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High seroprevalence and associated risk factors of visceral leishmaniasis in the Léré Health District, Chad

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Abstract

Visceral leishmaniasis (VL) is a major neglected tropical disease in Chad, particularly in the Léré Health District, where epidemiological data remain scarce. This study aimed to determine the seroprevalence of VL among symptomatic patients and to identify associated sociodemographic, behavioral, and environmental risk factors. A cross-sectional study was conducted from July to October 2022 among patients presenting symptoms suggestive of VL. After obtaining informed consent, participants completed a structured questionnaire capturing demographic, environmental, and behavioral characteristics. Blood samples were collected and analyzed using a rapid diagnostic test (RDT) for VL. Data analysis was performed using XLSTAT software. Among the 303 patients, the seroprevalence of VL was 37.62%. Women represented 55% of participants, and children aged 0-14 years constituted the most affected age group (38.28%). Significant associations were observed between VL positivity and rural residence, low education level, limited knowledge about VL, proximity to forested areas, presence of domestic animals, particularly dogs, and inadequate vector-control practices. VL remains a major public health concern in the Léré district. Transmission is driven by a combination of environmental factors, socio-economic vulnerability, and the presence of zoonotic reservoirs. Urgent action is required to strengthen disease surveillance, expand access to reliable diagnostic services, enhance community awareness, and implement integrated One Health interventions to reduce transmission and protect vulnerable populations.

Introduction

Leishmaniasis is a parasitic disease caused by several protozoan species belonging to the genus Leishmania. It affects a wide range of mammalian hosts, including humans. [1] The disease is transmitted through the bite of infected blood-feeding dipterans of the family Psychodidae, specifically sand flies of the genus Phlebotomus in the Old World and Lutzomyia in the New World. [2] There are four main forms of the disease: visceral leishmaniasis (VL; also known as kala-azar); post-kala-azar dermal leishmaniasis; cutaneous leishmaniasis; and mucocutaneous leishmaniasis. Cutaneous leishmaniasis is the most common form, but VL is the most severe, as it is almost always fatal if left untreated. [3]

This parasitic disease is spreading globally. It is endemic in 98 countries and has spread widely to the temperate zones of Southern Europe, North Africa, Asia, and the Americas. [1] In 2020, 208,357 new cases of cutaneous leishmaniasis and 12,838 new cases of VL were reported to the World Health Organization (WHO). [3] According to the WHO, the burden of disease caused by leishmaniasis remains poorly

understood, mainly because those most affected live in remote areas and rarely seek medical care. [4] In Chad, knowledge about leishmaniasis is poorly documented in the literature, yet a significant portion of the population suffers from it. [5, 6] Between 1976 and 2015, approximately 1,974 cases of all forms of leishmaniasis were reported by Chadian health facilities. [5, 7] In the Léré Health District in south-western Chad, the lack of a state-run program to treat VL is believed to be a key factor contributing to its increased prevalence. This study, therefore, aimed to determine the seroprevalence and identify the associated risk factors for VL in the Léré Health District to provide crucial data for informing effective public health interventions and drawing government attention to the need for an established disease control program.

Materials and Methods

Study design, sampling, and data collection

A cross-sectional study was conducted in the Léré Health District (Chad) between July and October 2022. All patients exhibiting symptoms suggestive of VL (e.g., prolonged fever, splenomegaly, weight loss) who presented at the district hospital laboratory were invited to participate in the investigation. Prior to inclusion, individual interviews were conducted to inform subjects about the study's purpose and procedures, a prerequisite for obtaining their informed consent.

Individuals who provided informed consent were asked to complete a questionnaire developed specifically for this research. The questionnaire collected data on sociodemographic characteristics, knowledge of the disease, and behavioral and environmental risk factors.

Laboratory analysis and data analysis

Blood samples were taken from consenting participants and analyzed using a rapid diagnostic test (RDT) for VL. The test used was the Leishmania IgG/IgM Rapid Test Cassette (Alltest Biotech Co., Ltd, China), an immunochromatographic assay for the qualitative detection of specific IgG and IgM antibodies against Leishmania spp. antigens. The procedure was performed according to the manufacturer's instructions using whole blood, with results read after 15 minutes. A positive result was indicated by the appearance of a colored band at both the control (C) and test (T) lines. This type of rapid test is a practical and widely used tool for the serological screening of VL in field conditions.

