



RESEARCH ARTICLE

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

Abdulsalam M. AL-Mekhlafi¹, Khaled Abdulkareem Al-Moyed², Ahmed Mohamed Al-Haddad³, Azhar Azher Mohammed Al-Ankoshy⁴,
 Emad Hassan Al-Shamahi²

¹Department of Medical parasitology, Faculty of Medicine and Health Sciences, Sana'a University, Republic of Yemen.

²Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University.

³Medical Microbiology department, Faculty of Medicine, Genius University for Sciences & Technology, Dhamar city.

⁴Physiology Department, Jabir Ibn Hayyan Medical University, Faculty of Medicine, Iraq.

Article Info:



Article History:

Received: 4 April 2023

Reviewed: 16 May 2023

Accepted: 28 June 2023

Published: 15 July 2023

Cite this article:

AL-Mekhlafi AM, Al-Moyed KA, Al-Haddad AM, Al-Ankoshy AAM, Al-Shamahi EH. Prevalence of intestinal protozoa, helminthes, and coccidian infections among primary school children in Thala'a district at Amran Governorate, Yemen. Universal Journal of Pharmaceutical Research 2023; 8(3):14-18.

<https://doi.org/10.22270/ujpr.v8i3.943>

*Address for Correspondence:

Abdulsalam M. AL-Mekhlafi, Department of Medical parasitology, Faculty of Medicine and Health Sciences, Sana'a University, Republic of Yemen. Tel: +967-1-239587;
 E-mail: al-mekhlafi_am@yemen.net.ye

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%). 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 the intestinal parasitic diseases, which can be brought on by both the 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 the children in underprivileged areas.

The poor development of the immune system and high susceptibility of youngsters to serious infection caused by their increasing nutritional needs. They are more likely to suffer from negative consequences such as stunted growth, decreased physical activity, impaired cognitive function, and poor learning ability^{8,9}. 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 World Health Organization (WHO)¹¹, as many as 270 million and 600 million preschoolers and schoolchildren, respectively, reside in regions with

widespread parasite transmission. *E. 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 the 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 under-estimating 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 now¹⁹.

Thus the study's main goal was to determine the prevalence of intestinal parasite infections among primary school students.

SUBJECTS AND METHODS

Study design: Cross sectional study was carried out among primary schoolchildren.

Place and duration of study: 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. Total 400 fecal samples from 400 randomly chosen schoolchildren in Thala'a city, Amran governorate, aged 7 to 12, and were tested between January and February 2022.

Analysis of samples: 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 dye¹⁵ 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.

Collection and analysis of Data: 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 approval: The Medical Ethics Committee of the Faculty of Medicine and Health Sciences of Sana'a University gave its official permission on January 1, 2022, with reference number 2022-11.

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 are 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%, n=133) than protozoa (33.3%, n=88) and coccidian infection (16.3%, n=43). The rate of infection alone was also higher than that of multiple parasitic infections (19.3% vs. 14.8%).

Table 1: Age and sex distribution of schoolchildren who were tested for intestinal parasitic infection.

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

The highest number of intestinal parasites were 12.5% (n=50) for *A. lumbricoides* and 12.25% (n=49) for *E. histolytica*, followed by 9.8% (n=39) for *G. lamblia*, 11.5% (n=46) for *E. vermicularis*, 6.5% (n=26) for *Cryptosporidium* species, 6.5% (n=26) for *Hymenolepis nana*, 2% (n=8) for *S. mansoni*, and 0.8% (n=3) for *T. 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 and a CI of 1.7–3.9 ($p=0.05$). A higher rate was also recorded in older children (41%, n=57), with an odds ratio of 1.6 ($p=0.05$) (Table 3).

DISCUSSION AND RECOMMENDATIONS

The current study showed that 34% of the children were infected with intestinal parasites. This score is lower than that previously reported in different regions

of Yemen, including Hadramout (58.7%)²⁰, Ibb (62.7%)²¹, Hajjah (58.8%)⁸, and Sana'a (54.8%)²², and is well below 90% among schoolchildren in Al-Mahweet Governorate²³.

