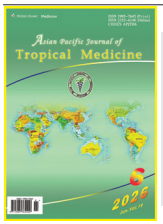

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Epidemiological and clinical features of cutaneous leishmaniasis cases in Jordan from 2013 to 2024

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ABSTRACT

Objective: To investigate the epidemiology, demographic risk factors, spatial distribution, and temporal trends of cutaneous leishmaniasis (CL) in Jordan from 2013 to 2024.

Methods: A retrospective epidemiological study was performed utilizing confirmed CL cases from the Jordanian Ministry of Health. Demographic (age, sex, age group), clinical (lesion location, year and month), and geographic information (district type) were analyzed using GraphPad Prism 9 software. Spearman's rank correlation and *Chi*-square test were used to explore the association between age and lesion locations.

Results: Between 2013 and 2024, a total of 1 281 confirmed cases were documented. Males represented 63.0% of the cases, while rural areas accounted for 80.6% of the burden. The age groups of 6-18 and 19-60 years accounted for the highest overall CL burden. Lesions were primarily found on the head and neck in children (0-18 years) and on limbs in adults (19-60 years). Persistent hotspots were identified in the Azraq district and the Jordan Valley. Seasonal peaks were noted in late autumn and winter, aligning with the sandfly transmission cycle. Significant association was found between younger age and head and neck lesion counts (r=-0.127, P<0.001), while older patients exhibited a greater involvement of limb lesion counts (for upper limbs lesion counts, r=0.134, P<0.001; for lower limbs lesion counts: r=0.066, P=0.019). Pairwise comparisons also indicated significant differences in lesion locations among different age groups (most P<0.01).

Conclusions: CL continues to pose a significant health threat in Jordan, especially in rural and refugee-affected areas. Factors such as underreporting, passive surveillance, and ecological risks contribute to ongoing transmission. A comprehensive national control strategy that includes molecular diagnostics, vector control, refugee health screening, and enhanced surveillance is required for better management of the disease.

KEYWORDS: Cutaneous leishmaniasis; Jordan; Epidemiology

Summary

Question: What are the epidemiological patterns and risk factors of cutaneous leishmaniasis (CL) in Jordan?

Findings: Analysis of 1 281 cases from 2013 to 2024 indicated a higher incidence among males and rural populations, with peaks occurring in the autumn and winter seasons. Adolescents and adults were the most affected demographics. An increase in lesion counts in the head and neck region was linked to younger patients, while lesions in the upper and lower limbs were more commonly seen in older individuals. The findings suggest that individuals living in rural areas are at a greater risk of developing CL than their urban counterparts.

Meaning: To mitigate transmission of CL, enhanced surveillance, vector control, and targeted interventions are crucial.

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1. Introduction

Leishmaniasis is a parasitic illness caused by the *Leishmania* (*L.*) *protozoan*, transmitted through the bite of infected female sandflies[1]. This disease is prevalent in tropical and subtropical areas around the globe and represents a significant public health challenge in nations with limited resources and insufficient healthcare systems[2,3]. Approximately 12 million individuals are affected by leishmaniasis worldwide, with over 350 million people at risk of infection across 100 different countries[4]. Additionally, there are 2 million new cases diagnosed each year, resulting in more than 60000 deaths, primarily among children[4]. Leishmaniasis manifests in various forms, each characterized by unique symptoms and levels of severity. The three primary forms include cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis, and visceral leishmaniasis[5]. CL is the most prevalent and least lethal variant of the disease, caused by *L. major*, *L. tropica*, *L. braziliensis*, *L. mexicana*, *L. guyanensis*, *L. aethiopica*, *L. panamensis*, *L. peruviana*, and *L. amazonensis*[6]. More than 70% of CL cases are reported from just five countries: Brazil, Colombia, Algeria, Afghanistan, and Syria[7]. CL is the mildest form of the disease, with symptoms primarily consisting of skin lesions and swollen lymph nodes. Mucocutaneous leishmaniasis impacts the mucous membranes of the mouth, nose, and throat, typically resulting in sores and bleeding[8]. This form is primarily caused by *L. braziliensis* and *L. panamensis*[8]. Visceral leishmaniasis occurs when the parasite infiltrates internal organs such as the liver, spleen, and bone marrow[9]. *L. donovani* and *L. infantum* are recognized as the causative agents of this type of leishmaniasis[9]. This form usually presents weeks after infection with symptoms including weight loss, fever, anemia, enlarged liver, and lymphadenopathy; it can be fatal if left untreated[9]. Over 90% of visceral cases are reported in five countries: Brazil, Bangladesh, India, Ethiopia, and Sudan[10].

