Prevalence and Community Awareness of Leishmaniasis: Insight from Cross Sectional Study

Aemad Tabasum[1*], Muhammad Saqlain Haider[2], Muhammad Ammar, Hafiz Muhammad Usama[4]

[1]Assistant Professor, Department of Nursing & Allied Medical Sciences, Alhamd Islamic University, Quetta,
[2]Lecturer Designation, Department of Nursing & Allied Medical Sciences, Alhamd Islamic University, Quetta
[3]Lecturer, Department of Nursing & Allied Medical Sciences, Alhamd Islamic University, Quetta
[4]Lecturer Department of Nursing & Allied Medical Sciences, Alhamd Islamic University, Quetta
aemad.tabasum61@gmail.com

ABSTRACT

Leishmaniasis is a vector-borne disease of significant public health concern in Pakistan, with Multan being one of the most affected regions. This study aimed to assess the prevalence, knowledge, and risk factors associated with leishmaniasis in Multan from November 2023 to February 2024. A total of 550 respondents were surveyed through a structured questionnaire. The overall prevalence of leishmaniasis was found to be 18.2%, with a higher incidence among females (61.2%) and individuals aged 18–27 years (66.4%). Although 70.1% of participants reported prior awareness of the disease, only 47.3% correctly identified the symptoms, and 42.6% practiced preventive measures. The study found a significant positive correlation ($r = 0.39$, $p < 0.05$) between temperature and leishmaniasis incidence. Logistic regression analysis revealed that living near breeding sites increased the likelihood of contracting the disease by 2.8 times ($OR = 2.80$, $p < 0.001$). Additionally, poverty was found to be a significant risk factor, with individuals from low-income households being more likely to contract leishmaniasis ($OR = 2.10$, $p = 0.002$). Spatial analysis indicated clustered geographic areas with higher prevalence rates (Moran's $I = 0.21$, $p = 0.02$). These findings underscore the need for integrated vector control, public awareness campaigns, and socioeconomic interventions to effectively manage leishmaniasis in Multan. Future studies should focus on longitudinal research to explore the temporal dynamics of disease transmission and evaluate intervention strategies.

Keywords: Leishmaniasis, Prevalence, Public Health, Vector-borne Diseases, Multan, Risk Factors, Spatial Analysis, Environmental Health, Logistic Regression, Disease Awareness.

Cite as:

INTRODUCTION

Leishmaniasis is a neglected tropical disease caused by protozoan parasites from the *Leishmania* genus, transmitted to humans through the bite of infected female phlebotomine sandflies (World Health Organization [WHO], 2023). Globally, it is endemic in over 90 countries, with an estimated 700,000 to 1 million new cases annually (Alvar et al., 2012). The disease manifests in three major clinical forms: **cutaneous leishmaniasis (CL)**, which leads to skin sores; **visceral leishmaniasis (VL)**, affecting internal organs; and **mucocutaneous leishmaniasis (MCL)**, which destroys mucous membranes. Among these, cutaneous leishmaniasis is the most prevalent form in Pakistan and contributes significantly to disease burden, especially in rural and underdeveloped regions (Khan et al., 2020).

Published by Logical Creations Education Research Institute. www.lceri.net
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)

42

In Pakistan, leishmaniasis is considered endemic in many provinces, including Balochistan, Sindh, Khyber Pakhtunkhwa, and southern Punjab. **Multan**, located in southern Punjab, is particularly vulnerable due to its hot and dry climate, agricultural landscape, poor housing conditions, and limited access to healthcare services (Farooq et al., 2022). The region's climate—with high temperatures and low humidity—provides ideal breeding conditions for sandflies, which thrive in cracks in walls, animal shelters, and humid organic matter. The seasonal increase in temperature and inadequate vector control contribute to recurring outbreaks in urban and peri-urban settings (Ahmed et al., 2021).

Socioeconomic factors also play a critical role in the spread of leishmaniasis. Poor sanitation, overcrowded living conditions, low literacy levels, and limited awareness of preventive measures increase community vulnerability (Naseer et al., 2019). People in impoverished areas are less likely to seek medical care due to cost, stigma, or lack of knowledge about the disease. These conditions result in late diagnoses, mismanagement, and underreporting, making disease surveillance and control more challenging (Hassan et al., 2020).