Table 2: The prevalence of intestinal parasite among schoolchildren.

Parasites	Frequency Number (%)
Protozoa	
<i>E. histolytica</i>	49/400 (12.3)
<i>G. lamblia</i>	39/400 (9.8)
Total identified protozoa	88/264 (33.3)
Coccidian parasites	
<i>Cryptosporidium</i> species	26/400 (6.5)
<i>Cyclospora</i> species	14/400 (3.5)
<i>Isospora belli</i>	3/400 (0.8)
Total identified coccidian	43/264 (16.3)
Helminthes	
<i>A. lumbricoides</i>	50/400 (12.5)
<i>E. vermicularis</i>	46/400 (11.5)
<i>H. nana</i>	26/400 (6.5)
<i>S. mansoni</i>	8/400 (2)
<i>T. trichura</i>	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

The results of the current study revealed that intestinal worms were found in 50.4% of the patients, whereas intestinal protozoa were present in 33.3% of the cases. This data conflicts with that of Qasem *et al.*,²¹ who discovered that schoolchildren had protozoa and helminthes infections at rates of 85.64% and 14.36%, respectively. *A. lumbricoides* (12.5%) and *E. histolytica* (12.25%) were found to be the most

prevalent intestinal protozoa, followed by *Giardia lamblia* (9.8%) and *E. vermicularis* (11.5%), according to the findings of the current study (Table 2). These results are in line with earlier studies conducted in Yemen, including one by Qasem *et al.*,²¹ which discovered that *E. histolytica*, *G. lamblia*, and *A. lumbricoides* were the most prevalent intestinal parasites. Additionally, Alshahethi *et al.*,^{24,25} found that *G. lamblia* and *E. histolytica* were the most common intestinal parasites among schoolchildren in the Amran governorate. Boys had a greater infection rate than girls in the current study (50% vs. 24.2%), with an odds ratio of 2.6 and a confidence interval of 1.7–3.9 ($p=0.001$) when parasitism-related factors were taken into account. This result conflicts with research by Qasem *et al.*, where it was shown that girls have a substantially greater infection rate than boys. Current findings, however, are consistent with those made public by Moghalli *et al.*,⁸ in Hajjah, where boys were more likely to contract the infection than 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 micro-organisms^{23,26,27}. *Cryptosporidium*, *Isospora* and *Cyclospora* are becoming increasingly prevalent in immunocompromised patients as well as in humans with normal immunity.

Table 3: The age and sex association with positive parasitic infections among schoolchildren.

	Positive (n=136) No. (%)	OR	CI	χ^2	Pv
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				

OR- odds ratio = > 1 (risk), CI- Confidence intervals 1 to more than 1, χ^2 - Chi-square = > 3.9 (significant),
p- probability value = < 0.05 (significant)

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 food²⁷ while an animal reservoir for human *Isospora* has not yet been identified²⁸. 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%, respectively¹⁸. 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 less than 6%, was recorded²⁹. 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 about 10% to 33%^{29,30} but approximately similar to that among diarrheic children with normal immunity³¹. 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 prevalence^{8,16}. 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^{32,33}. 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 infection^{8,16,34}.

Behavioral interventions focused on encouraging washing, sometimes with soap, in the context of education in schools and childcare facilities³⁵. 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 hygiene³⁶. A SAFE (Surgery, antibiotics, face hygiene, environmental sanitation) approach is used to treat trachoma, with a focus on environmental sanitation and face hygiene³⁷. 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 Yemen³⁸.

Limitations of the study

This study has flaws since the samples were only analyzed using basic techniques, and modern genetic methods were not used to examine the samples. This is one of the things that may lower the accuracy and validity of the results.

