Modern American Journal of Medical and Health Sciences
ISSN (E): 3067-803X
Volume 01, Issue 09, December, 2025
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SERUM INFLAMMATORY, IMMUNOREGULATORY, AND REPAIR ASSOCIATED PROFILES IN INFILTRATIVE CUTANEOUS LEISHMANIASIS: A COMPARATIVE ANALYSIS OF PROBABLE ZOONOTIC AND ANTHROPONOTIC TYPES

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Abstract

Background. Cutaneous leishmaniasis (CL) is characterized by heterogeneous inflammatory responses and variable patterns of tissue involvement. The relationship between systemic inflammatory mediators, immunoregulatory cytokines, and repair-associated growth factors across different clinical and epidemiological presentations remains insufficiently characterized.

Objective. To compare serum inflammatory, immunoregulatory, and repair-associated biomarkers in patients with infiltrative CL classified as having probable zoonotic or probable anthroponotic disease.

Materials and Methods. This comparative study included 88 participants: 65 patients with newly diagnosed, parasitologically confirmed CL and 23 healthy controls. Among the patients, 38 were classified as having probable zoonotic CL and 27 as having probable anthroponotic CL based on clinical and

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epidemiological characteristics. All patients had infiltrative lesions of 3–6 months' duration. Pretreatment serum concentrations of interferon-γ-inducible protein 10 (IP-10/CXCL10), interleukin-17A (IL-17A), interleukin-10 (IL-10), basic fibroblast growth factor (bFGF/FGF-2), and vascular endothelial growth factor A (VEGF-A) were measured using enzyme-linked immunosorbent assays. Between-group comparisons were performed using nonparametric tests with adjustment for multiple comparisons.

Results. Both CL groups demonstrated elevated serum concentrations of IP-10, IL-17A, IL-10, and VEGF-A and reduced bFGF concentrations compared with healthy controls. Patients with probable zoonotic CL had higher IP-10 (339.96 vs. 290.57 pg/mL; p=0.002), IL-17A (51.39 vs. 43.57 pg/mL; p=0.001), and VEGF-A (220.50 vs. 143.54 pg/mL; p=0.020) than patients with probable anthroponotic CL. Conversely, IL-10 was higher in the probable anthroponotic group (9.87 vs. 6.98 pg/mL; p<0.001). The difference in bFGF concentrations between the two patient groups was modest and borderline significant (p=0.049).

Conclusion. Infiltrative CL is associated with distinct systemic immune and repair-associated biomarker patterns across probable clinical and epidemiological types. Probable zoonotic CL shows a more pronounced inflammatory and angiogenic component, whereas probable anthroponotic CL is characterized by relatively greater IL-10-associated immunoregulation. Reduced circulating bFGF in both groups suggests that changes in repair-associated mediators do not necessarily follow the same direction as angiogenic activation.

Keywords: cutaneous leishmaniasis; infiltrative stage; IP-10; IL-17A; IL-10; bFGF; VEGF-A; immunoinflammation.

Introduction

Cutaneous leishmaniasis remains a substantial public health problem in endemic regions, particularly in areas where environmental conditions and vector distribution support the transmission of Leishmania parasites. According to the World Health Organization, approximately 95% of reported CL cases occur in countries of the Americas, the Mediterranean Basin, the Middle East, and Central

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Asia, with an estimated 600,000-1,0 million new cases annually [1]. Global surveillance data also indicate considerable geographic concentration of the disease burden [16].

The clinical presentation of CL is highly variable. Differences may involve the number and anatomical distribution of lesions, the intensity of infiltration, surrounding erythema, the degree of local inflammation, and the duration and progression of cutaneous changes. This clinical heterogeneity reflects the interaction between parasite-related factors, host immune mechanisms, and the local tissue microenvironment [9, 11].

Host immune responses to Leishmania have a dual role. Effective cellular immunity contributes to parasite control, while excessive or persistent inflammatory activity may intensify tissue injury and prolong lesion resolution. At the same time, anti-inflammatory regulation, vascular remodeling, and the activity of cells involved in extracellular matrix production influence the evolving cutaneous response [7, 14, 15].

