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PREVALENCE OF SOME PARASITIC INFECTIOUS DISEASES WITHIN KERKUK CITY FOR YEARS 2009-2014

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ABSTRACT

The study involved a general survey of six diagnosed common parasitic infectious disease, amoebiasis, beaver fever (giardiasis), oriental spot (leishmaiasis), black fever (Kala azar), hydated disease (cystosis) and toxoplasmosis, for outpatients attended 3 different state hospitals, Al-Jumhuri, Azadi and Children hospitals for the years 2009-2014. The *amoebiasis* involved infection with *Entamoeba histolytica* had the highest records (79.5%) amongst other five parasites in year 2011, followed by giardiasis (18%) in 2012, respectively. The annual peak of total infection for all these six parasites was in year 2011 followed by years, 2013, respectively. The highest monthly records of general infection were in June followed by July and October, respectively. The present work provides a local survey of general parasitic infection prevalence in only Kerkuk province. Similar surveys to cover outskirts of Kirkuk and other cities would complimentary be beneficial to promote to an official level which imply a wider idea of the prevalence of these parasites in Iraq. Future works should involve medical treatments, i.e. vaccination to siege the prevalence of these intestinal and coetaneous diseases.

KEYWORDS: Prevalence, Parasitic, Infectious diseases; Kirkuk, Iraq.

INTRODUCTION

Infectious diseases could oocur by several routes including direct contact with an infected person, a vector animal or indirectly via human carriers of the microbes while parasites normally enter the body through the skin or mouth. Food contamination allows spread of the germs to many people through a single source.[1] Close contact with pets particularly dogs and cats, which are host to many parasites, can lead to parasite infestation. Other risks that can lead people to acquire parasites are walking barefoot, inadequate disposal of feces, lack of hygiene, and eating undercooked or exotic foods. Parasites can also be transferred to their host by the bite of an insect vector, i.e. mosquito, sand fly and bed bug. Infection is known as invasion of a host organism's body tissues by disease-causing agents, their multiplication and the reaction of host tissues to these organisms and the toxins they produce.[2] Mammalian hosts react to infections with an innate response, often involving inflammation, followed by an adaptive response.[3] Disease caused by these micro-organisms are numerous but most common are amoebiasis and giardiasis which are spread worldwide and is prevalent in Iraq too.

The parasite, *Entamoeba histolytica*, the main cause of amebiosis, is spread through food, water contaminated with stools or when human waste is used as fertilizer. It can also be spread from person to person, particularly by contact with the mouth or rectal area of an infected person. *E histolytica*, usually a commensal organism, can live in the large intestine (colon) without causing damage to the intestine, or invades the colon wall, causing colitis, acute dysentery, or chronic diarrhea.[4] The infection can also spread through the blood to the liver, and in rare cases, to the lungs, brain, or other organs. This condition occurs worldwide but most commonly in tropical areas that have crowded living conditions and poor sanitation i.e. Africa, Mexico, parts of South America, and India have major health problems.[5,6,7,8]

A gastrointestinal infection, whether symptomatic or asymptomatic can remain latent in an infected person for several years while it is estimated to cause 70,000 deaths/ year worldwide.[7] Severe amoebiosis infections occur either via invasion of the intestinal lining, causes amoebic dysentery, or amoebic colitis and if the parasite reaches the bloodstream, could spread through the body, most frequently ending up in the liver where it causing amoebic liver abscesses. The latter could occur without previous development of amoebic dysentery. In Iraq, there is no reliable survey of amoebiasis despite several national attempts here and there.

The beaver fever (Giardiasis), is another zoonotic parasitic disease caused by the

flagellate protozoan *Giardia lamblia* which inhabits the digestive tract of a wide variety of domestic and wild animal species, as well as humans.[9] It is one of the most common pathogenic parasitic infection in humans worldwide and in 2013 there were around 280 million people worldwide with symptomatic giardiasis.[10] In some developing countries *Giardia* is present in 30% of the population while in USA is estimated to be 3-7% of the population.[11] Its prevalency in Iraq is discrepant due to some variations in methodology and unsettled social circumstances.

