



ISSN: 0067-2904

Prevalence of Some Parasitic Infections in Iraq from 2019 to 2020

Nada Hassan Bedair^{1*}, Israa Naif Zeki²

¹Al-Hikma University College, Medical Laboratory Techniques Department, Baghdad, Iraq

²Central Organization for Standardization and Quality Control, Baghdad, Iraq

Received: 12/5/2022

Accepted: 28/10/2022

Published: 30/7/2023

Abstract

Parasitic infections are associated with low education, wars and migration, absence of animal control and poor sanitation. Infections like visceral and cutaneous leishmaniasis (VL and CL), trichomoniasis, toxoplasmosis, malaria, echinococcosis and schistosomiasis are all spread worldwide and have harmful effects on individuals and societies. The aim of this survey was to identify the possible association of these infections with spatial distribution (province/governorate) and patient demographics (age and gender). According to the data collected from the Iraqi National CDC from 2019 to 2020, the predominant parasitic infections in both years were trichomoniasis and CL, followed by echinococcosis, VL and toxoplasmosis. Iraq is malaria and schistosomiasis free. The highest incidence rate of trichomoniasis was in Duhok (2019) and Al-Dewaniya (2020) and majority of CL cases were in Diala in both 2019 and 2020. The number of echinococcosis cases was the highest in Thi-Qar (2019) and in Nineveh (2020). VL mostly affected Al-Dewaniya (2019) and Thi-Qar (2020). Toxoplasmosis scored the highest incidence rate in Basra in 2019 and 2020. All infections were higher in 2019 than in 2020, except for CL. As for age groups: echinococcosis, toxoplasmosis and trichomoniasis were higher in age group 15 – 44 years, while VL and CL was most common in 0-14 years juveniles in both years. Females were more affected than males by echinococcosis, toxoplasmosis, and trichomoniasis, while VL and CL affected males more often in the years included in this study.

Keywords: Epidemiology, Parasites, Iraq, *Leishmania*, *Trichomonas*, *Echinococcus*, *Toxoplasma*

الإنتشار الوبائي لبعض الأمراض الطفيلية في العراق من عام 2019 الى عام 2020

ندى حسن بدير^{1*}، إسرائ نايف زكي²

¹كلية الحكمة الجامعة، قسم تقنيات المختبرات الطبية، بغداد، العراق

²الجهاز المركزي للتقييس والسيطرة النوعية، بغداد، العراق

الخلاصة

ترتبط الإصابات الطفيلية بانخفاض مستوى التعليم، الحروب والهجرة وغياب السيطرة على الحيوانات، بالإضافة لقلة النظافة. اللشمانيا الحشوية و الجلدية، داء المشعرات، داء القطط، الملاريا، داء الأكياس المائية والبلهارزيا جميعها منتشرة حول العالم وذات تأثير سيء على الأفراد والمجتمعات. إن الهدف من هذه الإحصائية

*Email: nada.arwen@yahoo.com

هو تحديد العلاقة المحتملة بين هذه الإصابات مع التوزيع المكاني (المحافظة) والتركيبة السكانية للمرضى (العمر والجنس). تم أخذ جميع البيانات من مركز الأمراض المتوطنة في العراق لعامي 2019 و 2020. الإصابات الطفيلية الأكثر انتشاراً كانت داء المشعرات والليشمانيا الجلدية في العامين المذكورين انفاً، يتبعها داء الأكياس المائية ثم الليشمانيا الحشوية وداء القطط، كما أظهرت البيانات ان العراق كان خالياً من الإصابة بالمalaria والبلهارزيا في تلك المدة. أعلى نسبة إصابة بداء المشعرات كانت في محافظة دهوك عام 2019 وفي الديوانية عام 2020. أغلب اصابات الليشمانيا الجلدية كانت في محافظة ديالى في 2019 و 2020. عدد الإصابات بالأكياس المائية كان الأعلى في ذي قار عام 2019 وفي نينوى عام 2020. أثرت الليشمانيا الحشوية بشكل كبير على الديوانية في 2019 و ذي قار في 2020. أما داء القطط فقد سجل أعلى نسبة إصابة في البصرة في هذين العامين. جميع الإصابات كانت نسبتها أعلى في 2019 مما في 2020 عدا الليشمانيا الجلدية. بالنسبة للفئات العمرية، الفئة من (15 - 44 سنة) كانت الأكثر إصابة بداء الأكياس المائية وداء القطط وداء المشعرات، بينما كانت الليشمانيا الحشوية والجلدية أكثر انتشاراً بين الأعمار الصغيرة (0 - 14 سنة) في هذين العامين. إن الإناث كن أكثر عرضة للإصابة بداء الأكياس المائية وداء القطط وداء المشعرات من الذكور، بينما أثرت الحمى السوداء والليشمانيا الجلدية على الذكور بشكل أكبر خلال المدة المتضمنة في هذه الدراسة.

