Karbala Governorate, Iraq: Multi-Facility Geographic Distribution, Seasonality, And Age And Sex Demographic Risk Study Of Leishmaniasis

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Abstract

Background: The cutaneous (CL) and visceral (VL) forms of leishmaniasis are prevalent in Iraq, and therefore, Karbala Governorate in specific is a major public health issue in Iraq. This study of the epidemiology of leishmaniasis in Karbala focused primarily on its seasonality, geographic distribution, sex-related inequities and age susceptibility across five Karbala area health facilities.
Methods: The five sentinel health facilities that were examined using cross-sectional retrospective study of confirmed cases of leishmaniasis were Ain Al-Tamr Hospital, Al-Hussein Medical City, Al-Hindiya Hospital, Al-Hussainiya Hospital and the Children Hospital. The size of the population screened was 62,374. The diagnosis was proven by direct microscopy and clinical examination. The variables used to stratify the data were month, sex, age bracket and location. Chi-square analysis was employed in order to measure geographical variance.
Findings: The total rate of infection was 0.300 and 186 cases of leishmaniasis were confirmed. The number of cases of cutaneous leishmaniasis was 178 and the cases of visceral leishmaniasis were 8 and were only seen in children. Among all the sites, the Ain Al-Tamr Hospital had the highest infection rate of 6.584 percent ($p < 0.0001$; chi-square = 702.75). Between December and February when temperatures were lower, there was a distinct seasonal high. The largest age group was children aged 110 and the proportion of all cases in this age group was 34.83%. It turned out that at the majority of the sites, there was a modest male majority.
Conclusion: In Karbala, children under the age of 10 years are disproportionately infected by leishmaniasis and the disease seems to be geographically and seasonally clustered with the activity of sand flies. These findings have significant implications on the policies and targeted measures on vectors in the region, as far as the health of the populace is concerned.

Keywords: Cutaneous leishmaniasis; visceral leishmaniasis; Karbala; Iraq; epidemiology; seasonal distribution; Phlebotomus; sand fly.

1. Introduction

The female phlebotomine sand fly is the host that transmits the obligatory intracellular protozoan parasites that infect mammals causing leishmaniasis and other vector-borne diseases (Reithinger et al., 2007). There are three primary manifestations of leishmaniasis with each having its own distinctive pathophysiology, geographic distribution, and clinical severity: cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis (MCL), and visceral leishmaniasis (VL). The highest case fatality rate is of untreated cases of VL (or kala-azar), whereas CL is predominant in the rest of the world (Alvar et al., 2012). With an estimated annual number of 0.7-1.0 million new cases, spread across 98 endemic countries, leishmaniasis is classified as a neglected tropical disease (NTD) by the World Health Organization (WHO, 2024). Low- and middle-income countries are disproportionately impacted and are at a greater risk of transmission due to poverty, hunger, population displacement, and lack of housing (Hassan et al., 20226). Postigo (2010) states that Iraq is among the countries with the highest CL and VL burden of the Eastern Mediterranean Region (EMR).
The interplay between environmental, social, and infrastructure factors all plays a complex role in influencing the leishmaniasis epidemiology in Iraq. The disruption of the traditional vector habitats and concentration of vulnerable people in poor settlements with limited preventive healthcare has been caused by a combination of factors such as rapid urbanization, changes in agricultural land use, and ongoing conflicts (Khalaf et al., 2020). A good example of this is the governorate of Karbala in the central region of the Euphrates in Iraq. It is inherently susceptible to an increase in the density

of sand flies and, consequently, increased risks of transmission; it consists of both densely populated metropolitan regions and distant desert fringe districts, with the Ain Al-Tamr district being particularly threatened (Al-Tae et al., 2024). Despite being a familiar issue in central Iraq, Karbala lacks comprehensive epidemiological data of leishmaniasis that incorporates various forms and facilities. The existing literature misses the key information concerning the geographical heterogeneity within the governorates, the seasonality of the fine-grained one, and the comparative resilience of different age and sex demographics (Al-Qazwini, Y. M., and Haddawee, R. H., 2020**,** Al-Khafaji et al., 2022; Jassim et al., 2024). These gaps in coverage hinder evidence-based programs in the control of vectors and case management programs. Thus, this paper aimed at accomplishing three tasks: (i) determine the number of individuals who contracted leishmaniasis at each of the five sentinel health facilities in the Karbala Governorate; (ii) establish the frequency, at which the disease occurs at various times of the year in relation to known sand fly ecology; and (iii) determine the age and sex groups at the highest risk so that public health interventions can be designed