In Jordan, leishmaniasis is prevalent in various areas, with occasional outbreaks occurring over the years[11]. The country's varied ecological environment, marked by arid zones and a Mediterranean climate, offers ideal breeding habitats for sandflies, which aids in the ongoing transmission of leishmaniasis. Research has underscored the significance of environmental elements, such as temperature, humidity, and land utilization, in influencing the distribution and dynamics of leishmaniasis transmission within the region[11,12]. Despite initiatives aimed at controlling the disease through vector management and improving access to treatment, challenges remain in effectively addressing leishmaniasis in Jordan[12]. Insufficient surveillance systems and the underreporting of cases impede the capacity to evaluate the actual impact of the disease and to carry out focused interventions. Additionally, socio-economic issues, including poverty, displacement, and poor housing conditions, heighten the risk of leishmaniasis transmission, especially among vulnerable populations.

In this study, we examined the records from the Jordanian Ministry of Health to explore the epidemiology of CL in Jordan over the last 12 years (2013-2024). Our aim was to identify temporal trends, geographical distribution, demographic factors, and the seasonality of CL cases. Additionally, we recorded the sites and locations of CL cases in patients and assessed their relationship with demographic characteristics of the cohort.

2. Methods

2.1. Study design and setting

This retrospective descriptive epidemiological study was carried out on a national scale, encompassing all documented instances of CL in Jordan from January 2013 to December 2024. Information was obtained from the leishmaniasis surveillance system managed by the Department of Communicable Diseases of the Ministry of Health, Jordan. This system encompasses all health directorates and sentinel sites throughout the nation, facilitating thorough national case documentation. The analysis included both Jordanian citizens and non-Jordanian residents. Jordan is administratively segmented into 12 governorates, each containing several districts, which were utilized as the spatial units for analysis in this research.

CL cases were categorized based on the definition provided by the World Health Organization (WHO) for CL. A confirmed case is identified as a person showing compatible clinical symptoms along with parasitological evidence of infection, which can be established through a positive smear or culture for *Leishmania* parasites obtained from a skin lesion. Only those confirmed cases that fulfilled these criteria were incorporated into the final analysis. Cases that were imported and diagnosed in non-residents were excluded if their travel history suggested that the infection was acquired outside of Jordan.

2.2. Data collection and analysis

The data of the cohort included demographic, clinical, and epidemiological variables sourced from surveillance records: age, sex, nationality, occupation, address, reporting site, month and year of report, and anatomical site of lesion. The address field was standardized to the district level and classified as urban or rural according to the administrative boundaries set by the Jordan

Department of Statistics. All records were entered into Microsoft Excel and subsequently analyzed with GraphPad Prism 9.

The association between age and lesion counts was examined using Spearman's rank correlation coefficient and *Chi*-square (χ^2) test. A *P*-value of less than 0.05 was deemed statistically significant.

3. Results

3.1. Demographic characteristics

This study included a total of 1 281 patients diagnosed with CL. The largest group consisted of Jordanians (59.6%), followed by Syrian refugees (35.9%), with a minor percentage from other nationalities (4.5%). Males were significantly more affected, comprising 63.0% of the cases, in contrast to females, who made up 37.0%. The median age of the patients was 15 years (IQR: 7-32 years) indicating a higher prevalence among younger individuals. The highest percentage of cases was observed in the age groups of 6–18 years (38.1%, *n*=488) and 19-60 years (37.9%, *n*=486). Children aged 0–5 years represented 19.8% (*n*=254) of the cases, while only 4.1% (*n*=53) were found in patients aged >61 years (Figure 1).

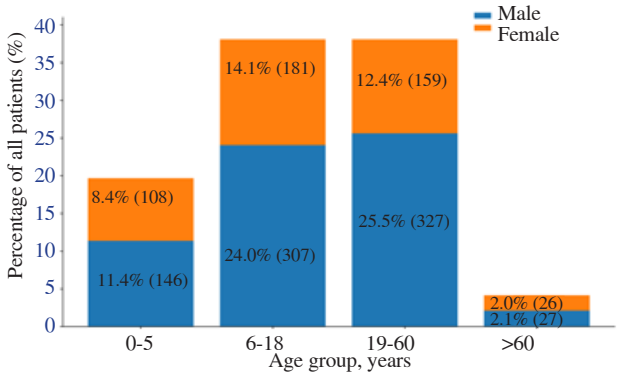

Figure 1. Distribution of cutaneous leishmaniasis cases classified by age group and sex.

Upon analysis by age group, males consistently outnumbered females in every category. The male-to-female ratio was most pronounced in the 6–18 and 19–60 years age groups, indicating a higher level of exposure or vulnerability among males. Conversely, the >60 years age group exhibited the lowest total case numbers for both males and females, as shown in Figure 1.

A total of 1 032 (80.6%) of the cases were recorded from rural districts, while 249 (19.4%) were reported from urban districts. In terms of occupation, the majority of instances were found among unemployed individuals (542/1 281, 42.3%), followed by those in the education sector (393/1 281, 30.7%). There were 198 examples (198/1 281, 15.5%) of children who were not eligible for work. There were 77 instances (77/1 281, 6.0%) of manual laborers, and 37 cases (37/1 281, 2.9%) of armed forces members. There were 16 cases (16/1 281, 1.2%) of public sector workers, and 12 cases (12/1 281, 0.9%) of transport workers and those in other jobs. Professionals made up the smallest group of workers, with only 6 cases (6/1 281, 0.5%).

