Is intestinal parasitic infection still a public health concern among Saudi children?

Faten A. Al-Braiken, MSC, PhD.

ABSTRACT

الأهداف: لتحديد الخطورة على الصحة العامة والمتعلقة بالإصابة بالطفيليات المعوية لدى الأطفال الذين يعانون من النزلات المعوية في مدينة جده – المملكة العربية السعودية.

الطريقة: أجريت دراسة مقطعية خلال الفترة مابين مارس 2007م وحتى أغسطس 2007م، لتحديد نسبة الإصابة بالطفيليات المعوية لدى أثنين من المستشفيات الحكومية الرئيسية هم مستشفى جامعة الملك عبدا لعزيز ومستشفى الملك فهد، في مدينة جده – المملكة العربية السعودية. شملت الدراسة أطفال تراوحت أعمارهم مابين 0 – 10 سنوات. تضمنت الدراسة اختبار عينات براز من 500 طفل مريض يعانون من نزلات معوية، 24 من الأطفال كانوا من المنومين في المستشفى، و 476 طفل من مرضى العيادات الخارجية. عينات البراز ركزت بطريقة الفورمول إيثيل اسيتيت واختبرت ميكروسكوبيا بعد الصبغ بالأيودين وصبغة الزيل نيلسون.

النتائج: نسبة الانتشار ألعامه للأمراض الطفيلية المعوية (33.8%)، الطفيليات المعوية المعرفة في كلا من المرضى المنومين ومرضى العيادات الخارجية هي: بلاستوسيست هومينس 0%، 9.5%، انتاميبا هيستوليتكا 8.3% ، 5.9%، جيارديا لامبيليا 12.5%، 2.7%، كريبتوسبوريديم 8.3%، 2.3%، دودة الصفر الخراطيني 0%، 0.4%، الدودة الخطافية 4.2%، 0.8%، والدودة السوطية 4.2%، 1.05%.

خاتمة: الأمراض المعوية الطفيلية مازالت مشكلة صحية شائعة لدى الأطفال في السعودية.

Objective: To determine the possible health risk associated with intestinal parasite infections among children with gastroenteritis in Jeddah, Kingdom of Saudi Arabia.

Methods: This cross-sectional study was undertaken between March and August 2007 in Jeddah, Kingdom of Saudi Arabia, to detect the prevalence of intestinal parasite infections in children aged 0-10 years. Two major public hospitals took part in the study. These hospitals are King Abdulaziz University Hospital (KAUH), and King Fahad Hospital (KFH). The study involved examination of fecal samples from 500 children (24 inpatients and 476 outpatients) complaining of gastroenteritis. The samples were concentrated by formol-ethyl acetate concentration method, and microscopically examined with iodine and Ziehl Neelsen staining methods.

Results: The overall prevalence of intestinal parasitic infection was 33.8%. The intestinal parasites identified in both inpatients and outpatients were *Blastocystis hominis* (0% inpatient, 9.5% outpatient), *Entamoeba histolytica/dispar* (8.3% inpatient, 5.9% outpatient), *Giardia lamblia* (12.5% inpatient, 2.7% outpatient), *Cryptosporidium spp* (8.3% inpatient, 2.3% outpatient), *Ascaris lumbricoides* (0% inpatient, 0.4% outpatient), hookworm (4.2% inpatient, 0.8% outpatient), and *Trichuris trichiura* (4.2% inpatient, 1.05% outpatient).

Conclusion: Intestinal parasitic infection is still a common health problem among children in Saudi Arabia.

Saudi Med J 2008; Vol. 29 (11): 1630-1635

From the Department of Medical Parasitology, College of Medicine, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia.

Received 27th July 2008. Accepted 20th October 2008.