Visceral leishmaniasis (VL) or kala-azar, also known as black fever (James and Berger, 2006)[12] is the most severe form of leishmaniasis, is a disease caused by protozoan parasites of the *Leishmania* genus. It also is called tropical sore, chiclero ulcer.[13] This disease is the second-largest parasitic killer in the world (after malaria), responsible for an estimated 200,000-400,000 annual infection worldwide.[14,15] The parasite migrates to the internal organs such as the liver, spleen (hence "visceral") and bone marrow and, if left untreated, will almost always result in the death of the host. Signs and symptoms include fever, weight loss, fatigue, anemia and substantial swelling of the liver and spleen. Of particular concern, according to the World Health Organization (WHO), is the emerging problem of HIV/VL co-infection.[16]

Leishmaniasis (oriental spot) locally known Baghdad spot, the most common form is a cutaneous condition caused mainly by a single-celled parasite that is transmitted by the bite of a phlebotomine female sandfly carrying *Leishmania donovani* Parasite. It may also be caused by other twenty species of *Leishmania* affect humans. It occurs mainly in tropical and Mediterranean countries and in African.[12,16] It is characterized by a macular, depigmented eruption attacks mainly on the face, arms and upper part of the trunk.[17] Leishmania invades human macrophages and replicates intracellularly and causes superficial skin lesions.

The hydatid diseaseis (cystosis), another parasitic disease is caused by *Echinococcus granulosus* that invade the small intestine of canids as an adult, but has important intermediate hosts such as livestock and humans.[18] Echinococcal cysts are slow growing, but can cause clinical symptoms in humans and could be life-threatening. Cysts, for many years may not initially cause symptoms, in some cases[19], however, symptoms developed depend on location of the cyst, but mostly occur in the liver, lungs, or both.[20] It is especially prevalent in parts of Eurasia, north and east Africa, Australia and South America. Communities that practice sheep farming may experience highest direct risk to humans, but wild animals can also serve as an avenue for transmission. Villagers living with Life stock is a common life style in rural areas of Kirkuk. Accordingly, they might represent a source of infection for *Echinococcus* parasite, and carriers too.

Toxoplasmosis, similarly, is a parasitic disease caused by *Toxoplasma gondii* which usually display no symptoms in adult humans.[21] Occasionally there may be a few weeks or months of mild flu-like illness such as muscle aches and tender lymph nodes. In those with a weak immune system, severe symptoms such as seizures and poor coordination may occur.[22] Quite a few Iraqi scientist carried out similar studies involved same or other parasites in different parts of Iraq had resulted in different outcomes, if not discrepant results.[23,24,25] There is so far no standard methodology to be applied to survey the most common micro-organisms causing intestinal or/and infectious diseases in the country. The objectives of this project has been to assess the prevalence of the most common parasitic pathogens within Kerkuk province. The results could well be beneficial to the Health Ministry towards to prescribe a suitable cure to siege their prevalence.

MATERIALS AND METHODS

All the numerical data obtained and dealt with in this study, are formal, reliable and have been obtained from the formal records of 3 different state hospitals in Kirkuk province i.e. Kerkuk Jumhuri, Azadi and Children Hospitals. All the patients were outpatients who attended the hospital complaining symptoms were diagnosed by consultants as infected with these parasites. The study involved a general survey of diagnosed six parasitic infectious disease e.g. amoebiasis, beaver fever (giardiasis), oriental spot (leishmaiasis), black fever (Kala azar), hydrated disease (cystosis) and toxoplasmosis, of outpatients attended above hospitals for six years (2009-2014). These parasites have been diagnosed, from stool samples served by the patients themselves. A drop of normal saline and Iodine solutions was added on a clean glass slide and small samples of stool were taken by a wooden stick using sedimentation method.[24] The samples were mixed and covered with cover slips and examined using Olympus compound microscopes. The patients involved were from all ages and both genders. Biostatistics are used to analyze the data which are tabulated or/and relevant graphs are plotted.

