RESEARCH ARTICLE

A Systematic Review and Meta-analysis of Most Endoparasites and Ectoparasites during Past Decade in Iraq

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ABSTRACT

Today, our society is polluted with the diseases belong to various types including inherited, germs, hazard infectious with physiologic one. Information on the disease epidemiology and reviewing data analysis helps us in controlling strategies. Since the early 1980s, this region has faced wars, political irregularity, and economic collapse, leads to the migration of over ten million people, two million have internally displaced. In addition to several other factors which mentioned by ministry of health includes poor sanitation, poor nutrition and also population density because population of Iraq has more than doubled in the last 25 years. The aim of any reviewed data analysis is to obtain an accurate picture of a particular health problem and they are used to finding out the variation of specific health problems, diagnose patterns in existence of the problem, determine any potent reasons and risk factors, evaluate the efficacy of protection scale and care them. The reviewed results reveal the existence of five genus of parasite as the most parasitic infection/infestation in Iraq during the years between 2011 and 2020. These include four species of protozoans (*Entamoeba histolytica*, *Toxoplasma gondii*, *Giardia lamblia*, and *Trichomonas vaginalis*) and one arthropod, *Pediculus humanus capitis*. Data analysis confirmed that there is a clear variation in the prevalence of parasitic infection among different Iraqi provenances. During the reviewed period, high prevalence of infection was recorded in several Iraqi provenances including, *E. histolytica* from Kirkuk (79.49%), *T. gondii* from in AL-Amaara (18.07%), *G. lamblia* and *T. vaginalis* from AL-Basrah (11.05%, 55.4%, respectively), and the head lice, *P. humanus capitis* from Koya District at Erbil provenance (41.14%). Variation in the rate of infection/infestation tells us that there is some instability among study area including, instability of the security and military situation, economic instability, population density instability. In addition to several other factors including, social behavior, the position of religious shrines, unwanted water network and poor public health control in Iraq which are decides also on the change in prevalence of infection.

Keywords: Ecto parasite; Endo parasite; Provinces Iraq

INTRODUCTION

Today, our society is polluted with the diseases belong to various types including inherited, germs, hazard infectious with physiologic diseases. Each disease having its special modes of the human affecting. Information on the disease epidemiology and reviewing data analysis helps us in controlling strategies. Review study is useful for disease surveillance, outbreak investigation, and observational studies to identify risk factors of zoonotic disease in both human and animal populations and the knowledge of these risk factors is used to direct further research investigation and to implement disease control measures (Bartlett and

Judge, 1997). None developed countries is not pointed on diseases distribution and on the other hand, all developing countries, having best commune health system based on infectious epidemiological data collection and analyzing (Akhtar, 2019). Since the early 1980s, Iraq has faced wars, political instability, and economic sanctions, resulting the displacement of over nine million people and nearly seven million have fled the country, also two million have internally displaced. In general, Health problems among Iraqi population includes mental illnesses, intestinal parasites, hepatitis B, tuberculosis, sexually transmitted diseases, HIV/AIDS, malaria and anemia (Kemmer and Teresa, 2003; Teng and Shao, 2011). The aim of any reviewed data analysis is to

obtain an accurate picture of a particular health problem and they are used to finding out the variation of specific health problems, diagnose patterns in existence of the problem, determine any potent reasons and risk factors, evaluate the efficacy of protection scale and care them.

Aim of this review is to know information on the most prevalent parasitic problems and its related factors.

CLASSIFICATION AND MORPHOLOGY

Parasites were classified according to (Brooke and Melvin, 2001) as shown in Table 1.

According to (Mehlhorn, 2016) following discription and measurements were drawn:

Entamoeba Histolytica

Having two stages during their life cycle, active stage, trophozoite and inactive stage, cyst (10 micron and 5 microns, respectively). Trophozoite moved by pseudopoda, regards to elongation protoplasmic. Cytoplasm contains various granules, food vacuoles, contractile vacuoles, lysosomal vacuole, and inclusion body. One nucleus contains central karyosome with irregular chromatin bars. The mature cystic stage is a protective and reproductive stage with protective cyst wall and contains four nuclei with central karyosome [Figure 1]. B- Trophozoite, scale bar = 0.2 Mm.

Toxoplasma Gondii

Different morphological stages exist during their life cycle, active stage, trophozoite includes: crescent shape tachyzoites and a collection of it called bradyzoites. Each of them contains rhoptary organelles, micronema, vacuules, and apical conoid. Inactive stage includes: tissue cyst which surrounded by human host cell membrane and its infective stage for animals while oocyst contains two sporocysts each with four sporozoites which serve as an infective stage for human [Figure 2].

