**Original Research Article**

**PREVALENCE OF INTESTINAL PROTOZOA, HELMINTHES, AND COCCIDIAN INFECTIONS AMONG PRIMARY SCHOOL CHILDREN IN THALA’A DISTRICT AT AMRAN GOVERNORATE, YEMEN**

**ABSTRACT**

**Background and objectives:**  The prevalence of intestinal parasite infection, which can range between 18% and 90%, is one of the most frequently reported diseases in Yemen and poses a serious health issue for schoolchildren. In Thala’a District, Amran Governorate, Yemen, the study's main goal was to ascertain the prevalence of intestinal parasite infection among primary school students.

**Subjects and methods:** A cross-sectional survey was conducted from January to April 2022 among 400 schoolchildren, in the age groups 7-12 years. All the children were residents of the city of Thala’a. A pre-tested structured questionnaire was used to collect data. Stool samples were examined for intestinal parasites according to standard laboratory methods.

**Results:** The children's ages ranged from 7 to 12 years, with a mean ± SD of 9.52 ± 2.9 years. The results showed that 136/400 (34%) of the tested children were positive for intestinal parasite infection with a higher prevalence of specific intestinal worms (50.4%) than protozoa (33.3%) and coccidian infection (16.3%). The rate of infection alone was also higher than that of multiple parasitic infections (19.3% vs. 14.8%).The highest number of intestinal parasites was 50/400 (12.5%) for *Ascaris lumbricoides*, and 49/400 (12.25%) for *Entameba histolytica* followed by 9.8% for *Giardia lamblia*, 11.5% for *Entrobius vermicularis*, 6.5% for *Cryptosporidium* species, 6.5%. % for *Hymenolepis nana*, 2% for *Schistosoma manso*ni, and 0.8% for *Trichuris trichiura*. Considering the associated factors, boys had a higher infection rate than girls (50% vs. 24.2%) with an *OR* of 2.6, *CI* = 1.7–3.9 (p < 0.001). A higher rate was also recorded in older children (41%) with an odds ratio of 1.6 (p = 0.03).

**Conclusion:** There is a high prevalence of intestinal parasites among school children in Thala’a city, and various control measures are required to control and prevent intestinal parasites among school children.

**Keywords**: Intestinal Parasitic Infections, Prevalence, Schoolchildren, Thala’a District, Yemen

**INTRODUCTION**

One of the world's major health issues is intestinal parasitic diseases, which can be brought on by both protozoa and helminthes parasites. These infections can affect up to 3.5 billion people worldwide, with 450 million of those cases being directly attributable to intestinal parasites1. According to estimates of up to 50%, parasite infection is highly prevalent in impoverished nations2-5. In developing nations, a number of conditions, including a lack of drinkable water, poor environmental hygiene, rapid population increase, and low economic status, have a significant influence in the transmission of intestinal parasites 6, 7. Intestinal parasite infection poses the greatest risk to children in underprivileged areas. The low immune system development and high susceptibility of youngsters to serious infection caused by their increasing nutritional needs. They are more likely to suffer from negative consequences such stunted growth, decreased physical activity, impaired cognitive function, and poor learning ability as a result of morbidity8,9. According to estimates, children between the ages of 5 and 14 in underdeveloped nations account for roughly 12% of the world's illness burdens brought on by intestinal parasites10. Additionally, according to the WHO11, as many as 270 million and 600 million preschoolers and schoolchildren, respectively, reside in regions with widespread parasite transmission. *Entameba histolytica*, *Giardia lamblia*, *Hymenolepis nana*, and *Enterobius vermicularis* are among the intestinal parasites that are disseminated more readily and more frequently among children in underdeveloped nations12.