3.2. Spatial and temporal distribution of CL cases

The number of cases showed seasonal clustering, with notable peaks occurring in early 2016 and again in late 2017 to 2018. Most cases were identified during the autumn and winter months, aligning with the epidemiological cycle of sandfly transmission. This pattern suggests repeated outbreaks, potentially influenced by environmental factors and vector behavior. Across the years of the surveillance period, the national annual incidence of CL fluctuated substantially. It peaked at 2.368 per 100 000 people in 2016 and reached its lowest level in 2019 (0.206 per 100 000 people). Although incidence declined substantially after 2018, a gradual increase was observed from 2019 onwards, culminating in a marked rise in 2023 and 2024. Figure 2.

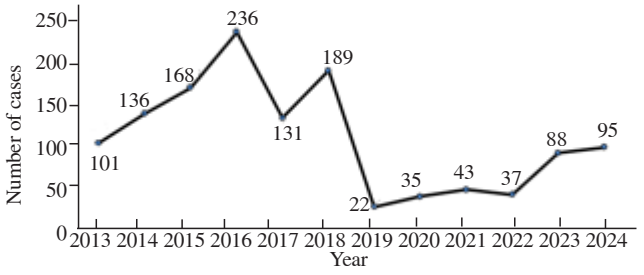

Figure 2. The annual distribution of cases from 2013 to 2024.

The Azraq district has recorded the highest incidence of cases, establishing it as the main hotspot for transmission. Other districts with significant burdens included Southern Shouneh, Tafileh, and Amman. In contrast, districts like Madaba, Jerash, and Northern Shouneh reported only occasional cases (Figure 3). These findings underscore the regional variability, with endemic concentrations found in rural desert-edge regions. These results align with established endemic regions that are defined by semi-arid climates and elevated vector populations.

A significant proportion of patients lived in rural areas, while just 19.4% were located in urban settings. In rural cases, there were more males (62.6%, 646/1 032) than females (37.4%, 386/1 032). This trend was mirrored in urban regions, where males (65.9%, 164/249) also exceeded females (34.1%, 85/249), as illustrated in Figure 4. This highlights the impact of environmental exposure in rural populations, where interaction with the sandfly vector is more probable.