1. Introduction

The spread of contagious diseases and animal-borne parasitic infections is facilitated by unsatisfactory sanitary conditions. About 50% of Iraqi people living in cities and 33% living in rural areas don't have access to clean drinking water supplies [1]. Since poverty limits the access to good healthcare conditions, most parasitic infections occur in developing countries [2]. Leishmaniasis is a poverty-related disease, caused by flagellated, intracellular protozoan parasites of the genus *Leishmania*. [3]. The disease is vector-borne, so the parasites are transmitted by the bite of infected *Phlebotomus* and *Lutzomyia* sand flies [4]. The major species that cause human diseases in Iraq are *L. tropica*, *L. major*, *L. infantum* and *L. donovani* [3, 5]. Three distinct clinical syndromes have been identified; visceral leishmaniasis (VL), cutaneous leishmaniasis (CL) and mucocutaneous leishmaniasis (ML) [6]. Visceral leishmaniasis (also known as Kala-azar black fever) is caused by the parasite *Leishmania donovani* and is characterized by symptoms such as fever, weight loss, hepatomegaly, splenomegaly, and pancytopenia [7]. There are probably thirty species of *Leishmania* that may cause cutaneous leishmaniasis (CL) [8]. The disease is distributed extensively worldwide in the Americas, Asia, Europe and Africa with its epidemiology being affected by climatic, environmental and migratory factors [9, 10]. About 1 million cases of leishmaniasis are reported from 100 endemic countries every year [11]., Iraq reported 17001 cases of CL from 2008 to 2015 [12].

Toxoplasmosis is a global animal-borne disease caused by *Toxoplasma gondii*, a single-celled, eukaryotic parasite of the Phylum Apicomplexa [13]. This parasite has a complex life cycle where humans serve as intermediate hosts and felids are the definitive hosts [14]. Relatively high percentages of infection with toxoplasmosis (40 – 45%) have been reported in different provinces of Iraq [15, 16].

Trichomoniasis is probably the most common non-viral sexually transmitted infection (STI), with prevalence higher than *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections combined [17]. It is a genital tract disease caused by a flagellated protozoan parasite named *Trichomonas vaginalis* that affects an estimated 3.7 million people in the United States and 276.4 million cases per year worldwide [18, 19]. With few exceptions, transmission mostly occurs via sexual contact [20].

Malaria caused by *Plasmodium* parasites, is one of the most life-threatening infectious diseases around the world. It is transmitted by infected female *Anopheles* mosquitoes bites [2]. Symptoms may include fever, fatigue, digestive tract problems and chills. In severe cases, these symptoms may develop into coma, seizures, cerebral malaria and death [21]. Iraq has been free of malaria for almost 40 years [22, 23].

Echinococcosis (Hydatid disease) is a zoonotic infection caused by a helminth named *Echinococcus granulosus* [24]. It requires two mammalian hosts for the completion of its life cycle. Dogs and other canids are the definitive hosts, while herbivores (sheep or cattle) are the intermediate hosts, and humans act as an accidental intermediate host (dead end) [25]. Schistosomiasis (Bilharziasis) is caused by trematode blood flukes named schistosomes [26]. Three species are responsible for causing dangerous diseases to human; *Schistosoma haematobium*, *S. mansoni* and *S. japonicum* [27]. Parasitic diseases are a major cause of global morbidity and mortality, mostly affecting people in the poorest regions of the world [28].

2. Materials and Methods

The data presented in this study was available surveillance database collected from the Iraqi National Communicable Diseases Control Center (CDC). It consisted of spatial and temporal analysis of protozoan and helminthic infections. The data was arranged according to the geographical distribution of all provinces of Iraq (n=18). Total number of patients during study analysis from 2019 to 2020 was 26,038. Each infection was arranged according to age group and gender of patients. The studied parasites were divided into two categories: Protozoa: (*Leishmania*, *Plasmodium*, *Toxoplasma* and *Trichomonas*), and Helminths (Cestoda tapeworm: *Echinococcus* and Trematoda blood fluke: *Schistosoma*).

Statistical Analysis:

The Statistical Analysis System (SAS 2012) software was used to analyze data concerning the effects of different parameters in this study [29]. Chi-square test was used to compare between percentages in this study with 0.05 and 0.01 probabilities.

3. Results

Five protozoan and two helminthic infections were reported in 18 provinces of Iraq. The total number of infected individuals in 2019 was 13649, while 12389 were infected in 2020. In 2019 the highest reported cases were trichomoniasis (with a total of 6977 infections), followed by cutaneous leishmaniasis (total 6199 infections). Trichomoniasis was more dominant than CL in Baghdad (917, 13.14%), Basrah (206, 2.95%), Al-Dewaniya (1003, 14.37%), Al-Anbar (927, 13.28%), Al-Muthanna (686, 9.8%), Erbil (918, 13.16%) and Duhok (1309, 18.76%). Whereas CL was the most common parasitic infection in Nineveh (605, 9.7%), Maysan (137, 2.2%), Diala (2405, 38.79%), Babylon (158, 2.54%), Kerbela (171, 2.76%), Kirkuk (485, 7.82%), Wasit (278, 4.48%), Thi-Qar (115, 1.85%), Salah Al-Deen (451, 7.27%), Al-Najaf (150, 2.42%) and Al- Sulaimaniya (108, 1.74%). The highest incidence rate of Echinococcosis (total 230 infections) was in Thi-Qar which harbored 59 infections (25.65%), while there were no infections in Baghdad, Al- Dewaniya, Babylon, Kirkuk, Wasit, Salah Al-Deen, Erbil and Al- Sulaimaniya. Visceral leishmaniasis (total 150) was most dominant in Al- Dewaniya with 29 infections (19.33%), while the highest incidence rate of toxoplasmosis (total 93) was in Basrah which was 35 (37.63%), as shown in (Table 1) where infections with (P value \leq 0.01) were considered significant while those with (P value $>$ 0.01) being non-significant.