Address correspondence and reprint request to: Dr. Faten A. Al-Braiken, King Abdulaziz University, PO Box 6903, Jeddah 21452, Kingdom of Saudi Arabia. Mobile.+966 505698846. Fax. +966 (2) 6649777. E-mail: albraikanfaten@hotmail.com

Disclosure: This research was funded by the Deanship of Scientific Research, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia.

Intestinal parasites are a leading cause of chronic infection in humans worldwide with estimates showing that at least one quarter of the world's population is infected.[1] Intestinal parasites present a major public health problem in the developing world. In these countries, over 80% of all deaths annually are due to infectious and parasitic disease accounting for more than 3 million deaths.[1] Protozoa and helminthic intestinal infections are estimated to affect 3.5 billion people worldwide, the majority being children.[2-4] The prevalence of these parasites is usually associated with an unsanitary environment, importation of infection from other countries, and unhygienic habits of the people. Moreover, most intestinal parasites have been associated with ill health in some countries especially in children. Despite the overall improvement in sanitation, the total number of people with special reference to children infected with parasites worldwide is thought to be increasing.[2,5-8] Several reports have been published on parasitic infection in Kingdom of Saudi Arabia (KSA) documenting a prevalence rate from 9.5-47.4% in symptomatic and asymptomatic children.[9-16] In Yemen, a neighboring country of KSA, between 30-53% of the stool specimens submitted to public health hospitals were positive for intestinal parasites.[7,17] Recorded data from some Middle East countries showed high prevalence rates of intestinal parasites infection among children; 31.5% in Egypt,[18] 27.6-53% in Gaza,[19,20] 26% in Tunis,[21] 21% in Lebanon,[22] 38.7% in Oman,[23] and 34.8% in Bahrain.[24] This study was undertaken to determine the possible health risk associated with intestinal parasites infections among children with gastroenteritis in Jeddah, KSA.

Methods. This cross-sectional study was carried out in Jeddah, KSA, between March and August 2007, to define the incidence of intestinal parasites in young children. The study population was children from 0-10 years of age attending hospitals and clinics, as inpatients or outpatients with gastroenteritis. All patients without gastroenteritis, or above this age range were excluded from the study. The definition and classification of diarrhea followed the WHO criteria.[25] The sample size was calculated as 500 children, with 99% confidence intervals when the expected prevalence was derived from a pilot study in 2000.[15] Two major public hospitals in the city of Jeddah participated in the study. The hospitals are King Abdulaziz University hospital (KAUH), and King Fahad Hospital (KFH). Two hundred and fifty children have been selected from clinics, or inpatients from each hospital. The purpose of the study was explained to the head of the hospital, and to the children's parents verbally, which is culturally accepted. A child was only sampled if the parents gave informed consent. This study was carried out after the approval of the experimental protocol by the local human ethics committee was obtained. The outpatient's parents, and/or nursing staff attending inpatients has been provided with plastic containers with a fitting screwball top and disposable gloves, and was instructed in the safe collection of the fecal samples from each selected child. All collected samples were immediately placed on ice for subsequent processing and examination in the laboratory. The samples were concentrated by formol-ethyl acetate sedimentation method as follows: 5-6 ml of fresh stool was mixed in 10% formalin in a plastic tube in ratio of 1:4. The suspension was strained through 2 layers of wet gauze into a 15 ml conical centrifuge tubes, centrifuged at 1500 rpm for 1-2 minutes, another wash with 0.85% saline solution was conducted if the supernatant of the tubes were still cloudy. The supernatant from each tube was discarded and re-suspended by 10% formalin, to bring the total volume of the suspensions to 10 ml. Three ml of ethyl acetate was added to each tube, and then the tubes were shaked vigorously for 30 seconds. The tubes were then centrifuged at 1500 rpm for 2-3 minutes. The sediments left after the supernatant fatty plug, debris, and liquid had been discarded. On a clean slide, direct smear was prepared by mixing a drop of the concentrated feces sediment with a drop of Lugol's iodine. On another slide, a drop from the same sample was smeared, and left to air dry for at least one hour. The samples were then fixed with 100% methanol for 5 minutes, and stained using the modified Ziehl Neelsen for *Cryptosporidium spp*,[26] and slides were immersed in cold concentrated carbolic fuchsin solution, and stained for 15 minutes. The smears were then rinsed in tap water for 4 minutes, and decolorized with 1% acid alcohol for a few seconds, and briefly rinsed in tap water for one minute. Then the slides were counterstained with 0.4% methylene blue for 30 seconds, rinsed in tap water for 4 minutes, and air-dried.