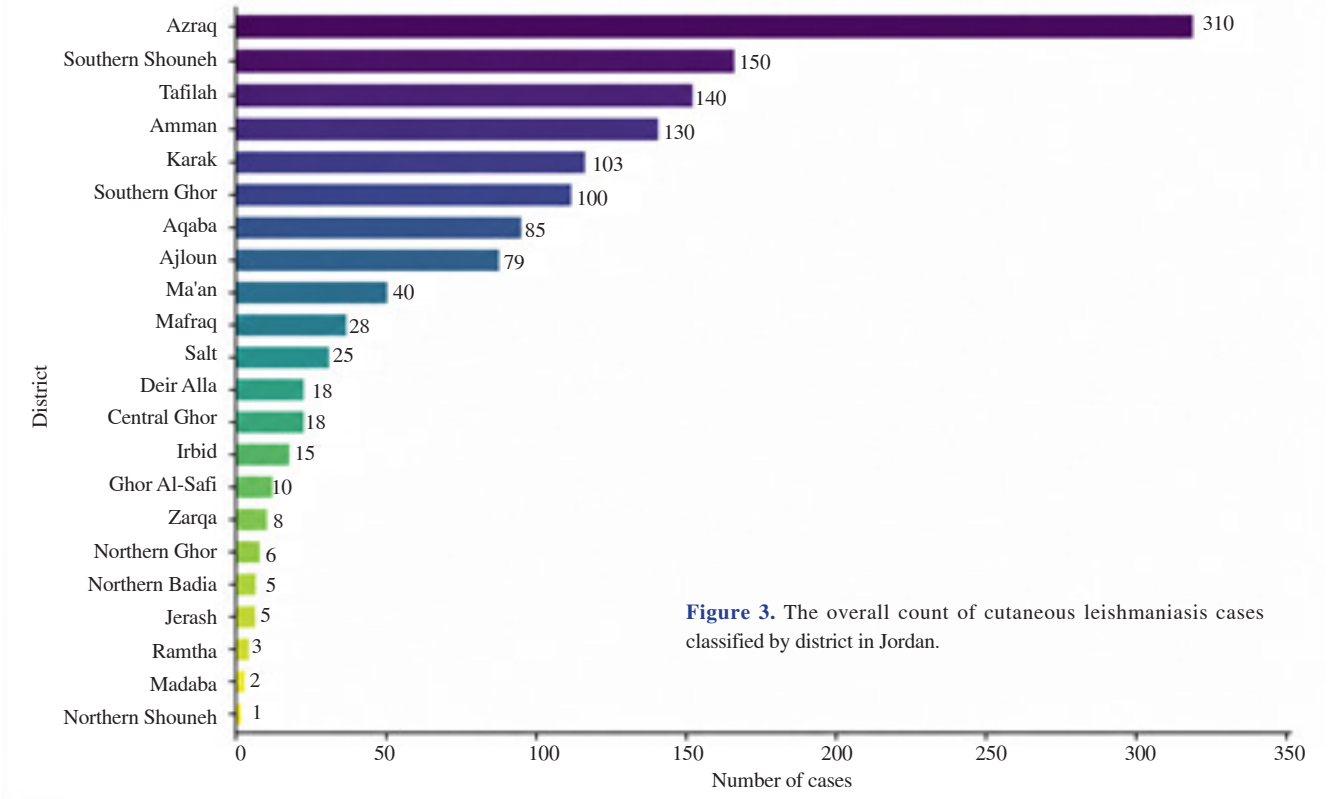

Figure 3. The overall count of cutaneous leishmaniasis cases classified by district in Jordan.

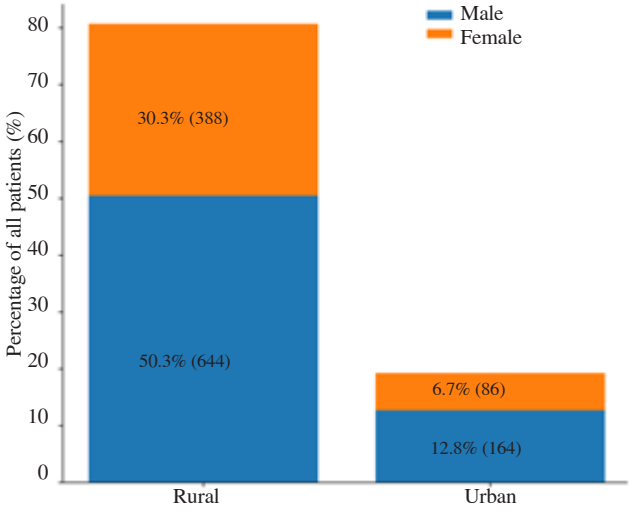

Figure 4. The stacked bar chart depicts the number of patients from both rural and urban areas, classified by sex.

3.3. CL lesion site analysis

A total of 2528 lesions were recorded in total. The most prevalent sites for lesions were the upper limbs, accounting for 32.9% (831/2528), especially among adults (age group of 19-60 years), which indicates a higher exposure of unprotected skin. The head and neck were the second most affected site (n=798/2528, 31.6%), followed by the lower limbs (n=673/2528, 26.6%), whereas the trunk had the lowest incidence (n=226/2528, 8.9%). Male patients demonstrated a marginally higher frequency of lesions across all anatomical regions.

Throughout age groups of 0-5 and 6-18 years, lesions were predominantly found on the head and neck, followed by the upper and lower limbs, while the trunk was the least affected area, as demonstrated in Figure 5. Whereas age groups of 19-60 and >60 years showed the most lesions in the upper limbs.

The age groups of 6-18 and 19-60 years accounted for the highest overall burden. The pairwise comparisons indicated that most differences among age groups (0-5, 6-18, 19-60, and >60) across various lesion locations (head and neck, trunk, upper limbs, and lower limbs) were statistically significant (P<0.01). However, there were a few comparisons that did not have statistical significance (P= 0.94, 0.57, 0.34, 0.32, 0.05) (data not shown).

A significant association was found between younger age and head and neck lesion counts (r=-0.127, P<0.001), while older patients exhibited a greater involvement of limb lesion counts (for upper limbs lesion counts, r=0.134, P<0.001; for lower limbs lesion counts: r=0.066, P=0.019). The analysis of lesion site distribution over the months revealed significant temporal and spatial trends, as illustrated in Figure 6. Throughout the majority of the months, the head and neck region exhibited the highest frequency of occurrences, followed by the upper limbs. Conversely, the trunk region recorded the lowest lesion frequency. Seasonal variations were noted, with an increase in cases during January and October, which represent the early and

