J. Amr. Uni. ***03*** *(2023) p.279*

Prevalence of Intestinal Parasitic Infections among Children Attending Some Schools in Amran Governorate, Yemen

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Abstract

Background and Aim: Intestinal parasitic infections (IPIs) are a global health issue among schoolchildren, with high morbidity and mortality. Therefore, this study aimed to determine the prevalence of intestinal parasite infections among schoolchildren in the Amran governorate, Yemen. **Methods:** This is a cross-sectional study carried out among 200 schoolchildren aged 7–15 years between December 2021 and March 2022. The stool specimens were collected and the parasite species was detected according to standard laboratory methods. **Results:** The overall rate of parasite infection was 48%. *Entamoeba histolytica* was the most prevalent parasite among children (25%), followed by *Giardia lamblia* (13.5%), *Entamoeba coli* (12%), *Enterobius vermicularis* (10%), and *Hymenolepis nana* (6.5%). Furthermore, a higher infection was among males (57%), those aged 7 to 10 (45%), those whose parents had a basic education (60.7%), and those who consume unwashed vegetables and fruits (57.7%). Additionally, a higher infection was among those who do not wash their hands after defecation (57.7%) and individuals who maintain their nails (54.8%). **Conclusion:** As a result of the high prevalence of IPIs among the study's participants, environmental sanitation, personal hygiene, and health education are all required for promotion in order to avoid parasitic infection among children.

Keywords: Intestinal Parasite, Prevalence, Schoolchildren, Amran, Yemen.

الملخص: الخلفية والهدف: تعد الالتهابات الطفيلية المعوية (IPIs) مشكلة صحية عالمية بين أطفال المدارس الذين يعانون من ارتفاع معدلات الإصابة بالأمراض والوفيات. هدفت هذه الدراسة الى معرفة مدى انتشار العدوى بالطفيليات المعوية بين أطفال المدارس في محافظة عمران، اليمن. الطرق: هذه دراسة مقطعية أجريت على 200 تلميذ تتراوح أعمارهم بين 7−15 سنة خلال الفترة من ديسمبر 2021 ومارس 2022. تم جمع عينات البراز وتم إجراء الكشف عن أنواع الطفيليات وفقًا للطرق المخبرية القياسية. النتائج: أظهرت النتائج بأن نسبة الاصابة بالطفيليات كانت 48%. أظهرت النتائج بأن طفيل *Entamoeba histolytica* هو الأكثر أنواع الطفيليات انتشارًا بين الأطفال بنسبة (25%)، يليه طفيل *Giardia lamblia* بنسبة (13.5%)، وطفيل *Entamoeba histolytica* (12%)، وطفيل *E*nterobius vermicularis (10%)، وطفيل *Hymenolepis nana* (6.5%). أيضاً، لوحظ بأن معدل انتشار العدوى كان أعلى بين الذكور (57%)، والفئة العمرية من 7 إلى 10 سنة (45%)، والذين أباءهم حاصلين على تعليم أساسي (60.7%)، والأفراد الذين يتناولون الخضار والفواكه غير المغسولة (57.7%). بالإضافة إلى ذلك، لوحظ ارتفاع معدل انتشار العدوى بين الأفراد الذين لا يغسلون أيديهم بعد استخدام الحمام (57.7%) والأفراد الذين لا يقصرون أظافرهم (54.8%). الاستنتاج: نتيجة لارتفاع معدل انتشار الطفيليات المعوية بين المشاركين في الدراسة، فإن تعزيز الصحة البيئية والنظافة الشخصية والتثقيف الصحي كلها متطلبات ضرورية وذلك لتجنب لانتشار الإصابة بالطفيليات بين الأطفال.

Introduction

Intestinal parasitic infections (IPIs) are among the most common neglected tropical diseases that cause a major public health problem in developing countries [1]. They are often transmitted by contaminated food or drinking water, but they may also be spread from person to person through fecal or oral contact [2]. The World Health Organization (WHO) estimates that 3.5 billion people are exposed to IPIs and 450 million are clinically affected; more than half of them are children, with 39 million disability-adjusted life years. They cause over 33% of deaths worldwide [3]. Over 267

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million preschool-aged children and 568 million school-aged children worldwide live in locations where intestinal parasites are endemic [4].