Statistical analysis. The prevalence data were analyzed using the package EPI-INFO 2007 software package (Centers for Disease Control and Prevention, Atlanta, Georgia. USA). Odds ratio and 95% confidence intervals were used to test the statistical significance of the exposure of the patients to intestinal parasitic infection. The results were considered significant if the *p*-value was less than 0.05.

Results. A total of 500 children with gastroenteritis were enrolled in the study. Two hundred and fifty children were from KAUH, and the other 250 children were from KFH (**Table 1**). The parents of all children agreed to participate in the study. A total of 226 samples were from the outpatient cases, and 24 from the inpatients from KFH. However, the 250 participants from KAUH were from outpatient cases. A total of

Table 1 - The parasitic distribution in the 2 hospitals.

Parasites	KAUH N=250 n (%)	KFH N=250 n (%)	Total N=500 n (%)
Blastocystis hominis	35 (14.0)	10 (4.0)	45 (9.0)
Entamoeba histolytica/ dispar	20 (8.0)	10 (4.0)	30 (6.0)
Giardia lamblia	10 (4.0)	6 (2.4)	16 (3.2)
Cryptosporidium	7 (2.8)	6 (2.4)	13 (2.6)
Endolimax nana	19 (7.6)	15 (6.0)	34 (6.8)
Escherichia coli	5 (2.0)	3 (1.2)	8 (1.6)
Chilomastix mesneli	4 (1.6)	3 (1.2)	7 (1.4)
Ascaris lumbricoides	1 (0.4)	1 (0.4)	2 (0.4)
Hookworm	3 (1.2)	2 (0.8)	5 (1.0)
Trichuris trichiuria	4 (2.0)	2 (1.0)	6 (1.2)
Mixed infection	1 (0.4)	2 (0.8)	3 (0.6)
Total	**109 (43.6)**	**60 (24.0)**	**169 (33.8)**

KAUH - King Abdulaziz University Hospital,
KFH - King Fahad Hospital

Table 2 - The prevalence of various parasites identified from the study population.

Parasites	n	(%)
Blastocystis hominis	45	(9)
Entamoeba histolytica/dispar	30	(6)
Giardia lamblia	16	(3.2)
Cryptosporidium	13	(2.6)
Endolimax nana	34	(6.8)
Escherichia coli	8	(1.6)
Chilomastix mesneli	7	(1.4)
Ascaris lumbricoides	2	(0.4)
Hookworm	5	(1)
Trichuris trichiuria	6	(1.2)
Mixed infection	3	(0.6)
Total	**169**	**(33.8)**

500 stool samples were analyzed for intestinal parasite infections by microscopy. A total of 169 (33.8%) children were found to be positive for one or more of different intestinal parasites. Our findings revealed the presence of 11 different intestinal parasitic infections. The most common and prevalent parasites were *Blastocystis hominis (B. Hominis*), *Entamoeba histolytica/dispar (E. histolytica/dispar*), and *Endolimax nana (E. nana)* **Table 2**. The *E. histolytica/dispar* was found to be the sole parasite in 30 cases. *Giardia lamblia (G. Lambia)*, and *Cryptosporidium spp* were also common infections in the study. *Giardia lamblia* shows the highest percentage of inpatients infection with significant statistical differences between inpatients and outpatients (**Table 3**). There were low prevalence rates of other parasites (**Table 2**). There were 3 mixed infection samples, one with 5 different parasites (*Ascaris lumbricoide*s [*A. lumbricoides*], *Hymenolepis nana* [*H. nana]*, *Entamoeba coli [E. coli]*, and *Chilomastix mesneli [C. mesenli]*), the second one with 2 parasites (*B. hominis*, *E. nana*), and the last one also with 2 parasites (*E. nana, Trichuris trichiuria [T. trichiuria]*).