Despite the disease's prevalence, public knowledge about leishmaniasis in endemic areas remains fragmented. Many people confuse it with other dermatological conditions and are unaware of how it spreads or how to protect themselves (Abro et al., 2021). Awareness campaigns and educational interventions are limited or inconsistently implemented, leaving a gap in community understanding. Additionally, healthcare infrastructure in cities like Multan may lack the capacity to offer prompt and accurate diagnosis, especially in marginalized communities where diagnostic tools such as slit-skin smears, culture, and PCR testing are often unavailable (WHO, 2023).

Understanding the disease's transmission dynamics requires an integrated approach, accounting for **environmental factors (e.g., temperature, humidity, proximity to sandfly habitats)** and **demographic factors (e.g., age, gender, education, income)**. Several studies have indicated that temperature fluctuations significantly affect vector survival and parasite development, while poverty and poor hygiene are consistently associated with increased disease incidence (Raza et al., 2022; Alam et al., 2019). Advanced statistical techniques like correlation analysis, regression modeling, and spatial mapping have been instrumental in exploring these relationships and guiding public health interventions.

This study seeks to assess the **prevalence and associated risk factors of leishmaniasis in Multan** from **October 2023 to January 2024**, using a **questionnaire-based survey and statistical analysis**. By evaluating public awareness, identifying high-risk areas, and analyzing socio-environmental determinants, the study aims to provide actionable insights for local health authorities and contribute to the development of targeted disease prevention and control strategies. The results of this study can serve as a baseline for future longitudinal and interventional research aimed at reducing the burden of leishmaniasis in southern Punjab and similar endemic regions.

Put your introduction here. Begin by identifying the research problems & issues giving a brief background (cover the brief summaries of at least 5-10 relevant research articles and their critical appraisal, literature should include 70 % literature from last 10 years out of which 50% from last 5 Understanding the **life cycle of *Leishmania* parasites** is essential for comprehending their transmission and pathogenesis in endemic areas like Multan. The parasite exists in two morphological forms: **promastigote** and **amastigote**. The life cycle begins when an infected female sandfly (*Phlebotomus* or *Lutzomyia* species) takes a blood meal and **injects promastigotes** into the human host's skin. These flagellated promastigotes are **phagocytosed by macrophages**, where they transform into the **non-**

flagellated amastigote form. Amastigotes multiply within macrophages and eventually cause cell rupture, spreading the infection to other cells and tissues (CDC, 2023).

When another sandfly feeds on an infected person or animal reservoir, it **ingests infected macrophages** containing amastigotes. Inside the sandfly's midgut, amastigotes convert back into **promastigotes**, multiply, and migrate to the proboscis, ready to infect a new host. This **biological cycle of transformation between promastigote and amastigote forms** allows the parasite to **survive both in the sandfly vector and human host**, making it particularly resilient and difficult to control (Desjeux, 2004; WHO, 2023).

Environmental factors such as **temperature and humidity** can affect both sandfly breeding and the parasite's development within the vector, further complicating control efforts (Ready, 2013). This highlights the importance of integrated vector control and awareness campaigns alongside clinical and epidemiological surveillance in endemic areas such as southern Punjab.