Giardia lamblia

It possesses two stages during their life cycle, active stage, trophozoite and inactive stage, cyst (2–6 micron). Human faced like trophozoite moved by flagella (two apical, four mat the middle, and two caudal flagella) also having pair of adhesive disk and two nuclei. Cytoplasm contains various granules, food vacuoles, contractile vacuoles, lysosomal

vacuole, and inclusion body. One nucleus contains central karyosome with irregular chromatin bars. The mature oval cystic stage is a protective and reproductive stage with protective cyst wall and contains four nuclei which located at one end central karyosome [Figure 3].

B- Trophozoite, scale bar = 0.2 Mm.

Trichomonas Vaginalis

Having only trophozoite stage (10–20 micron) during their life cycle, it is active stage, moved by 5 flagella four apical and one undulation extend to caudal one. Cytoplasm

Figure 1: *Entamoeba histolytica*, (a) Cystic stage scale bar=0.1 Mm (b) Trophozoite, scale bar =0.2Mm

Figure 2: *Toxoplasma gondii*, Tachyzoite. Scal bar=0.4Mm

Table 1: Classification of the reviewed parasites

Parasites	Kingdom	Sub-Kingdom	Phylum	Class	Order	Genus
<i>Entamoeba histolytica</i>	Animalia	Protozoa	Sarcomastogoph-ora	Lobosea	Diplomonadia	<i>Entamoeba</i>
<i>Toxoplasma gondii</i>	Animalia	Protozoa	Apicomlexa	Sporozoa	Eucoccidia	<i>Toxoplasma</i>
<i>Giardia lamblia</i>	Animalia	Protozoa	Sarcomastogoph-ora	Zoomastigophora	Diplomonadia	<i>Giardia</i>
<i>Trichomonas vaginalis</i>	Animalia	Protozoa	Sarcomastogoph-ora	Zoomastigophora	Trichomonadia	<i>Trichomonas</i>
<i>Pediculus humanus capitis</i>	Animalia	Metazoa	Arthropoda	Insecta	Anuplura	<i>Pediculus</i>

contains various granules, food vacuoles, contractile vacuoles, lysosomal vacuole, and inclusion body. One nucleus contains central karyosome [Figure 4].

Pediculus Humanus Capitis

In vitro, study on the morphological development was conducted by (Al-Marjan et al., 2015). They described that the body of the adult louse as follow: body composed of three main parts, head, thorax and abdomen, head is conical and bear a pair of short antennae with five segments. The body of adult louse composed of three main parts includes head, thorax and abdomen. Compound eyes reduced or absent. Thorax small or completely fused. It bears three pair of well-developed legs and it is composed of coxa, trochanter, femur, tibia, tarsus and tarsus claw [Figure 5] nine segment abdomens in female abdomen wider than in male. The former 2.4–3.3 mm and the later 2.1–2.6 mm in length. Same description also reported by (Khalifa et al., 2007).

EPIDEMIOLOGY AND PREVALENCE OF INFECTION/INFESTATION

During the reviewed period high prevalence of infection were recorded in several Iraqi provenances including, *E. histolytica* from Kirkuk (79.49%), *T. gondii* from AL-Ammara (18.07%), *G. lamblia* and *T. vaginalis* from Basrah (11.05%, 55.4% respectively) and the head lice, *P. humanus capitis* from Koya District at Erbil provenance (41.14%).

***E. histolytica*, Schaudinn (1903)**

The assessment of almost all academic research articles revealed during 2015 and confirmed a variation in the recording of *E. histolytica* infection among different

Figure 3: *Giardia lamblia*, (a) Cystic stage, scale bar=0.24 Mm

provinces, high prevalence of infection (50.16%) was recorded in Sulaymaniyah (Ali, 2015), while the low prevalence of infection (5.52%) was recorded in Salahaddin (Tikrit) as mentioned by (Al-Ammash, 2015). Nearly similar results were recorded in Bbil, Al-Nasiria, Erbil, AL-Karbala and Kirkuk (23.37%, 23.78%, 24.4%, 26%, 26.32%,

Figure 4: *Trichomonas vaginalis*, Trophozoite, scale bar=0.3 Mm

Figure 5: Adult stage of the head lice, *Pediculus humanus capitis*, scale bar=0.32 mm

respectively) according to (Ali, 2015), (Khwam, 2015), (Faraj, 2015) (Fatima, 2018) and (Obaid, 2015). During 2016, a variation in the recording *E. histolytica* infection among different provinces had been demonstrated, similarly high prevalence of infection (79.49% and 70.1%), was recorded in Kirkuk and Diwania respectively (Ahmad, 2016) and (Al-Damerchi, 2016), while the low prevalence of infection (5.58%) was recorded in AL-Karbala (Muhsin, 2016). In 2017, data analyses reveal a variation in the recording of *E. histolytica* infections among different provinces, the high prevalence of infection (22.8%) was recorded in Erbil (Abdullah, 2017). While the low prevalence of infection (2.2%) was recorded in Kirkuk (Saheb, 2017).