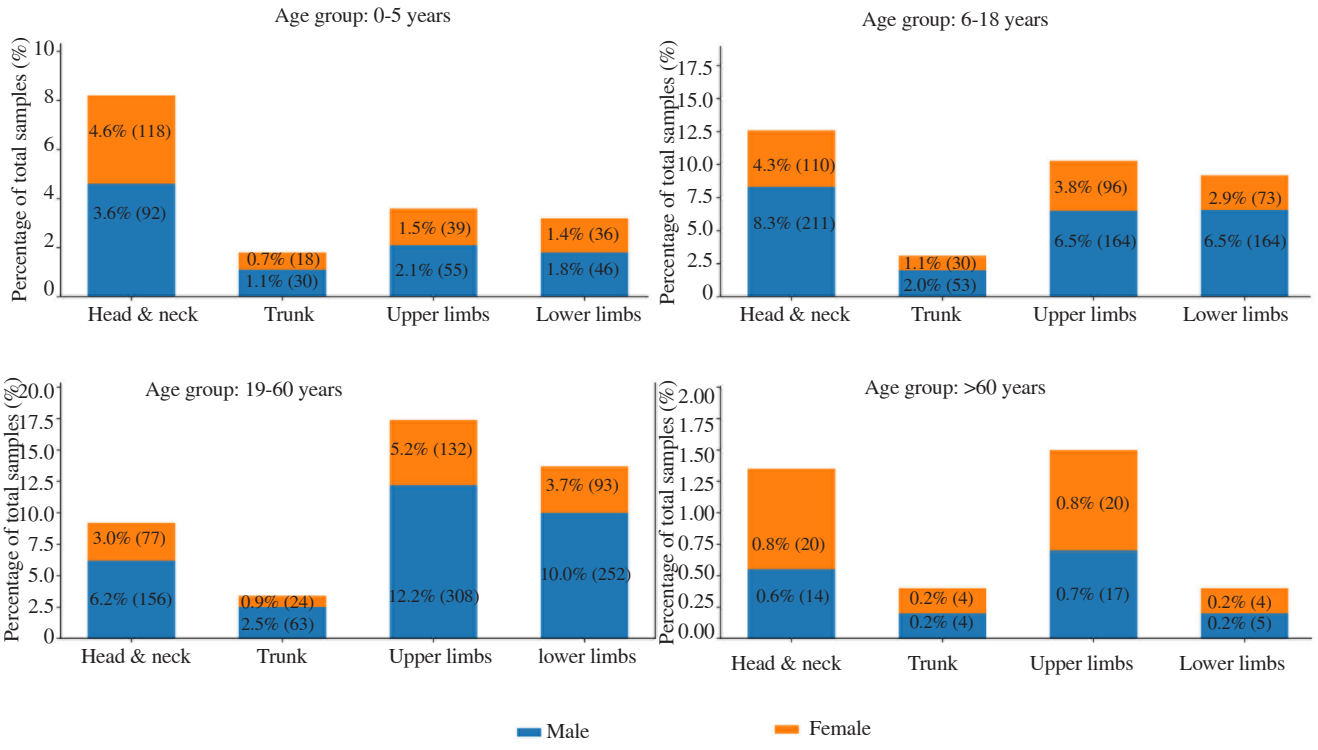

Figure 5. The distribution of lesions classified by location, sex, and age group among patients with confirmed lesions. Patients may present with lesions at multiple anatomical sites; therefore, lesion totals (n=2528) exceed the number of patients. *Chi*-square test showed significant difference among age groups (0-5, 6-18, 19-60, and >60 years) across various lesion counts (head and neck, trunk, upper limbs, and lower limbs) (P<0.01).