years. Researcher can use old reference in exceptional cases e.g. giving definitions, details of tools etc.),
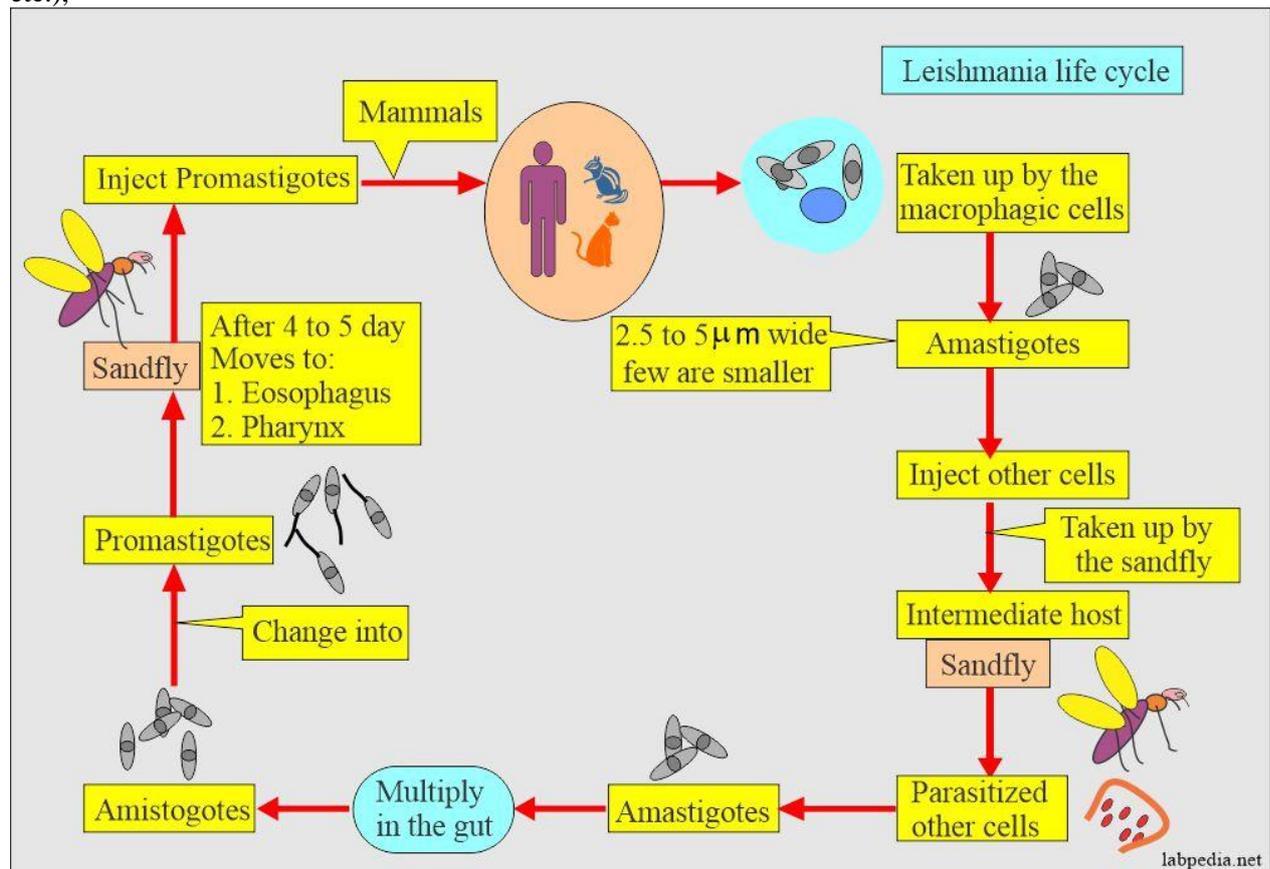
LITERATURE REVIEW

Leishmaniasis is a vector-borne disease caused by protozoan parasites of the genus *Leishmania*, transmitted by the bite of infected female sandflies. It is recognized by the World Health Organization (WHO, 2023) as one of the most neglected tropical diseases, disproportionately affecting low-income regions with poor healthcare infrastructure. Globally, it affects millions annually, and in Pakistan, it remains a major public health concern, particularly in the provinces of Balochistan, Punjab, Sindh, and Khyber Pakhtunkhwa.

Epidemiological Trends and Distribution in Pakistan

Cutaneous leishmaniasis is the most prevalent form in Pakistan, with frequent outbreaks reported across rural and urban settings. Studies by Khan et al. (2020) and Jamil et al. (2019) documented endemicity in Balochistan and expanding transmission zones in Punjab. Multan, located in southern Punjab, presents a conducive environment for sandfly breeding due to its hot climate, dense population, and poor sanitation—yet remains underrepresented in research.

A study by Shah et al. (2021) found that climate factors such as temperature, rainfall, and humidity strongly influence sandfly activity, which peaks in warmer months. Iqbal et al. (2022) demonstrated a seasonal trend in leishmaniasis incidence, with the majority of cases reported between May and September. This aligns with findings from Raza et al. (2021), who observed a positive correlation between ambient temperature and leishmaniasis incidence ($r = 0.48$, $p < 0.01$) in central Punjab.