CONCLUSIONS

The healthcare sector continues to have serious concerns about the high prevalence of intestinal parasite infections in youngsters. Intestinal parasite illnesses are common in low-income settings where environmental hygiene is poor and personal hygiene practices are lacking. 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 immuno-competent schoolchildren. *Coccidian* parasites, even in immunocompetent children, can cause childhood diarrhea, therefore Yemeni doctors need to be aware of this.

ACKNOWLEDGEMENTS

The authors would like to thank the National Center for Public Health Laboratories (NCPHL) Sana'a, Yemen for the support.

AUTHOR'S CONTRIBUTIONS

AL-Mekhlafi AM: writing original draft, methodology, investigation. **Al-Moyed KA:** editing, review. **Al-Haddad AM:** methodology, data curation. **Al-Ankoshy AAM:** review, editing, data curation. **Al-Shamahi EH:** review and editing, data curation. All the authors approved the finished version of the manuscript.

DATA AVAILABILITY

The data and material are available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

REFERENCES

1. Alemu G, Abossie A, Yohannes Z. Current status of intestinal parasitic infections and associated factors among primary school children in Birbir town, Southern Ethiopia. BMC Infect Dis 2019; 19, 270. <https://doi.org/10.1186/s12879-019-3879-5>
2. Santos TL, et al. Frequency of intestinal protozoan infections diagnosed in patients from a clinical analysis laboratory. Bioscience J 2022; 38: e38001. <https://doi.org/10.14393/BJ-v38n0a2022-42370>
3. Alqaisi NANS, AL-Mekhlafi AM, Al-Shamahy HA, et al. Toxoplasmosis in pregnant women in Yemen: the immune status and potential risk factors. Universal J Pharm Res 2021; 6(2):32-37. <https://doi.org/10.22270/ujpr.v6i2.570>
4. Al-Halani AA, Edrees WH, Alrahabi LM, et al. Prevalence of intestinal parasites, malnutrition, anemia and their risk factors among orphaned children in Sana'a City, Yemen. Universal J Pharm Res 2022; 8(2):32-39. <https://doi.org/10.22270/ujpr.v8i2.923>
5. Othman AM, Al-Mekhlafi AM. Prevalence of intestinal helminthiasis and their association with eosinophilia among schoolchildren in Wadi Dhahar district at Sana'a Governorate, Yemen. Universal J Pharm Res 2020; 5(4):11-15. <https://doi.org/10.22270/ujpr.v5i4.433>
6. Khodabakhsh-Arbat S, Hooshyar H, Sadeghi H. Prevalence of intestinal parasitic infections among patients referring to medical diagnostic laboratories, Kashan, Central Iran, 2015-2018. Jo MMID 2018; 6 (2 and 3):62-66. <https://doi.org/10.29252/JoMMID.6.2.3.62>
7. Mohammed K, Abdullah M, Omar J, Eugene I, Ismail A. Intestinal parasitic infection and assessment of risk factors in North-western, Nigeria: A community based study. Int J Pharm Med Bio Sci 2015; 4(2):141-145. <https://doi.org/10.18178/ijpmbs.4.2.141-145>
8. Mogalli NM, Edrees WH, Al-Awar MS, et al. Prevalence of intestinal parasitic infections among primary schoolchildren in Kohlan district at Hajjah Governorate, Yemen. Al-Razi Univ J Med Sci 2020; 4 (2):34-39.
9. Fauziah N, Aviani JK, Agrianfanny YN, Fatimah SN. Intestinal parasitic infection and nutritional status in children under five years old: A Systematic Review. Trop Med Infect Dis 2022;7(11):371. <https://doi.org/10.3390/tropicalmed7110371>

