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WHE, BAA and LMA conceived and designed the study. AGA, ABA, DHO, EQA, SSA, SMA and STA performed the experiments, and analyzed data. WHE and BAA wrote and revised the paper.

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*Correspondence

Wadhah Hassan Edrees

Email:

wadah.edrees@alraziuni.edu.ye;
edrees2020@gmail.com

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Prevalence of Intestinal Parasitic Infections among Asymptomatic Primary Schoolchildren at Al-Sabeen District in Sana'a City, Yemen

Wadhah Hassan Edrees^{1,2*}, Bashir Ahmed Al-Ofairi^{3,4}, Ahmed Gabr Alsaifi⁴, Lutf Mohammed Alrahabi⁵, Ali Abdo Alnjar⁴, Daris Hamid Othrub⁴, Ebtahal Qasem Alhadhri⁴, Sabria Sadeq Alghuzi⁴, Sarah Mustafa Alyousfi⁴, Souad Taufik Alansi⁴

¹Medical Microbiology Department, Faculty of Applied Sciences, Hajjah University, Yemen.

²Medical Laboratory Department, Faculty of Medical Sciences, Al-Razi University, Yemen.

³Microbiology/Biological Sciences, Faculty of Sciences, Sana'a University, Yemen.

⁴Medical Laboratory Department, Faculty of Medical Sciences, Queen Arwa University, Yemen.

⁵Dental Department, Faculty of Medical Sciences, Queen Arwa University, Yemen.

Abstract:

Intestinal parasitic infections are the most regularly documented in Yemen and are a significant health problem among schoolchildren, with an occurrence ranging from 18% to 90%. Therefore, the present study aimed to determine the prevalence of intestinal parasitic infections among asymptomatic primary schoolchildren at Al-Sabeen district in Sana'a city, Yemen. A total of one hundred and seventy-three (173) stool specimens were collected from January to March 2021 from primary school children according to standard laboratory methods. The simple sedimentation technique was used for specimen processing and the specimen was examined under a light microscope. The required information was collected by a structured questionnaire. The results showed that the overall intestinal parasitic infection was among 107 (61.85%) schoolchildren, 56 (63.63%) in public schools, and 51 (60%) in private schools. Also, male children were more infected by intestinal parasitic infection compared to females. The infection rate by intestinal protozoa and helminths was 79.72% and 20.28%, respectively. The most predominant parasite found among public schools was *Entamoeba histolytica* (49.32%), followed by *Giardia lamblia* (30.14%), *Hymenolepis nana* (9.59%), *Taenia* species (6.84%), and *Ascaris lumbricoides* (4.11%). Whereas in private schools, *G. lamblia* was recorded at 48.57% followed by *E. histolytica* (31.43%), *H. nana* (7.14%), *A. lumbricoides* (7.14%), *Taenia* species (6.84%), and *Enterobius vermicularis* (2.86%). The high multiple infection rate was 23.53%, as recorded by two types of intestinal parasites. From this study, it can be recommended that regular treatment of intestinal parasitic infections and deworming of schoolchildren, as well as health education programs, will provide parents with information on how to avoid parasitic infections among children, promote personal hygiene, adequate water supply, and sufficient sanitary practices.

INTRODUCTION

Intestinal parasitic infections are one of the major health concerns worldwide and are responsible to infect more than 3.5 billion people and approximately 450 million of them individuals are ill (Okayay *et al.*, 2004). In developing countries, the frequency rate of intestinal parasites is up to 50% (Chacon-Cruz and Mitchell, 2003).

The environment and the social and cultural habits of the people might be attributable to the increased rate of intestinal parasites prevalent in developing countries. Furthermore high population density, paucity of resources, malnutrition, the inaccessibility of drinking water, poor health outcomes, and poor personal hygiene provide optimum environments for the intestinal parasite's transmission. In these countries, schoolchildren are the most exposed to intestinal parasitic infections (Kia *et al.*, 2008; Mohammed *et al.*, 2015; Satoskar *et al.*, 2009).

The children are susceptible to heavy infection because their immune systems are less developed and increased nutritious requirements. As a result of morbidity, children are at increased risk for detrimental effects like poor growth, impaired cognitive function, reduced physical activity, and learning ability. The most important drawback of intestinal parasitic infection is that approximately 90% of infected children are carriers (Sackev, 2001).

