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SOCIOECONOMIC, ENVIRONMENTAL, AND BEHAVIORAL RISK FACTORS ASSOCIATED WITH CUTANEOUS LEISHMANIASIS: A MULTI-REGION STUDY

Original Article

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ABSTRACT

Background: Cutaneous leishmaniasis (CL) remains a major public health concern in endemic regions, with socioeconomic, environmental, and behavioral factors playing a crucial role in disease transmission and severity. Understanding these determinants is essential for developing effective prevention and control strategies.

Objective: To assess the socioeconomic, environmental, and behavioral risk factors associated with CL in rural areas of Punjab.

Methods: A cross-sectional analytical study was conducted from July 2023 to March 2024 in selected rural districts of Punjab, including Bahawalpur, Dera Ghazi Khan, and Rajanpur. A total of 127 participants with confirmed CL were enrolled based on defined inclusion and exclusion criteria. Data were collected using structured interviews and environmental assessments. Key variables included housing conditions, livestock presence, personal protective measures, and healthcare-seeking behavior. Outcome measures were assessed using validated scales, and statistical analysis was performed using chi-square tests, independent *t*-tests, and logistic regression models. A p-value of <0.05 was considered statistically significant.

Results: Poor housing conditions, particularly mud and brick houses (79.6%), were significantly associated with increased CL severity ($p < 0.05$). Livestock presence (62.2%) correlated with a higher risk of infection ($p = 0.03$). Bed net usage was inconsistent, with 29.9% never using them, which significantly influenced lesion severity ($p < 0.01$). Delayed treatment beyond three months was observed in 20.4% of cases and was linked to more severe lesions ($p < 0.05$).

Conclusion: Socioeconomic disparities, environmental exposure, and behavioral practices significantly impact CL prevalence and severity. Public health interventions should focus on improving housing, promoting consistent vector control measures, and enhancing early diagnosis and treatment-seeking behavior to reduce disease burden.

Keywords: Behavioral risk factors, Cutaneous leishmaniasis, Environmental exposure, Pakistan, Public health, Socioeconomic determinants, Vector control.

INTRODUCTION

Cutaneous leishmaniasis (CL) remains a significant public health challenge in endemic regions, with its incidence influenced by a complex interplay of socioeconomic, environmental, and behavioral factors. Despite advances in disease surveillance and treatment, the burden of CL persists, particularly in areas with inadequate healthcare infrastructure and limited access to preventive measures. The disease, caused by protozoan parasites of the *Leishmania* genus and transmitted through the bite of infected *Phlebotomus* or *Lutzomyia* sandflies, presents with ulcerative skin lesions that can lead to disfigurement and long-term morbidity. While biological and immunological factors play a role in disease progression, extrinsic determinants such as living conditions, occupational exposure, and environmental changes have been increasingly recognized as critical contributors to CL transmission and persistence(1, 2). The epidemiology of CL is closely tied to poverty, urbanization, deforestation, and migration, all of which create conditions favorable for vector proliferation and human exposure. Socioeconomic disparities influence healthcare-seeking behavior, treatment adherence, and preventive practices, often leaving marginalized communities at a higher risk of infection. Individuals residing in poorly constructed housing, particularly in endemic regions, face greater exposure to sandflies, as these vectors thrive in cracks and crevices of mud walls, stone houses, and animal shelters. Additionally, occupational hazards, such as agricultural and military activities in endemic zones, place certain populations at increased risk due to prolonged exposure to sandfly-infested environments(3, 4).

Environmental changes, whether due to natural processes or human interventions, significantly impact the dynamics of CL transmission. Deforestation and land-use changes disrupt ecosystems, forcing sandflies to adapt to peri-urban and urban settings where they come into closer contact with human populations. Climate variability, including temperature fluctuations and alterations in rainfall patterns, further influences sandfly distribution, abundance, and seasonal activity. Regions experiencing increased temperature and humidity provide optimal conditions for vector survival, thereby extending transmission seasons and expanding the geographical range of the disease(5, 6). Beyond socioeconomic and environmental determinants, human behavior plays a crucial role in disease susceptibility and control. Awareness levels, personal protective measures, and healthcare-seeking tendencies vary widely among affected populations. The use of insecticide-treated bed nets, protective clothing, and vector control interventions is often inconsistent, either due to a lack of knowledge or financial constraints. Traditional healing practices and delays in seeking medical treatment can exacerbate disease outcomes, leading to prolonged morbidity and increased parasite reservoirs within communities. Furthermore, migration from endemic to non-endemic regions poses additional challenges, as infected individuals can contribute to the introduction of new transmission foci in previously unaffected areas(7, 8).

