan and mostly among schoolchildren. Therefore, this study was conducted to determine the prevalence of *E. histolytica* and *G. lamblia* and the associated risk factors among schoolchildren from Um-Asher area, South Khartoum, Sudan.

Methodology

Study area, period and study subjects

A cross-sectional study conducted in Um-Asher (Al Kalakla) area, from November 2017 until June 2018. Um-Asher is located at the latitude of 15°28'04″ N and longitude of 32°29'08″ E, a height of 384 m and 16.3 km south of Khartoum, Sudan. Convenience sampling method was used to enrol children aged between 6 and 17 years who were attending the selected primary schools. Any children who were taking medication for amoebiasis or giardiasis within the three weeks of data collection were excluded. Accordingly, 170 primary schoolchildren (75 males and 95 were females) were selected and enrolled.

Sample collection and examination

Approximately 5–7 g of fresh stool specimens were collected in sterile, carefully labelled plastic containers. The stool sample was added with 10% formaldehyde as preservative. The stool specimens were individually inspected for the presence of mucous or blood and consistency. The detection of *E. histolytica* and *G. lamblia* infections was carried out using direct faecal smears in normal saline. All patient details including socio-demographic characteristics and associated risk factors were obtained via previously developed standardised questionnaire (10).

Statistical analysis

SPSS 24.0 was used to conduct the descriptive and logistic regression analyses. The descriptive data were presented as frequencies and percentages. Simple and multiple logistic regression analyses were performed to identify variables associated with the positive outcome of *E. histolytica* and *G. lamblia*. In the simple logistic regression analysis, the variables with a p-value < 0.25 were considered important and therefore included in the multiple logistic regression analysis. The final model was assessed for fitness by using the receiver operating characteristics (ROC) curve, the Hosmer and Lemeshow test, the classification table, interaction between the study variables and multicollinearity.

Results

Socio-demographic characteristics of study participants

A total of 170 students from two primary schools were involved. The majority of the participants (68.2%) were between the age of 10 and 13 years. Amongst the study participants, 33.5% (n = 57) were residing less than 1 km from a water source, and 66.5% (n = 113) were residing more than 1 km away from a water source. The main source of water was tap water 94.7% (n = 161). The majority of the participants (61.8%, n = 105) had no sanitary latrine. The summary of all the participant’s characteristics is presented in Table 1.

Table 1
Socio-demographic characteristics of participants (n = 170)

Variables	Categories	Frequency	Percent
Gender	Male	75	44.1
	Female	95	55.9
Age	6–9	38	22.4
	More than 10	132	77.6
Distance of residence from water source	< 1 Km	57	33.5
	> 1 Km	113	66.5
Source of Drinking water	Ground/ Pure Water	9	5.3
	Tap water	161	94.7
Type of latrine	Non Sanitary Latrine	105	61.8
	Sanitary latrine	65	38.2
Washing cloth	In the house	165	97.1
	In the river	2	1.2
	Other	3	1.8
Hand washing before meals	No	109	64.1
	Yes	61	35.9
Habit of washing vegetables and fruits	No	9	5.3
	Yes	161	94.7
breakfast	In the house	63	37.1
	In the school	107	62.9
Bathing habit	Home	151	88.8
	Canal	3	1.8
	River	3	1.8
	All	13	7.6
Frequency of Trimming finger nail	Once a week	100	58.8
	More than one week	70	41.2
E. Histolytica	Negative	157	92.4
	Positive	13	7.6

Variables	Categories	Frequency	Percent
G. lamblia	Negative	147	86.5
	Positive	23	13.5
Residency during school holiday	Outside the area	84	49.4
	In the area	86	50.6

Prevalence of E. histolytica infection and its associated risk factors

Microscopic analysis showed that only 13 (7.6%) were found positive for *E. histolytica*. In the simple logistic regression analysis, three variables, namely: gender, latrine type, and breakfast had an unadjusted crude odds ratio (COR) with p-values less than 0.25 (Table 2). Male were 3.1 times more likely to test positive for *E. histolytica* than female children (COR = 3.10, p-value = 0.069). The subjects who ate breakfast in the school were 7.8 times more likely to test positive than those who took breakfast at home (COR = 7.83, p-value = 0.051). Furthermore, subjects with no sanitary latrine were 64% less likely to test positive than those with sanitary latrine (COR = 0.36, p-value = 0.082). The forward LR and backward LR selection method was used in the multiple logistic regression analysis. All the three variables (gender, type of latrine and breakfast) were selected and run using the enter method. Male were 3.5 times more likely to test positive than female, with adjusted odds ratio (AOR) = 3.50 and p-value = 0.052. Subjects who took their breakfast in school were 9.5 times more likely to test positive than those who ate breakfast at home (AOR = 9.50, p-value = 0.035). Those with no sanitary latrine were 71% less likely to test positive than those with sanitary latrine (AOR = 0.29, p-value = 0.043).