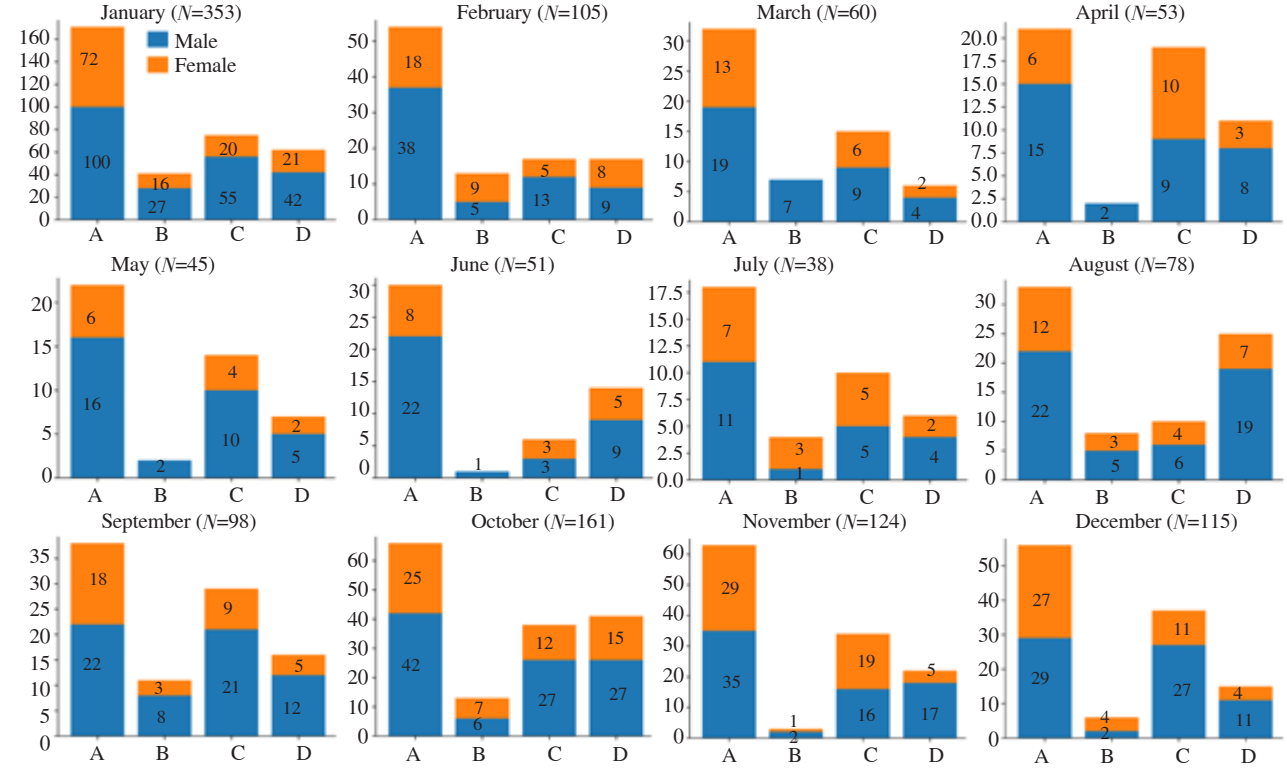

Figure 6. Monthly distribution of cases categorized by lesion location and sex. A: Head & neck lesions; B: Trunk lesions; C: Upper limbs lesions; D: Lower limbs lesions.

late months of the year, respectively. In contrast, the mid-year period experienced a decline in case numbers. When examining the data by sex, it was observed that men constituted a greater proportion of cases across most anatomical sites and time frames. Nevertheless, the overall distribution pattern of lesion locations remained consistent for both sexes. These findings indicate that lesions may evolve over time and can also exhibit higher prevalence in certain locations.

4. Discussion

Each year, Jordan reports around 200-300 cases of CL; however, this figure is likely an underrepresentation due to instances of under-reporting. The incidence rate saw an increase from 2013 to 2016, which coincided with the arrival of Syrian refugees[12]. In this retrospective examination of CL data sourced from the Jordan Ministry of Health, spanning the years 2013 to 2024, we report that the total number of documented cases of CL reached 1 281. Among these cases, a significant majority were males, comprising 63.0% of the total. Additionally, the incidence rates for the age brackets of 6-18 years and 19-60 years were markedly higher in comparison to those for children aged 0-5 years and adults aged >60 years. It was reported, in most Middle Eastern and Central Asian studies, young males are more frequently affected[13-16]. Rural regions were disproportionately impacted in comparison to urban areas, accounting for 80.6% of the cases. A study that concentrated on the ecology of the sand fly species, *Phlebotomus* (*Ph.*) *papatasi*, which primarily resides in the warmer climates of the Middle East, North Africa, and the Mediterranean, determined that the distribution of this sand fly is influenced by factors such as low terrain, vegetation cover, gentle slopes, and a warm annual mean temperature[17]. Although our investigation does not specifically focus on the endemic vector, the ecological insights regarding *Ph. papatasi* are consistent with the demographic data of the district region analyzed in this study.

The geographical spread of cases analyzed in the current study indicates notable regional variations, with the Azraq district showing the highest rates of incidence, followed in order by Southern Shouneh, Tafilah, and Amman. While districts with a desert climate are acknowledged as endemic zones for the disease, those with non-desert climates have also documented a significant number of cases[18]. This finding suggests that the proximity of these districts to endemic regions may increase the transmission of the disease, possibly aided by sandflies or human activities.

A significant hotspot was recognized in the Azraq district, which aligns with the Syrian Refugee Camps, where numerous displaced Syrians have taken residence and several individuals were diagnosed with CL. Furthermore, a substantial number of refugees from Azraq and other camps were engaged in seasonal work within the agricultural sector of the Jordan Valley, resulting in extended outdoor exposure and heightened susceptibility to sandfly bites. While the majority of cases were validated in Jordan, the infections likely indicate a combination of previous exposure during displacement and persistent occupational hazards within host communities.

Temporal trends revealed notable peaks in early 2016, late 2017, and throughout 2018 when juxtaposed with other years within the examined timeframe. These time periods correspond with the influx of Syrian refugees. A retrospective analysis spanning 2010-2016 in Jordan (1 243 reported cases) indicated that the average annual incidence increased from approximately 1.70 per 100 000 (2010-2013) to around 3.00 per 100 000 (2014-2016)[12]. Notably, 37% of CL cases were found in individuals aged 5-14 years, with children under 15 years exhibiting a higher incidence than older demographics. Other studies indicated that among Syrian refugee cases (n=558), 514 (92.1%) were categorized as imported infections (i.e., infections contracted prior to arrival in Jordan), while only a minor fraction (~2.5%) were acquired locally[19,20]. This suggests that the influx of infected refugees may have exacerbated incidence rates in the surrounding area due to anthroponosis. The majority of the cases identified in this study were found to occur predominantly during the autumn and winter months within the examined timeframe. The peak incidence in January observed in this study mirrors the seasonal cycle of CL across the Middle East, where *Phlebotomus* sandfly activity peaks during the summer months (June–September) and lesions appear after an incubation period of approximately 2–4 months, leading to clinical manifestation in late autumn and winter[17-19]. Similar winter peaks have been documented in Syria, Iraq, Saudi Arabia, and North Africa, reflecting the lag between transmission and symptomatic presentation[17-21]. Additionally, the increase in winter case reporting may correspond to greater healthcare-seeking behavior during cooler months, when lesions become more apparent or symptomatic[17]. These findings emphasize that vector-control measures should be intensified in early summer—prior to peak sandfly activity—to reduce the subsequent winter burden of disease. In contrast to our findings, a previous investigation concerning *Ph. papatasi* indicated that peak activity was observed in August, followed by September, as illustrated in a seasonal distribution map[21]. However, two plausible explanations may clarify the differences between these results. Firstly, there could be a lag in the reporting and identification of the disease until lesions become apparent, which may take weeks or even months following the sandfly bite and subsequent disease transmission. Secondly, the observed sandfly activity during the colder months may suggest that these insects migrate to warmer microhabitats within the districts, particularly human residences, especially if substandard housing conditions allow for their entry. This hypothesis