The seroprevalence of VL, along with sociodemographic and environmental variables, was analyzed. Correlation analyses were performed using chi-square tests. All statistical analyses were conducted using XLSTAT software, with a significance level set at $p<0.05$.

Results

A total of 303 symptomatic patients were included in this study. The overall seroprevalence of VL, as determined by the RDT, was 37.62%.

The demographic characteristics of the study population are presented in Table 1. Women constituted the majority of participants (55%). The most represented age group was 0-14 years, accounting for 38.3% of the cohort.

The distribution of patients according to their serological status is shown in Figure 1. Significant associations were observed between VL seropositivity and several sociodemographic, knowledge-based, and environmental risk factors.

The relationship between VL and sociodemographic parameters is detailed in Table 2. Seropositivity was significantly associated with rural residence ($p<0.0001$) and a lower level of education ($p=0.038$).

As shown in Table 3, patients with no knowledge about the disease had a significantly higher risk of being seropositive ($p=0.003$).

Finally, Table 4 presents the significant environmental risk factors associated with VL, including animal ownership, waste disposal practices, the use of protective measures, and proximity to forested areas (all $p<0.05$).

Discussion

Leishmaniasis is currently classified by the WHO as one of the most neglected tropical diseases worldwide, with a significant epidemiological burden, particularly in East Africa and India. [7] In Chad, recent outbreaks of the disease have been reported by the WHO, highlighting the urgency of local studies to better understand transmission dynamics and risk factors. [8] Our study, conducted to determine

seroprevalence and gather information on sociodemographic, environmental, and biological parameters associated with VL in the Léré district, involved 303 patients.

Women accounted for 55% of the sample, contrasting with reports of male predominance in the literature. [9] This observation may be explained by women's greater exposure to sand fly bites, as their domestic and agricultural activities often keep them in high-risk environments for longer periods, particularly at dusk. Previous studies on gender roles and exposure to vectors of neglected diseases have frequently highlighted these differences in exposure patterns.

A large proportion of the patients were children aged 0-14 years. This finding is consistent with studies conducted in Tunisia by Aoun et al. 10 (2009) and Algeria by Fendri et al. 11 (2012), which also identified children as a high-risk population for VL. Their vulnerability is mainly explained by an immature immune system, making them more susceptible to parasitic infections, as well as behaviors that increase their exposure to sand flies. The higher frequency of visits to health centers for other conditions, such as malaria, as observed during our study, may also contribute to more frequent detection of VL cases in this age group.

The majority of patients (61%) came from rural areas. This finding is consistent with the typically rural localization of VL endemic areas in sub-Saharan Africa. [7] It is explained not only by the lack of well-equipped health centers in these regions, forcing patients to travel to cities for diagnosis and treatment, but also by environmental conditions more conducive to the spread of vectors.

Almost half of the patients (47.19%) were illiterate, and most (62.70%) were unemployed. These data reflect the socio-economic challenges in Chad and underscore the importance of social determinants of health in the transmission of leishmaniasis. A low level of education is often associated with less knowledge about transmission modes and preventive measures, as well as poorer housing and hygiene conditions. [12] Unemployment and precariousness can limit access to protective means and delay seeking care, worsening the disease prognosis. [13]

The frequency of patients positive for leishmaniasis (seroprevalence) was 37.62%, a figure slightly higher than the 30% found by Kodindo et al. (2021) in a previous retrospective study in the same city. [14] This increase suggests a possible expansion or intensification of leishmaniasis transmission in Léré. However, it is crucial to note that this figure might be an underestimate of the true prevalence in the population, as only symptomatic patients who consulted the hospital and were tested were included in this study; asymptomatic or undiagnosed cases were not accounted for.