*Coccidian* is an essential microscopic parasite that infects the intestinal tract of most human and animal organisms. These organisms are a major concern for clinicians, especially with the increasing rate of HIV infection and immuno-compromised cases. *Coccidian* parasites (*Cryptosporidium* spp., *Isospora belli*, and *Cyclospora* spp.) are the most common intestinal parasites in immunocompromised patients that can usually lead to fatal acute diarrhea while causing mild and limited gastrointestinal disturbances in individuals with a normal immune system13-16. The above-mentioned variables contribute to the underestimating of the significance of this illness because it is consistently viewed as a parasite that is neglected and there aren't enough investigations, particularly in Yemen17. Globally and in Yemen, a number of risk factors for coccidian parasites have been documented, including the use of tainted drinking water, contact with animals, a lack of sanitation, and poverty. Children are also at risk for contracting this infection18. Yemen is a developing country that lacks programming strategies to eliminate or control the transmission of parasitic infections in the population. The prevalence of intestinal parasitic infection among children in different regions of Yemen has been recorded in several reports and at a high rate 3-5, 19. Also in Yemen, the spread of coccidian parasites has not been studied, among immunocompromised patients as well as children with diarrhea or malnutrition, as the rate of malnutrition among children has increased in Yemen due to the war that has been going on for 8 years and has not ended until now 19. Thus the study's main goal was to determine the prevalence of intestinal parasite infections among primary school students.

**SUBJECTS AND METHODS**

The research was carried out at Sana'a University in Sana'a, Yemen, at the Faculty of Medicine and Health Sciences, Medical Microbiology and Parasitology departments. 400 fecal samples from 400 randomly chosen schoolchildren in Thala'a city, Amran governorate, aged 7 to 12, were tested between January and February 2022. Following receipt of the samples in the lab, wet-mount preparations with saline and iodine were made and screened within two hours of sample collection to look for motile Trophozoites, larvae, eggs, and cysts. Fecal samples were also treated with a formalin-ether concentration technique and re-examined with wet saline-iodine preparations as well as stained with a modified acid-fast dye 15 to look for *Cryptosporidium*, *Cyclospora* and *Isospora oocysts*. Each wet form and stained fecal swabs were examined by a clinical microbiologist and researcher (Prof. AMA) independently and the results verified. After that, demographic data were collected in a standard questionnaire, and the results of intestinal parasites, helminthes, and *coccidian* parasites were analyzed and their association with demographic data were studied.

**Ethical consideration:** Consents were taken from all the participants and their families and the participants were informed that participation is voluntary and that they can refuse without giving any reason.

**RESULTS**

The study findings represented in three Tables. The children's ages ranged from 7 to 12 years, with a mean ± SD of 9.52 ± 2.9 years (Table 1). The results showed that 136/400 (34%) of the tested children were positive for intestinal parasite infection with a higher prevalence of specific intestinal worms (50.4%) than protozoa (33.3%) and coccidian infection (16.3%). The rate of infection alone was also higher than that of multiple parasitic infections (19.3% vs. 14.8%).The highest number of intestinal parasites was 50/400 (12.5%) for *Ascaris lumbricoides*, and 49/400 (12.25%) for *Entameba histolytica* followed by 9.8% for *Giardia lamblia*, 11.5% for *Entrobius vermicularis*, 6.5% for *Cryptosporidium* species, 6.5%. % for *Hymenolepis nana*, 2% for *Schistosoma manso*ni, and 0.8% for *Trichuris trichiura* (Table 2). Considering the associated factors, boys had a higher infection rate than girls (50% vs. 24.2%) with an *OR* of 2.6, *CI* = 1.7–3.9 (p < 0.001). A higher rate was also recorded in older children (41%) with an odds ratio of 1.6 (p = 0.03) (Table 3).