Table 2
Factors associated with test positivity for *E. histolytica*

Characteristics	Negative No. (%)	Positive No. (%)	Crude OR (95% CI)	P value	Adjusted OR	P
Gender						
Female	91 (95.8)	4 (4.2)	1		1	
Male	66 (88.0)	9 (12.0)	3.10 (0.92, 10.51)	0.069	3.50 (0.99, 12.39)	0.052
Age						
6–9	36 (94.7)	2 (5.3)	1			
More than 10	121 (91.7)	11 (8.3)	1.64 (0.35, 7.72)	0.534		
Distance of residence from water source						
< 1 Km	54 (94.7)	3 (5.3)	1			
> 1 Km	103 (91.2)	10 (8.8)	1.75 (0.46, 6.62)	0.411		
Type of latrine						
Non Sanitary Latrine	100 (95.2)	5 (4.8)	0.36 (0.11, 1.14)	0.082	0.29 (0.08, 0.96)	0.043
Sanitary latrine	57 (87.7)	8 (12.3)	1			
Hand washing before meals						
No	100 (91.7)	9 (8.3)	1			
Yes	57 (93.4)	4 (6.6)	0.78 (0.23, 2.65)	0.690		
Habit of washing vegetables and fruits						
No	8 (88.9)	1 (11.1)	1.55 (0.18, 13.5)	0.690		
Yes	149 (92.5)	12 (7.5)	1			
Breakfast						
In the house	62 (98.4)	1 (1.6)	1		1	
In the school	95 (88.8)	12 (11.2)	7.83 (0.99, 61.75)	0.051	9.50 (1.17, 77.16)	0.035

Characteristics						
	Negative No. (%)	Positive No. (%)	Crude OR (95% CI)	P value	Adjusted OR	P
Frequency of Trimming finger nail						
Once a week	92 (92.0)	8 (8.0)	1			
Moe than once a week	65 (92.9)	5 (7.1)	0.89 (0.28, 2.83)	0.885		

No significant interaction was found between all the pairs of variables tested (p-values > 0.05). No multicollinearity for all the variables (VIF < 10) was observed. The assumption for the Hosmer and Lemeshow test was satisfied (p-value = 0.961), indicating adequate model fitness with the three variables. The area under the ROC curve (AUC) was 79.5%, indicating the sufficient discriminant ability of the final model with gender, type of latrine and place of breakfast.

Prevalence of G. lamblia infection and its associated risk factors

A total of 23 children (13.5%) were found to be infected with *G. lamblia*. In simple logistic regression analysis, three variables, namely: age, bathing habit, and frequency of trimming had an unadjusted COR with p-values less than 0.25, (Table 3). Children aged more than 10 years were 52% less likely to be diagnosed positive for *G. lamblia* than those aged 6–9 years (COR = 0.48, p-value = 0.130). For bathing habit, children who took their baths in the river were 13.1 times more likely to test positive than those who took their baths at home (COR = 13.10, p-value = 0.039). Children who trimmed their nails more than once in a week were 74% less likely to test positive than those who trimmed their nails once in a week (COR = 0.26, p-value = 0.019).

Table 3
Factors associated with test positivity for *G. lamblia*

Characteristics	Negative No. (%)	Positive No. (%)	Crude OR (95% CI)	*P* value	*AOR*	*P*
Gender						
Male	63 (84.0)	12 (16.0)	1.46 (0.60, 3.51)	0.404		
Female	84 (88.4)	11 (11.6)	1			
Age						
6–9	30 (78.9)	8 (21.1)	1		1	
More than 10	117 (88.6)	15 (11.4)	0.48 (0.19, 1.24)	0.130	0.33 (0.12, 0.93)	0.035
Distance of residence from water source						
< 1 Km	47 (82.5)	10 (17.5)	1			
> 1 Km	100 (88.5)	13 (11.5)	0.61 (0.25, 1.50)	0.280		
Source of Drinking water						
Ground/Pure Water	7 (77.8)	2 (22.2)	1			
Tap water	140 (87.0)	21 (13.0)	0.53 (0.10, 2.70)	0.440		
Type of latrine						
Non Sanitary Latrine	92 (87.6)	13 (12.4)	0.78 (0.32, 1.90)	0.579		
Sanitary latrine	55 (84.6)	10 (15.4)	1			
Hand washing before meals						
No	94 (86.2)	15 (13.8)	1			
Yes	53 (86.9)	8 (13.1)	0.95 (0.38, 2.38)	0.906		
Habit of washing vegetables and fruits						
No	8 (88.9)	1 (11.1)	0.79 (0.09, 6.63)	0.828		
Yes	139 (86.3)	22 (13.7)	1			
Breakfast						

Characteristics	Negative No. (%)	Positive No. (%)	Crude OR (95% CI)	*P* value	*AOR*	*P*
In the house	55 (87.3)	8 (12.7)	1			
In the school	92 (86.0)	15 (14.0)	1.12 (0.45, 2.82)	0.808		
Frequency of Trimming finger nail						
Once a week	81 (81.0)	19 (19.0)	1		1	
More than once a week	66 (94.3)	4 (5.7)	0.26 (0.08, 0.90)	0.019	0.20 (0.06, 0.66)	0.008

In the multiple logistic regression analysis, two variables were selected and run using the enter method (age and frequency of trimming). Children aged more than 10 years were 67% less likely to be diagnosed positive for *G. lamblia* than those aged 6–9 years (AOR = 0.33, p-value = 0.035). The children who trimmed theirs nails more than once in a week were 80% less likely to be diagnosed positive for *G. lamblia* than those who trimmed their nails once in a week (AOR = 0.20, p-value = 0.008).