is supported by a study conducted in Ethiopia on the female *Ph. longipes*, which revealed a significant relationship between the activity of this sandfly and seasonal fluctuations, with the majority of outdoor activity occurring in the dry season, while most captures during the wet season took place indoors[22]. Although *Ph. longipes* is found in Ethiopia, this behavioral trend can be noted across a wider array of vectors that adjust to seasonal changes to fulfill their requirements[23].

A significant finding of this study pertains to the distribution of lesion sites across three demographic categories: age, sex, and types of districts. In general, the upper limbs exhibited the highest incidence of lesions, while the head and neck regions were the most frequently affected sites among children and adolescents in the age brackets of (0-5 years) and (6-18 years). Notably, the younger group displayed a more balanced male-to-female ratio, indicating a lesser degree of protection for these vulnerable anatomical areas for both sexes. This observation is corroborated by additional analysis, which demonstrated that the likelihood of the correlation by age and head and neck regions occurring by mere chance is considerably low. The incidence rates of lesions in the head and neck regions diminish within the adult age groups, particularly among female patients, which align with the increased coverage of these areas. Conversely, there is a marked rise in limb lesion sites as the age groups increase from 0-5 years to 19-60 years, especially among male patients. This trend may suggest greater exposure of the limbs due to occupational activities, particularly in rural districts engaged in agricultural and pastoral work, resulting in heightened vulnerability to sandfly bites. The trunk region is notably the least affected site across all age groups, indicating that this area is predominantly covered, thereby reducing the likelihood of bites, although it is not entirely immune. For patients aged >60 years, there is a low overall incidence rate and fewer lesion sites; however, the head and neck and upper limbs remain the two most prevalent lesion sites for both sex, consistent with the overall distribution of lesions. Furthermore, additional correlation analysis revealed a strong relationship between district types—rural and urban—, the number of samples, and distribution of lesions across the body. This finding implies that individuals residing in rural areas, who engage in both occupational and recreational activities, are subjected to continuous exposure of their limb areas, leading to an increase in the number of lesions and their spread across multiple sites. Together, our data show that in Jordan (where *L. major* and *L. tropica* are the main species), CL lesions are most commonly on exposed body parts, especially the limbs and the face. This pattern is broadly consistent with studies from other Middle Eastern and Central Asian countries; where exposed sites (hands, feet, arms, face) are more frequent[14,24-31]. Percentages vary between studies, but lesions on hands and feet are the most predominant lesions. Facial lesions were frequently prevalent among children.

Several studies show species differences matter such as *L. tropica* infections are relatively more likely to involve the face, nose and ears, while *L. major* often produces multiple lesions on the limbs[32-34]. New-World CL also typically affects exposed sites but has regional variation in exact site distribution and number of lesions[35].

Despite CL being a recognized illness, official case numbers significantly understate the true incidence. Surveillance is primarily based on passive case detection, meaning cases are only reported when patients seek treatment at a health center. A 2008 study found that active case-finding in the Mid-Jordan Valley identified up to 47 times more cases than official passive reporting had indicated in the early 2000s[36]. Poor compliance with full treatment courses, especially in rural areas, is another challenge. The arrival of Syrian refugees in Jordan has resulted in a rise in cases of CL and the possible introduction of new strains of parasites from Syria. This phenomenon was especially observed in refugee camps, such as Al-Azraq refugee camp in Zarqa, where the environment is conducive to the transmission of sandflies[19].