**DISCUSSION**

The current study showed that 34% of the children were infected with intestinal parasites. This result is lower than that previously reported in different regions of Yemen including Hadhramout (58.7%) [20], Ibb (62.7%) 21, Hajjah 8 and Sana’a (54.8%)22, also much lower than 90% among school children in Al-Mahweet Governorate23. The present work showed that 33.3% of the cases were infected with intestinal parasites while 50.4% of the cases were infected with intestinal worms. This finding is in disagreement with Qasem *et al*. 21, where this study found that infections with protozoa and helminthes were 85.64% and 14.36%, respectively, among school children. According to the results of the current investigation, *Ascaris lumbricoides* (50/400, 12.5%) and *Entameba histolytica* (49/400, 12.25%) were the most common intestinal parasites, followed by *Giardia lamblia* (9.8%) and *Entrobius vermicularis* (11.5%) (Table 2). These findings are consistent with other research done in Yemen, such as that by Qasem *et al.*21, which found that *E. histolytica*, *G. lamblia*, and *A. lumbricoides* were the most common intestinal parasites. Additionally, *G. lamblia* and *E. histolytica* were discovered to be the most prevalent intestinal parasites among schoolchildren in Amran governorate by Alshahethi *et al.*24, 25. In the current study, taking into account factors associated with parasitism, boys had a higher infection rate than girls (50% vs. 24.2%) with an odds ratio of 2.6, confidence interval = 1.7–3.9 (p < 0.001). This finding contradicts a study by Qasem *et al.*21 Where it was found that the infection of girls is much higher than that of boys. However, our result is similar to that reported by Moghalli *et al.* 8 in Hajjah, where the infection rate for boys was higher than for girls. This could be explained by the excessive movement of boys and more exposure to eating habits outside the home and/or poor personal hygiene behavior compared to girls. The infection rate alone was also higher than the rate of multiple parasitic infections (19.3% vs. 14.8%), and multiple parasitic infections may lead to gastrointestinal bleeding, malabsorption of nutrients, nutritional deficiencies, and cell and tissue damage. Ultimately, these outcomes generally result in growth retardation, slow weight growth, decreased mental development, truancy, reduced academic performance and a predisposition to malnutrition and infection by other microorganisms23, 26, 27.

*Cryptosporidium, Isospora* and *Cyclospora* are becoming increasingly prevalent in immunocompromised patients as well as in humans with normal immunity. Humans can become infected with *coccidiosis* through the fecal-oral route, through direct person-to-person or animal-to-person contact as well as consumption of contaminated water or food28 while an animal reservoir for human *Isospora* has not yet been identified29. In the current study, the prevalence of *Cryptosporidium* spp was 6.5%, while *Cyclospora* spp was the second most common spherical pathogen (3.5%). The results of this study are lower than those reported among schoolchildren in Al-Turbah city, Taiz governorate, by Shamsan *et al.*16 As the prevalence of *Cryptosporidium* spp, *Cyclospora* spp, and *Isospora belli* parasites reached 75.9%, 45.6%, and 1.75%, respectively 18. However, the results of this study are similar to those reported in the general population of developing and developed countries where *Cryptosporidium oocysts* rate of 6.1 and 2.1%, respectively, was recorded30. Also, the current study rate of *Cryptosporidium* spp (6.5%) was lower than the prevalence rates of *Cryptosporidiosis* among HIV/AIDS diarrheal patients which ranged from 10% to 33.4% 30,31 but approximately similar to that among diarrheic children with normal immunity (7%) 32.

In order of the present findings, however, many research-based interventions have mostly taken place in disadvantaged nations and regions, where sanitation is a key concern for disease prevalence8, 16. Methods of preventing intestinal parasites are not isolated to certain geographic areas. Using correct hand washing techniques, using restrooms that are built properly and have enough ventilation, having a piped water source, and wearing shoes are some of the current best practices for preventing intestinal parasites 33,34. Currently, up to 80% of the population does not have access to washing facilities in some areas of Yemen where the disease is most widespread. Even though this number is large, 93% of people have access to latrines, but only 29.2% of them are built properly to prevent parasite infection8, 16, 35. Behavioral interventions focused on encouraging washing, sometimes with soap, in the context of education in schools and childcare facilities36. In recent studies, the best interventions take a multidisciplinary approach by: increasing environmental sanitation to promote hand-washing and shoe-wearing habits, and teaching children from an early age at school and at home. However, all that was mentioned has no effect in Yemen, and schools have become recruitment centers for children. Yemen also need particular evidence-based interventions, such as those in schools that concentrate on creating better restrooms with better ventilation, offering clean drinking water, and teaching kids about good hygiene 37. A SAFE (Surgery, Antibiotics, face Hygiene, Environmental Sanitation) approach is used to treat trachoma, with a focus on environmental sanitation and face hygiene38. Cutting nails and washing hands with soap at key periods can both help to lower re-infection rates, but additional research is required before developing and implementing these interventions on a wide scale. Programs that incorporate anthelmintic medication administration with measures to improve environmental cleanliness (such minimizing fecal pollution) also can be applicable in Yemen39.