In 2020 the most dominant parasitic infection was CL (with a total of 7957), followed by trichomoniasis with total 4337 infections. As for incidence rates in the Iraqi governorates, Diala had the highest number of CL (3768 infection, 47.35%) followed by Salah Al-Deen (846

infection, 10.63%), whereas infection with trichomoniasis was the highest in Al-Dewaniya (910 infection, 11.43%) followed by Al-Muthanna (852 infection, 10.7%). A total of 46 infected individuals had VL, the governorate with highest incidence rate was Thi-Qar (12 infection, 26.08%). Echinococcosis showed a total of 41 infections, with 29 of them (70.73%) in Nineveh. Only 8 infections were diagnosed with toxoplasmosis, while Basrah harbored 5 of them (62.5%). No infections with malaria or schistosomiasis were reported in any governorate in both years and VL was absent in the north. (Table 1). All parasitic infections included in this study were higher in 2019 than in 2020, except CL which showed a percentage of 45.41% in 2019 and 64.22%)in 2020. (Figure 1)

Cutaneous leishmaniasis and trichomoniasis infections were the most dominant parasitic infections in Iraq in both years, followed by echinococcosis, VL and toxoplasmosis, (Figure 1)

Table 1: Parasitic infections in all Iraqi Governorates, 2019 and 2020

Governorate	Echinococcosis		Toxoplasmosis		Visceral Leishmaniasis		Cutaneous Leishmaniasis		Trichomoniasis		Malaria		Schistosomiasis	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Baghdad/Al-Karkh	0	0	3	0	6	2	85	149	729	370	0	0	0	0
Baghdad/Al-Rusafa	0	0	4	0	4	0	28	188	188	226	0	0	0	0
Basrah	25	1	35	5	11	1	47	21	206	23	0	0	0	0
Nineveh	27	29	3	3	7	0	605	682	397	265	0	0	0	0
Maysan	13	2	0	0	2	0	137	151	4	35	0	0	0	0
Al-Dewaniya	0	0	0	0	29	11	116	176	1003	910	0	0	0	0
Diala	12	2	0	0	3	8	2405	3768	90	57	0	0	0	0
Al-Anbar	3	0	0	0	2	0	546	348	927	177	0	0	0	0
Babylon	0	0	0	0	9	0	158	323	97	12	0	0	0	0
Kerbela	2	0	8	0	9	0	171	136	8	0	0	0	0	0
Kirkuk	0	0	0	0	10	0	485	104	3	1	0	0	0	0
Wasit	0	0	2	0	21	4	278	542	26	81	0	0	0	0
Thi-Qar	59	0	29	0	16	12	115	63	0	3	0	0	0	0
Al-Muthanna	54	4	0	0	5	4	298	141	686	852	0	0	0	0
Salah Al-Deen	0	0	8	0	5	0	451	846	274	369	0	0	0	0
Al-Najaf	28	3	0	0	11	4	150	110	112	37	0	0	0	0
Erbil	0	0	1	0	0	0	2	1	918	421	0	0	0	0
Duhok	7	0	0	0	0	0	14	0	1309	498	0	0	0	0
AlSulaimaniya	0	0	0	0	0	0	108	208	0	0	0	0	0	0
Grand total	230	41	93	8	150	46	6199	7957	6977	4337	0	0	0	0
Chi-Square (χ^2)	15.48**	13.04**	13.37**	9.02**	16.52**	9.37**	42.74**	31.68**	73.28**	67.22**	0.00NS	0.00NS	0.00NS	0.00NS
P-value	0.0001	0.0001	0.0001	0.0016	0.0001	0.0022	0.0001	0.0001	0.0001	0.0001	1.00	1.00	1.00	1.00

** (P≤0.01).

The data was further analyzed to compare between age groups and sexes. The study detected that the same age groups were affected in both 2019 and 2020; as echinococcosis infections were higher in 15-44 years age group, with 66.08% of infections in 2019 and 48.78% in 2020. Toxoplasmosis highly affected the same age group. 89.24% of infections were in age group 15-

44 years age group in 2019 and 100% in 2020. Trichomoniasis was higher in the same age group as well, 63.56% in 2019 and 76.25% in 2020. On the other hand, leishmaniasis infections were more dominant in younger ages, (0-14 years); VL scored 93.33% in 2019 in this age group and 100% in 2020, whereas CL showed 62.99% in 2019 and 57.28% in 2020. There was a significant difference ($p < 0.05$) among age groups regarding infections with these parasites, (Figure 2)