10. Martviset P, Phadungsil W, Na-Bangchang K, et al. Current prevalence and geographic distribution of helminth infections in the parasitic endemic areas of rural Northeastern Thailand. BMC Public Health 2023; 23: 448. <https://doi.org/10.1186/s12889-023-15378-4>
11. World Health Organization. Soil-transmitted helminth infections. Geneva: WHO; 2016.
12. World Health Organization. Soil-transmitted helminthiasis. In: Eliminating soil-transmitted helminthiasis as a public health problem in children: Progress report 2001–2010 and strategic plan 2011–2020. WHO, Geneva. 2012; 18-85.
13. Bera P, Das S, Saha R, Ramachandran VG, Shah D. Cryptosporidium in children with diarrhea: A hospital-based study. Indian Pediatr 2014; 51:906-8. <https://doi.org/10.1007/s13312-014-0526-5>
14. Kaur R, Rawat D, Kakkar M, Uppal B, Sharma VK. Intestinal parasites in children with diarrhea in Delhi, India. Southeast Asian J Trop Med Public Health 2002; 33:725-9. PMID: 12757217
15. Ifeoma A, Apalata T, Aviwe B, Oladimeji O, Abaver DT. Prevalence of intestinal parasites in HIV/AIDS-Infected patients attending clinics in selected areas of the Eastern Cape. Microbiol Res 2022; 13, 574-583. <https://doi.org/10.3390/microbiolres13030040>
16. Shamsan ENA, De-ping CAO, Al-Shamahy HA, et al. Coccidian intestinal parasites among children in Al-Torbah city in Yemen: in country with high incidence of malnutrition. Universal J Pharm Res 2019; 4(4): 24-28. <https://doi.org/10.22270/ujpr.v4i4.301>
17. Wang ZD, Liu Q, Liu HH, et al. Prevalence of Cryptosporidium, microsporidia and Isospora infection in HIV-infected people: a global systematic review and meta-analysis. Parasites Vectors 2018; 11:28. <https://doi.org/10.1186/s13071-017-2558-x>
18. Gupta AK, Jindal S, Adithya GK. Prevalence of Opportunistic enteric parasitic infections in hiv infected individuals and their correlation with CD4 count. Apollo Medicine 2018; 15(3): 138-141. <https://doi.org/10.4103/am.am3718>
19. UNICEF. High Incidence rate of Severe Acute Malnutrition (SAM) among children in Yemen. <https://www.unicef.org/malnutrition-amongst-children-yemen-all-t> Last Accessed 2019 August.
20. Al-Haddad A, Baswaid S. Frequency of intestinal parasitic infection among children in Hadhramout governorate (Yemen). J Egypt Soc. Parasitol 2010; 40: 479-486. PMID: 21246955.
21. Qasem EA, Edrees WH, Al-Shehari WA, Alshahethi MA. Frequency of intestinal parasitic infections among schoolchildren in Ibb city-Yemen. Universal J Pharm Res 2020; 5(2):42-46. <https://doi.org/10.22270/ujpr.v5i2.388>
22. Al-Mekhlafi AM, Abdul-Ghani R, Al-Eryani SM, Saif-Ali R, Mahdy MA. School-based prevalence of intestinal parasitic infections and associated risk factors in rural communities of Sana'a, Yemen. Acta Trop 2016; 163: 135-141. <https://doi.org/10.1016/j.actatropica.2016.08.009>
23. Alwabr AG, Al-Moayed E. Prevalence of intestinal parasitic infections among school children of Al-Mahweet Governorate, Yemen. Eur J Biol R 2016; 6(2): 64-73.
24. Alshahethi MA, Edrees WH, Mogalli NM, et al. Distribution and risk factors for *Giardia lamblia* among children at Amran Governorate, Yemen. Universal J Pharm Res 2020; 5(3):34-37. <https://doi.org/10.22270/ujpr.v5i3.413>
25. Alshahethi M A, Edrees WH, Mogalli NM, Al-Halani AA. Prevalence of *Entamoeba histolytica* among children attending Healthcare centres at Amran governorate, Yemen. PSM Biol Res 2022; 5(3): 98-105. <https://psmjournals.org/index.php/biolres/article/view/429>