Children who trimmed their nails every two weeks were 91% less likely to be diagnosed positive than those who trimmed their nails every week (AOR = 0.09, p-value = 0.027). Children who trimmed their nails every three weeks were 79% less likely to test positive than those who trimmed their nails every week (AOR = 0.21, p-value = 0.158). Children who trimmed their nails every month were 57% less likely to test positive than those who trimmed their nails every week (AOR = 0.43, p-value = 0.315) (data not shown).

There was no significant interaction between the age and frequency of nail trimming (p-value = 0.376). No multicollinearity for all the variables (VIF < 10) was observed. The assumption for the Hosmer and Lemeshow test was satisfied (p-value = 0.663), indicating adequate model fitness with the two variables. The area under the ROC curve (AUC) was 68.5%, indicating the sufficient discriminant ability of the final model with age and frequency of nail trimming.

Discussion

Epidemiological information that confirms the spread of intestinal parasitic infections is a prerequisite in the design and implementation of appropriate prevention and control strategies. This study was conducted to determine the prevalence of two gastrointestinal parasites, i.e. *E. histolytica* and *G. lamblia*, and the associated risk factors among schoolchildren in Um-Asher area, South Khartoum, Sudan.

The overall prevalence of the two parasites among the 170 children was 20% (34 of 170), with 13 children infected with *E. histolytica* (7.6%) and 23 with *G. lamblia* (13.5%). Mixed infections with *G. lamblia* and *E. histolytica* were detected in 1.2% (2 of 170) of the children. *G. lamblia* was remarkably more frequent among the children than *E. histolytica*. This finding is consistent with the results of previous studies conducted in different parts of Sudan and globally. The predominance of *G. lamblia* over *E. histolytica* was also identified in a study conducted by Suliman et al. (11), Siddig et al. (12) and Gabbad and Elawad (13). Similar infection patterns were reported from other countries, such as Ethiopia (14), Nepal (15) and Iran (16).

The proportion of children infected with *E. histolytica* was higher than those infected with *G. lamblia*, similar to the report of a study conducted in the same geographical area (17) and in Côte d'Ivoire, Iraqi and Ethiopia (5, 18, 19). The discrepancy in prevalence and predominance of the two parasites among studies conducted inside or outside the country may be due to several factors, including climatic conditions, poverty level, nutritional status, socio-economic conditions, high population density, health-related behaviour, illiteracy and poor sanitation (20).

The infection with *E. histolytica* and *G. lamblia* was not significantly associated with gender ($p > 0.05$). However, males were 3.1 and 1.5 times more likely to test positive for *E. histolytica* and *G. lamblia* than females, respectively (COR = 3.10 and 1.46). This finding is in agreement with other reports that showed that more males were infected with both parasites (18, 21, 22). The majority of the positive cases were also reported in females, who also had higher odds of being infected with *E. histolytica* and *G. lamblia* (4). Other studies reported slight gender differences (1), while a significant association with boys being more infected than girls were also reported (23). These findings indicate that the possibility of being infected with both parasites might be related to gender-specific behaviour within a community. However, males are more exposed to outdoor activities, which make them more vulnerable to intestinal parasitic infections, whereas females mostly remain indoors.

This study revealed no significant differences in the prevalence of *E. histolytica* and *G. lamblia* associated with age. However, a relatively higher infection rate was found in children aged more than 10. These children were 1.6 times more likely to test positive for *E. histolytica* than those from the 6–9 years group. For *G. lamblia*, children in the same age were 52% less likely to be diagnosed positive than those aged 6–9 years (COR = 0.48, p-value = 0.130). This finding could be attributed to the common pattern of children behaviour, that is, their outdoor activities increase as they grow older, thereby increasing their exposure to intestinal parasites.

In conclusion: Urgent actions, i.e. long-term control measures and improvement of personal hygienic practices and sanitary and living conditions, must be implemented.

Limitations

The major limitation of this study was the small sample size. Therefore, the estimated prevalence cannot reflect the burden of the disease across the study area.

List Of Abbreviations

E.: *Entamoeba*, *G: Giardia,* ROC: Receiver Operating Characteristics, COR: Crude Odds Ratio, AOR: Adjusted Odds Ratio, AUC: Area under the ROC Curve

Declarations

Ethics approval and consent to participate

The study was conducted after the approval of the project by the ethical review committee of the Research Directorate, Federal Ministry of Health (fmoh/nhrc/rd/rec). Verbal consent was obtained from the heads of the target schools. The children were involved in the study after informed written consent was obtained from the parents or guardians and assent from all participating children.

Consent for publication

Not applicable.

Availability of data and material

All original or analyzed data for this study is available on request from the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

KH, AMM, MJ and ZM: Conceived and designed the study, TA, ZMS, HAE, EE and EN: field and laboratory work, AS: Statistical analysis. All authors read and approved the final manuscript.

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