2. Materials and Methods

2.1. The study design and setting will be described firstly, as follows:

Verified cases of leishmaniasis among five hospitals in the Karbala Governorate of Iraq were surveyed as a retrospective cross-sectional study. The selected hospitals represented the various geographical regions and populations that it served: Ain Al-Tamr Hospital, a remote desert-fringe district, Al-Hussein Medical City, a large urban tertiary referral center, Al-Hindiya Hospital, a peri-urban district, Al-Hussainiya Hospital, a rural district, and the Children's Hospital, a paediatric tertiary These institutions were hand-picked in order to cover the entire governorate.

2.2 Population and Data Collection of the Study.

The study population consisted of all patients that had attended any of the five centers during the research period to seek leishmaniasis screening. A total of 62,374 individuals were reported in all the sites. Case records were retrieved by use of medical records and outpatient clinic logs in each of the facilities. Data variables that were obtained on each verified case included the following: the facility of diagnosis, age at presentation, clinical form (CL or VL), sex (male or female), and date of diagnosis (month).

2.3 Diagnostic Criteria

The clinical diagnosis of cutaneous leishmaniasis was confirmed by direct microscopic examination of Giemsa-stained slitskin smears that revealed Leishmania amastigotes and is defined by the presence of typical painless, indurated skin ulcers or nodules. A constellation of symptoms such as anemia, weight loss, splenomegaly, and persistent fever were found to be symptoms of visceral leishmaniasis in the case of pediatric patients. Serological tests (rK39 dipstick) were performed when the diagnosis was in doubt. Only cases with confirmed diagnosis by a laboratory were analyzed, with all diagnoses being done by competent clinicians.

2.4 Statistical Analysis

The infections rate of each facility were obtained by dividing the number of confirmed cases by the total number of persons tested. The percentage obtained was then indicated. The percentage of new infections per month by sex and expressed as a ratio of new infections per month at each institution. The age group distributions were tabulated in ten year intervals. They used Pearson Chi-square test to determine the change in infection rate between institutions according to their geographical location (chi-square = 702.75; $p < 0.0001$). All the statistics were computed with the help of SPSS 26.0, which is designed and supported by IBM Corp. in Armonk, NY, USA. To be significant, a p-value of less than 0.05 was considered significant.

2.5 Ethical Considerations

This research followed all the guidelines provided in the Declaration of Helsinki. Formal informed consent of individual patients was not necessary since this study was a retrospective analysis of anonymized institutional data. Ethical approval was given by the institutional review committee of the relevant health authority in Karbala Governorate.

3 . Results

3.1 Cutaneous Leishmaniasis: Monthly Distribution by Sex and Facility.

Table 1 presents the monthly rates of infections by sex in each of the four CL-reporting institutions. The concentration of the bulk of instances was during the cooler months of November through February, suggesting a definite seasonal pattern. The rates were much higher during December and January (7.04% and 11.26% respectively among females and males) and reached the second peak in February (2.70% and 10.81% respectively). The Phlebotomus sand fly vector showed all the signs of a temperature-sensitive biology during the summer months (June through September) as most of the facilities reported nearly no confirmed cases. The concentration at the Al-Hussein Medical City was less but January and February continued to record the highest number of cases.

Table 1. Percentage of Cutaneous Leishmaniasis (CL) Infection by Sex Per Month in Study Facilities.