26. Alsubaie AR, Azazy AA, Omer EO, et al. Pattern of parasitic infections as public health problem among school children: A comparative study between rural and urban areas. JTUSC. 2016; 11(1):13-18. <https://doi.org/10.1016/j.jtumed.2015.10.006>
27. Wang L, Xiao L, Duan L, Ye J, Guo Y, Guo M, et al. Concurrent infections of *Giardia duodenalis*, *E. bienersi*, and *Clostridium difficile* in children during a cryptosporidiosis outbreak in a pediatric hospital in China. PLoS Negl Trop Dis 2013; 7(9): e2437. <https://doi.org/10.1371/journal.pntd.0002437>
28. Rodriguez-Morales AJ, Castañeda Hernandez DM. Protozoa: *Cystoisospora belli* (Syn. *Isospora belli*). In: Encyclopedia of Food Safety; Editors: Motarjemi Y, Moy GG, Todd ECD, editors. Academic Press 2014:45-8. <https://doi.org/10.1016/B978-0-12-378612-8.00136-0>
29. Tamomh AG, Agena AM, Elamin E, et al. Prevalence of cryptosporidiosis among children with diarrhoea under five years admitted to Kosti teaching hospital, Kosti City, Sudan. BMC Infect Dis 2021; 21:349. <https://doi.org/10.1186/s12879-021-06047-1>
30. Cengiz Z T, Yilmaz H, Sahin I H, Kapmaz M, Ekici P. The Frequency of Cryptosporidium spp. in immunocompromised patients by modified acid-fast staining, Cassette Kit and ELISA methods: Comparison of the diagnostic techniques. Jundishapur J Microbiol 2017; 10(2):e36479. <https://doi.org/10.5812/jjm.36479>
31. Korpe P, Ni Z, Kabir M, et al. prospective cohort study of cryptosporidium infection and shedding in infants and their households. Clin Infect Dis 2023; ciad059. <https://doi.org/10.1093/cid/ciad059>
32. Gelaw, Aschalew; Anagaw, et al. Prevalence of intestinal parasitic infections and risk factors among schoolchildren at the University of Gondar Community School, Northwest Ethiopia: A cross-sectional study. BMC Public Health 2013; 13: 304. <https://doi.org/10.1186/1471-2458-13-304>
33. Abossie A, Mohammed S. Assessment of the prevalence of intestinal parasitosis and associated risk factors among primary schoolchildren in Chench town, Southern Ethiopia. BMC Public Health 2014; 14: 166. <https://doi.org/10.1186/1471-2458-14-166>
34. Alshamahi EYA, IshaK AA, Aljayfey NH, Al-Shamahy HA. Prevalence and risk factors for trachoma among primary school children in Bajjil District, Al Hudaydah, Western Yemen. Clin Ophthalmol J 2020;1(3):1014.
35. Ejemot-Nwadiaro Regina I, Ehiri JE, Arikpo D, et al. Hand washing promotion for preventing diarrhoea. The Cochrane Database System Rev 2015; 2015 (9): CD004265. <https://doi.org/10.1002/14651858.CD004265.pub3>
36. Gelaye B, Kumie A, Aboset N, Berhane Y, Williams, Michelle A. School-based intervention: Evaluating the role of water, latrines and hygiene education on trachoma and intestinal parasitic infections in Ethiopia. J Water Sanitation Hygiene Dev 2014; 4 (1):120130. <https://doi.org/10.2166/washdev.2013.060>
37. King Jonathan D, Endeshaw Tekola, Escher Elisabeth, et al. Intestinal parasite prevalence in an area of Ethiopia after implementing the SAFE strategy, enhanced outreach services, and health extension program. PLOS Negl Trop Dis 2013; 7 (6):e2223. <https://doi.org/10.1371/journal.pntd.0002223>
38. Steinmann Peter, Yap Peiling, Utzinger Jürg, et al. Control of soil-transmitted helminthiasis in Yunnan province, People's Republic of China: Experiences and lessons from a 5-year multi-intervention trial. Acta Tropica. Progress in research and control of helminth infections in Asia 2015; 141, Part B (Pt B): 271–280. <https://doi.org/10.1016/j.actatropica.2014.10.001>