The study showed that living in a rural area significantly increased the risk of having VL ($p<0.0001$). This result is well supported by the literature. Rural areas are often characterized by poor waste management, traditional housing, and proximity to domestic animals, which offer ideal resting and breeding sites for sand flies. [15]

A low education level was also linked to a high risk of contracting the disease. This risk factor is directly related to individuals' capacity to access information and understand the risks associated with sand fly bites. Lack of knowledge about VL, as highlighted in the study, increases the risk, arguing for an urgent need for population awareness-raising by the Léré Health District. Studies on knowledge, attitudes, and practices have demonstrated that improving health education is essential for controlling vector-borne diseases. [16]

Owning certain domestic animals was a significant risk factor ($p<0.0001$), favoring the multiplication of sand flies. [6] Poor management of waste and animal enclosures can promote the proliferation of sand flies that feed on these animals' blood. Many patients had dogs, which are well-known reservoirs of leishmaniasis, even without apparent symptoms. This observation highlights the importance of a One Health approach integrating animal health into leishmaniasis control strategies.

Finally, the lack of use of protective measures, like impregnated mosquito nets, was significantly linked to the disease. Although mosquito nets are widely recognized for malaria prevention, their role is also crucial against sand flies, which bite primarily at dusk and dawn. The lack of specific knowledge about protection against sand flies could be an underlying cause. The fact that some mosquito net users were positive raises questions about proper use or the possible presence of insecticide resistance in local sand fly populations, a phenomenon documented for other vectors. [17] Furthermore, living near the forest also increased the risk, as these areas constitute the natural habitat of sand flies, thus facilitating disease transmission to nearby human populations.

Furthermore, living near the forest also increased the risk, as these areas constitute the natural habitat of sand flies, thus facilitating disease transmission to nearby human populations.

Study limitations

While this study provides crucial insights into the epidemiology of VL in Léré, some limitations should be considered. First, the use of an RDT, while practical for field conditions, may have limitations in sensitivity and specificity compared to molecular methods such as the polymerase chain reaction. Second, the study sample consisted of symptomatic individuals presenting at a health facility, which may not represent the true prevalence in the general community, where asymptomatic infections are known to occur. This facility-based recruitment likely results in an underestimation of the overall infection rate and may introduce selection bias. Third, the crosssectional design identifies associations but cannot establish causality between the identified risk factors and disease occurrence. Finally, data on certain potential confounders, such as detailed nutritional status, co-infections, or genetic factors, were not collected. Future community-based longitudinal studies incorporating more advanced diagnostic techniques are recommended to confirm these findings and better understand the causal pathways and transmission dynamics.

Conclusions

This study confirms that VL is a major public health issue in the Léré district, with a high prevalence driven by socioeconomic vulnerabilities, environmental proximity to vector habitats, and the presence of animal reservoirs. The findings provide compelling evidence for the urgent implementation of an integrated control program. We strongly recommend the adoption of a responsible One Health framework, which would include: i) strengthening diagnostic capacity and case management in primary health centers; ii) implementing targeted community health education on risk factors and protective measures; iii) promoting responsible animal ownership and exploring dog vaccination or treatment; and iv) integrating environmental management, such as improved waste disposal and housing conditions, into local development plans. Such a holistic strategy is crucial to reducing the transmission of VL and protecting the most vulnerable populations in Chad and similar Sahelian contexts.

Table 1. Distribution of patients by age and gender (n=303).

Parameter	Variable	Number	Frequency (%)
Age (year)	0-14	116	38.28
	15-29	87	28.71
	30-44	49	16.17
	>44	51	16.83
Gender	Female	167	55.11
	Male	136	44.88

Table 2. Relationship between visceral leishmaniasis and sociodemographic parameters.

Variable	Category	Seronegative (%)	Seropositive (%)	Chi-square (df, p)
Area of residence	Rural	33.0	28.4	19.13 (1, <0.0001)
	Urban	30.4	8.3	
Level of education	Illiterate	29.49	17.8	8.44 (3, 0.038)
	Primary	16.5	7.6	
	Secondary	8.9	8.9	
	Higher	8.6	2.3	

Table 3. Relationship between knowledge about visceral leishmaniasis and seropositivity.