Discussion. Human infection with intestinal parasites is a common health problem in Saudi Arabia.[10,13-16,27] Rapid economic growth in Saudi Arabia, and an improved standard of living have been accompanied by importation of expatriate workers, with a potential also for importation of disease. This does not mean that the intestinal parasites are not normally found in Saudi Arabia despite the overall improvement of sanitation and living standards. However, importation of these workers may also increase the importation of the intestinal parasites commonly found in their countries. Female housekeepers arriving in Saudi Arabia come mainly from Indonesia, Sri Lanka, Bangladesh,

Table 3 - The prevalence of the different parasitic infection identified in the inpatients and outpatients cases from the study population.

Parasites	Inpatients N=24 n (%)	Outpatients N=476 n (%)	Odds ratio	95% Confidence interval	*P*-value
Blastocystis hominis	0	45 (9.5)	0.00	0 - 2.05	0.11
Entamoeba histolytica/dispar	2 (8.3)	28 (5.9)	1.45	0 - 6.89	0.62
Giardia lamblia	3 (12.5)	13 (2.7)	5.09	1 - 21.3	0.00
Cryptosporidium	2 (8.3)	11 (2.3)	3.84	0 - 20.19	0.07
Endolimax nana	3 (12.5)	31 (6.5)	2.05	0.4 - 7.8	0.25
Escherichia coli	0	8 (1.7)	0.00	0.0 - 14.0	0.52
Chilomastix mesneli	0	7 (1.5)	0.00	0.0 - 16.4	0.54
Ascaris lumbricoides	0	2 (0.4)	0.00	0.0 - 84.9	0.75
Hookworm	1 (4.2)	4 (0.8)	5.13	1.0 - 40.1	0.11
Trichuris trichiuria	1 (4.2)	5 (1.05)	4.10	1.0 - 32.3	0.17
Mixed infection	0	3 (0.6)	0.00	0.4 - 6.9	0.69

the Philippines, India, and Thailand. Many of these workers are infected with various types of parasites, and other diseases indigenous to their home countries, which may present potential health hazards. However, with increased awareness and efforts directed towards control of tropical and communicable diseases, foreign employees are required to submit a certificate of medical examination before coming to Saudi Arabia. In a study by Al-Madani and Mahfouz,[28] 46.5% of the surveyed Asian female housekeepers in the Abha district were infected with one or more parasites. The possibility of spreading such infections throughout the community should be considered in the light of the nature of work of this group being in close contact with different family members.