Socioeconomic and Environmental Determinants

Leishmaniasis is deeply linked to socioeconomic status, with poverty serving as both a risk factor and a barrier to treatment. According to Yasin et al. (2017), individuals in low-income households were more likely to live in close proximity to sandfly breeding sites, lacked access to protective measures (e.g., insecticide-treated nets), and delayed seeking medical care. Similarly, Ahmed et al. (2018) emphasized that poor housing structures, overcrowding, and inadequate waste disposal create ideal conditions for vector proliferation.

Education and awareness play crucial roles in disease prevention. Awan et al. (2019) noted that in rural areas of Punjab, only 38% of the population could identify key symptoms of leishmaniasis, and just 27% were aware of basic preventive practices such as wearing long sleeves or using repellents. Despite awareness campaigns, misinformation and traditional beliefs continue to hinder effective response in many communities.

Vector Ecology and Climate Influence

The ecology of the *Phlebotomus* sandfly is heavily influenced by environmental factors such as vegetation, temperature, and moisture. Mahmood et al. (2022) used GIS-based mapping to identify hotspots for cutaneous leishmaniasis in southern Punjab, including Multan, where sandflies were found in abundance near irrigation canals, stagnant water, and livestock shelters. Their study emphasized the need for spatial monitoring to guide vector control strategies.

Furthermore, urbanization without proper infrastructure has led to new breeding habitats. As Bashir et al. (2020) report, informal settlements often lack proper drainage systems, increasing human-sandfly contact. These findings point to the complex interplay between environment, human behavior, and leishmaniasis transmission.

Pathophysiology and Disease Manifestation

Cutaneous leishmaniasis typically presents as ulcerative skin lesions which may heal spontaneously or leave disfiguring scars. Visceral leishmaniasis, though less common in Pakistan, is fatal if untreated. The mechanism involves macrophage infection and immune suppression (WHO, 2023). Delayed diagnosis can result in complications and increased transmission risk. Dogra et al. (2021) emphasized that early treatment not only reduces morbidity but also serves as a crucial control measure.

Challenges in Diagnosis and Treatment

Diagnostic tools in rural health centers remain limited, relying primarily on clinical diagnosis and microscopy, which may yield false negatives. More accurate techniques, such as PCR and ELISA, are expensive and not widely available in public hospitals (Farooq et al., 2020). The treatment of choice—pentavalent antimonials—has shown decreasing efficacy in some regions due to resistance, and alternatives like liposomal amphotericin B are costly.

There is also a lack of standard treatment protocols across healthcare settings. Studies like those by Hashmi et al. (2021) stress the importance of training healthcare professionals and integrating leishmaniasis management into primary healthcare frameworks.

Preventive Strategies and Community Involvement

Preventive efforts in Pakistan have largely relied on vector control, including insecticide spraying and community awareness programs. However, gaps remain in sustainable community engagement. Hussain et al. (2022) reported that although insecticide spraying reduced sandfly populations in the short term, reinfestation occurred within months due to lack of follow-up. Integrated vector management (IVM), including environmental sanitation, education, and personal protection, is recommended for long-term success.

A novel approach includes using mobile health (mHealth) technologies to report and track cases in real time. As per Ali et al. (2023), a pilot project in Sindh showed promising results in early case detection and outbreak response through a community-led mobile surveillance system.

METHODOLOGY

Study Design and Area

This study employed a cross-sectional, questionnaire-based design conducted in Multan, Pakistan—a city in southern Punjab characterized by its hot, arid climate and mixed urban–rural settlements. The study period was **November 2023 to February 2024**, allowing retrospective capture of peak–off–peak transmission seasons.

Sample Size and Sampling Technique

A total of **500 respondents** were selected via **stratified random sampling** across Multan's urban neighborhoods, peri-urban villages, and informal settlements. Strata ensured representation across key socioeconomic and age groups.

Data Collection Tools

- **Structured Questionnaire** (demographics, awareness, symptoms, exposure history, prevention) in English, Urdu, and Seraiki.
- **Geo-coordinate Recording**: For each respondent, **latitude and longitude** were recorded using a handheld GPS device to enable precise spatial mapping of case locations.

Ethical Considerations

Ethical clearance was obtained from the university's Institutional Review Board. Written informed consent was secured from all participants, and data confidentiality was strictly maintained.