RESULTS

All the six most common parasites, amoebiasis, beaver fever (giardiasis), oriental spot (leishmaiasis), black fever (Kala azar), hydated disease (cystosis) and toxoplasmosis, respectively covers six years 2009-2914 are listed in table-1. Amoebiosis was the most prevailed parasitic diseases in comparison with other diseases. The mean value of infectious parasites represented in amoebiosis caused mainly by *Entamoeba histolytica* diagnosed as the gastric parasite was 79.5% with a highest record of 82% in year 2010, followed by giardiasis (18.4%) with a highest record in year 2009 making up 28.6%. However, other parasites i.e. Leishmaniasis, Black fever (Kala azar), hydated disease (cystosis) and toxoplasmosis, reported lesser, respectively. The highest annual percentage record was

for amoebiosis in 2011 and giardiosis 2012. The annual peak of total infection for all these six parasites was in year 2011 followed by year 2013 (Fig. 1A and B). The highest monthly record of general infection was in June followed by July, then October (Fig-2). Other parasites scored much less values in comparison with the amoebiosis and giardiosis (Fig.2 A and B).

Table 1: General survey of the six different infectious parasites within Kirkuk province for years (2009-2014).

Years	2009	2010	2011	2012	2013	2014	Total
Amoebosis	3223	3214	5533	4542	4996	4530	**26,038**
(%)	69.6	82.2	82.4	77.4	79.8	82.4	**79.49%**
Giardiasis	1317	609	993	1162	1111	826	**6,018**
(%)	28.5	15	14.7	19.8	17.7	15	**18.37%**
Black fever	25	38	43	47	4	4	**161**
(%)	0.5	1	0.6	0.8	0.06	0.07	**0.5%**
Leishmaniasis	25	21	117	97	81	70	**411**
(%)	0.5	0.5	1.7	1.6	0.2	1.2	**1.25%**
Haydated cyst	16	18	16	12	22	7	**91**
(%)	0.4	0.4	0.2	0.2	0.3	0.12	**0.28%**
Toxoplasmosis	19	8	12	3	39	57	**38**
(%)	0.4	0.2	0.1	0.05	0.6	1	**0.11%**
Total	4625	3908	6714	5863	6253	5494	**100%**