It was assessed that around 12% of the disease burden globally caused by intestinal parasites is observed among children of age group between 5 to 14 years in low-income countries (Awasthi *et al.*, 2003). Similarly, more than 270 and 600 million pre-school and schoolchildren, respectively, are existing in an area where the parasites are widely transmitted (WHO, 2016). The *Entameba histolytica*, *Giardia lamblia*, *Enterobius vermicularis*, and *Hymenolepis nana* are more commonly parasites spread among children in developing countries (WHO, 2012).

Yemen belongs to the developing countries that lack the strategies and programs for controlling

or preventing the transmission of pathogenic microorganisms among the population. Also, drinking unsafe water, poor personal hygiene, poor sanitary conditions, low level of awareness about the transmission of infectious diseases, and ignorance of health-promotion practices are the most important factors contributing to increasing infectious diseases transmission (Abdullah *et al.*, 2020; Edrees and Anbar, 2021; Edrees *et al.*, 2021a).

Several studies have been carried out in different regions in Yemen to determine intestinal parasitic infections among schoolchildren. A study by, Al-Haddad and Baswaid, (2010) showed that the *G. lamblia*, *E. histolytica*, *Ascaris lumbricoides*, *Trichuris trichiura*, *H. nana*, *Taenia saginata*, and *Schistosoma mansoni* were the most infective parasites reported among children in Hadramowat.

However, Alyousefi *et al.* (2011) found that the intestinal parasites were *G. duodenalis*, *E. histolytica/dispar*, *Cryptosporidium*, *A. lumbricoides*, *S. mansoni*, *H. nana*, and *E. vermicularis* among children in Sana'a. Also, Qasem *et al.* (2020) showed that the frequency rate of *E. histolytica* *G. lamblia*, *A. lumbricoides*, *H. nana*, and *E. vermicularis* was 61.70%, 23.94%, 7.45%, 4.3%, and 2.61%, respectively, were recorded among children in Ibb city.

The data about the frequency of intestinal parasitic infection among asymptomatic schoolchildren in Sana'a city are limited. Therefore, the objective of the present investigation was to determine the prevalence the intestinal parasitic infections among asymptomatic primary schoolchildren at Al-Sabeen district in Sana'a city, Yemen.

MATERIAL AND METHODS

Study area and period

The present work is a cross-section study carried out primarily in schools at Al-Sabeen

district which is situated in south Sana'a and administratively belong to Sana'a capital of Yemen from January to March 2021. The experimental work was done in the Parasitology lab., Medical Lab., Department, Queen Arwa University (QAU), Sana'a, Yemen.

Data collection

Before specimen collection, the purpose and aims of the study were explained briefly to the manager of schools and participated children to an agreement for inclusion in this work. A structured questionnaire that includes the data about the information of socio-demographic, source of drinking water, behavioral habits, and clinical signs and symptoms were obtained.

Ethical statement

The protocol of the present study was approved by the Queen Arwa University, Yemen Research Ethics Review Committee, and permission to start data collection by the Education office belonging to the Sana'a city. Further, participation was voluntary and participants completed a consent form by their parents or investigators.

Inclusion criteria

The students who signed informed consent didn't use anti-parasites before 7 days of specimens collection, and delivered stool specimens were included.

Exclusion criteria

In contrast, students who use anti-parasites didn't sign informed consent, those who did not properly collect their stool sample were excluded.

Sample collection

A total of one hundred and seventy-three (173) stool specimens were collected from schoolchildren participants. Stool specimens were sampled using clean, labeled, dry, wide-mouthed plastic containers (60 mL) which were given to each of participating students and

informed how to collect properly stool specimens. Stool specimens collected were transported and analyzed in the Medical Laboratory Department at QAU, Sana'a, Yemen (Cheesbrough, 2010).

Sample processing and examination

The simple sedimentation technique was used for sample processing. A small amount of stool specimen (about two grams) was transferred into a container containing 10 mL of normal saline and mixed well and left for 30-60 minutes to sediment. The supernatant was discarded and the sediment was examined under a light microscope using 10X and 40X objectives (Cheesbrough, 2010).