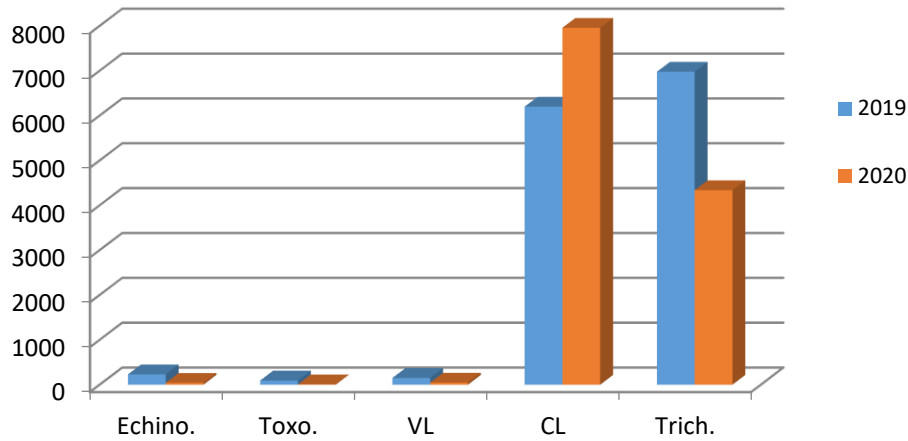


Figure 1: Total parasitic infection representation in 2019 and 2020

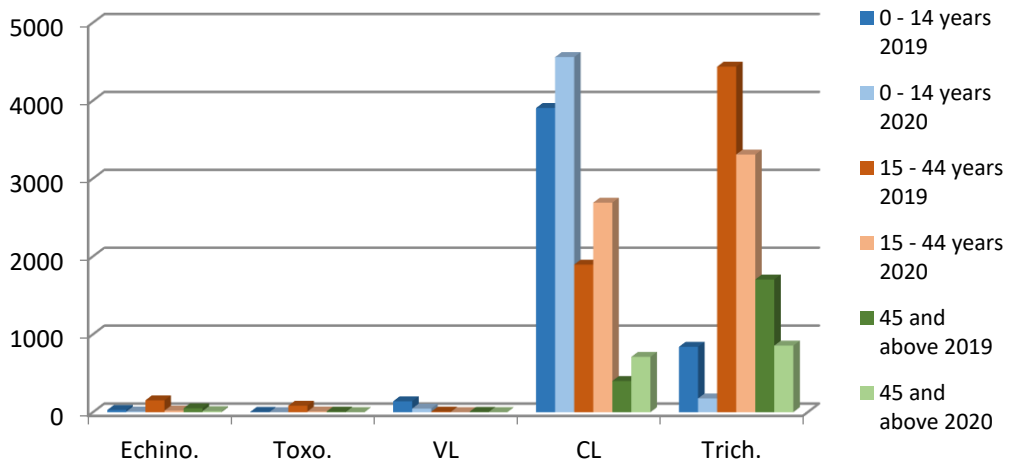


Figure 2: Relationship between age groups and parasitic infections

As for gender, Females were more affected than males by echinococcosis: 61.73% in 2019 and 75.6% in 2020, toxoplasmosis 92.47% in 2019 and 100% in 2020, and trichomoniasis 97.69% in 2019 and 98.1% in 2020, while VL and CL had more effects on males, with ratios of 51.33% and 54.70% in 2019, and 54.3% and 55.5% in 2020, respectively, (Figure 3)

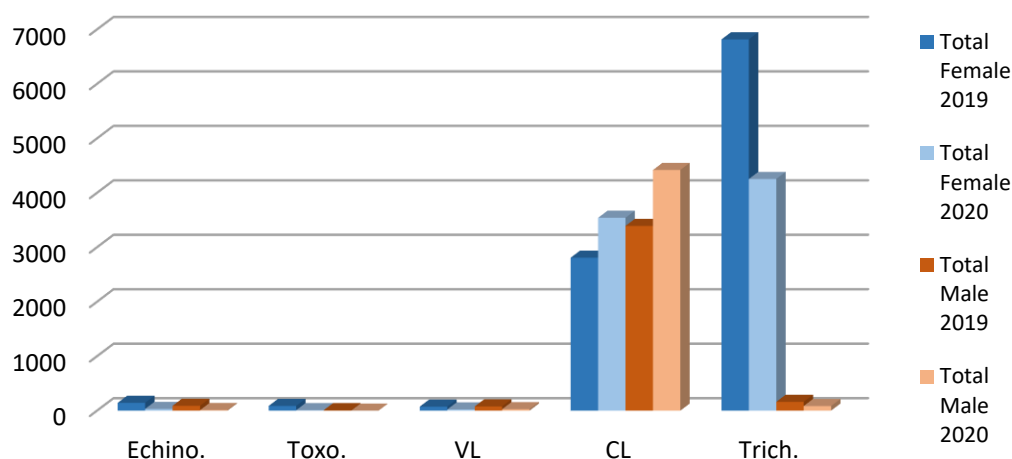


Figure 3: Relationship between genders and parasitic infections

4. Discussion

This study indicated high occurrence of protozoan and helminthic parasites in Iraq. The most common parasitic infections were cutaneous leishmaniasis, trichomoniasis, echinococcosis, visceral leishmaniasis and toxoplasmosis. The number of infections within survey years showed that total cases exceeded 12000. Epidemiological information on parasitic infections and associated factors is very important to develop new prevention methods and appropriate control, as well as monitoring existing programs [30].