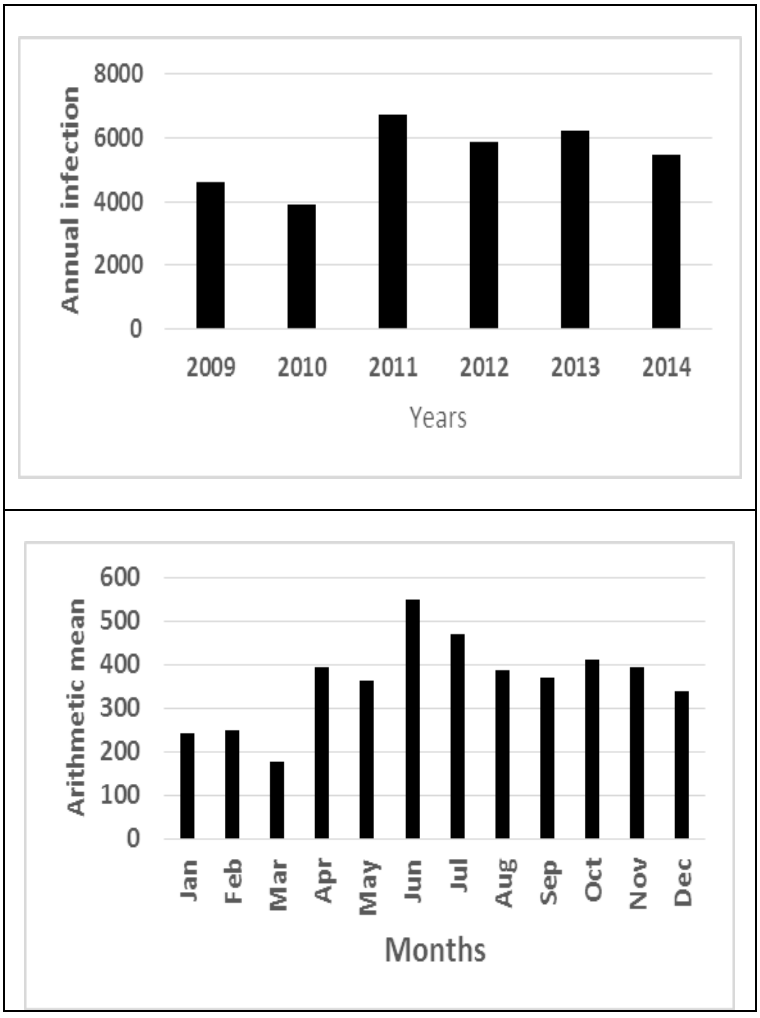
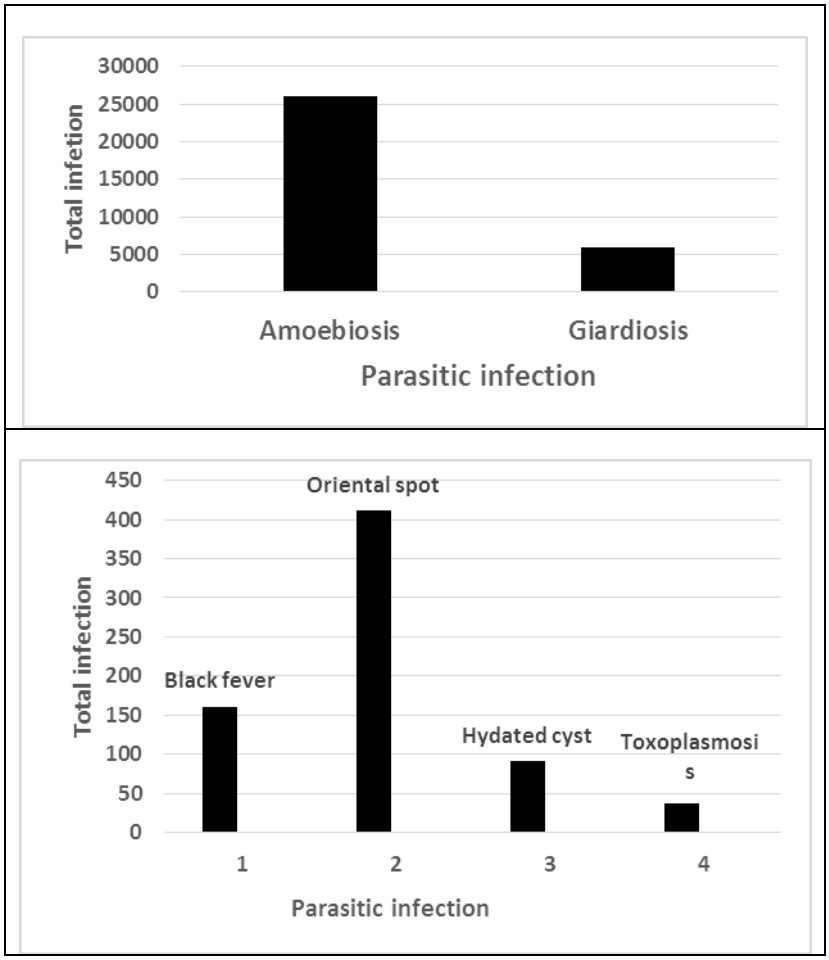


Fig. 1 A and B): (A). Distribution frequency of general parasitic infections of the six parasites within only Kerkuk city and (B): Frequency of Amoebiosis amongst months of the year.



(Fig. 2A and B): Total infection of (A). Amoebiosis and Giardiosis; (B). Black fever, Oriental spot (Lieshmaniasis), hydated cyst and Toxoplasmosis within only Kirkuk city for 6 years (2009-2014).