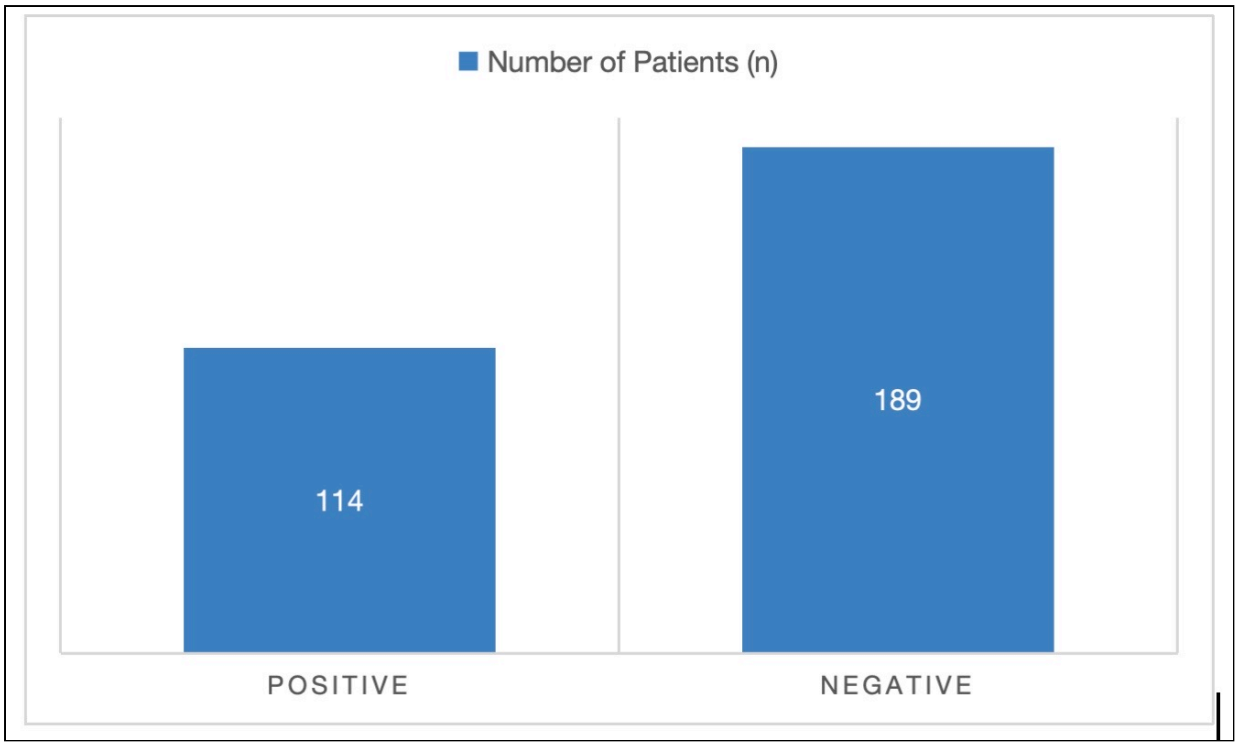
Variable	Seronegative (%)	Seropositive (%)	Chi-square test (df, p)
Knowledge of the disease			8.83 (1, 0.003)
No	31.7	24.8	
Yes	31.7	11.9	

Table 4. Relationship between visceral leishmaniasis and environmental parameters.

Variable	Category	Seronegative (%)	Seropositive (%)	Chi-square (df, p)
Type of animal	Dog	2.6	3.6	51.56 (3, <0.0001)
	Vector source*	31.7	5.6	
	Vector source/dog	19.5	24.8	
	None	9.6	2.6	
Waste disposal site	House courtyard	4.0	0.3	4.9 (1, 0.027)
	Around the house	59.4	36.0	
Protection method	Treated mosquito nets	41.6	12.9	53.92 (3, <0.0001)
	Untreated mosquito nets	14.5	8.3	
	Insecticide use	0.3	0.0	
	None	5.0	15.5	
Residential area	House inside the forest	3.0	7.6	40.11 (2, <0.0001)
	House on the forest edge	16.5	16.5	
	Cleared land	43.9	12.5	

**Cattle, sheep, goats, donkeys.*

Figure 1. Seroprevalence of visceral leishmaniasis at Léré District Hospital.Bar chart showing the frequency distribution of patients based on rapid diagnostic test results.



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Ethics Statement

Ethics approval and consent to participate: this study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Research authorization was granted by the University of Ngaoundéré. Administrative approvals were secured from the Head of the Léré Health District and the Director of the Léré District Hospital. Written informed consent was obtained from all adult participants and from parents or legal guardians of participants under the age of 16 prior to their inclusion in the study.

Data Availability

Availability of data and materials: the datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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