In the present study, intestinal parasites were highly prevalent in the study population with 33.8% having at least one parasite in their stools. This high prevalence is in agreement with previous reports from Saudi Arabia and other countries in the region including Jordan, Gaza, Lebanon, Yemen, Bahrain, Oman, Egypt, Iran, and Sudan.[7,19,20,22-24,27,29,30-34] This was reassuring in validation of our results, nevertheless, the results were very similar to those recorded in the previous studies. In our study, *B. hominis*, *E. histolytica/dispar*, and *G. lamblia* were the 3 parasites that comprised the largest proportion of the enteric parasites found in the area. The outpatients group had a higher prevalence of parasitic infections, however, this was not statistically significant. The prevalence of *B. hominis* was 9%. Current reports suggest that the parasite is associated with some gut pathology, and modulate immune responses indicating it should be considered an opportunistic parasite,[35,36] moreover, it is significantly associated with the occurrence of watery diarrhea.[37] Our results show that *B. hominis* occurs occasionally among the parasites' fauna, and this was in agreement to that reported for this parasite in the area[3,38] *Entamoeba histolytica/ dispar* was identified in 6%, and this was comparable reports for this parasite. In Saudi Arabia a prevalence of 1.2-14% has been reported from different cities in the country.[10,14,15,28,39] The diagnosis of amoebiasis by microscopic identification of the parasites in stool is insensitive, and is still a problem in routine diagnostic laboratories. This is due to the failure to distinguish non-pathogenic amoeba such as *E. histolytica/dispar* and *Entamoeba hartmanni*, which may increase the apparent prevalence of *E. histolytica* infection. This explains the absence of accurate prevalence data on infections with the invasive *E. histolytica*, and therefore it will be important to differentiate between the pathogenic and non-pathogenic strains of amoeba even with other diagnostic methods.[39] Moreover, *E. histolytica* cysts have been identified in asymptomatic carriers.[40,41] The *G. lamblia* were found in 3.2%. In the Middle East, several studies was carried out to determine the prevalence of *G. lamblia* infection,[24,34,42-44] indicating it to be most common protozoan identified in children. However, the prevalence rate detected in this study was even less than that previously reported for this parasite in Jeddah.[10,15,38,39,45] The lack of detection of cases of *G. lamblia* infection in children during the whole duration of the study may indicate the absence of the infection, or the sporadic excretion of the cysts as the cysts can be passed at 2-3, or even 7-8 day intervals, and sometimes the parasites cannot be found in the stools of the patients with giardiasis even with repeated microscopic examination.

In the present study, *Cryptosporidium* infection was found in 2.6% Saudi children. Since most laboratories examine stools specifically for *Cryptosporidium* only on physician's request, cryptosporidiosis is generally under-diagnosed in the area. The prevalence of *Cryptosporidium* infection in this study was in agreement with the results of other studies from the Middle East.[33,34,46,47] However, the prevalence of the infection is lower than that observed in a study from the same area,[15,48] which reported a prevalence of *Cryptosporidium* infection in symptomatic (32%), and asymptomatic (4.7%) children in 2000 in Jeddah, and 69.7% among immunosuppressed children less than 2 years. Infection with *A. lumbricoides*, *T. trichiuria*, and hookworm were found in low prevalence, and this was in agreement with other studies in the area.[11,14-16] Moreover, most of these infections were from school children who are deemed to be at higher risk of intestinal parasites. The prevalence of the commensal, and potentially pathogenic parasites identified in the present study suggested environmental contamination, and transmission was high for the intestinal parasites. Since pathogens, as well as commensals are derived from a similar environment, the presence of the latter in patient specimens signifies the potential for acquiring, or harboring parasite causing diseases. The presence is generally indicative of existing public health problems. In general, poor hygiene and poor levels of socioeconomic development have been thought to be associated with increasing risk of acquisition of intestinal protozoa,[49] however, this is not the case in most of the Jeddah population. There is a need to know the risk factors for acquisition of intestinal parasites in the area, as these factors have not been well defined.

In conclusion, with the high efforts supplied from the Saudi Arabia government towards improving the health services, the living standards, and the community sanitation, Saudi children are still facing health hazards of the intestinal parasitic infection. It is clear that intestinal parasites infection is an important cause of gastroenteritis, but one that does not always necessitate hospital management. Further studies should be undertaken to focus on the exact mode of transmission for the intestinal parasite infection in the Jeddah city.