RESULTS

Socio-demographic characteristics

Most specimens of public schools were collected from females (57.94%) with age groups of 11-13 years and whose parents have a primary certificate. While the most specimens collected from private schools were from females (51.76%) with an age group of 9-10 years whose parents have a secondary certificate (Table 1). Also, it was noticed that a higher number of specimens were collected from schoolchildren of public and private schools who drink treated water, wash vegetables and fruits before eating as well as wash hands after defecation, and cut their nails periodically. Table 2 shows the clinical signs and symptoms characteristic from participated children of public and private schools. Most of the specimens of collected participants didn't suffer from clinical signs and symptoms.

Prevalence and type of intestinal parasitic infection

The overall intestinal parasitic infection in the present research was among 107(61.85%) schoolchildren. The high prevalence of intestinal parasitic infection was recorded among schoolchildren in public 56(63.63%) and private schools 51(60%) (Figure 1).

Table 1. Socio-demographic characterization of schoolchildren participated in this study.

Personal characterization		Public school	Private school
		No. examined (%)	No. examined (%)
Gander	Male	37(42.06)	41(48.24)
	Female	51(57.94)	44(51.76)
Age (in years)	9-10	41(46.59)	53(62.35)
	11-13	47(53.41)	32(37.65)
	Illiterate	15(17.05)	11(12.94)
Parents' educational status	Primary	39(44.31)	27(31.77)
	Secondary	17(19.32)	28(32.94)
	Graduate	17(19.32)	19(22.35)
Source of drinking water	Treated water	54(61.36)	48(56.47)
	Not treated	34(38.64)	37(43.53)
Washing vegetables before eating	Yes	81(92.05)	79(92.94)
	No	7(7.95)	6(7.06)
Washing fruits before eating	Yes	85(96.59)	79(92.94)
	No	3(3.41)	6(7.06)
Hand washing after defecation	Yes	79(89.77)	78(91.76)
	No	9(10.23)	7(8.24)
Cutting nails periodically	Yes	48(54.55)	57(67.06)
	No	40(45.45)	28(32.94)

Table 2. Clinical signs and symptoms characterization.

Variables		Public school	Private school
		No. examined (%)	No. examined (%)
Bloody in stool	Yes	3 (3.41)	8 (9.41)
	No	85 (96.59)	77 (90.59)
Fever	Yes	24 (27.27)	20 (23.53)
	No	64 (72.73)	65 (76.47)
Cough	Yes	28 (31.81)	17 (20)
	No	60 (68.82)	68 (80)
Muscles pain	Yes	34 (38.64)	18 (21.18)
	No	54 (61.36)	66 (78.82)
Diarrhea	Yes	33 (37.5)	21 (24.70)
	No	55 (62.5)	64 (75.3)
Itchy skin	Yes	34 (38.64)	17 (20)
	No	54 (61.36)	68 (80)
Abdominal pain	Yes	39 (44.32)	40 (47.06)
	No	49 (55.68)	45 (52.94)
Weight loss	Yes	29 (32.95)	20 (23.53)
	No	59 (67.05)	65 (76.47)

These results revealed that the male children in public school had a higher rate of intestinal parasitic infection (24; 64.86%) compared to females (32; 62.74%). Similarly, in private schools, the higher rate of intestinal parasitic

infection was among 28(68.3%) male children when compared to females 23(52.27%) (Figure 2).