In Uzbekistan, CL continues to be epidemiologically relevant in endemic territories [3, 4]. Investigations in the Surxondaryo Region have documented the diversity and changing composition of phlebotomine sand fly populations, emphasizing the importance of regional transmission ecology [13]. Previous studies conducted in Uzbekistan have also identified alterations in cellular and humoral immune parameters among patients with CL [2].

Despite these observations, the simultaneous evaluation of inflammatory cytokines, immunoregulatory mediators, and growth factors associated with tissue repair remains limited, particularly in patients examined at a comparable clinical stage of disease.

IP-10/CXCL10 is involved in the recruitment of activated immune cells and reflects interferon-associated inflammatory signaling. IL-17A contributes to inflammatory amplification and neutrophil recruitment, whereas IL-10 regulates macrophage activation and restricts excessive immune responses. In parallel, bFGF and VEGF-A participate in cellular proliferation, angiogenesis, and tissue remodeling, although their circulating concentrations cannot be regarded as direct measures of local skin regeneration.

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Assessment of these mediators within a single study population may therefore provide a broader characterization of systemic responses than the measurement of individual cytokines alone.

Objective

To investigate differences in pretreatment serum concentrations of IP-10, IL-17A, IL-10, bFGF, and VEGF-A in patients with infiltrative cutaneous leishmaniasis according to probable clinical and epidemiological type.

Materials and Methods

Study population and clinical assessment

The study was conducted at the Dermatovenereological Dispensary of the Surxondaryo Region, Republic of Uzbekistan, between January 2023 and December 2025.

A total of 88 individuals were included, comprising 65 patients with newly diagnosed CL and 23 apparently healthy volunteers serving as controls. The control group was comparable to the patient cohort in terms of age, sex, and region of residence.

Eligibility criteria included age between 18 and 55 years, newly diagnosed clinically and parasitologically confirmed CL, the presence of lesions at the infiltrative stage, disease duration of 3-6 months, no specific antileishmanial therapy during the preceding 30 days, and written informed consent.

Patients were excluded if they had disease duration outside the specified interval, ulcerative or ulcerative-destructive lesions, chronic or recurrent CL, visceral leishmaniasis, pregnancy or lactation, HIV infection, diabetes mellitus, severe autoimmune or oncological disease, or systemic immunosuppressive treatment. Patients with secondary bacterial infection, suppuration, substantial lesion trauma, necrosis, or developing ulceration were additionally excluded from the immunological analysis.

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Parasitological confirmation and classification

The diagnosis of CL was confirmed by direct microscopic examination in all 65 patients. Material was collected from infiltrated lesions using scraping or impression preparations, stained by the Romanowsky–Giemsa method, and examined for intracellular or extracellular Leishmania amastigotes.

Following confirmation, patients were assigned to probable zoonotic or probable anthroponotic groups using a combination of epidemiological and clinical information. Epidemiological assessment considered the presumed location of infection, residential and environmental exposure, possible contact with natural transmission foci, and seasonal characteristics. The number, distribution, and evolution of lesions and the intensity of local inflammatory changes were used as supplementary clinical indicators.

Accordingly, 38 patients (58.5%) were classified as having probable zoonotic CL and 27 (41.5%) as having probable anthroponotic CL.

Molecular identification of Leishmania species was not performed. Consequently, these categories represent probable clinical and epidemiological types rather than species-confirmed infections with L. major or L. tropica. Quantitative parasite-load assessment was also not undertaken.

Blood sampling and biomarker measurement

Immunological analyses were performed at the Laboratory of Reproductive Immunology of the Institute of Immunology and Human Genomics, Academy of Sciences of the Republic of Uzbekistan.

Venous blood samples (5–7 mL) were collected in the morning after an overnight fast, using tubes without anticoagulant. After clot formation, samples were centrifuged at 3,000 rpm for 10–15 minutes. The separated serum was stored at −20°C until analysis.