Children with poor hygiene, normal hand-mouth behavior, uncontrolled fecal activity, and undeveloped immune systems are more likely to acquire IPIs. It is significantly associated with undernutrition, iron deficiency anemia, weight loss, difficulty paying attention, diarrhea, and stunted growth in school-aged children, which influences their ability to develop physically, intellectually, and cognitively [5].

The common parasites infecting young children in developing countries include *Entamoeba histolytica*, *Giardia lamblia*, *Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis*, and *Hymenolepis nana*. These types of IPIs are associated with limited levels of income, inadequate hygiene practices, contaminated water sources, limited access to healthcare, poor environmental conditions, and poor health status [6].

Yemen belongs to the group of developing countries that lack strategies and programs for controlling or preventing the transmission of pathogenic microorganisms among their populations. Additionally, drinking unsafe water, poor personal hygiene, poor sanitary conditions, a low level of awareness about the transmission of infectious diseases, and ignorance of health promotion practices are the main factors contributing to the increasing transmission of infectious diseases [7–10].

Numerous studies have been conducted in various Yemeni regions to identify intestinal parasite infections in children. The most common intestinal parasites were *E. histolytica*, *G. lamblia*, *E. vermiculari*, *A. lumbricoides*, *T. trichiura*, *H. nana*, *Taenia saginata*, and *Schistosoma mansoni* [11–14].

There is a lack of data regarding the prevalence of intestinal parasite infection in schoolchildren in the Amran governorate. Therefore, the current study aimed to determine the prevalence of intestinal parasite infections among asymptomatic schoolchildren in the governorate of Amran, Yemen.

Materials and Methods

Study Area and Period

This is a cross-sectional study carried out among children aged 7–15 years old who attended some schools in the Amran governorate during the period from December 2021 to March 2022. Amran is a small city in western and central Yemen. It is located 52.9 kilometers (32.9 mi) by road northwest of the Yemeni capital of Sana'a. According to the 2004 census, it had a population of 76,863 and an estimated population of 92,763 in 2013 (Fig. 1).

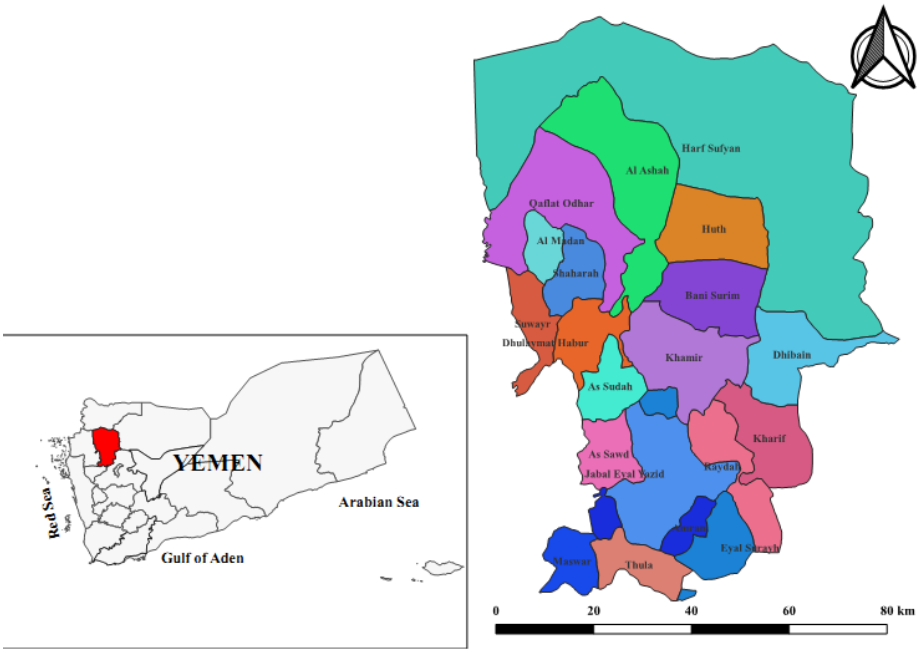

Figure 1. Map of Yemen indicating the study area in Amran governorate

Data Collection

A pre-tested standard questionnaire was designed to gather relevant data from each participant. The students who were selected for the study were interviewed to obtain information regarding their gender, age, residence, and various other factors, such as the educational level of their parents. The sources of drinking water, washing vegetables and fruits before eating, handwashing after defecation, and periodically cutting nails from suspected cases. Additionally, the relevant clinical signs and symptoms, such as diarrhea, blood in the stool, abdominal pain, fever, cough, muscle pain, itching skin, and weight loss, were obtained.