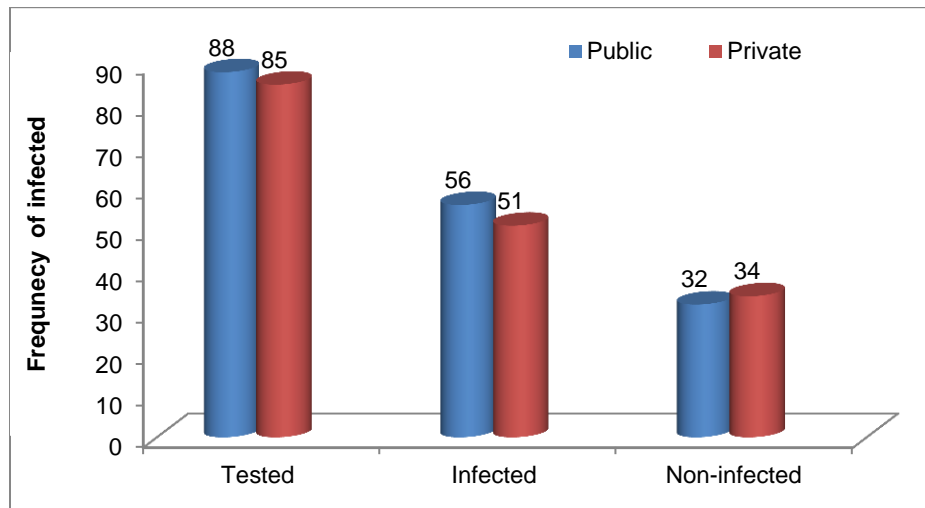


Fig. 1. Frequency of intestinal parasitic infection.

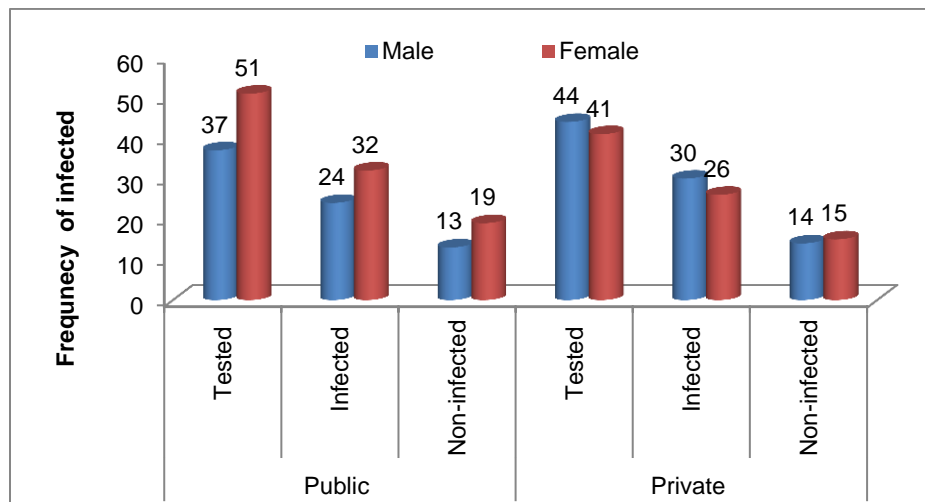


Fig. 2. The frequency rate of infected school children according to gender.

This study revealed that the age group of 11-13 years and 9-10 years of males and females had a higher rate of intestinal infection among schoolchildren in public schools. While the higher prevalence of intestinal parasitic infection in the private schools was reported among the

age group of 9-10 years for both males and females (Table 3).

Table 4 shows that 114(79.72%) of the positive specimens were infected by intestinal protozoa (cyst) while 29(20.28%) were infected by intestinal helminths (eggs).

Table 3. Distribution of intestinal parasitic infection based on gender and age

Age	Public (n= 88)				Private (n= 85)			
	Male		Female		Male		Female	
	Tested	Positive (%)	Tested	Positive (%)	Tested	Positive (%)	Tested	Positive (%)
9-10	24	15(62.5)	17	12(70.59)	23	17(73.91)	14	9(64.3)
11-13	13	9(69.23)	34	20(58.82)	18	11(61.1)	30	14(46.7)
Total	37	24(64.86)	51	32(62.74)	41	28(68.3)	44	23(52.27)

Table 4. Type of intestinal parasitic infection among schoolchildren.

School type	Tested (%)	Protozoa (%)	Helminthes (%)	Total
Public	88 (50.87)	58(79.45)	15(20.55)	73
Private	85 (49.13)	56(80)	14(20)	70
Total	173 (100)	114(79.72)	29(20.28)	143

The current results found that the *E. histolytica* was the most predominant parasite (49.32%) found among schoolchildren in public schools followed by *G. lamblia* (30.14%), *H. nana* (9.59%), *Taenia* species (6.84%), and *A. lumbricoides* (4.11%). In private school children,

the most predominant parasite found was *G. lamblia* (48.57%), followed by *E. histolytica* (31.43%), *H. nana* (7.14%), *A. lumbricoides* (7.14%), *Taenia* species (6.84%), and *E. vermicularis* (2.86%) (Figure 3).