References

1. World Health Organization. Removing obstacles to healthy development. Report on Infectious Disease. 1999 [accessed June 2008]. Available at URRL: http://www.who.int/infectious-disease-report/pages/textonly.html
2. Bundy DA. This wormy world-then and now. ***Parasitology Today*** 1997; 3: 407-408.
3. Khan ZA, Alkhalife IS. Prevalence of Blastocystis hominis among healthy food handlers in Dammam, Saudi Arabia. ***J Egypt Soc Parasitol*** 2005; 35: 395-401.
4. Alkhalife IS. Retrospective analysis of intestinal parasitic infections diagnosed at a university hospital in central, Saudi Arabia. ***Saudi Med J*** 2006; 27: 1714-1718.
5. Curtis V, Cairncross S, Yonli R. Domestic hygiene and diarrhoea - pinpointing the problem. ***Trop Med Int Health*** 2000; 5: 22-32.
6. Scolari C, Torti C, Beltrame A, Matteelli A, Castelli F, Gulletta M, et al. Prevalence and distribution of soil-transmitted helminth (STH) infections in urban and indigenous schoolchildren in Ortigueira, State of Parana, Brasil: implications for control. ***Trop Med Int Health*** 2000; 5: 302-307.
7. Azazy AA, Raja'a YA. Malaria and intestinal parasitosis among children presenting to the paediatric center in Sana'a, Yemen. ***East Mediterr Health J*** 2003; 9: 1048-1053.
8. Nissapatorn V, Lim YA, Jamaiah I, Agnes LS, Amyliana K, Wen CC, et al. Parasitic infections in Malaysia: changing and challenges. ***Southeast Asian J Trop Med Public Health*** 2005; 36 (Suppl 4): 50-59.
9. Bolbol AS, Mostafa SD, Al-Sekait M, Al-Nasser AA. Pattern of intestinal parasitic infection in preschool children in Riyadh, Saudi Arabia. ***J Hyg Epidemiol Microbiol Immunol*** 1989; 33: 253-259.
10. Omar MS, Al-Awad ME, Al-Madani AA. Giardiasis and amoebiasis infections in three Saudi closed communities. ***J Trop Med Hyg*** 1991; 94: 57-60.
11. Al-Ballaa SR, Al-Sekeit M, Al-Balla SR, Al-Rashed RS, Al-Hedaithy MA, Al-Mazrou AM. Prevalence of pathogenic intestinal parasites among preschool children in Al-Medina district, Saudi Arabia. ***Ann Saudi Med*** 1993; 13: 259-263.
12. Al-Eissa YA, Assuhaimi SA, Abdullah AM, Abobakr AM, Al-Husain MA, Al-nasser MN, et al. Prevalence of intestinal parasites in Saudi children: a community-based study. ***J Trop Pediatr*** 1995; 41: 47-49.
13. Al-shammari S, Khoja T, El-khwasky F, Gad A. Intestinal parasitic diseases in Riyadh, Saudi Arabia: prevalence, sociodemographic and environmental associates. ***Trop Med Int Health*** 2001; 6: 184-189.
14. El-Sheikh SM, el-Assouli SM. Prevalence of viral, bacterial and parasitic enteropathogens among young children with acute diarrhea in Jeddah, Saudi Arabia. ***J Health Popul Nutr*** 2001; 19: 25-30.
15. Al-Braiken FA, Amin A, Beeching NJ, Hommel M, Hart CA. Detection of Cryptosporidium amongst diarrhoeic and asymptomatic children in Jeddah, Saudi Arabia. ***Ann Trop Med Parasitol*** 2003; 97: 505-510.
16. Zakai HA. Intestinal parasitic infections among primary school children in Jeddah, Saudi Arabia. ***J Egypt Soc Parasitol*** 2004; 34: 783-790.
17. Farag HF. Intestinal parasitosis in the population of the Yemen Arab Republic. ***Trop Geogr Med*** 1985; 37: 29-31.
18. Mahfouz AA, el-Morshedy H, Farghaly A, Khalil A. Ecological determinants of intestinal parasitic infections among pre-school children in an urban squatter settlement of Egypt. ***J Trop Pediatr*** 1997; 43: 341-344.
19. Yassin MM, Shubair ME, Al-Hindi AI, Jadallah SY. Prevalence of intestinal parasites among school children in Gaza City, Gaza strip. ***J Egypt Soc Parasitol*** 1999; 29: 365-373.