Ethical Statement

The ethical statement of the study was approved by the Research Ethics Review Committee of Amran University, Yemen. The education office granted permission to start data collection. Before collecting specimens, the purpose of the study was explained to the managers of schools and the children who agreed to be part of this work. Further, participation was voluntary, and participants completed a consent form provided by the investigators.

Inclusion and Exclusion Criteria

All participants who provided stool samples, signed informed consent, and didn't use anti-parasite drugs were included in this study. In contrast, participants who received anti-parasite treatment, refused to sign an informed consent, and did not collect stool specimens were excluded from this study.

Sample Collection

There were 200 stool samples collected from schoolchildren. Each of the participating pupils received a clean, labeled, dry, wide-mouthed plastic container (60 mL) along with instructions on how to collect stool samples correctly. The samples were transported to the National Center of Public Health Laboratories for analysis [15].

Sample Processing and Examination

For sample processing, a simple sedimentation method was employed. About two grams of feces were transferred into a container with 10 mL of normal saline, stirred thoroughly, and allowed to settle for 30 to 60 minutes. The sediment was examined under a light microscope with 10X and 40X objectives [15].

Statistical Analysis

The data were analyzed using the SPSS program (version 22.0). Categorical variables were reported as frequencies and percentages in tables and figures. Additionally, all probability values were considered statistically significant at *P*-values <0.05.

Results

Sociodemographic Characterizations

Stool samples from the 200 students involved in this study were collected equally from public and private schools (100 from each), as well as from male and female students (100 from each). Additional data were collected from children between the ages of 11 and 15, 59 (29.5%) from those whose parents had completed secondary school, and 126 (63%) from those who drank untreated water. A total of 174 (87%) were collected from those who did not wash their hands after defecating and 113 (56%) from those who did not cut their nails on a regular basis (Table 1).

Table 1. Sociodemographic characterizations of participants in this study

Variables		**Frequency**	**%**
School type	Public	100	100
	Private	100	100
Gander	Male	100	50

	Female	100	50
Age (in years)	7-10	60	30
	11-15	140	70
Parents' educational status	Illiterate	29	14.5
	Primary	56	23
	Secondary	59	29.5
	Graduate	56	23
Source of drinking water	Treated water	74	27
	Not treated	126	63
Washing vegetables before eating	Yes	185	92.5
	No	15	7.5
Washing fruits before eating	Yes	174	87
	No	26	13
Hand washing after defecation	Yes	174	87
	No	26	13
Cutting nails periodically	Yes	87	43.5
	No	113	56.5

Prevalence of Intestinal Parasitic Infection

The current finding indicated that 96 (48%) schoolchildren were positive for parasite infection while 104 (52%) were negative (Fig. 2).

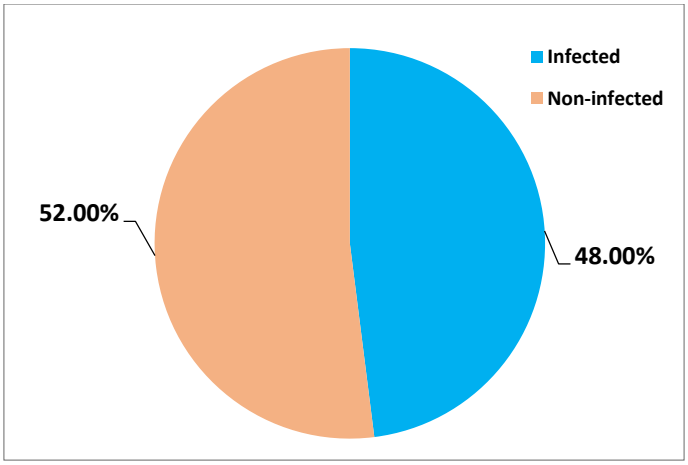

Figure 2. Prevalence rate of parasite infection

This finding revealed a significant association between intestinal parasitic infection and the type of school, with the public having a significantly higher prevalence rate compared to private schools (57% vs. 39%; *P* = 0.011) (Table 2).

Table 2. Prevalence rate of parasite infection by type of school

School type	Frequency	Infected No. (%)	Non-infected No. (%)	*P*-value
Public	100	57 (57.0)	43 (43.0)	0.011
Private	100	39 (39.0)	61 (61.0)	
Total	**200**	**96 (48.0)**	**104 (52.0)**	

Significant statistics at *p*-value <0.05.