Month	Ain Al-Tamr (F / M %)	Al-Hussainiya (F / M %)	Indian Hospital (F / M %)	Al-Hussein Medical City (F / M %)
January	12.82 / 5.13	1.10 / 0.55	0.46 / 0.23	0.88 / 1.21
February	2.70 / 10.81	0.48 / 1.72	0.19 / 0.19	0.93 / 1.39
March	3.12 / 3.12	0.16 / 0.00	0.09 / 0.09	0.16 / 0.16
April	0.00 / 0.00	0.00 / 0.00	0.11 / 0.00	0.00 / 0.00
May	0.00 / 0.00	0.00 / 0.00	0.48 / 0.60	0.00 / 0.06
June	0.00 / 5.45	0.11 / 0.00	0.00 / 0.00	0.00 / 0.16
July	0.00 / 0.00	0.00 / 0.11	0.00 / 0.00	0.00 / 0.04
August	0.00 / 0.00	0.00 / 0.00	0.00 / 0.00	0.06 / 0.13
September	0.00 / 0.00	0.00 / 0.20	0.00 / 0.00	0.04 / 0.00
October	1.75 / 0.00	0.00 / 0.00	0.00 / 0.00	0.13 / 0.00
November	0.00 / 2.17	0.00 / 0.00	0.00 / 0.00	0.16 / 0.04
December	7.04 / 11.26	0.00 / 0.12	0.18 / 0.62	0.18 / 0.26
Total	**27.43 / 37.94**	**1.85 / 2.70**	**1.51 / 1.73**	**2.54 / 3.45**

Note: Values are percentages of female (F) / male (M) infection of the total population screened in each facility.

3.2 Leishmaniasis of the kidney: monthly incidence.

The Children Hospital was the sole tertiary referral center that included pediatrics and was involved in the study and Table 2 is a summary of the cases of VL that were registered there. Among the eight confirmed cases, three-quarters of the females and one-third of the males were infected with VL. No incidences were witnessed in the spring season or during the high season of summer and the instances were distributed within six months. The highest monthly rates were 0.12% males and 0.08% females in February and, respectively. On the basis of these findings, one can conclude that VL is a rather rare disease in Karbala, with children being mostly affected.

Table 2. The rates of sex-based infection monthly with visceral leishmaniasis (VL) at the children hospital.

Month	Female (%)	Male (%)
January	0.05	0.05
February	0.00	0.12
April	0.00	0.05
August	0.08	0.00
September	0.00	0.09

Month	Female (%)	Male (%)
October	0.00	0.06
Total	**0.13**	**0.37**

3.3 Cases of Leishmaniasis by Age

Table 3 presents the age of 178 people with leishmaniasis (CL and VL combined). Among the total number of patients, 62 (34.83 percentage of the total) were children aged 1-10 years. Following young adults (21–30 years old) (n = 32; 17.98%), teenagers (11–20 years old) made up the second biggest group (n = 41; 23.03%). It was the youngest group (people between 51-60 years old; n = 7; 3.93%), with the lowest case frequency, which dropped gradually with age. This inverse age-incidence relationship indicates that younger individuals are more exposed to the vector habitats around the homes and their immunological naivety is underscored by the relation.

Table 3. The Age Dispersal of those persons who are Diagnosed with Leishmaniasis.

Age Group (Years)	Number of Patients	Percentage (%)
1 – 10	62	34.83
11 – 20	41	23.03
21 – 30	32	17.98
31 – 40	21	11.80
41 – 50	15	8.43
51 – 60	7	3.93
Total	**178**	**100.00**

3.4 .The Infection Rates by Counties.

The overall rate of infection in all five research sites is presented in Table 4. Having just 486 patients screened, Ain Al-Tamr Hospital confirmed the presence of 6.584% and 32 cases. This was 15 times more than the highest rated institution, Al-Hussein Medical City, with a rate of 0.428 percent, and approximately 153 times more than the Children's Hospital, with a rate of 0.043 percent. Amongst 62,374 individuals that were screened, 186 cases (or 0.30) were detected to be infectious. Chi-square analysis revealed that this geographical difference in the rate of infection was very statistically significant (chi-square = 702.75; $p < 0.0001$).