Leishmaniasis is a vector-borne disease affecting millions of people worldwide, yet it is a neglected tropical disease which is affected by climate changes, including temperature, rainfall and humidity [31]. The results of this study showed that only CL infections rose in 2020 which agreed with the World Health Organization (WHO) reports in 2022 that over 85% of new CL cases occurred in 10 countries including Iraq during 2020 [32]. VL cases are mostly found in central Iraq, as well as in the capital of the country as a result of the increased number of sand flies and unsatisfactory health condition, whereas CL mostly occurred in Baghdad and Mosul where the sanitary conditions were unsatisfactory [1, 22]. The number of reported VL cases has decreased substantially in the past 10 years as a result of better diagnosis and treatment, in addition to vector control and elimination [11]. In the current study, the highest reported cases of CL were noticed in the provinces of Diala and Salah Al- Deen, while there were no infections in VL in Dahok, Erbil and Sulimania. These results are in line with Al-Obaidi *et al.* (2016) study which showed the highest prevalence of CL were also noticed in Salah Al-Deen as a mean of 8 years from 2008 to 2015 [12]. Moreover, our results also agree with Saheb's study in 2018 which reported no cases of VL in provinces of North of Iraq, although Diala harbored the highest rate of VL infection [23]. This may be explained by the variation in studies due the relationship of the size of individuals under study. The population prevalence of both types of leishmaniasis are often associated with migration and movement of non-immune people into areas with sandfly vectors and mammalian reservoirs [33]. This study also reported that both CL and VL infections were higher in males than in females. Moreover, the main age group of individuals infected was from 0-14 years. These results were supported by other previous studies [12, 23, 34]. This may be explained due to the fact that CL is an age, sex, seasonal and geographical dependent disease [12].

Despite the fact that Iraq is a Muslim country with specific religious and social prohibitions, sexually transmitted infections are still prevalent. In the year 2000, trichomoniasis infection in Iraq was only 9% [1]. However, it increased greatly and reached 51.1% and 35% in 2019 and 2020 as recorded in our study. Another study between 2018 and 2019 showed results almost similar to ours, indicating that 40.3% of tested Iraqi women were indeed infected with trichomoniasis [35]. This increase raises serious concerns since trichomoniasis is considered a public health threat to pregnant women and infants because it causes lower abdominal pain, pre-term labors and even abortions [36]. The reason why women are the most affected gender is the asymptomatic nature of the infection in men where they show no symptoms while women may suffer from itching and abnormal vaginal discharge [37]. It is noticed that 15-44 years age group was most affected, since this is the sexually active age of most individuals. Our results agree with 2016 estimates published by the WHO in 2019 about the prevalence and incidence of the four most common curable STIs in men and women aged between 15–49 years, including trichomoniasis [38, 39].

Echinococcosis is one of the most important parasitic infections in the under developed and developing countries [40]. In this study, infections with echinococcosis significantly decreased between the two years. The disease is endemic in rural areas with wide livestock breeding activities, where close contact may occur between humans and the domestic dogs and livestock. This explains its high prevalence in rural localities than urban areas [40, 41]. Additionally, the results proved that the number of infected females was higher than males, probably because they have more contact with raw meat while cooking and dog feces while farming. The high prevalence rate within the adults' age group may be due to the fact that hepatic cysts may exist for 20 years before becoming large enough to cause problems such as pain, cirrhosis, nausea and liver disease. Pulmonary cysts also grow for many years before causing cough, dyspnea and hemoptysis [42]. A recent Iraqi study reported that the incidence rate of echinococcosis started decreasing between 2011-2015. Moreover, these results agree with ours about gender and age group [40, 42]. Our results also agree with another study that included Echinococcosis where Thi-Qar had the highest incidence rate of hydatid disease [43].

Toxoplasmosis is a globally distributed parasitic zoonosis, affecting approximately 35% of the human population [44]. In Iraq, the frequency of infection has elevated more than 40% compared to the eighties where infected women did not exceed 2% of the Iraqi population [15]. This is due to many risk factors such as female age, number of deliveries, contact with cats and uncooked meat, drinking unpasteurized milk, low health education and series of wars in the attacked country [15]. According to this study, Basrah and Thi-Qar showed the highest incidence rates of toxoplasmosis (35 and 29/ 93) respectively, whereas Diayla governorate did not record any *Toxoplasma gondii* infection neither in 2019 nor 2020. Our results disagree with another Iraqi study which reported that Najaf, Misan and Erbil governorates (67, 67 and 55/ 335) showed the highest rates of prevalence in 2016 [23]. Additionally, there was an incidence rate of 205/ 500 of toxoplasmosis in Baquba City, Diyala in 2018 [45]. The prevalence of toxoplasmosis varies among countries as well as regions within one country. These variations are a result of climatic, geographic and cultural differences. However, over the past decades, the number of positive individuals has decreased globally [46]. Our results, regarding age group and gender, are in line with a study which recorded that women of childbearing age were at higher risk of acquiring toxoplasmosis than older women [44].