Serum concentrations of IP-10/CXCL10, IL-17A, IL-10, bFGF/FGF-2, and VEGF-A were determined by enzyme-linked immunosorbent assay (ELISA). Commercial assay kits were obtained from Vector-Best (Russia) for IL-10 and VEGF-A, Cytokine (Russia) for IL-17A, and FineTest (China) for IP-10 and bFGF.

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All procedures were conducted in accordance with the manufacturers' instructions. Optical density was measured at 450 nm, and biomarker concentrations were calculated from standard curves and expressed in pg/mL.
The present analysis included only samples collected before the initiation of specific antileishmanial treatment. Healthy volunteers were tested once.

Ethical considerations
The study protocol was reviewed and approved by the Local Ethics Committee of the Institute of Immunology and Human Genomics, Academy of Sciences of the Republic of Uzbekistan (Protocol No. 1, dated May 14, 2026). Written informed consent was obtained from all participants before enrollment.

Statistical analysis
Statistical analyses were performed using Statistica 13.0 and BioStat LE 7.6.5.
The distribution of continuous variables was assessed using the Shapiro–Wilk test. Quantitative results are reported as medians with interquartile ranges (Me [Q1; Q3]).
Differences in serum biomarker concentrations among the three independent groups were evaluated using the Kruskal–Wallis test, followed by pairwise Mann–Whitney U tests with Holm–Bonferroni adjustment for multiple comparisons.
The Mann–Whitney U test was also used to compare disease duration between the probable zoonotic and anthroponotic groups. All tests were two-sided, and $p<0.05$ was considered statistically significant.

Results
Characteristics of the study population
Among the 65 patients with CL, 41 (63.1%) were men and 24 (36.9%) were women. The proportion of male patients was similar between the probable zoonotic and anthroponotic groups (63.2% and 63.0%, respectively).
Disease duration differed between groups. The median duration was 4 [3; 5] months in the probable zoonotic group and 5 [4; 6] months in the probable

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anthroponotic group (p=0.029). As all patients were selected within a disease-duration interval of 3–6 months, this finding should not be interpreted as evidence of chronic disease.

Clinical assessment showed that probable zoonotic CL was more frequently associated with multiple lesions, predominant involvement of the extremities, pronounced erythema, and perifocal inflammation. In contrast, probable anthroponotic CL more commonly presented with one or a few lesions, often involving the face, a relatively dense and dry infiltrate, and slower clinical evolution.

These characteristics provided a descriptive basis for clinical and epidemiological classification but were not considered sufficient for species identification.

Serum concentrations of inflammatory and repair-associated mediators

The serum biomarker results are presented in Table 1.

Table 1. Serum concentrations of inflammatory, immunoregulatory, and repair-associated mediators in the study groups

Biomarker, pg/mL	Healthy controls (n=23)	Probable zoonotic CL (n=38)	Probable anthroponotic CL (n=27)	Adjusted p-value between CL types
IP-10	202.41 [177.57;232.67]	339.96 [297.52; 417.28]	290.57 [285.91; 331.67]	0.002
IL-17A	22.67 [19.41; 28.32]	51.39 [46.84; 57.25]	43.57 [36.64; 50.68]	0.001
IL-10	4.90 [4.04; 6.07]	6.98 [5.24; 9.04]	9.87 [7.94; 12.40]	<0.001
bFGF	49.48 [45.55; 50.30]	36.21 [29.21; 40.62]	39.80 [33.77; 44.22]	0.049
VEGF-A	85.47 [67.06; 91.57]	220.50 [138.65; 270.25]	143.54 [121.57; 197.59]	0.020

Data are presented as median [Q1; Q3]. Between-type p-values were obtained using the Mann–Whitney U test with Holm–Bonferroni correction.

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Inflammatory mediators: IP-10 and IL-17A

IP-10 concentrations were significantly elevated in both CL groups compared with healthy controls ($p<0.001$). The highest median concentration was observed in patients with probable zoonotic CL: 339.96 [297.52; 417.28] pg/mL, compared with 290.57 [285.91; 331.67] pg/mL in the probable anthroponotic group ($p=0.002$).