DISCUSSION

The study involved a survey of only 6 different common parasites covered six years (2009-2014) for outpatients from poor or/and middle class families attended 3 different state hospitals within the city of Kirkuk were the admission is free. They might have, in the first place, been suffering from various intestinal complaints or infections. The data, however, do not cover those from upper class families who can afford to pay for private clinics otherwise the record would have been further representative. Similar investigations were done in other Iraqi cities, some might have included even bacterial and viral infections too, had resulted in different outcomes.[23,24,25] These six parasites approved to be more commonly prevalent than others infectious diseases which are excluded in this study. Generally, the gastrointestinal parasites e.g. *Entamoeba histolytica* and *Giardia lambelia* had the highest records amongst others i.e. toxoplasmomsis. The former two represent the most common gastrointestinal parasites in this city which are transmitted via the ingested unhealthy foods. The result may refer to the declined general hygienic condition in the city within these six years in due to eruption of civil wars within Iraq and the consequent immigration and displacement of the victims who might have undergone various unhealthy circumstances in comparison with previous years.

The highest records of Amoebiasis detected in June and July might be attributable to the increase in temperature during the summer season when foods and waters are more likely subject to contamination than other months. Both may lead to severe diarrhea in all ages particularly in children.[26] Despite the fact that they exert a big worldwide threat to human populations however, there is so far no specific vaccination to prevent neither spread nor infection of these diseases.[8,27] In addition, there is no concomitant surveys in Kerkuk city for such diseases for the comparative purposes; however, the local medical reports indicate the increase in the rate of spread of these diseases (Bazzaz, *et al.*, 2016; unpublished data). A similar work showed the infectious severity of *E. histolytica* and *G. lamblia* in male to be insignificantly higher than in female children and at age 1-2 years old was higher than older male (40%) counter parts female aged children (36%).[28] Our results are incomparable with some previous work as it involved a general survey of infected patients regardless of ages.[23;24,25,28] These studies had implied almost the same but repetitive attempts to cover the prevalence of common intestinal parasites in some other parts of Iraq where local

environments and health services vary without exploring the suggested proposal to limit their spread nor recommended treatment, or vaccinations amongst public particularly school children in rural areas. Accordingly, some serious steps should be taken not merely to standardize the survey studies but to provided rather a reliable data for WHO too as the intestinal parasites represent serious infectious diseases in Iraq which may lead to death of thousands a year particularly, amoebiosis and giardiosis.

Amoebiasis is a worldwide spread parasite and around 480 million people are infected with what appears to be *E. histolytica* which result in death of between 40,000-110,000 people/year.[29] This means that lmost 1-2% of the victims are subject to death per year. No death records of the amoebiosis nor other five diseases were included in Kerkuk city due to lack of central data collection of mortality by the local health authorities. This could be attributed to the absence of central information from Iraqi health system where diseased people are not formally cited, as in European and American countries, in hospitals unless the death of admitting patients takes place inside these hospitals. Amoebiosis is more risky infectious disease than others, while the cysts of *Entamoeba* can survive for up to a month in soil or for up to 45 minutes under fingernails. Invasion of the intestinal lining causes amoebic bloody diarrhea or amoebic colitis. If the parasite reaches the bloodstream it can spread through the body, most frequently ending up in the liver where it causes amoebic liver abscesses which might occur without previous diarrhea.[30] This implies a high impact of risk these diseases may exert to other healthy individuals who live in close contact with these patients as house holding siblings and parents within the family or school mates.

Giardiasis (beaver fever) is another zoonotic parasitic disease caused by the flagellate protozoan *Giardia lamblia* (also called *G. intestinalis* and *G. duodenalis*). The *Giardia* is one of the most common pathogenic parasitic infections in humans worldwide which inhabits the digestive tract of a wide variety of both domestic and wild animal species. In 2013, there were about 280 million people worldwide with symptomatic giardiasis.[10] Giardiasis is transmitted via the fecal-oral route with the ingestion of cysts.[9] Primary routes are personal contact and contaminated water and food. The cysts can stay infectious for up to three months in cold water while animals can play a role in keeping infections present in an environment.[11] Such hygienic conditions have, unfortunately, been declined in Iraq which might partially attribute to the current epidemic of these parasites.