Nearly similar results were recorded in AL-Nasiria, AL-Karbala, Babil, Diwania, and Salahadin (9.38%, 9.8%, 10.1%, 10.3%, and 12.8% respectively, [Table 1]) according to (Saheb, 2017), (Al-Saqr et al., 2017; Saheb, 2017; Al-Saqr et al., 2016), and (Bazzaz et al., 2017) respectively.

The incidence rates are differing according to life style, behavior style and personal hygienic, besides, a best knowledge of the several parameters such as ecological conditions, poor sanitation, drinking water and the community behaviours all of them help us to putting a best strategy for disease controlling. Also eruption of civil wars within Iraq and the frequent immigration and displacement of the people who might have play an important role in the variation in the prevalence of infection [Figure 2a].

***T. gondii*, Nicolle and Manceaux (1908)**

Toxoplasmosis is caused by the protozoan parasites *T. gondii*. Data analysis reveals that the highest mean prevalence of infection was recorded during 2011–2016 (18.07%) in AL-Amarra while the lowest mean percentage of infection was recorded from Dehuk (1.42%) at the same period [Table 1 and Figure 2b]. The prevalence of this parasite in many parts of the country is different due to many factors including the variation in climate and cultural practices in different regions of Iraq (Abdul-Aziz and Zghair, 2014). It is generally assumed that approximately 25–30% of the world's population is infected by *Toxoplasma* (Robert-Gangneux and Dardé, 2012). The prevalence varied between countries, from 0% to 10% and among different communities within the same region. Many factors can affect seroprevalence of *T. gondii* variation among population including a biotic factor that affect the availability of infective stage, oocyst. The higher incidence rate is naturally observed in wormed region and in the moisture area. During the past year, several molecular studies had been done for the detection of this parasite either directly or indirectly include those of (Bakre, 2016) from Erbil, (Mikael and Al-Saeed, 2019) from Dehuk, (Al-Toban, 2021) from Baghdad. They

recorded a seroprevalence of infection 23.3%, 28%, 8.3%, respectively. Molecular detection of this parasite was not included in the epidemiological interpretation due to using of several techniques in the diagnosis which may leads to poor results. Its need to mention that there are several other molecular searching process for this parasite in a stray cats rather than human host from Erbil city as mentioned by (Mawlood et al., 2019).

***G. lamblia*, Lambl, 1859; Kofoid and Christiansen, 1915**

The results of this review have been taken from all 18 provinces of Iraq during 2016 and 2017. The total number of patients have been tested from 2016 were 15,013 tests, while the total number of patients tested from 2017 were 50,970 tests. The mean of infection in 2016 in Iraq were 4.7% while it was 3.05% in 2017. In 2016 as shown in Figure 2c, the highest percentage of positive cases was recorded in AL-Basrah city which was 11.05% and the lowest percentage which recorded in Dehuk city was 0.38%. The other data which was recorded in other cities of Iraq shown accordingly as Erbil, Sulaymaniyah, Kirkuk, Salahadin, AL-Semawa, Baghdad, AL-Anbar, Babil, AL-Najaf, AL-Karbala, AL-Amarra, AL-Nasirya, Diwania, Diyala and Wasit the percentages were 1.28%, 1.53%, 1.43%, 0.68%, 8.55%, 3.49%, 1.25%, 7.59%, 7.41%, 2.94%, 4.9%, 7.08%, 5.73%, 9.26%, 4.26%, respectively, (Al-Saqr et al., 2016) Table 1.

During the year 2017, highest percentage of positive cases which recorded in AL-Najaf city was 7.9% while the number of the positive cases was 1588 and the lowest percentage which recorded from AL-Anbar city was 0.13%. The other data which recorded in other cities of Iraq shown accordingly Erbil, Sulaymanyah, Kirkuk, Tikrit, AL-Semawa, Baghdad, Babil, AL-Karbala, AL-Amarra, AL-Nasirya, Diwania, Diyala and Wasit since the percentage were 0.6%, 1%, 3.9%, 2.8%, 2.30%, 2.7%, 1.5%, 4.8%, 7%, 0.6%, 6.3%, 1.7%, 4.1%, respectively (Saheb, 2017).