CL remains a persistent and evolving public health challenge in Jordan, shaped by the interaction of environmental, demographic, and geopolitical factors[37]. Our findings, consistent with earlier studies, indicate a marked rise in CL incidence since 2013, which temporally coincided with the influx of Syrian refugees. While CL is endemic in Jordan, population displacement and the conditions within refugee settings have altered transmission dynamics, increased population vulnerability, and contributed to localized surges in incidence. The introduction of infections from highly endemic regions, particularly those associated with anthroponotic *L. tropica*, further complicates control efforts by sustaining transmission cycles in densely populated and resource-limited environments[36]. Despite CL being a notifiable disease with free treatment available through the national health system, current surveillance relies heavily on passive reporting. This approach likely underestimates the true burden of disease, particularly in high-risk regions such as the Jordan Valley. Limited active case detection and the absence of systematic field surveillance constrain the ability to identify transmission foci and respond effectively. While Jordan has established a functional framework for case reporting and treatment, these measures remain primarily reactive and insufficient for long-term disease control[37].

The epidemiological patterns observed in this study underscore the importance of environmental and behavioral determinants. Rural populations, agricultural workers, and individuals residing in suboptimal housing conditions face disproportionately higher risks. Exposure is strongly linked to outdoor activities during peak sandfly activity periods (dusk to dawn), as well as to peri-domestic environmental factors such as poor waste management, proximity to animal shelters, and structural housing deficiencies.

Additionally, inconsistent use of personal protective measures, often driven by gaps in awareness rather than solely economic limitations, contributes to sustained transmission. These findings highlight critical gaps in current prevention strategies, particularly the reliance on generalized awareness campaigns that fail to address context-specific behaviors. Effective control of CL requires a transition from broad messaging to targeted, evidence-based behavioral interventions tailored to local practices and risk profiles. Such approaches should be integrated within a broader One Health framework that recognizes the interconnected roles of human behavior, environmental conditions, and potential animal reservoirs. From a policy perspective, several priorities emerge. First, strengthening surveillance systems is essential. This includes expanding active case detection in endemic and high-risk areas, integrating community-based reporting mechanisms, and improving data quality and timeliness. Incorporating geospatial analysis into surveillance could further enhance the identification of transmission hotspots and guide targeted interventions. Second, vector control strategies should be intensified and made more proactive. Current efforts, which largely focus on reactive measures, need to be complemented by sustained environmental management, targeted insecticide application, and seasonal interventions timed to precede peak sandfly activity. Collaboration with local municipalities is critical to address environmental risk factors at the community level. Third, refugee health policies must be more closely integrated into national CL control strategies. This includes systematic screening, improved living conditions in camps, access to preventive tools such as insecticide-treated materials, and health education programs tailored to displaced populations. Given the role of population movement in shaping disease dynamics, coordinated regional approaches may also be necessary. Fourth, enhancing community engagement and behavioral interventions is crucial. Public health campaigns should move beyond generic recommendations and instead provide practical, culturally appropriate guidance on reducing exposure, such as the correct use of repellents, protective clothing, and environmental modifications within households. Finally, there is a critical need to incorporate structured clinical monitoring and outcome evaluation into national programs. Current systems focus primarily on case detection, with limited data on treatment outcomes, relapse, reinfection, and long-term complications. Integrating these indicators into surveillance frameworks would provide a more comprehensive understanding of disease burden and support evidence-based improvements in clinical management. Monitoring psychosocial and economic impacts, including scarring and reduced productivity, would further inform policy and resource allocation.

This study has several limitations that should be considered when interpreting the findings. First, the analysis relies on retrospectively collected data from the national surveillance system, which is primarily based on passive case detection. As a result, the true burden of CL is likely underestimated due to underreporting, particularly in rural and underserved regions where access to healthcare may be limited. Second, the dataset is dependent on the accuracy and completeness of records from the Ministry of Health. Missing or incomplete data on variables such as lesion characteristics, exposure history, and treatment outcomes may have introduced information bias and limited the depth of analysis. Third, the study did not include entomological or molecular data. The absence of vector surveillance and parasite typing restricts the ability to directly link epidemiological patterns to specific sandfly species or *Leishmania* strains. Fourth, the impact of population movement—particularly among Syrian refugees—could not be fully distinguished between imported and locally acquired infections, limiting causal inference regarding transmission dynamics. Finally, behavioral and environmental risk factors were inferred from demographic and geographic patterns rather than directly measured, which may limit the strength of conclusions regarding exposure pathways. Despite these limitations, this study provides valuable long-term epidemiological insights into CL trends in Jordan and highlights key areas for future research and public health intervention. In conclusion, CL control in Jordan requires a shift from reactive case management toward a comprehensive, integrated strategy that combines strengthened surveillance, proactive vector control, targeted behavioral interventions, refugee health integration, and systematic clinical monitoring. Addressing these interconnected factors is essential for reducing transmission, improving patient outcomes, and achieving sustainable disease control in the long term.

Conflict of interest statement

The authors declare no conflicts of interest.

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Authors' contributions

Sudi Maiteh: data collection and analysis, as well as manuscript writing and editing; Esra'a Al-Zoubi: data analysis, manuscript writing, and editing; Mira AlQousi: data analysis, manuscript writing, and editing; Yousef Khader: manuscript writing and editing; Khaldon Bodoor: conceptualization, data analysis, and manuscript writing and editing; Firas Qarqaz: conceptualization, data analysis, and manuscript writing and editing.

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