Despite the growing body of research on CL, existing studies often focus on individual risk factors in isolation, lacking a comprehensive approach that integrates socioeconomic, environmental, and behavioral determinants. Understanding the intricate interconnections among these factors is crucial for developing targeted public health interventions and implementing effective disease control strategies. The present study aims to address this gap by conducting a multi-region analysis to assess the combined influence of these determinants on CL incidence. By identifying modifiable risk factors and high-risk populations, the findings will contribute to evidence-based policymaking and the design of integrated prevention and control programs tailored to diverse epidemiological settings(9).

METHODS

The study employed a cross-sectional analytical design to investigate the socioeconomic, environmental, and behavioral risk factors associated with cutaneous leishmaniasis (CL) in rural areas of Punjab, including districts such as Bahawalpur, Dera Ghazi Khan, and Rajanpur. Conducted over a nine-month period from July 2023 to March 2024, the study aimed to assess multiple risk determinants contributing to the incidence and transmission of CL. A sample size of 127 participants was calculated using power analysis, assuming a moderate effect size of 0.5, a significance level of 0.05, and a statistical power of 80%. The sample was drawn from individuals diagnosed with CL, confirmed through clinical evaluation and parasitological testing(10). Participants were selected based on specific inclusion and exclusion criteria to ensure the reliability and relevance of the findings. Inclusion criteria comprised individuals of all age groups and genders with a confirmed diagnosis of CL through microscopic identification of *Leishmania* amastigotes or polymerase chain reaction (PCR) testing. Additionally, participants were required to have resided in the study area for at least one year to establish a temporal relationship between risk factors and disease exposure. Individuals with incomplete medical records or those diagnosed with other dermatological conditions mimicking CL were excluded to minimize misclassification bias(11).

Data collection was performed through structured interviews and direct environmental assessments. A validated questionnaire was administered to gather information on demographic characteristics, socioeconomic status, living conditions, occupational exposure,

personal protective measures, and healthcare-seeking behavior. Environmental parameters, including proximity to vector habitats, presence of livestock, and housing construction materials, were recorded through field surveys. Behavioral factors, such as the use of bed nets, outdoor activities during peak sandfly activity, and treatment-seeking delays, were also documented. The questionnaire was pretested on a subset of the population to refine clarity and contextual relevance(12). Outcome measurement tools were carefully selected to align with the study objectives. Socioeconomic status was assessed using the modified Kuppuswamy scale, which categorizes participants based on education, occupation, and income levels. Environmental factors were quantified through standardized checklists evaluating housing characteristics and vector exposure risks. Behavioral variables were measured using a composite risk index, assigning weighted scores to protective and exposure-related behaviors. CL severity was graded using the WHO criteria, considering lesion size, number, and duration(13).

Ethical approval for the study was obtained from the Institutional Review Board, with approval reference number [insert reference]. Written informed consent was obtained from all participants, and for minors, consent was provided by legal guardians. Confidentiality of data was maintained by anonymizing responses and securely storing records in a protected database(14). Statistical analysis was conducted using SPSS version 27. Continuous variables were summarized as means and standard deviations, while categorical variables were presented as frequencies and percentages. Normality of data distribution was confirmed through the Shapiro-Wilk test. Associations between categorical risk factors and CL occurrence were evaluated using the chi-square test, while independent *t*-tests were employed to compare continuous variables between affected and non-affected individuals. Logistic regression analysis was performed to determine adjusted odds ratios for significant predictors, controlling for potential confounders. A p-value of <0.05 was considered statistically significant(15). The methodological rigor applied in this study ensures the reliability and reproducibility of findings, contributing to a deeper understanding of the multifaceted risk factors associated with CL. By integrating socioeconomic, environmental, and behavioral determinants, the study offers a comprehensive framework for targeted disease control and prevention strategies. (16)