The mean of infection in 2016 in Iraq were 4.7% while it was 3.05% in 2017. because of some factors, the main one is the situation in Iraq that has happened in 2016 including ISIS attack which is caused to the numbers of refugees and displaced families in which made them to live in campuses, this caused unhealthy environment and lead to increase the percentage of infection in 2016. Several other factors affect the elevation and lowering down in the rate of infection as the sample size, sample (patient) age seasonal diversity, improved personal hygiene and public health services.

***T. vaginalis*, Donne' (1836)**

The assessment of almost all academic research articles revealed during 2016 demonstrates a variation in the

Figure 6: A diagram shows variation of the most parasitic infection among different Iraqi provinces during the last seven years ago. (a) *Entamoeba histolytica*, (b) *Toxoplasma gondii*, (c) *Giardia lamblia*, (d) *Trichomonas vaginalis*, (E) *Pediculus humanus capitis*

Figure 7: Map of Iraq Showing most prevalent area by parasites, *Pediculus humanus capitis*, *Entamoeba histolytica*, *Toxoplasma gondii* and *Trichomonas vaginalis* from Erbil, Kirkuk, Messan and Al-Basrah

recording of *T. vaginalis* infections among different provinces with the mean prevalence of (26.5%). The highest rate of infection was in AL-Basrah (55.4%) in 2013 (ALquraishi and Khaliq, 2015), while lowest percentage of infection was (3.1%) from Erbil in 2015 (Nouraddin and Alsakee, 2015).

The high percentage of infection that recorded in Basrah indicates a considerable number of women in Al-Basrah provenance suffering with this parasite. The other factors of infection with this parasite are personal hygienic habit and absence of health education related to this parasite which may lead to increase cases of trichomoniasis among females (Saheb et al., 2016). The lowest frequency of *T. vaginalis* infection recorded in Erbil city has diminished markedly than most other previous studies because of a wide prescription of metronidazole as anti-diarrheal and anti-bacterial medication. However, such lower rate of infection may also be attributed to some technical limitations such as sample selection and size in addition to the procedures that have been used to identify the parasite (Nouraddin and Alsakee, 2015) from one place to another.

Table 2: Prevalence of infection/infestation by most common parasite occurrences among different Iraqi provenance

Type of parasites	<i>Entamoeba histolytica</i>			<i>Giardia lamblia</i>		<i>Toxoplasma gondii</i>	<i>Trichomonas vaginalis</i>	<i>Pediculus humanus capitis</i>
Year Provinces	2015	2016	2017	2016	2017	Mean% (2011–2016)	(2013–2017)	(2015–2020)
AL-Anbar	–	–	–	1.25	0.13	3.8	–	–
Babil	23.37	26.4	10.1	7.59	1.50	–	50	–
Baghdad	–	–	–	3.49	2.70	1.5	48.29	–
AL-Basrah	–	–	–	11.05	6.10	7	55.4	–
Diyala	–	–	–	9.29	1.07	12.1	54.1	–
Diwania	–	70.1	10.3	5.73	6.30	–	–	–
Dehuk	–	–	–	0.38	1.70	1.42	–	–
Erbil	24.4	61.2	22.8	1.28	0.60	12.45	3.1	14.52
Erbil (Koya district)								41.14
AL-Karbala	26	5.58	9.8	2.94	4.80	2.42		
Kirkuk	26.32	79.49	2.2	1.43	3.90	2.61	20.49	34.7
Amarra	–	–	–	4.90	7	18.07	–	
Ninawa	–	–	–	–	0.40	4.7	–	27.44
AL-Najaf	–	–	–	7.41	7.90	15.5	17.64	22.9
AL-Nasiria	–	–	–	7.08	0.60	–	4.8	–
Al Samawa	–	–	–	8.55	2.30	–	–	–
Sulaymaniyah	50.16	–	4.5	1.53	1	11.2	–	1.12* 14.43**
Salahadin	5.52		12.8	0.68	2.80	–	11.2	21.9
AL-Wasit	–	–	–	4.26	4.10	7.3	20.83	–
	–	–	–	–	–		20.83 (2013) 21.76 (2014)	–
Dhi Qar	23.78	–	9.38	–	–	9.1	–	–
AL-Qadisiyyah	–	–	–	–	–	7.2	–	–
Al-Samawa	–	–	–	–	–	9	–	–