20. al-Agha R, Teodorescu I. Intestinal parasites infestation and anemia in primary school children in Gaza Governorates, Palestine. ***Roum Arch Microbiol Immunol*** 2000; 59: 131-143.
21. Bouratbine A, Aoun K, Siala E,Chahed MK, Ben Hassine L, Meherzi A. For a better estimation of the prevalence of intestinal parasitism in the Tunis region. ***Bull Soc Pathol Exot*** 2000; 93: 353-355.
22. Araj GF, Abdul-Baki NY, Hamze MM, Alami SY, Nassif RE, Naboulsi MS. Prevalence and etiology of intestinal parasites in Lebanon. ***J Med Liban*** 1996; 44: 129-133.
23. Patel PK, Khandekar R. Intestinal parasitic infections among school children of the Dhahira Region of Oman. ***Saudi Med J*** 2006; 27: 627-632.
24. Mukhtar A. Intestinal parasites in the state of Bahrain. ***Indian J Pathol Microbiol*** 1995; 38: 341-344.
25. Persistent diarrhoea in children in developing countries: Memorandom from a WHO meeting. ***Bull World Health Organ*** 1998, 66: 709-719.
26. Casemore DP, Armstrong M, Sands RL. Laboratory diagnosis of cryptosporidiosis. ***J Clin Pathol*** 1985; 38: 1337-1341.
27. Milaat WA, Elassouli SM. Epidemiology of diarrhoea in two major cities in Saudi Arabia. ***J Commun Dis*** 1995; 27: 84-91.
28. Al-Madani AA, Mahfouz AA. Prevalence of intestinal parasitic infections among Asian female house keepers in Abha District, Saudi Arabia. ***Southeast Asian J Trop Med Public Health*** 1995; 26: 135-137.
29. Amini S, Solati AA, Fayaz A, Mahmoodi M. Rotavirus infection in children with acute diarrhea in Tehran. ***Med J Islam Repub Iran*** 1990; 4: 25-28.
30. Kopecky K, Giboda M, Aldova E, Dobahi SS, Radkovsky J. Pilot studies on the occurrence of some infectious diseases in two different areas in south Yemen (Aden). Part I. Parasitology. ***J Hyg Epidemiol Microbiol Immunol*** 1992; 36: 253-261.
31. Karrar ZA, Rahim FA. Prevalence and risk factors of parasitic infections among under-five Sudanese children: a community based study. ***East Afr Med J*** 1995; 72: 103-109.
32. Youssef M, Shurman A, Bougnoux M, Rawashdeh M, Bretagne S, Strockbine N. Bacterial, viral and parasitic enteric pathogens associated with acute diarrhea in hospitalized children from northern Jordan. ***FEMS Immunol Med Microbiol*** 2000; 28: 257-263.
33. Rizk H, Soliman M. Coccidiosis among malnourished children in Mansoura, Dakahlia Governorate, Egypt. ***J Egypt Soc Parasitol*** 2001; 31: 877-886.
34. Nimri LF. Cyclospora cayetanensis and other intestinal parasites associated with diarrhea in a rural area of Jordan. ***Int Microbiol*** 2003; 6: 131-135.
35. Lee JD, Wang JJ, Chung LY, Chang EE, Lai LC, Chen ER, et al. A survey on the intestinal parasites of the school children in Kaohsiung country. ***Kaohsiung J Med Sci*** 2006; 16: 452-458.
36. Gassama A, Sow PS, Fall F, Camara P, Gueye-N'diaye A, Seng R, et al. Ordinary and opportunistic enteropathogens associated with diarrhea in Senegalese adults in relation to human immunodeficiency virus serostatus. ***Int J Infect Dis*** 2001; 5: 192-198.
37. Chunge RN, Karumba N, Ouma JH, Thiongo FW, Sturrock RF, Butterworth AE. Polyparasitism in two rural communities with endemic Schistosoma mansoni infection in Machakos District, Kenya. ***J Trop Med Hyg*** 1995; 98: 440-444.
38. Amin AM. Blastocystis hominis among apparently healthy food handlers in Jeddah, Saudi Arabia. ***J Egypt Soc Parasitol*** 1997; 27: 817-823.