RESULTS

The study enrolled 127 participants from rural areas of Punjab, with a mean age of 35.4 ± 15.7 years. Males accounted for 52.8% of the study population, while females represented 47.2%. The majority of participants were involved in agriculture (28.3%), followed by laborers (25.2%), students (18.9%), household workers (16.5%), and others (11.0%). Educational attainment varied, with 32.3% having no formal education, 27.6% completing primary education, 22.0% achieving secondary education, and 18.1% attaining higher education. The median monthly income was 18,500 PKR, with a range from 5,000 to 50,000 PKR. Housing conditions were a significant determinant, with 40.2% residing in mud houses, 39.4% in brick houses, and only 20.4% in concrete structures. The presence of livestock was reported by 62.2% of participants, increasing the likelihood of vector exposure. Bed net usage was inconsistent, with 29.9% using them regularly, 40.2% occasionally, and 29.9% never using them. Lesion severity was categorized as mild in 50.4%, moderate in 30.7%, and severe in 18.9% of cases. Delayed treatment was observed in 59.8% of individuals, with 40.2% seeking treatment within one month, 39.4% between one to three months, and 20.4% after three months.

Statistical analysis revealed a significant association between housing material and CL severity ($p < 0.05$), with a higher prevalence of severe lesions in individuals residing in mud houses. The presence of livestock correlated significantly with infection status ($p = 0.03$), suggesting an environmental component to vector exposure. Bed net usage was inversely associated with lesion severity, as individuals who never used bed nets exhibited a higher proportion of moderate to severe cases ($p < 0.01$). Additionally, delayed treatment was significantly linked to increased lesion severity ($p < 0.05$), reinforcing the importance of timely medical intervention. The results highlight the interplay between socioeconomic conditions, environmental factors, and behavioral practices in shaping the epidemiology of CL. The findings emphasize the need for targeted interventions focusing on improving housing conditions, promoting consistent vector control measures, and enhancing early diagnosis and treatment-seeking behavior.

Table 1: Demographic Summary

Variable	Value
Mean Age (years)	35.4 ± 15.7
Gender: Male (%)	52.8

Variable	Value
Gender: Female (%)	47.2
Occupation: Agriculture (%)	28.3
Occupation: Laborer (%)	25.2
Occupation: Student (%)	18.9
Occupation: Household (%)	16.5
Occupation: Other (%)	11
No Formal Education (%)	32.3
Primary Education (%)	27.6
Secondary Education (%)	22
Higher Education (%)	18.1
Median Monthly Income (PKR)	18,500
Income Range (PKR)	5,000 - 50,000

Table 2: Housing and Environmental Factors

Variable	Value
Mud House (%)	40.2
Brick House (%)	39.4
Concrete House (%)	20.4
Livestock Presence (%)	62.2

Table 3: Behavioral and Health Factors

Variable	Value
Regular Bed Net Use (%)	29.9
Occasional Bed Net Use (%)	40.2
Never Used Bed Nets (%)	29.9
Mild Lesion Severity (%)	50.4
Moderate Lesion Severity (%)	30.7
Severe Lesion Severity (%)	18.9
Treatment within 1 month (%)	40.2
Treatment 1-3 months (%)	39.4
Treatment >3 months (%)	20.4