*% at the center of city, **% at the Kalar District

There were some similarities in results between different provinces of Iraq in which the prevalence of *T. vaginalis* from Diyla (Baqubah) was 54.1% during 2017 (Salman and Hussein, 2017), similar records were found in Babil in 2015 and AL-Basrah in 2013 which were 50% and 55.4%, respectively (ALquraishi and Khaliq, 2015) (Al-Mayah et al., 2013), and there was a similarity in the result that recorded in 2013 in AL-Wasit (Rahi et al., 2013) and Kirkuk in 2013 (Salman and Kareem, 2013) which were 20.83% and 20.49%, respectively. In 2013 and 2017, two different provinces recorded two near –one results, which were 20.83% and 17.64% in Wasit (Merdaw et al. 2014) and AL-Najaf (Al-Kafagy and Al-Hadraawy, 2017), respectively. The result of this checklist shows similarity in the prevalence of occurrence of *T. vaginalis* in Erbil 2015 (Nouraddin and Alsakee, 2015) and AL-Nasseria 2013 (Khalaf et al., 2013) which were 3.1% and 4.8% respectively. The prevalence of *T. vaginalis* in Diyala was 12.41% during 2014 (Hussein and Shaker, 2014) and this considered a parallel agreement with the prevalence of *T. vaginalis* in Salahadin during 2014 which was 11.2 % (Hussein and Shaker, 2014). During 2014, two near – one results in both provinces of Babil and Baghdad had been recorded (Al–Quraishi, 2014) which was 50% and 48.29%, respectively. Both near and similar results among different cities may be related to the fact that all women

were exposed to the chance of infection due to living under the same conditions and this is agree with that mentioned by (Salman and Hussein, 2017). Moreover, the similarity in the results between different provinces may be due to using similar sample sizes, socioeconomic states, material status, and using the same techniques for identification of *T. vaginalis* [Table 1and Figure 2d].

***P. humanus Capitis*, De Geer (1767)**

Data of a number of articles on the prevalence of infestation by head lice were collected and analyzed in different Iraqi provenances, and the result reveals as follow: Koya district 41.14%, Erbil 14,52%, Kirkuk 34.7%, AL-Najaf 22.9%, Sulaimanya 1.12%, Kalar district 14.43%, Ninawa 27.44% and Salahadin 21.9% (Mahmood and Nasraddin, 2015; Khidhir et al., 2017; Kadir et al., 2017; Al-Zayadi, 2018; Ali and Hama, 2018; Amin et al., 2019; Sulaiman et al., 2020; Tawfeeq, 2020) respectively. The highest prevalence of infestation was recorded in Koya district from Sulaymaniah governments in 2015 and the lowest one was recorded in centre of Sulaymaniah city during 2018. Many students in schools in one class, carrying hair wetly, hair extending (length of hair), using oily (fatty) shampoos and hair conditioner, mixing children outside the house with each other and lack of low quality anti lice

among the most important factors affecting variation in the rate of head lice infestation in different Iraqi governments.

Najaf and Nainawa provenance shows relatively high prevalence of infestation [Table 1 and Figure 2e]. Several other factors lead to this variation in the different region in Iraq for example those regions which are closely contacted with the Iranian population due occurrences of a large number of Iranian people in Najaf in order to apply religious visit and traveling a lot of Iraqi citizen's ton for medical treatment and mixing with them. Hence, depending on several study Asian countries especially Iran, among the countries with the high prevalence of infestation by the head lice (Falagas et al., 2008). Other factors included the poor hygiene and lower economic level for example families living in a shanty houses, lack of in-house bathroom, lower levels of income and socioeconomic status (Al-Marjan and Kamil, 2014) and the creation of a large number of refugee camps and displaced area because of ISIS ware which is not according to the standard of public health which are all associated with the variation in the rate of head lice infestation [Figures 6 and 7].

CONCLUSION

The reviewed results reveal the existence of five genus of parasite as the most parasitic infection/infestation in Iraq during the year between 2011 and 2020. These include four species of protozoans (*E. histolytica*, *T. gondii*, *G. lamblia* and *T. vaginalis*) and one arthropod, *P. humanus capitis*. Data analysis confirmed that there is a clear variation in the prevalence of parasitic infection among different Iraqi provenances. During the reviewed period, high prevalence of infection was recorded in several Iraqi provenances including, *E. histolytica* from Kirkuk (79.49%), *T. gondii* from AL-Amarra (18.07%), *G. lamblia* and *T. vaginalis* from Basrah (11.05%, 55.4% respectively) and the head lice, *P. humanus capitis* from Koya District at Erbil provenance (41.14%). Variation in the rate of infection/infestation tells us that there is some instability among study area including, instability of the security and military situation, economic instability, population density instability. In addition to several other factors including, social behavior, the position of religious shrines, unwanted water network and poor public health control in Iraq which are decides also on the change in prevalence of infection [Table 2].

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