Prevalence of Parasite Species among Study Subjects

According to the current findings, *E. histolytica* was the most common parasite (25%) discovered among children, followed by *G. lamblia* (13.5%), *E. coli* (12%), *E. vermicularis* (10%), and *H. nana* (6.5%) (Fig. 3).

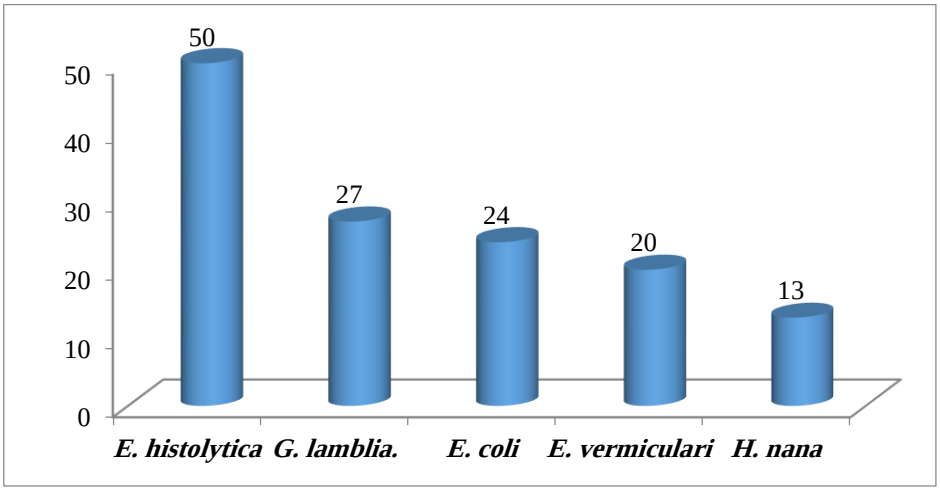

Figure 3. Prevalence of parasite species among study subjects

Risk Factors Associated with Parasite Infection

The current finding showed that male individuals had considerably greater proportions of parasitic infections (57%) than female participants (39%) with a statistical difference (P = 0.010). Additionally, compared to the age range of 7–10 years (45%), the age group of 11–15 years showed a greater risk of parasitic infections (51.4%). Regarding parental education, children with parents who possess primary certificates (60.7%) had a considerably higher prevalence of intestinal parasite infection (Table 3).

The prevalence of parasite infection is significantly greater in children who use treated water than in those who use untreated water (54.1% vs. 46.2%; P = 0.324), although the relationship between the two is not statistically significant. The rate of parasite infection was also greater among people who consumed unwashed vegetables and fruits at 60% and 57.7%, respectively, with a non-statistical difference (P > 0.05). A similar finding has been obtained regarding study participants who did not wash their hands after defecation (57.7%) and trimmed their nails (54.8%). Both of those were associated with a greater rate of intestinal infection and a non-significant statistical difference (P > 0.05) (Table 3).

Table 3. Risk factors associated with the parasite infection among participating

Variables		F	Infected No. (%)	Non-infected No. (%)	P-value
Gander	Male	100	57 (57.0)	43 (43.0)	0.011
	Female	100	39 (39.0)	61 (61.0)	
Age (in years)	7-10	60	27 (45.0)	33 (55.0)	0.405
	11-15	140	72 (51.4)	68 (48.6)	
Parents' educational status	Illiterate	29	12 (41.4)	17 (58.6)	0.051
	Primary	56	34 (60.7)	22 (39.3)	
	Secondary	59	33 (55.9)	26 (44.1)	
	Graduate	56	21 (37.5)	35 (62.5)	
Source of drinking water	Treated	74	40 (54.1)	34 (45.9)	0.324
	Not treated	126	59 (46.8)	67 (53.2)	
Washing vegetables before eating	Yes	185	91 (49.2)	94 (50.8)	0.421
	No	15	9 (60.0)	6 (40.0)	
Washing fruits before eating	Yes	174	91 (52.3)	83 (47.7)	0.607
	No	26	15 (57.7)	11 (42.3)	
Hand washing after defecation	Yes	174	91 (52.3)	83 (47.7)	0.607
	No	26	15 (57.7)	11 (42.3)	
Cutting nails periodically	Yes	87	38 (43.7)	49 (56.3)	0.117
	No	113	62(54.8)	51(45.2)	

Significant statistics at p-value <0.05.