39. Barnawi AB, Tonkal AM, Fouad MA, Al-Braiken FA. Detection of Entamoeba histolytica/dispar in stool specimens by using enzyme-linked immunosorbent assay in the population of Jeddah City, Saudi Arabia. ***J Egypt Soc Parasitol*** 2007; 143-150.
40. Tachibana H, Kobayashi S, Nagakura K, Kaneda Y, Takeuchi T. Asymptomatic cyst passers of Entamoeba histolytica but not Entamoeba dispar in institutions for the mentally retarded in Japan. ***Parasitol Int*** 2000; 49: 31-35.
41. Zaki NR, Ibrahim SA, Atef SM, Omar HM. Evaluation of laboratory techniques for differentiation between Entamoeba histolytica and Entamoeba dispar. ***J Egypt Soc Parasitol*** 2001; 31: 335-344.
42. Ahmed MM, El Hady HM. A preliminary survey of parasitic infections and nutritional status among school children in Riyadh, Saudi Arabia. ***J Egypt Soc Parasitol*** 1989; 19: 101-105.
43. al-Tukhi MH, al-Ahdal MN, Das SR, Sadiqi S, Siddiqui Y, Ackers J, et al. Pathogenicity and antigenic components of excysted Giardia lamblia isolated from patients in Riyadh, Saudi Arabia. ***Am J Trop Med Hyg*** 1991; 45: 442-452.
44. Mahmud MA, Chappell C, Hossain MM, Habib M, Dupont HL. Risk factors for development of first symtomatic Giardia infection among infants of a birth cohort in rural Egypt. ***Am J Trop Med Hyg*** 1995; 53: 84-88.
45. Al-Harthi SA, Jamjoom MB.Enteroparasitic occurrence in stools from residents in southwestern region of Saudi Arabia before and during Umrah season. ***Saudi Med J*** 2007; 28: 386-389.
46. Stazzone AM, Slaats S, Mortagy A, Kleinosky M, Diab A, Mourad A, et al. Frequency of Giardia and Cryptosporidium infections in Egyptian children as determined by conventional and immunofluorescence methods. ***Pediatr Infect Dis J*** 1996; 15: 1044-1046.
47. Iqbal J, Hira PR, Al-Ali F, Philip R. Cryptosporidiosis in Kuwaiti children: seasonality and endemicity. ***Clin Microbiol Infect*** 2001; 7: 261-266.
48. Sanad MM, Al-Malki JS. Cryptosporidiosis among immunocompromised patients in Saudi Arabia. ***J Egypt Soc Parasitol*** 2007; 37 (Suppl 2): 765-774.
49. Shlim DR, Hoge CW, Rajah R, Scott RM, Pandy P, Echeverria P. Persistent high risk of diarrhea among foreigners in Nepal during the first 2 years of residence. ***Clin Infect Dis*** 1999; 29: 613-616.

Related topics

Almerie MQ, Azzouz MS, Abdessamad MA, Mouchli MA, Sakbani MW, Alsibai MS, Alkafri A, Ismail MT. Prevalence and risk factors for giardiasis among primary school children in Damascus, Syria. Saudi Med J 2008; 29: 234-240.

Al-Harthi SA, Jamjoom MB. Enteroparasitic occurrence in stools from residents in Southwestern region of Saudi Arabia before and during Umrah season. ***Saudi Med J*** 2007; 28: 386-389.

Patel PK, Khandekar R. Intestinal parasitic infections among school children of the Dhahira Region of Oman. ***Saudi Med J*** 2006; 27: 627-632.