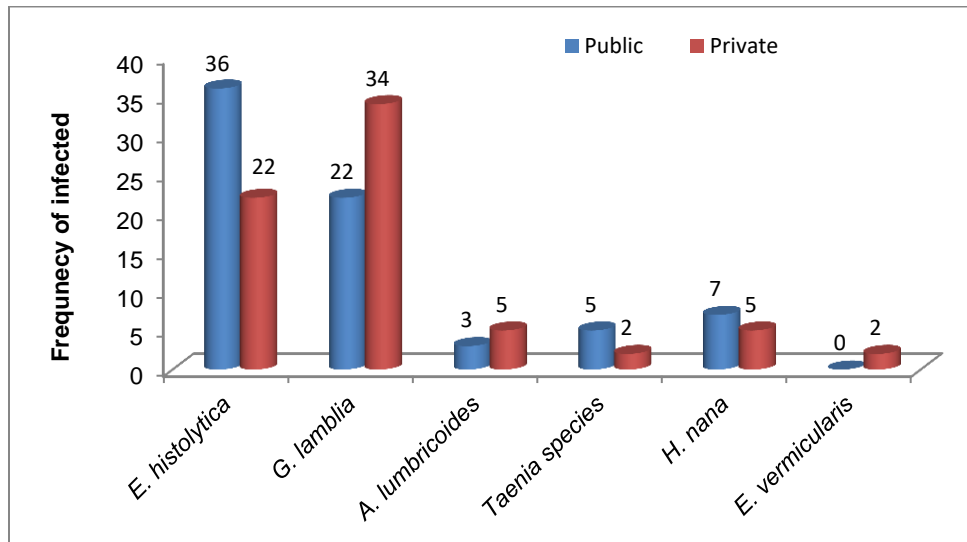


Fig. 3. Prevalence of parasites species among schoolchildren.

Table 5 shows the mixed parasitic infection among participated children of public and private

schools. The high rate of two parasites as co-infection was *E. histolytica* + *G. lamblia*.

Table 5. Multiplicity of parasitic infections among schoolchildren.

Infections multiplicity	Public	Private
	Frequency (%)	Frequency (%)
One parasite	27 (52.94)	28 (66.67)
Two parasite:		
<i>E. histolytica</i> + <i>G. lamblia</i>	12 (23.53)	9 (21.43)
<i>E. histolytica</i> + <i>H. nana</i>	4 (7.84)	2 (4.76)
<i>G. lamblia</i> + <i>A. lumbricoides</i>	2 (3.92)	0(0)
<i>G. lamblia</i> + <i>H. nana</i>	1 (1.96)	2 (4.76)
<i>E. histolytica</i> + <i>Taenia</i> species	3 (5.88)	0(0)
There parasite:		
<i>E. histolytica</i> + <i>G. lamblia</i> + <i>A. lumbricoides</i>	1 (1.96)	0(0)
<i>E. histolytica</i> + <i>G. lamblia</i> + <i>Taenia</i> species	1 (1.96)	1(2.38)
Total	51	42

Risk factors for intestinal parasitic infections

Table 6 shows the higher rate of parasites was found between the parents of children with an illiterate level of education in public schools while in private schools the high rate was found between the parents of children having a primary

certificate. Also, a higher rate of intestinal parasitic infection was reported among schoolchildren who drank untreated water, didn't wash their hands after defecation, ate unwashed vegetables and fruits, and didn't cut their nails periodically.

Table 6. Risk factors associated the intestinal parasitic infections among schoolchildren.

Variables		Public school		Private school	
		Tested	Infected (%)	Tested	Infected (%)
Educational level of parents	Illiterate	15	12(80)	11	8(72.73)
	Primary	39	24(61.53)	27	20(74.07)
	Secondary	17	10(58.82)	28	12(42.86)
	Graduate	17	10(58.82)	19	11(57.89)
	Total	88	56 (63.63)	85	51(60)
Source of drinking water	Treated water	54	32(59.26)	48	28(58.33)
	Not treated	34	24(70.89)	37	23(62.16)
	Total	88	56 (63.63)	85	51(60)
Hand washing after defecation	Yes	79	48 (60.76)	78	45(57.69)
	No	9	8 (88.88)	7	6(85.71)
	Total	88	56 (63.63)	85	51(60)
Washing vegetables before eating	Yes	81	51(62.96)	79	46(58.23)
	No	7	5(71.43)	6	5(83.33)
	Total	88	56 (63.63)	85	51(60)
Washing fruits before eating	Yes	85	53(62.35)	79	47(59.49)
	No	3	3(100)	6	4(66.67)
	Total	88	56 (63.63)	85	51(60)
Cutting nails periodically	Yes	48	27(52.25)	57	37 (64.91)
	No	40	29(72.5)	28	14(50)
	Total	88	56 (63.63)	85	51(60)