Prevalence of Parasite Infection Based on Clinical Signs and Symptoms

The study's observations revealed that the study participants who experienced diarrhea, blood in the stool, abdominal pain, fever, cough, muscle pain, itchy skin, and weight loss had a significant prevalence of intestinal infections. The results of this investigation revealed a statistically significant difference (P = 0.000) (Table 4).

Table 4. Clinical signs and symptoms characterization

Variables		F	Infected No. (%)	Non-infected No. (%)	P-value
Diarrhea	Yes	47	34 (72.3)	13 (27.7)	0.000
	No	153	66 (43.1)	87 (56.9)	
Bloody in stool	Yes	38	38 (100)	0 (0)	0.000
	No	162	62 (38.3)	100 (61.7)	
Abdominal pain	Yes	93	61 (65.6)	32 (34.4)	0.000
	No	107	39 (36.4)	6 (63.6)	
Fever	Yes	20	20 (100)	0 (0)	0.000
	No	180	80 (44.4)	100 (55.6)	
Cough	Yes	72	50 (69.4)	22 (30.6)	0.000
	No	128	50 (39.1)	78 (60.9)	
Muscles pain	Yes	33	27 (81.8)	6 (18.2)	0.000
	No	167	73 (43.7)	94 (56.3)	
Itch skin	Yes	56	41 (73.2)	15 (26.8)	0.000
	No	144	59 (41.0)	85 (59.0)	
Weight loss	Yes	85	58 (68.2)	27 (31.8)	0.000
	No	115	42 (36.5)	73 (63.5)	

Significant statistics at *p*-value <0.05.

Discussion

Yemen's schoolchildren are reported to have a high prevalence of intestinal parasites. The findings of this study revealed that the overall proportion of intestinal parasites detected among participants was 48%. This finding is lower than what is reported in a previous study conducted in Yemen that documented the frequency rate of parasite infection at 58.7% in Hadramowat [11], 90% in Al-Mahweet [16], 62.7% in Ibb [14], 73.25% in Hajjah [17], 61.85% in Sana'a [18], 51.26% in Taiz [19], and 61.85% in Amran [20]. Moreover, this finding is reported lower in different countries: 29.4% in Ethiopia [21], 46.2% in Egypt [3], 15% in Ghana [22], and 5.3% in Saudi Arabia [23].

The difference in prevalence rate may be attributed to variations in geographical locations, study population, sample size, hygienic condition, socio-economic status, food consumption behavior differences, and diagnostic methods employed by the participants.

This finding revealed a significant association between intestinal parasitic infection and the type of school, with the public having a significantly higher prevalence rate compared to private schools (57% vs. 39%; $P = 0.011$). The present finding showed that male participants had considerably greater proportions of parasitic infections than did female participants, with a statistical difference ($P = 0.010$). This outcome is supported by similar previous studies conducted in Yemen [16, 24]. This may be referred to as the habitat behavior of boys contributing to their fathers' agricultural activities. It allows them to spend a significant amount of time outside the home on a daily basis, which increases their exposure to intestinal parasitic infections compared to females. Regarding the age group, the age group of 11–15 years showed a greater rate of parasitic infections compared to the age range of 7–10 years. This finding is in disagreement with early reports conducted in different nations that documented that lower-age children had a higher rate of IPI compared to older-age children [13, 25–27]. In this result, children with parents who had primary certificates had a considerably higher rate of parasite infection. This result is similar to the report by Alshahethi *et al.* [28], which revealed statistically significant higher prevalence rates of *E. histolytica* among children with uneducated parents than those with educated parents in Amran city.

Education is considered an important social determinant of health. Also, a strong association between educational status and health has been recognized. The effect of education is to create

better overall self-awareness of personal health and make healthcare more accessible. Well-educated people have better health, as reflected in the low levels of mortality, morbidity, and disability. Education helps promote health equity, sustain healthy lifestyles and positive choices, nurture relationships, and enhance personal, family, and community well-being [29].

The prevalence of parasite infection is significantly greater in children who use treated water than in those who use untreated water. These results are in disagreement with the work of previous studies that acknowledged the higher prevalence of intestinal parasites among those who drink untreated water [16, 25, 30]. The source of drinking water appeared to play a great role in increasing the chance of getting an intestinal parasite infection; hence, children who used water from the pond accounted for a relatively high number of positive cases. This might be due to the contamination of water and food with human waste during open-field defecation [21].