Schistosomiasis (Bilharziasis) was eliminated from Iran, Oman, Lebanon and Tunisia, and was greatly reduced in Egypt, Saudi Arabia, Morocco, Syria, Jordan and Iraq. However, it is still considered a major health problem in Yemen [47]. A paper that focused on the effects of climatic changes on tropical diseases including schistosomiasis in the Eastern Mediterranean

Region, showed an alteration of neglected diseases related to climate change, in addition to the expectation of more effects on vectors and reservoir, and even the survival of adult worms in the coming years [31]. According to retrospective survey that included all Iraqi governorates, no infections with schistosomiasis were recorded in Iraq from 2011 to 2015 [43]. For the last several years, due to the planned action of drying wet soil which led to the death of the *Bulinus truncatus* snail (the intermediate host for *S. haematobium*) in both of the rivers in the country, Iraq has been free from schistosomiasis [48]. Additionally, due to the national control programs, the current study ensured schistosomiasis elimination from all Iraqi governorates in 2020. Although, a study was carried out in Babylon province from 2016 to 2017 which indicated that only 2 (0.4%) patients were infected. This study detected prevalence of *S. haematobium* and enrolled of 592 patients [49]. The contradiction in results between these studies is likely due to big differences in sample size.

Reduction of mortality and morbidity caused by malarial infections require sensitive diagnostic tools, the use of anti-malarial drugs, improved personal and community protection, in addition to mosquito control. The goal is to eliminate mosquitos through spraying with insecticides to control malaria as well as the tracking of human illnesses [50]. About 600,000 cases of malaria were treated yearly in health service centers from 26 to 266 cases for every 1000 citizens, mostly in Karbala [1]. Cases of malaria caused by *P. falciparum* last occurred in Iraq in the 1980s [22, 51]. The current study ensured malaria removal from all Iraqi provinces in 2020. These results are exactly consistent with [23] who carried out to provide information on the prevalence of this parasite in Iraq in 2016.

Conclusions:

Since Iraq is free of malaria and schistosomiasis, it is very important to focus on how to reduce infection rates with leishmaniasis, trichomoniasis, echinococcosis toxoplasmosis, and any other parasitic infections by animal control and spread of safe sexual contact awareness.

Acknowledgments:

We would like to appreciate the CDC Center of parasitology and helminthology units in Baghdad for their cooperation in providing data for this study.

References

- [1] K. Korzeniewski, "The epidemiological situation in Iraq," *Przegląd epidemiologiczny*, vol. 60, p. 845, 2006.
- [2] World Health Organization. *World malaria report 2020: 20 years of global progress and challenges*. Switerland: World Health Organiation, 2020. [E-book]. Available: https://www.google.iq/books/edition/World_malaria_report_2020/KMFqEAAAQBAJ?hl=en&gbpv=0
- [3] D. Steverding, "The history of leishmaniasis," *Parasites & vectors*, vol. 10, pp. 1-10, 2017.
- [4] M. Maroli, M. Feliciangeli, L. Bichaud, R. Charrel, and L. Gradoni, "Phlebotomine sandflies and the spreading of leishmaniasis and other diseases of public health concern," *Medical and veterinary entomology*, vol. 27, pp. 123-147, 2013.
- [5] N. Salam, W. M. Al-Shaqha, and A. Azzi, "Leishmaniasis in the Middle East: incidence and epidemiology," *PLoS neglected tropical diseases*, vol. 8, p. e3208, 2014.
- [6] S. P. Georgiadou, K. P. Makaritsis, and G. N. Dalekos, "Leishmaniasis revisited: current aspects on epidemiology, diagnosis and treatment," *Journal of Translational Internal Medicine*, vol. 3, pp. 43-50, 2015.
- [7] N. Lekic, B. Tadic, V. Djordjevic, D. Basaric, M. Micev, D. Vucelic, M. Mitrovic, and N. Grubor, "Splenectomy for Visceral Leishmaniasis Out of an Endemic Region: A Case Report and Literature Review," *Medicina*, vol. 58, p. 184, 2022.