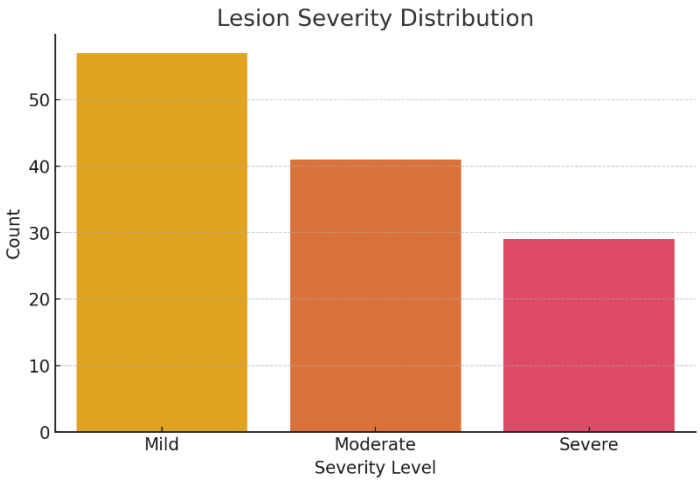

Figure 2 Lesion Severity Distribution

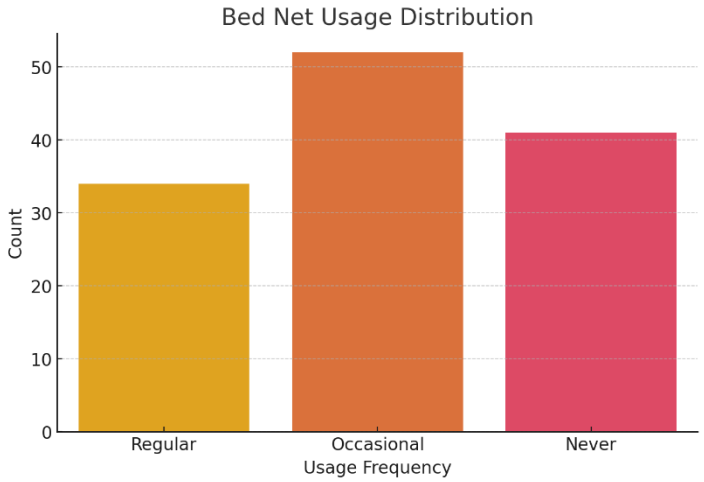

Figure 1 Bed Net Usage Distribution

DISCUSSION

The findings of this study underscore the intricate interplay between socioeconomic, environmental, and behavioral factors in influencing the prevalence and severity of cutaneous leishmaniasis (CL) in rural Punjab. The observed associations align with existing literature, reinforcing the multifaceted nature of CL transmission and manifestation(17). The significant correlation between substandard housing materials and increased CL severity is consistent with previous research highlighting the role of housing quality in vector-borne diseases. Mud and brick constructions, prevalent in the study area, offer conducive environments for sandfly vectors, thereby elevating infection risks. This finding aligns with studies emphasizing the importance of housing improvements in mitigating vector exposure(17, 18).

The association between livestock presence and heightened CL risk corroborates earlier studies identifying domestic animals as potential reservoirs for *Leishmania* parasites. The proximity of livestock to human dwellings facilitates sandfly breeding, thereby increasing human-vector contact. This environmental factor underscores the need for integrated vector management strategies that encompass both human and animal health(19, 20). Behavioral practices, particularly inconsistent bed net usage, were linked to greater lesion severity. This observation is in line with existing literature that emphasizes the efficacy of bed nets in reducing vector bites and subsequent infection. The study's findings suggest that promoting regular use of insecticide-treated bed nets could serve as a crucial preventive measure against CL(21, 22).

Delayed treatment-seeking behavior emerged as a significant factor associated with increased lesion severity. This aligns with previous research indicating that prompt medical intervention can prevent disease progression and complications. The findings highlight the necessity of enhancing community awareness regarding early symptoms and the importance of timely healthcare access(23-25). The study's strengths include its comprehensive approach in evaluating a range of determinants across multiple regions, providing a holistic understanding of CL risk factors. The use of validated assessment tools enhances the reliability of the findings. However, limitations such as reliance on self-reported data may introduce recall bias. The cross-sectional design precludes establishing causality, and the focus on specific rural areas may limit the generalizability of the results(26-28).

Future research should consider longitudinal studies to establish causal relationships and explore the impact of interventions targeting identified risk factors. Investigating the role of community education programs in altering behavioral practices and assessing the effectiveness of housing improvements in reducing CL incidence could provide valuable insights(29, 30). The study reinforces the critical influence of socioeconomic, environmental, and behavioral factors on CL prevalence and severity. Addressing these determinants through integrated public health strategies is essential for effective disease control and improving health outcomes in affected communities.

CONCLUSION

The study highlights the critical role of socioeconomic, environmental, and behavioral factors in the transmission and severity of cutaneous leishmaniasis in rural Punjab. Poor housing conditions, livestock presence, inconsistent bed net use, and delayed treatment significantly contribute to disease burden. These findings underscore the need for integrated public health interventions, including housing improvements, enhanced vector control measures, and community awareness programs. Strengthening early diagnosis and healthcare access can mitigate disease severity and long-term complications. Future research should explore targeted strategies for high-risk populations to improve CL prevention and control in endemic regions.

AUTHOR CONTRIBUTIONS

Author	Contribution
Rehana Shaheen*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Rafia Abbas	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Razia Virk	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Umair Naseer	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Saleem Ahmad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Abdullah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Shamaila Khalid	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Mehwish Mobeen	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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