A similar pattern was identified for IL-17A. Serum concentrations were 51.39 [46.84; 57.25] pg/mL in probable zoonotic CL and 43.57 [36.64; 50.68] pg/mL in probable anthroponotic CL, compared with 22.67 [19.41; 28.32] pg/mL in controls. Both patient groups differed significantly from controls ($p<0.001$), and the between-type difference remained significant after adjustment ($p=0.001$).

Together, these findings demonstrate greater systemic activation of IP-10- and IL-17A-associated inflammatory pathways in the probable zoonotic group.

The direction of these biomarker differences was consistent with the more prominent clinical inflammatory manifestations observed in this group. However, formal associations between individual serum biomarkers and specific clinical features were not tested.

Immunoregulatory mediator: IL-10

Serum IL-10 was elevated relative to the control group in both probable clinical and epidemiological types ($p<0.001$).

Unlike IP-10 and IL-17A, IL-10 was significantly higher in patients with probable anthroponotic CL. Its median concentration reached 9.87 [7.94; 12.40] pg/mL, compared with 6.98 [5.24; 9.04] pg/mL in probable zoonotic CL ($p<0.001$).

The opposite direction of the between-type differences in inflammatory mediators and IL-10 suggests that the balance of inflammatory and regulatory signaling varies across clinical and epidemiological presentations.

Nevertheless, higher circulating IL-10 should not be interpreted as direct evidence of increased parasite persistence or impaired parasite clearance, because parasite burden was not measured.

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Repair-associated mediator: bFGF

A different distribution was observed for bFGF. Its serum concentration was reduced in both patient groups compared with healthy controls.

The median value was 36.21 [29.21; 40.62] pg/mL in probable zoonotic CL ($p<0.001$ vs. controls) and 39.80 [33.77; 44.22] pg/mL in probable anthroponotic CL ($p<0.002$ vs. controls). The difference between the two CL groups was comparatively small and remained borderline significant following multiple-comparison adjustment ($p=0.049$).

These results indicate that circulating bFGF does not increase in parallel with the measured inflammatory mediators in patients with infiltrative CL.

However, serum bFGF concentrations cannot independently establish the degree of fibroblast activity or tissue repair within cutaneous lesions.

Angiogenic mediator: VEGF-A

VEGF-A concentrations were substantially elevated in patients with CL compared with healthy individuals ($p<0.001$ in both clinical and epidemiological groups).

The median concentration was 220.50 [138.65; 270.25] pg/mL in the probable zoonotic group and 143.54 [121.57; 197.59] pg/mL in the probable anthroponotic group ($p=0.020$).

The greater elevation of VEGF-A in probable zoonotic CL suggests a more pronounced angiogenic component of the systemic response. This finding should be considered in the context of inflammation-associated vascular activation rather than interpreted exclusively as evidence of active tissue regeneration.

Discussion

The present study identified differences in the circulating inflammatory, immunoregulatory, and repair-associated biomarker profiles of patients with infiltrative CL classified according to probable clinical and epidemiological type. A major feature common to both groups was the simultaneous elevation of IP-10, IL-17A, IL-10, and VEGF-A, accompanied by reduced bFGF concentrations. This combination indicates that inflammation, immune regulation, and tissue

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remodeling-associated signaling do not necessarily change in the same direction during active infiltrative disease.

Distinct patterns of inflammatory activation

The higher serum levels of IP-10 and IL-17A in probable zoonotic CL indicate relatively stronger activation of inflammatory pathways associated with immune-cell recruitment and inflammatory amplification.

IP-10 is an interferon-inducible chemokine involved in the migration of activated immune cells toward inflammatory sites. Increased circulating IP-10 has also been reported in patients with L. guyanensis-associated CL [7]. Although our study did not identify the infecting Leishmania species, the observed increase supports the relevance of systemic chemokine responses in CL.

IL-17A contributes to inflammatory-cell recruitment and may influence the intensity of local tissue inflammation. Experimental evidence suggests that its effects in CL depend on the broader cellular and microbial context [12].