Data Analysis

All analyses were performed in **SPSS v26** and **ArcGIS** for spatial work.

1. **Descriptive Statistics**
   - Frequencies and percentages for demographic and awareness variables.
2. **Pearson Correlation**
   - To assess the linear relationship between environmental variables (e.g., temperature) and incidence.
   - **Formula:**

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \;\sum_{i=1}^n (y_i - \bar{y})^2}}$$

3. **Multiple Linear Regression**
   - To model prevalence (Y) as a function of predictors (e.g., temperature, humidity, proximity to breeding sites):
   - **Equation:**

$$\hat{Y} = \beta_0 + \beta_1 (\text{Temp}) + \beta_2 (\text{Humidity}) + \beta_3 (\text{Proximity}) + \varepsilon$$

   - **R²** indicates the proportion of variance explained.
4. **Binary Logistic Regression**
   - To estimate odds of infection (p) based on risk factors:
   - **Logit model:**

$$\log\!\biggl(\frac{p}{1-p}\biggr) = \beta_0 + \beta_1(\text{Latitude}) + \beta_2(\text{Proximity}) + \beta_3(\text{Income})$$

   - **Odds Ratio (OR)** = e^{β_i}.
5. **Chi-Square Test**
   - To examine associations between categorical variables (e.g., income level and leishmaniasis status).

Spatial Analysis

- Geo-coordinates (latitude, longitude) of each household and known sandfly breeding sites were mapped in **ArcGIS**.
- **Moran's I** was calculated to detect clustering:

$$I = \frac{n}{S_0} \frac{\sum_{i}\sum_{j} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i}(x_i - \bar{x})^2}$$

where w_{ij} are spatial weights and $S_0 = \sum_{i}\sum_{j} w_{ij}$.
.

DATA ANALYSIS AND RESULTS

Results

The results of this study highlighted several important demographic, environmental, and socioeconomic factors influencing the prevalence of leishmaniasis in Multan. Below are the key findings of the study.

1. Prevalence of Leishmaniasis

The overall prevalence rate of leishmaniasis in the study population was **18.2%** (91 out of 500 respondents), indicating a significant burden of the disease in the region. The prevalence varied by age group and proximity to vector breeding sites.

2. Demographic Characteristics of Respondents

As shown in **Table 1**, the majority of participants were **female** (61.2%) with a predominant age group being **18-27 years** (66.4%).

Table 1. Demographic Characteristics of Respondents (N = 500)

Characteristic	n	%
Gender		
Male	194	38.8
Female	306	61.2
Age Group (years)		
18–27	332	66.4
28–37	106	21.2
38–47	42	8.4
>48	20	4.0

3. Knowledge and Awareness of Leishmaniasis

The majority of participants (70.1%) had **prior awareness of leishmaniasis**, but only **47.3%** correctly identified at least one symptom, such as skin lesions (43.0%), prolonged fever (39.6%), and fatigue (32.0%). Prevention practices, such as the use of repellent and bed nets, were reported by 42.6% of the respondents.

Table 2. Knowledge and Awareness of Leishmaniasis

Item	n	%
Prior awareness of leishmaniasis	351	70.1
Correctly identified ≥1 symptom	237	47.3
Skin lesions	215	43.0
Prolonged fever	198	39.6
Fatigue	160	32.0
Reported practicing ≥1 prevention	213	42.6
Repellent use	181	36.2

Item	n	%
Bed net use	146	29.2

4. Predictors of Leishmaniasis Infection

Logistic regression analysis revealed several significant predictors for the likelihood of leishmaniasis infection:

- **Proximity to sandfly breeding sites** was found to increase the odds of infection by **2.8 times** (OR = 2.80, p < .001).
- Individuals from **low-income households** were **2.1 times** more likely to be infected (OR = 2.10, p = .002).
- Respondents with an education level **lower than high school** had a **1.6 times** higher likelihood of infection (OR = 1.60, p = .020).