Regarding the clinical signs and symptoms, it was found that most specimens collected from children have blood in stool and suffer from

fever, cough, muscles pain, itching skin, and weight loss (Table 7).

Table 7. Intestinal infection associated with clinical signs and symptoms.

Signs and symptoms	Public school		Private school	
	Yes (%)	No (%)	Yes (%)	No (%)
Bloody in stool	2 (66.67)	54 (63.53)	8 (100)	43 (55.84)
Fever	17(70.83)	39 (60.93)	14 (70)	37 (55.22)
Cough	20 (71.42)	36 (60)	10 (58.82)	41(60.29)
Muscles pain	22 (64.70)	34 (62.96)	14 (77.77)	37(56.06)
Diarrhea	22 (66.6)	34(61.18)	15 (71.42)	36(56.25)
Itch skin	26(76.47)	30(55.55)	10 (58.82)	41(60.29)
Abdominal pain	28(71.79)	28(57.14)	25(62.5)	26(57.77)
Weight loss	21(72.41)	34(57.63)	15(75)	36(55.38)

DISCUSSION

The high frequency of intestinal parasites among schoolchildren in Yemen is well-known. The present work revealed that the overall rate of intestinal parasitic infection was 61.85% reported intestinal parasitic infections among collected specimens. Similar findings were documented in different regions of Yemen including Hadramowat (58.7%) (Al-Haddad and Baswaid, 2010), Ibb (57.4%) (Alsubaie *et al.*, 2016), Sana'a (54.8%) (Al-Mekhlafi *et al.*, 2016), Amran 61.25% (Alshahethi *et al.*, 2020a), Ibb (62.7%) (Qasem *et al.*, 2020), and Hajjah (73.25%) (Mogalli *et al.*, 2020).

However, the lower rate was found in Yemen; in Sana'a city 40.3% (Alyousefi *et al.*, 2011), while the higher frequency was 90% recorded in Al-Mahweet governorate (Alwabr and Al-Moayed, 2016).

The current results revealed that the male children had a higher rate of intestinal parasitic infection compared to females. These results

have been supported by the preceding reports carried out in Yemen (Alwabr and Al-Moayed, 2016; Alshahethi *et al.*, 2020b). This may be referred to the habitat behavior of children on contributing their fathers in agriculture activities which allow them to remain for a long time daily outside the home and making them more exposed to intestinal parasitic infection than females.

In this study, the age group of 11-13 years and 9-10 years of male and female, respectively, had a higher rate of intestinal infection among schoolchildren in public schools. While the higher prevalence of intestinal parasitic infection in private schools was reported among the age group of 9-10 years for both males and females. In the current study, the intestinal protozoa were the most predominant infections among schoolchildren at 79.72%, while the intestinal helminths infections were 20.28%. This result is consistent with findings carried out in Yemen (Mogalli *et al.*, 2020; Qasem *et al.*, 2020).

The study results showed that the most predominant parasite found in schoolchildren attending public schools was *E. histolytica* (49.32%) followed by *G. lamblia* (30.14%), *H. nana* (9.59%), *Taenia* species (6.84%), and *A. lumbricoides* (4.11%). In schoolchildren attending private schools, *G. lamblia* was the most predominant parasite found (48.57%), followed by *E. histolytica* (31.43%), *H. nana* (7.14%), *A. lumbricoides* (7.14%), *Taenia* species (6.84%), and *E. vermicularis* (2.86%). These findings are in agreement with the results reported in Yemen. A study by Alsubaie *et al.* (2016) showed the commonest intestinal parasites were *E. histolytica*, *G. lamblia*, *A. lumbricoides*, *T. trichiura*, *H. nana*, *S. mansoni*, *A. duodenale*, *E. vermicularis*, and *S. stercoralis* were 33.7%, 23.6%, 14.3%, 9.3%, 6.2%, 3.1%, 1.2%, 0.8%, and 0.8%, respectively. Also, Mogalli *et al.* (2020) showed that the *E. histolytica* was the most parasites predominate followed by *G. lamblia*, *E. vermicularis*, *A. lumbricoides*, *H. nana*, *S. mansoni*, *T. trichiura*, and *A. duodenale*.