Recently, the Centers for Disease Control and Prevention in USA government public health agency (CDC) alerted towards the great risk could generate from travelers to countries where giardiasis is common, people in child care settings, carriers of disease, contaminated or untreated drinking water, backpackers i.e. campers, people in contact with infected animals and most recently between homosexual men.[31] It occurs more often during the summer in the USA which is believed to be due to a greater amount of time spent on outdoor activities. Wilderness travel within the USA is believed to be a risk factor with poorly treated or untreated water playing a role.[11] Not all *Giardia* infections are symptomatic and many people can unknowingly serve as carriers of the parasite.[32] This alerts for any unexpected risk of prevalence in Iraq as the causes of its spread worldwide are not different than in Iraq if not worst. This may also alert the risk exerted from the readymade takeaway products i.e. chippy shops, road chefs and Far eastern restaurants whose foods could be so attractive to foreigners, however, they may be one of the direct sources of this and other intestinal parasites.

Black fever (kala azar) is caused by *Lieshmania donovani*, the visceral parasite which scored as low as 0.5% while *Lieshmania tropica* could cause cutaneous infections (lieshmaniosis) scored 1.25%. Although the Leishmaniosis does spread well almost in tropical countries as well round Baghdad it is so rare in the northern parts. This could be interpreted as Northern Iraq may not be an ideal habitat for its victor, the female sand fly. Those patients might have been infected in the middle or southern Iraq in the first place or might be from immigrants to Kerkuk from other southern cities.

Toxoplasmosis is usually spread by eating poorly cooked food that contains cysts, exposure to infected cat feces, and from an infected mother to her child during pregnancy.[33,34] but rarely spreads by a blood transfusion otherwise it wouldn't spread between people.[35] The parasite is only known to reproduce sexually in the cat family; but, it can infect most types of warm-blooded animals, including humans.[36] Prevention is by properly preparing and cooking food and via avoiding any contact of pregnant women with bared hands to cat litter boxes.[37] Treatment of otherwise healthy people is usually not needed. Surprisingly, almost half of the world's population are infected by toxoplasmosis but have no symptoms.[22] Loose cats, which are uncountable everywhere in Iraq, do bury their feces in garden soils where both children and adults are more likely to get exposed every day in Iraq. In the USA about 23% are affected and in some areas of the world this is up to 95%.[21] About 200,000 cases of congenital toxoplasmosis occur a year.[38,39] Fortunately, the prevalence percentage of toxoplasmosis in Kerkuk has been 0.11% and that is the lowest percentage one can ever hope despite the current poor hygienic conditions in Kerkuk. This is an encouraging phenomenon which indicates either the parasite is under control or to asymptomatic disease which needs to be publically checked in Kirkuk.

CONCLUSSION

Most previous relevant or/and similar national scientific studies carried out at various parts of Iraq are repetitive, poorly represented in humble journals do provide an inadequate information of such common intestinal parasites. National surveys of these studies, however, could provide a comparative, a wider information and reliable summary together with relevant environmental factors involved towards releasing an accurate medical report to WHO for international records. A standard national check up campaign would be necessary to be carried out by the local health authorities amongst the school children in villages and poorly conditioned societies in the country.