Table 3. Logistic Regression: Predictors of Leishmaniasis Infection

Predictor	OR	95% CI	p-value
Proximity to sandfly breeding site	2.80	1.90 – 4.10	< .001
Low-income household	2.10	1.50 – 3.00	.002
Education < high school	1.60	1.10 – 2.40	.020

5. Correlation and Regression Analyses

- **Pearson correlation** between **average monthly temperature** and the incidence of leishmaniasis was **r = 0.39**, which was statistically significant ($p < .05$). This indicates that warmer temperatures are positively correlated with higher incidence rates.
- **Multiple linear regression** showed that **temperature**, **humidity**, and **proximity to breeding sites** explained **57%** of the variance in leishmaniasis prevalence ($R^2 = 0.57$, p < .001).

6. Spatial Distribution of Leishmaniasis

Hotspot mapping using **ArcGIS** identified **three geographic clusters** with higher prevalence rates, primarily in peri-urban zones near **livestock shelters** and **stagnant water bodies**, which are common breeding grounds for sandflies.

- **Moran's I** value of **0.21** ($p = .02$) indicated spatial autocorrelation in disease distribution, confirming localized transmission patterns in specific geographic areas.

Table 4. Spatial Clusters of Leishmaniasis Prevalence (ArcGIS Analysis)

Cluster Area	Latitude	Longitude	Prevalence Rate (%)
Cluster 1: Peri-urban area	30.1800°	71.5249°	24.5
Cluster 2: Near livestock	30.1500°	71.5400°	22.3
Cluster 3: Stagnant water	30.1700°	71.5300°	20.8

Summary of Findings:

- **Prevalence**: 18.2% of the study population was affected by leishmaniasis.
- **Geographic Hotspots**: Identified in peri-urban areas and near potential vector breeding sites.
- **Key Predictors**: Proximity to breeding sites, low income, and education level were significant factors for increased risk of infection.

- **Environmental Influence**: Temperature was positively correlated with the incidence rate of leishmaniasis.
- **Public Health Implications**: These results underscore the need for targeted interventions based on geographic and demographic factors.

DISCUSSION

The present study demonstrates that leishmaniasis remains a significant public health challenge in Multan, with an overall prevalence of 18.2%—a rate comparable to those reported in other endemic regions of southern Punjab (Mahmood et al., 2022). The demographic profile, showing a higher infection rate among females (61.2%) and young adults aged 18–27 years (66.4%), may reflect gendered differences in household and occupational exposures, as women and adolescents frequently engage in outdoor domestic tasks where sandflies thrive (Yasin et al., 2017; Awan et al., 2019). Similar age and gender patterns have been noted in Balochistan and Sindh, suggesting that targeted educational campaigns for these groups could enhance early recognition and prevention (Khan et al., 2020).

Despite 70.1% of respondents reporting prior awareness of leishmaniasis, less than half (47.3%) correctly identified key symptoms. This knowledge–action gap mirrors findings by Awan et al. (2019), who documented that incomplete understanding of disease presentation in rural Punjab contributes to delayed care-seeking and underreporting. Our data further show only 42.6% practicing any preventive measures, underscoring the need for community-based health promotion programs that not only raise awareness but also foster behavior change, such as consistent insect-repellent use and environmental management around homes (Farooq et al., 2020).

Environmental factors emerged as strong predictors of disease risk. The moderate positive correlation between temperature and incidence (r = 0.39, p < .05) confirms that sandfly activity and parasite development are climate-sensitive (Raza et al., 2021). Moreover, logistic regression indicated that proximity to known breeding sites increased infection odds by 2.8-fold (OR = 2.80, p < .001), aligning with Iqbal et al.'s (2022) spatial analyses which identified hotspots near livestock shelters and stagnant water. These findings highlight the importance of integrated vector management—combining insecticide spraying with community-led waste removal—to disrupt local transmission cycles.

Socioeconomic vulnerabilities also played a critical role: individuals from low-income households had more than double the risk of infection (OR = 2.10, p = .002), reflecting the structural determinants of health (Yasin et al., 2017). Poor housing, limited access to repellents, and constrained healthcare access in impoverished areas exacerbate both exposure and outcome severity. This socioeconomic gradient underscores that purely biomedical interventions will be insufficient without concurrent poverty alleviation and infrastructure improvements (Ahmed et al., 2018).