Table 4. Leishmaniasis Infection Rates by Study Locations.

Region / Hospital	Examined Population	Infected Cases	Infection Rate (%)
Ain Al-Tamr Hospital	486	32	6.584
Al-Hussein Medical City	23,109	99	0.428
Al-Hindiya Hospital	12,512	31	0.248
Al-Hussainiya Hospital	7,847	16	0.204
Children's Hospital	18,420	8	0.043
Total / Average	**62,374**	**186**	**0.300**

Statistical note: Chi-square test ($p < 0.0001$) results reveal extremely important geographic differences between facilities.

4. Discussion

4.1 Local differences and Ain Al-Tamr Paradox.

The rate of leishmaniasis infection in a single governorate presents a significant geographical variation, which is probably the most unexpected finding of this research. The infection rates in all other facilities were rated significantly lower than the one at the Ain Al-Tamr Hospital (6.584%) ($p < 0.0001$). Real ecological and sociodemographic processes are at play in this remote desert fringe district, and this deviation cannot be attributed only to monitoring artefacts. The main CL vector in Iraq is phlebotomus papatasi; Ain Al-Tamr is found in the west desert fringe of Karbala, along the Euphrates river valley. The habitat is good at breeding as it has sandy soils, rodent holes, and irrigated farmlands (Ready, 2013; Yaghoobi-Ershadi, 2012). The human-vector contact risk is also increased in this district as most of the homes of communities are traditional clay buildings, and they lack proper insect proofing (Al-Warid et al., 2020). Moreover, those in this area who seek health care might be over reporting the actual incidence rate as only the most severe or numerous cases are taken to the hospital. These conclusions are in line with results of other, more remote, dry regions of Iraq. Equally, Hamad and Nadhom (2021), observed that CL rates were greater in rural and agricultural locations in Wasit Governorate, and they explained this variation by the characteristics of the habitats of vectors and home structure. Salim (2023) discovered similar trends in Najaf, another governorate of central Iraq, which has similar geomorphological features to Ain Al-Tamr. These results combined suggest a strong argument against adopting a uniform approach to be used to control vectors nationwide and in favor of carrying out specific campaigns in high risk periphery zones where environmental control and application of residual insecticides would suit better.

4.2 Role of Seasons and Vectors in Biology

It is logical and consistent that the period of maximum CL cases is between December and February. The lowest populations of sand flies in central Iraq are typically observed in the harshest winter months (DecemberFebruary), yet, surprisingly enough, that is also the period in central Iraq when the most cases are reported in the clinical facilities (Khalaf et al., 2020). This appears to be a contradictory observation, which can be attributed to the incubation period of Leishmania. Transmission of CL usually occurs in the fall transmission period (September to November) and it may take 4-12 weeks before the CL lesion will be clinically evident. Therefore, fall-infected patients tend to consult the doctor during the winter (Reithinger et al., 2007). This biological lag should be considered when passive surveillance data is analyzed. Ready (2013) notes that the adult sand flies can survive and feast on blood at very high temperatures, but the adult sand fly survival and blood feeding activity reduces drastically beyond approximately 40 C. This observation is consistent with the well-known thermal threshold of Phlebotomus activity, which is always surpassed in the summer months in Karbala, during the hot and dry summer months (June to August). The secondary slight rise observed in May in certain facilities could be the result of the spring transmission window when the sand flies begin to re-emerge with moderating temperatures (Gonzalez et al., 2010). These seasonal dynamics may have a direct impact on prevention programs. The pre-transmission period is between August and October and should be intensified to make the most of the impact of the vector control efforts i.e. indoor residual spraying (IRS) and the use of bed nets impregnated with insecticide during the pre-transmission period. To prevent the development of ugly chronic lesions, publicity campaigns and active case detection should be the priority between November and the first months of the year as early symptoms are more likely to be noticed at this time.