- [8] R. Reithinger, J. C. Dujardin, H. Louzir, C. Pirmez, B. Alexander, and S. Brooker, "Cutaneous leishmaniasis," *The Lancet infectious diseases*, vol. 7, pp. 581-596, 2007.
- [9] M. Mokni, "Cutaneous leishmaniasis," *Ann Dermatol Venereol*, vol. 146, pp. 232-246, 2019.
- [10] E. Torres-Guerrero, M. R. Quintanilla-Cedillo, J. Ruiz-Esmenjaud, and R. Arenas, "Leishmaniasis: a review," *F1000Res*, vol. 6, p. 750, 2017.
- [11] S. Burza, S. L. Croft, and M. Boelaert, "Leishmaniasis," *Lancet*, vol. 392, pp. 951-970, 2018.
- [12] M. J. Al-Obaidi, M. Y. Abd Al-Hussein, and I. M. Al-Saqr, "Survey study on the prevalence of cutaneous leishmaniasis in Iraq," *Iraqi Journal of Science*, vol. 57, pp. 2181-2187, 2016.
- [13] D. J. Ferguson, "Toxoplasma gondii: 1908-2008, homage to Nicolle, Manceaux and Splendore," *Memorias do Instituto Oswaldo Cruz*, vol. 104, pp. 133-148, 2009.
- [14] J. P. Dubey. *The history and life cycle of Toxoplasma gondii*, in *Toxoplasma gondii*, 3rd ed. Elsevier, 2020. [E-book]. Available: <https://www.sciencedirect.com/book/9780128150412/toxoplasma-gondii>
- [15] 8150412/toxoplasma-gondii
- [16] M. Al-Jebouri, M. Al-Janabi, and H. Ismail, "The prevalence of toxoplasmosis among female patients in Al-Hawija and Al-Baiji Districts in Iraq," *Open Journal of Epidemiology*, 2013.
- [17] M. A. H. Al Se'adawy, "Prevalence of Toxoplasmosis in pregnant women in Al Muthana province/Iraq," *Kufa Journal For Veterinary Medical Sciences*, vol. 1, pp. 166-173, 2010.
- [18] L. Newman, J. Rowley, S. Vander Hoorn, N. S. Wijesooriya, M. Unemo, N. Low, G. Stevens, S. Gottlieb, J. Kiarie, and M. Temmerman, "Global estimates of the prevalence and incidence of four curable sexually transmitted infections in 2012 based on systematic review and global reporting," *PloS one*, vol. 10, p. e0143304, 2015.
- [19] Centers for Disease Control and Prevention, "Trichomoniasis," USA, 2017. Available: www.cdc.gov/std/trichomonas
- [20] T. Edwards, P. Burke, H. Smalley, and G. Hobbs, "Trichomonas vaginalis: Clinical relevance, pathogenicity and diagnosis," *Crit Rev Microbiol*, vol. 42, pp. 406-17, 2016.
- [21] J. R. Schwebke and D. Burgess, "Trichomoniasis," *Clinical microbiology reviews*, vol. 17, pp. 794-803, 2004.
- [22] A. Bartoloni and L. Zammarchi, "Clinical aspects of uncomplicated and severe malaria," *Mediterranean journal of hematology and infectious diseases*, vol. 4, p. e2012026, 2012.
- [23] K. Korzeniewski, "Health hazards in areas of military operations conducted in different climatic and sanitary conditions," *International maritime health*, vol. 63, pp. 41-62, 2011.
- [24] E. J. Saheb, "The prevalence of parasitic protozoan diseases in Iraq, 2016," *Karbala International Journal of Modern Science*, vol. 4, pp. 21-25, 2018.
- [25] A. T. Gessese, "Review on epidemiology and public health significance of hydatidosis," *Veterinary Medicine International*, vol. 2020, p. , 2020.
- [26] C. J. Paniker, *Paniker's textbook of medical parasitology*, 7th ed. India: JP Medical Ltd, 2013. Available: <http://repository.stikesrspadgs.ac.id/65/1/Paniker%27s%20Textbook%20of%20Medical%20Parasitology-276hlm.pdf>
- [27] A. J. Molehin, D. P. McManus, and H. You, "Vaccines for Human Schistosomiasis: Recent Progress, New Developments and Future Prospects," *International Journal of Molecular Sciences*, vol. 23, p. 2255, 2022.
- [28] S. Dawaki, H. M. Al-Mekhlafi, I. Ithoi, J. Ibrahim, A. M. Abdulsalam, A. Ahmed, H. Sady, W. M. Atroosh, M. A. Al-Areeqi, F. N. Elyana, N. A. Nasr, and . Surin, "Prevalence and risk factors of schistosomiasis among Hausa communities in Kano State, Nigeria," *Revista do Instituto de Medicina Tropical de São Paulo*, vol. 58, p. 54, 2016.
- [29] C. Fitzpatrick and D. Engels, "Leaving no one behind: a neglected tropical disease indicator and tracers for the Sustainable Development Goals," *International health*, vol. 8, pp. i15-i18, 2016.
- [30] J. SAS, "Statistical Analysis System, v. 10.0. 2," Cary, North Carolina. USA, 2012.
- [31] G. Alemu, Z. Aschalew, and E. Zerihun, "Burden of intestinal helminths and associated factors three years after initiation of mass drug administration in Arbaminch Zuria district, southern Ethiopia," *BMC infectious diseases*, vol. 18, pp. 1-8, 2018.
- [32] A. K. Al-Delaimy, "The Prospective Effects of Climate Change on Neglected Tropical Diseases in the Eastern Mediterranean Region: a Review," *Current Environmental Health Reports*, pp. 1-9, 2022.