However, a study by Alwabr and Al-Moayed (2016) observed the frequency rate of intestinal parasites was 64%, 36.5%, 18%, and 13%, respectively, for *E. histolytica*, *S. mansoni*, *Trichuris trichiura*, and *E. vermicularis*. Recently, Qasem *et al.* (2020) observed that *E. histolytica* was the most predominant intestinal parasite with (61.70%) followed by *G. lamblia* (23.94%), *A. lumbricoides* (7.45%), *H. nana* (4.3%), and *E. vermicularis* (2.61%).

The existing study revealed that the high multiple infections were 23.53% recorded by two types of intestinal parasites. Similarly, the earlier reports documented the multiple infections by intestinal parasites in Yemen; in Sana'a city

11.7% (Alyousefi *et al.*, 2011), in Sana'a governorate 8.5% (Al-Mekhlafi *et al.*, 2016), in Al-Mahweet 75.5% (Alwabr and Al-Moayed, 2016), and Hajjah governorate 44% (Mogalli *et al.*, 2020).

The higher rate of intestinal parasites among schoolchildren in this study was found among children whose parents were less educated, children who drank from untreated water didn't wash their hands after defecation, ate unwashed vegetables and fruits, and didn't cut their nails periodically.

A similar report recognized by Alshahethi *et al.* (2020a) revealed statistically significant higher prevalence rates of *E. histolytica* among children with low-education parents than those with educated parents in Amran City. The educational status of the parents is considered a significant factor that has been stated to influence the parasitic infection (Nematian *et al.*, 2004).

However, the current result is in contestant with the previous studies conducted in Yemen that acknowledged the higher prevalence of intestinal parasitic infections were found in children drinking from untreated water sources (Alyousefi *et al.*, 2011; Alwabr and Al-Moayed, 2016). Also, the association between the prevalence of intestinal parasitic infection and vegetables in Sana'a city were documented by Edrees *et al.* (2021b) who observed that the *G. lamblia* (65.3%), *E. histolytica* (34.67%), *E. vermicularis* (47.33%), *A. lumbricoide* (36.67%), *H. nana* (35.33%), *A. duodenale* (24.67%), and *S. mansoni* (24.67%) were reported among marketing fresh vegetables.

In developing countries, it has been well documented that contaminated hands play a major role in the transmission of fecal-oral, and

washing hands before eating or after evacuation have been reckoned as a secondary barrier (Anuar *et al.*, 2012).

The major factors associated with the prevalence of pathogenic microorganisms in Yemen are referring to the poor hygienic practices, environmental contamination with fecal, unavailable of safe water, and health awareness resulting from a high level of poverty (Edrees and Anbar; 2020; Edrees and Al-Awar, 2020; Edrees and Banafa, 2021).

The present result found that the common clinical signs and symptoms such as blood in stool and suffering from fever, cough, muscle pain, itching skin, and weight loss. are associated with intestinal parasitic infection. These results were supported by Al-Haddad and Baswaid (2010) and Qasem *et al.* (2020) in Yemen revealed that different symptoms such as diarrhea, abdominal pain and distention, nausea, constipation, vomiting, and fever were presented among participants.

CONCLUSION

In conclusion, these results revealed higher rates of intestinal parasitic infections among primary schoolchildren represented a real threat to the health system in Yemen. The higher rate of intestinal parasites is commonly prevalent among schoolchildren whose parents were less educated, drank from untreated water, didn't wash their hands after defecation, ate unwashed vegetables and fruits, and didn't cut their nails periodically. The regular treatment of intestinal parasitic infections and deworming of school children are needed as well as health programs that provide parents of children how to prevent

parasitic infection among children, promoting personal hygienic practices, safe drinking water, and good sanitary practices.

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CONFLICT OF INTEREST

The authors declare that this article's content has no conflict of interest.

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