4.3 The Effect on the Resilience and Health of Kids.

It conforms to the global and regional literature on the epidemiology of leishmaniasis in that children aged 1-10 years represent disproportionately high number of cases (34.83% of all cases). The protection against Leishmania antigens that children develop as a result of subclinical exposure is not yet developed in babies and toddlers (Bates, 2018; Dawit et al., 2013). Due to their behavioral ecology, children at endemic sites have increased likelihood of sleeping outside or close to open doors at night when the sand flies Phlebotomus are the most active, and are less likely to use repellents or other personal protective measures. It is amazing that VL is only concentrated in the Children Hospital. In this region, children younger than five years are more prone to the contraction of visceral leishmaniasis which is predominantly caused by Leishmania donovani or L. infantum. The latter can be explained by the fact that their cell-mediated immunity is weaker in this age group (Al-Khafaji et al., 2022; Collin et al., 2006). Although the cases are few (8; 0.043% of the population of paediatric screening), since the case-fatality rates are high (more than 90% without treatment), even a few undetected or untreated VL cases can be fatal (Desjeux, 2004). On these findings, children below the age of 10 years should be the focus of screening programs in high-risk areas such as Ain Al-Tamr. Introduction of leishmaniasis awareness during children vaccination check-ups and implementation of skin examination programs at schools are some of the implementation avenues.

4.4 Biological Differences and differences depending on gender.

Male predominance in the CL infection rates was slight but constant in most facilities and months. This tendency has been demonstrated not only in two studies in the Middle East and Iraq by Jussim et al. (2024) and Postigo (2010) but also in various other studies. Different theories have been put forward to explain this phenomenon. One of them is that the male population in rural Iraq is more likely to work out of doors during the season of sand flies, thus they are likely to be bitten. Another reason is that men sleep out more frequently because of cultural norms. Finally, men are more likely to consult a doctor in case of skin lesions, particularly on those areas that are exposed to the sun and the wind such as the forearms and face (Mansueto et al., 2014). It is important to mention, though, that in January, female rates (12.82) were more than rates among males at Ain Al-Tamr. This may imply that this male advantage in outdoor exposure is lessened or even inverted in domestic transmission situations where there is a high density of household vectors and women spend more indoors or in the vicinity of house. More qualitative studies about this finding need to be completed by us.

4.5 Limitations

It should be noted that this research has several limitations. The research can have underreported the true prevalence in the community due to a retrospective review of passively-gathered facility data and only those individuals who presented to healthcare facilities. This implies that subclinical/self-limiting cases of CL that were either managed at the primary care level or failed to seek treatment would have been missed. There is a shortage of entomological data (sand fly population and species composition) and environmental variables (land use, temperature, rainfall), so causal inference on the causes of regional and seasonal fluctuation cannot be made. We are not informed about the species of the Leishmania parasites that cause CL and VL in this population since we had not performed molecular species identification. Finally, the cross-sectional design does not allow assessing time trends, reinfection rates, and treatment outcomes.

5. CONCLUSION

The present multi-facility epidemiological image of leishmaniasis in Karbala Governorate is the most detailed so far, and the present study provides such a profile, which is cross-sectional. The statistics give three key insights. First, cases are concentrated in a single area; namely, the Ain Al-Tamr District has an unproportionate and statistically significant high rate of CL infection (6.584%). This increases the district to be of great priority in upgraded health infrastructure, targeted management of vectors and active case identification. Secondly, epidemiological dimension of seasonality must be considered in the planning of preventative interventions and clinical surveillance. The cases were more concentrated during the colder months of December to February which resembles the autumn to winter spread and incubation period. Third, prevention and early detection strategies should target children, who represent the entire number of cases of VL and more than a third of all cases. These results provide useful evidence that the Iraqi Ministry of Health and health authorities in Karbala Governorate can consider to design leishmaniasis management interventions, which are age-specific, season-driven, and risk-stratified. As a further way of curbing this neglected yet preventable disease, future research must integrate entomological surveillance with molecular parasite characterization, environmental evidence collected through satellites and other types of scientific observations.

6. References

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