The rate of parasite infection in this study was higher among people who consumed unwashed fruits and vegetables. These results are in consonance with earlier reports showing that eating unwashed vegetables was significantly associated with protozoa infection among examined children [3, 21].

Furthermore, a significant increase in intestinal infection was observed in the current study among participants who didn't wash their hands after defecation and trimmed their nails, which was consistent with the results previously reported elsewhere [21, 32]. This could be attributed to the lack of removal of accumulated dirt containing parasite eggs in fingernails, which could serve as a source of infection [33]. Moreover, it suggests that unwashed hands and dirty fingers are liable to harbor parasite ova or cysts, thus increasing the risk of infection. Pit-latrines without slabs and shared pit-latrines with slabs were significantly associated with IPIs. This finding was consistent with another study [34].

In developing countries, it has been well documented that contaminated hands play a major role in the transmission of facal-oral, and washing hands before eating or after evacuation has been reckoned as a secondary barrier [35]. The major factors associated with the prevalence of pathogenic organisms in Yemen are poor hygienic practices, environmental contamination with fecal, the lack of safe water, and health awareness resulting from a high level of poverty [7, 36–40].

According to the current findings, *E. histolytica* was the most common parasite (25%) detected among children, followed by *G. lamblia* (13.5%), *E. coli* (12%), *E. vermicularis* (10%), and *H. nana* (6.5%). The results are in consonance with those of other workers who reported that the most predominant parasite found in schoolchildren was *E. histolytica*, *G. lamblia*, *A. lumbricoides*, *T. trichiura*, *H. nana*, *S. mansoni*, *A. duodenale*, *E. vermicularis*, and *S. stercoralis* [12, 14, 16, 17].

In a different study by Hailu and Ayele [27], showed the predominant parasites were *A. lumbricoides*, *E. histolytica*, and *H. nana*. Similarly, *E. histolytica* and *A. lumbricoides* were the most predominant parasites, followed by *E. vermicularis*, *G. lamblia*, *Cryptosporidium parvum*, *Heterophyes heterophyes*, and *H. nana* [2]. The distribution and prevalence of various species of intestinal parasites differ from region to region because of several environmental, social, geographical, and other factors.

Regarding clinical signs and symptoms, the observation of this result revealed that all participants who had diarrhea, blood in the stool, abdominal pain, fever, cough, muscle pain, itchy skin, and weight loss had a significant prevalence of intestinal parasites. All participants who had diarrhea had a significant prevalence of intestinal parasites, with a statistically significant difference (P = 0.000). These data were consistent with the results previously reported in other studies [13–14].

Conclusion

This investigation highlighted high rates of intestinal parasites among participants and considered potential health consequences in the study area. The use of unclean water, inadequate handwashing after toilet use, eating raw or unwashed vegetables and fruits, and untrimmed fingernails may be important risk factors contributing to the rise in the frequency of intestinal parasite infection among schoolchildren. Regular screening and treatment of IPIs in children, improved environmental sanitation, the supply of safe drinking water, raising awareness about personal

hygiene practices, and public health education about the risks and prevention of IPIs. These are effective interventions for monitoring and controlling parasitic infections.

Conflict of Interest

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

Acknowledgments

The authors would like to thank the team investigators, including Anas Q. Abadi, Khaled H. Al-Qaini, Zakaria A. Suleiman, Ammar D. Al-Ghudaifi, Kamal N. Rashid, Muhammad A. Al-Zakri, Muhammad A. Al-Hada, and Yahya A. Al-Ashwal, for their generous help in collecting data and specimens. All authors would like to gratefully express their gratitude to the different schools, teachers, and children and their parents for their contribution and support during the various aspects of the study. They also express their thankfulness to the National Center of Public Health Laboratories staff in Amran City for their invaluable help in specimen analysis

Author Contributions

Al-Hadheq and Al-Eryani Conceived and designed the experiments. Al-Hadheq; Performed the experiments: Al-Hadheq and Edrees: Analyzed the data and wrote the first draft of the manuscript. Al-Nosar: Contributed to the writing of the manuscript. Al-Hadheq and Al-Eryani: Agree with the manuscript results and conclusions. All authors have read, revised, and approved the final manuscript.

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