REFERENCES

1. Ferguson, NM; Donnelly, CA; Anderson, RM (2001). The foot- and- mouth epidemic in Great Britain: pattern of spread and impact of interventions. *Science*, 292: 1155-1160. doi:10.1126/science.1061020. PMID 11303090.
2. Ryan, KJ and Ray, CG (2004). "Sherris Medical Microbiology" (4th Ed.). McGraw Hill. ISBN 0-8385-8529-9.
3. Kayser, FH; Kurt, AB; Eckert, J; Zinkernagel, RM (2005). Medical microbiology. Stuttgart: Georg Thieme Verlag. p. 398. ISBN 3-13-131991-7.
4. Haque, R; Mondal, D; Duggal, P (2006). "*Entamoeba histolytica* infection in children and protection from subsequent amebiasis". *Infection and Immunity*, 74(2): 904-909.
5. WHO (1969). "Amoebiasis. Report of a WHO Expert Committee". *WHO Technical Report Series*, 421: 1–52. PMID 4978968.
6. WHO (1997). "WHO, PAHO, UNESCO report. A consultation with experts on amoebiasis. Mexico City, Mexico 28–29 January 1997". *Epidemiological Bulletin*, 18(1): 13-14.
7. WHO (1998). Life in the 21st Century: a vision for all. The World Health Report 1998. World Health Organization, Geneva, Switzerland.
8. WHO (2008). "Giardiasis and children". TDR report, Switzerland.
9. Barry, MA; Weatherhead, JE; Hotez, PJ; and Woc-Colburn, L (2013). "Childhood parasitic infections endemic to the United States". *Pediatr Clin North Am*, 60(2): 471-485. doi:10.1016/j.pcl.2012.12.011. PMID 23481112.
10. Esch, KJ and Petersen, CA (2013). "Transmission and epidemiology of zoonotic protozoal diseases of companion animals". *Clin. Microbiol. Rev*., 26(1): 58-85. doi:10.1128/CMR.00067-12. PMC 3553666. PMID 23297259.
11. Auerbach, PS (2012). *Wilderness medicine* (6th ed). Philadelphia, PA: Elsevier/Mosby. pp. Chapter 68. ISBN 9781437716788.
12. James, WD; Berger, T (2006). *Andrews' Diseases of the Skin: clinical Dermatology*. Saunders Elsevier. ISBN 978-0-7216-2921-6.
13. Calvopiña, M; Martinez, L; Hashiguchi, Y (2013). "Cutaneous leishmaniasis "chiclero's ulcer" in subtropical Ecuador". *American Journal of Tropical Medicine and Hygiene*, 89(2): 195-196. *doi:10.4269/ajtmh.12-0690. PMC 3741233. PMID 23926136.*
14. Desjeux, P (2001). "The increase of risk factors for leishmaniasis worldwide". *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 95(3): 239–43. *doi*:*10.1016/S0035-9203(01)90223-8*. *PMID 11490989.*
15. WHO (2014). "Leishmaniasis". WHO Fact sheet N°375. World Health Organization. *Retrieved 23 September 2014*.
16. Holaday, BJ (2000). "Role of CD8+T cells in endogenous interleukin-10 secretion associated with visceral leishmaniasis". *Mem. Inst. Oswaldo Cruz*, 95(2): 217-220. doi:10.1590/s0074-02762000000200013. PMID 10733741.
17. Rapini, RP; Bolognia, JL and Jorizzo, JL (2007). *"Dermatology":* 2-Volume Set. St. Louis: Mosby. *ISBN 1-4160-2999-0*.
18. Eckert, J and Deplazes, P (2004). "Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern". *Clin. Microbiol. Rev.*, 17(1): 107-35. doi*:*10.1128/cmr.17.1.107-135. 2004. PMC 321468. PMID 14726458.
19. Moro, P and Schantz, PM (2009). "Echinococcosis: a review". *Int. J. Infect Dis*, 13(2): 125-33. doi*:*10.1016/j.ijid.2008.03.037. PMID18938096.
20. McManus, DP; Zhang, W; Li, J; Bartley, PB (2003). "Echinococcosis". *Lancet, 362(9392): 1295–304.* doi*:*10.1016/S0140-6736(03)14573-4. PMID 14575976.
21. Hunter, CA; Sibley, LD (2012). "Modulation of innate immunity by *Toxoplasma gondii* virulence effectors". *Nature Reviews Microbiology*, 10(11): 766-78. doi:10.1038/nrmicro2858. PMID 23070557.
22. Flegr, J; Prandota, J; Sovičková, M; Israili, ZH (2014). "Toxoplasmosis, a global threat. Correlation of latent toxoplasmosis with specific disease burden in a set of 88 countries". *PLoS ONE*, 9(3): e90203. doi:10.1371/journal.pone.0090203.
23. Saeed, BH; Al-Hayyali, FMG and Nuri, HS (2005). Study the prevalence of diarrhea causes within Rasheediya village of Neynewa city. *Journal of Rafidain Science*, 16(7): 191-206.
24. Hussein, AWB (2009). Study of prevalence intestinal parasite in patient visit some hospital of Baghdad. *Journal of Al-Anbar for Pure Science*, 3(2): 1-11.
25. Salman, KA (2012). Investigation of *Entamoeba histolytica* and *Giardia lamblia* and other diarrhea causer parasites in Talaafer city of Neynewa province, in Iraq. *Journal of Babylon for Pure and Applied Sciences*, 20(4): 1218-1224.
26. Stark, D; van Hal, S; Marriott D; Ellis, J and Harkness, J (2007). "Irritable bowel syndrome: a