- [33] World Health Organization, "Leishmaniasis," USA, WHO, 2022. Available: <https://www.who.int/health-topics/leishmaniasis>
- [34] World Health Organization, "Leishmaniasis, Fact Sheet," USA, WHO, 2017. Available: <http://www.who.int/mediacentre/factsheets/fs375/en/>
- [35] S. M. Al-Hamash, "Study of visceral leishmaniasis (kala-azar) in children of Iraq," *Mustansiriya Medical Journal*, vol. 11, pp. 15-19, 2012.
- [36] N. H. Bedair and H. Z. Ali, "Comparison of trichomoniasis diagnosis by microscopic methods and indirect ELISA technique in a sample of Iraqi women," *Iraqi Journal of Science*, pp. 742-748, 2020.
- [37] O. T. Oyeyemi, O. Fadipe, and I. T. Oyeyemi, "Trichomonas vaginalis infection in Nigerian pregnant women and risk factors associated with sexually transmitted infections," *Int J STD AIDS*, vol. 27, pp. 1187-1193, 2016.
- [38] S. Caini, S. Gandini, M. Dudas, V. Bremer, E. Severi, and A. Gherasim, "Sexually transmitted infections and prostate cancer risk: a systematic review and meta-analysis," *Cancer Epidemiol*, vol. 38, pp. 329-338, 2014.
- [39] I. Klavs, M. Milavec, L. Berlot, T. Kustec, M. Grgic-Vitek, D. Lavtar, *et al.*, "Prevalence of sexually transmitted infections with Chlamydia trachomatis, Neisseria gonorrhoeae, Mycoplasma genitalium and Trichomonas vaginalis: findings from the National Survey of Sexual Lifestyles, Attitudes and Health, Slovenia, 2016 to 2017," *Euro Surveill*, vol. 27(14), p. 2100284 2022.
- [40] J. Rowley, S. V. Hoorn, E. Korenromp, N. Low, M. Unemo, L. J. Abu-Raddad, R. M. Chico, A. Smolak, L. Newman, S. Gottlieb, S. S. Thwin, N. Brouteta, and M. M. Taylo, "Chlamydia, gonorrhoea, trichomoniasis and syphilis: global prevalence and incidence estimates, 2016," *Bull World Health Organ*, vol. 97, pp. 548-562P, 2019.
- [41] S. A. Al-Naimi, "Hydatid Disease: A Retrospective Study of Three Hospitals in Baghdad during 2003-2008," *Iraqi Journal Of Community Medicine*, vol. 25(1), 2012.
- [42] G. Acosta-Jamett, F. A. Hernández, N. Castro, F. Tamarozzi, L. Uchiumi, J. C. Salvitti, M. Cueva, and A. Casulli, "Prevalence rate and risk factors of human cystic echinococcosis: A cross-sectional, community-based, abdominal ultrasound study in rural and urban north-central Chile," *PLoS neglected tropical diseases*, vol. 16, p. e0010280, 2022.
- [43] M. O. Mohammed, "The Human Seroprevalence of Echinococcus Granulosus in Sulaimani Governorate," *The Iraqi Postgraduate Medical Journal*, vol. 12, pp. 45-50, 2013.
- [44] E. J. Saheb, S. G. Mahdi, I. S. Mosa, M. I. Abdul-Karim, and A. N. Khistawi, "Epidemiology of Some Parasitic Helminthes in Iraq from 2011 until 2015," *Iraqi Journal of Science*, vol. 58, pp. 789-796, 2017.
- [45] M. Stopić, T. Štajner, L. Marković-Denić, V. Nikolić, I. Djilas, S. J. Srzentić, *et al.*, "Epidemiology of Toxoplasmosis in SERBIA: A Cross-Sectional Study on Blood Donors," *Microorganisms*, vol. 10, p. 492, 2022.
- [46] M. N. J. AL-Khafaji, S. R. Muhamed, and S. F. Abdl-Kareem, "Occurrence of Toxoplasmosis in Baquba City, Diyala, Iraq," *Tikrit Journal of Pure Science*, vol. 25, pp. 34-41, 2020.
- [47] B. Bobić, A. Nikolić, I. Klun, and O. Djurković-Djaković, "Kinetics of Toxoplasma infection in the Balkans," *Wiener Klinische Wochenschrift*, vol. 123, pp. 2-6, 2011.
- [48] E. Yunusa, K. Awosan, M. Ibrahim, and B. Isah, "Prevalence, epidemiological characteristics and predictors of occurrence of urinary schistosomiasis among Almajiri school children in Sokoto, Nigeria," *International Journal of Medicine and Medical Sciences*, vol. 8, pp. 22-29, 2016.
- [49] Centers for Disease Control and Prevention, "Summary of Health Information for International Travel," USA, 2003. Available: <http://www.cdc.gov/travel/blusheet.htm>
- [50] J. Ali and E. Kadhim, "Prevalence of Schistosomiasis among Patients attending hospitals in Babylon province," *Kufa Journal For Veterinary Medical Sciences*, vol. 9(1), 2018.
- [51] W. R. Brieger, "World malaria report 2015: prospects for malaria elimination," *Africa Health*, vol. 38, pp.14-16, 2016.
- [52] World Health Organization, "Communicable disease profile for Iraq," USA, 2003. Available: <http://www.who.int/infectious-disease-news/IDdocs/whocds200317/1profile.pdf>