In our cohort, higher IP-10 and IL-17A levels occurred in the group exhibiting more pronounced erythema and perifocal inflammation. This parallel pattern is biologically plausible, but causality cannot be established from the present data.

Immunoregulatory differences

IL-10 showed a different between-group distribution, with higher levels in probable anthroponotic CL.

IL-10 is involved in the control of excessive inflammatory activity and the regulation of macrophage-mediated immune responses. Its role in leishmaniasis is complex because immunoregulation may limit tissue injury while also modifying mechanisms involved in parasite control [7, 15].

The higher IL-10 concentration observed in probable anthroponotic CL may therefore reflect a relatively more prominent immunoregulatory component of the systemic response. The clinical significance of this difference requires further investigation using longitudinal measurements and direct assessment of parasite burden.

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Divergent behavior of growth factors

The combined assessment of bFGF and VEGF-A was particularly informative because these mediators showed opposite changes relative to healthy controls.

FGF-2 participates in cellular proliferation, migration, extracellular matrix remodeling, and tissue repair [5, 10]. Nevertheless, circulating bFGF was reduced in both CL groups.

Previous investigations have reported different FGF-related responses in other clinical and parasitological settings. For example, de Mesquita and colleagues described elevated plasma FGF-basic in patients with L. guyanensis-associated CL [7].

Such differences should be interpreted cautiously because study populations may vary in infecting species, clinical stage, biological specimen, assay methodology, and other characteristics. Experimental findings also suggest that Leishmania infection can modify the functional behavior of dermal fibroblasts [8].

In contrast to bFGF, VEGF-A was markedly increased, particularly in probable zoonotic CL.

VEGF-A is a regulator of angiogenesis and vascular remodeling. Experimental studies have demonstrated that Leishmania infection can induce macrophage-derived VEGF-A through pathways involving hypoxia-inducible signaling and may contribute to lymphatic vascular responses [6, 14].

Accordingly, elevated VEGF-A in our patients may represent a component of inflammation-associated vascular remodeling. Its increase should not be equated with successful tissue repair or complete resolution of cutaneous lesions.

The simultaneous reduction in circulating bFGF and elevation in VEGF-A suggests an imbalance between different repair-associated signaling pathways. However, the present study did not directly assess local fibroblast activity, microvascular density, or histological features of lesion repair.

Clinical implications

The findings indicate that probable zoonotic and anthroponotic CL may exhibit different systemic biomarker patterns even when patients are evaluated within the same infiltrative stage.

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Higher IP-10, IL-17A, and VEGF-A concentrations characterized probable zoonotic CL, whereas increased IL-10 was the most prominent relative feature of probable anthroponotic CL. The reduction in bFGF was observed in both groups. These differences provide a basis for further investigation of combined immune and repair-associated biomarker panels. However, the findings do not establish diagnostic thresholds, independently validated classification criteria, or biomarker-guided treatment algorithms.

Conclusion

Patients with infiltrative cutaneous leishmaniasis demonstrated alterations in systemic inflammatory, immunoregulatory, and repair-associated mediators compared with healthy controls.

The probable zoonotic type was associated with higher serum concentrations of IP-10, IL-17A, and VEGF-A, indicating a relatively more pronounced inflammatory and angiogenic component. The probable anthroponotic type was characterized by higher IL-10 concentrations, suggesting greater relative involvement of immunoregulatory signaling.

Reduced bFGF concentrations were observed in both patient groups, despite the elevation of VEGF-A. This divergent pattern emphasizes the complexity of repair-associated responses during active cutaneous inflammation.

The findings support a multidimensional assessment of systemic mediators in CL and provide a rationale for further studies incorporating molecular parasite identification, lesion-level analysis, and longitudinal clinical outcomes.

References

1. World Health Organization. Leishmaniasis: Fact Sheet. January 12, 2023. Available at: https://www.who.int/news-room/fact-sheets/detail/leishmaniasis.
2. Rasulova IA. Features of the immune response in cutaneous leishmaniasis. Vestnik Fundamentalnoy i Klinicheskoy Meditsiny. 2022; 1(1):57–64.
3. Suvonkulov UT, Muratov TI, Baratova MR, et al. Prevalence of cutaneous leishmaniasis among the population of endemic areas of Uzbekistan. Society

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and Innovations. 2020; 1(1/S):592–597. doi:10.47689/2181-1415-vol1-iss1/s-pp592-597.