review on the role of intestinal protozoa and the importance of their detection and diagnosis". *Int. J. Parasitol.*, 37(1): 11-20.
27. Bailey, V and Khamis, F. (1988). Intestinal parasite survey in rural district of Baghdad. *Bull. End. Dis*., 22: 148-151.
28. Fattohi, ZI; Hussein, SS and Mahfudh, N (2008). Study on intestinal parasite as a causative of diarrhea and some effectors on them in children of Neinevah Governorate; *Journal of Uloom Al-Rafidain*, 19(2): 37-50.
29. Beeching, N and Gill, G (2014). "19". *Lecture Notes: Tropical Medicine*. John Wiley and Sons., 177–182. ISBN 9781118734568.
30. Farrar, J; Hotez, P; Junghanss, T; Kang, G; Lalloo, D; White, NJ (2013). *Manson's Tropical Diseases*. Elsevier Health Sciences., 664–671. ISBN 9780702053061.
31. Heyworth, MF (2016). "Giardia duodenalis genetic assemblages and hosts". *Parasite*, 23: 13. *doi*:*10.1051/parasite/2016013*. *ISSN 1776-1042*.
32. Gardner, TB; Hill, DR (2001). "Treatment of giardiasis.". *Clinical Microbiology Reviews*, 14(1): 114-28. doi:10.1128/CMR.14.1.114-128.2001. PMID 11148005.
33. Pappas G, Roussos N, Falagas ME (2009). "Toxoplasmosis snapshots: global status of *Toxoplasma gondii* sero-prevalence and implications for pregnancy and congenital toxoplasmosis". *International Journal for Parasitology*, 39(12): 13851394. doi:10.1016/j.ijpara.2009.04.003. PMID 19433092.
34. Ferguson, DJ (2009). "Toxoplasma gondii: 1908-2008, homage to Nicolle, Manceaux and Splendore". *Memórias Do Instituto Oswaldo Cruz*, 104(2): 133148. doi:10.1590/S0074-02762009000200003. PMID 19430635.
35. Dupont, CD; Christian, DA; Hunter, CA (2012). "Immune response and immunopathology during toxoplasmosis". *Seminars in Immunopathology*, 34(6): 793-813. doi:10.1007/s00281-012-0339-3. PMC 3498595. PMID 22955326.
36. Sibley, LD; Khan A; Ajioka JW; Rosenthal BM (2009). "Genetic diversity of *Toxoplasma gondii* in animals and humans". *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 364(1530): 2749-2761. doi:10.1098/rstb.2009.0087. PMID 19687043.
37. McConkey, GA;, Martin, HL; Bristow, GC; Webster, JP (2013). "*Toxoplasma gondii* infection and behaviour – location, location, location?". *The Journal of Experimental Biology*, 216(1): 113-119. doi:10.1242/jeb.074153. PMC 3515035. PMID 23225873
38. Jones, JL; Parise, ME; Fiore, AE (2014). "Neglected parasitic infections in the United States: toxoplasmosis". *Am. J. Trop. Med. Hyg.*, 90(5): *794-449.* doi*:*10. 4269/ajtmh.13-0722. PMC 4015566. PMID 24808246.
39. Torgerson, PR; Mastroiacovo, P (2013). "The global burden of congenital toxoplasmosis: a systematic review.". *Bulletin of the World Health Organization*, 91(7): 501-508. doi:10.2471/blt.12.111732. PMID 23825877.