**CONCLUSIONS**

The high prevalence of intestinal parasite diseases among children continues to be a significant concern for the healthcare system, according to the data. Low communities with low environmental hygiene and a lack of personal hygiene habits frequently have intestinal parasite diseases. Therefore, a variety of control strategies are needed to reduce and eventually eliminate the incidence of intestinal parasitosis among students. The report also emphasizes how common coccidian parasites are among Yemen's immunocompetent schoolchildren. Coccidian parasites, even in immunocompetent children, can cause childhood diarrhea, therefore Yemeni doctors need to be aware of this.

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**CONFLICT OF INTEREST**

No conflict of interest associated with this work.

**AUTHOR CONTRIBUTIONS**

All authors contributed to fieldwork, lab work, data analysis, paper drafting and review, and gave final approval for the research.

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**Results**

Table 1: Age and sex distribution of school children who were tested for intestinal parasitic infection, Thala’a city - Yemen

|  |  |  |
| --- | --- | --- |
| **Characters** | **Total (n =400 )** | |
| **No.** | **%** |
| **Sex** | | |
| Male | 189 | 47.25 |
| Female | 211 | 52.75 |
| **Age groups** | | |
| 7- 8 years | 122 | 30.5 |
| 9-10 years | 139 | 34.75 |
| 11-12 years | 139 | 34.75 |
| Mean Age | 9.52 years | |
| SD | 2.9 years | |
| Min | 7 years | |
| Max | 12 years | |

Table 2: The prevalence of intestinal parasite among school children in Thala’a city, Yemen

|  |  |  |
| --- | --- | --- |
| **Parasites** | **frequency** | |
| **Number** | **percentage** |
| **Protozoa** | | |
| *E. histolytica* | 49/400 | 12.3 |
| *G. lamblia* | 39/400 | 9.8 |
| *Total identified protozoa* | 88/264 | 33.3 |
| ***Coccidian* parasites** | | |
| *Cryptosporidium species* | 26/400 | 6.5 |
| *Cyclospora species* | 14/400 | 3.5 |
| *Isospora belli* | 3/400 | 0.8 |
| *Total identified coccidian* | 43/264 | 16.3 |
| **Helminthes** | | |
| *A. lumbricoides* | 50/400 | 12.5 |
| *E. vermicularis* | 46/400 | 11.5 |
| *H. nana* | 26/400 | 6.5 |
| *S. mansoni* | 8/400 | 2 |
| *T. trichura* | 3/400 | 0.8 |
| Total identified helminthes | 133/264 | 50.4 |
| One parasite | 77/400 | 19.3 |
| Multiple parasites | 59/400 | 14.8 |
| Total infected children | 136/400 | 34 |
| Total identified parasites | 264 |  |

Table 3: The age and sex association with positive parasitic infections among school children Thala’a, Amran governorate, Yemen

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | positive (n=136) | | *OR* | *CI* | χ 2 | *Pv* |
| No. | % |
| **Sex** | | | | | | |
| Male n=189 | 85 | 50 | 2.6 | 1.7-3.9 | 19.2 | <0.0001 |
| Female n=211 | 51 | 24.2 | 0.39 | 0.25-0.59 | 19.2 | <0.0001 |
| **Age groups** | | | | | | |
| 7- 8 years n=122 | 30 | 24.6 | 0.52 | 0.32-0.85 | 6.9 | <0.0001 |
| 9-10 years n=139 | 49 | 35.3 | 1.1 | 0.7-1.6 | 0.14 | 0.69 |
| 11-12 years n=139 | 57 | 41 | 1.6 | 1.04-2.4 | 4.7 | 0.03 |
| Total n=400 | 136 | 34 |  | | | |

*OR odds ratio* = > 1 (risk)

*CI Confidence intervals* 1 to more than 1

*X 2 Chi-square* = > 3.9 (significant)

*p* Probability value = < 0.05 (significant)