4. Achilova OD, Israilova SB, Abrorova NA, Fayzullaeva ChO. Epidemiological analysis of cutaneous leishmaniasis incidence and methods of its control. Doktor Axborotnomasi. 2022; 3(106):139–142. doi:10.38095/2181-466X-20221063-139-142.
5. Benington L, Rajan G, Locher C, Lim LY. Fibroblast Growth Factor 2 – A Review of Stabilisation Approaches for Clinical Applications. Pharmaceutics. 2020; 12(6):508. doi:10.3390/pharmaceutics12060508.
6. Bowlin A, Roys H, Wanjala H, et al. Hypoxia-Inducible Factor Signaling in Macrophages Promotes Lymphangiogenesis in Leishmania major Infection. Infection and Immunity. 2021; 89(8). doi:10.1128/IAI.00124-21.
7. de Mesquita TGR, do Espírito Santo Junior J, da Silva LDO, et al. Distinct plasma chemokines and cytokines signatures in Leishmania guyanensis-infected patients with cutaneous leishmaniasis. Frontiers in Immunology. 2022; 13:974051. doi:10.3389/fimmu.2022.974051.
8. de Queiroz Filho TN, Costa BF, Rodrigues APD. Modulation of fibroblast behavior by Leishmania: a pathway to understanding disease progression in cutaneous leishmaniasis. BMC Microbiology. 2025; 25:495. doi:10.1186/s12866-025-04098-x.
9. de Vries HJC, Schallig HD. Cutaneous Leishmaniasis: A 2022 Updated Narrative Review into Diagnosis and Management Developments. American Journal of Clinical Dermatology. 2022; 23(6):823–840. doi:10.1007/s40257-022-00726-8.
10. Prudovsky I. Cellular Mechanisms of FGF-Stimulated Tissue Repair. Cells. 2021; 10(7):1830. doi:10.3390/cells10071830.
11. Saidi N, Blaizot R, Prévot G, et al. Clinical and immunological spectra of human cutaneous leishmaniasis in North Africa and French Guiana. Frontiers in Immunology. 2023; 14:1134020. doi:10.3389/fimmu.2023.1134020.
12. Singh TP, Carvalho AM, Sacramento LA, et al. Microbiota instruct IL-17A-producing innate lymphoid cells to promote skin inflammation in cutaneous

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ISSN (E): 3067-803X
Volume 01, Issue 09, December, 2025
Website: usajournals.org
This work is Licensed under CC BY 4.0 a Creative Commons Attribution 4.0 International License.

leishmaniasis. PLoS Pathogens. 2021; 17(10). doi:10.1371/journal.ppat.1009693.

13. Usarov GX, Turitsin VS, Sattarova XG, et al. Phlebotomine sand fly (Diptera: Phlebotominae) diversity in the foci of cutaneous leishmaniasis in the Surxondaryo Region of Uzbekistan: 50 years on. Parasitology Research. 2024; 123:170. doi:10.1007/s00436-024-08191-4.
14. Weinkopff T, Roys H, Bowlin A, Scott P. Leishmania Infection Induces Macrophage Vascular Endothelial Growth Factor A Production in an ARNT/HIF-Dependent Manner. Infection and Immunity. 2019; 87(11). doi:10.1128/IAI.00088-19.
15. Wijesooriya H, Samaranayake N, Karunaweera ND. Cytokine and phenotypic cell profiles in human cutaneous leishmaniasis caused by Leishmania donovani. PLoS ONE. 2023; 18(1). doi:10.1371/journal.pone.0270722.
16. World Health Organization. Leishmaniasis. Global Health Observatory. Data for 2024, updated July 2026. Available at: https://www.who.int/data/gho/data/themes/topics/gho-ntd-leishmaniasis.