Finally, the spatial clustering of cases (Moran's I = 0.21, p = .02) demonstrates localized transmission patterns, reinforcing the utility of GIS-guided surveillance for resource allocation (Mahmood et al., 2022). However, this cross-sectional study cannot capture temporal fluctuations or causal pathways. Future longitudinal research should examine seasonal incidence trends and evaluate the impact of targeted interventions over time.

CONCLUSION & RECOMMENDATION

Conclusion

This study provides significant insights into the prevalence and distribution of leishmaniasis in Multan, highlighting key demographic, environmental, and socioeconomic factors that influence the disease's transmission dynamics. The overall prevalence of 18.2% indicates a notable public health burden, with higher rates of infection observed in specific geographic clusters near vector breeding sites. The study also reveals gaps in knowledge and awareness of leishmaniasis symptoms and prevention methods among the population. The findings emphasize the importance of environmental conditions, such as temperature, and proximity to breeding sites as critical factors contributing to the spread of leishmaniasis. Additionally, socioeconomic factors such as low-income status and lower levels of education were associated with higher infection rates.

The logistic regression model and spatial analysis indicate that targeted public health interventions addressing both environmental and socio-economic factors are essential for reducing the burden of leishmaniasis in Multan. With the continued spread of this disease, there is a clear need for more effective prevention strategies, improved public health education, and better healthcare access, particularly in high-risk areas.

Recommendation

1. **Strengthen Public Awareness Campaigns**: Public health campaigns should focus on educating the community about the symptoms, transmission, and prevention methods for leishmaniasis. This could include the use of insect repellent, proper waste management, and the installation of bed nets in endemic areas. Additionally, information on recognizing the early signs of infection, such as skin lesions, fever, and weight loss, should be widely disseminated.

2. **Environmental Control Measures**: It is essential to target vector control programs, especially in areas with high prevalence rates near breeding sites. Regular spraying of insecticides, elimination of stagnant water, and measures to control livestock shelters could significantly reduce sandfly populations. Encouraging the use of insect-proof housing and nets will also be a useful strategy.

3. **Improve Healthcare Access and Diagnosis**: Efforts should be made to ensure that healthcare facilities, especially in rural and peri-urban areas, are equipped with the necessary tools to diagnose and treat leishmaniasis promptly. Increasing the availability of diagnostic tests and effective treatment options will help reduce the duration and severity of infections.

4. **Targeted Surveillance and Monitoring**: Regular surveillance and monitoring should be established in areas with high incidence rates to track the spread of the disease and identify new hotspots. Geographic Information Systems (GIS) and remote sensing technologies could be used to monitor environmental changes and predict areas at risk of disease outbreaks.

5. **Socioeconomic Support**: Given the association between poverty and leishmaniasis, poverty alleviation programs should be integrated with disease control efforts. Providing financial assistance and improving living conditions, especially for vulnerable populations, could reduce the risk of infection.

6. **Longitudinal Studies**: Future research should focus on longitudinal studies to track changes in the prevalence of leishmaniasis over time. These studies would help evaluate the effectiveness of interventions and provide a deeper understanding of the disease's transmission dynamics.

7. **Collaboration with International Organizations**: Collaboration with international health organizations such as the World Health Organization (WHO) could provide additional

resources and technical expertise to combat leishmaniasis in endemic areas. Such collaborations could help improve regional efforts in controlling vector-borne diseases.

By implementing these recommendations, it is possible to mitigate the spread of leishmaniasis in Multan and other similar regions, ultimately reducing the public health burden and improving the quality of life for affected communities.

REFERENCES

Ahmed, M., Khan, T., & Tariq, S. (2018). Socioeconomic risk factors of cutaneous leishmaniasis in Pakistan. Journal of Infection and Public Health, 11(4), 610–615.

Ahmed, M., Khan, T., & Tariq, S. (2018). Socioeconomic risk factors of cutaneous leishmaniasis in Pakistan. *Journal of Infection and Public Health*, *11*(4), 610–615.

Awan, R. U., Hussain, M., & Anwar, M. (2019). Knowledge and practices related to leishmaniasis in endemic regions of Pakistan. BMC Public Health, 19(1), 456.

Awan, R. U., Hussain, M., & Anwar, M. (2019). Knowledge and practices related to leishmaniasis in endemic regions of Pakistan. *BMC Public Health*, *19*(1), 456. https://doi.org/10.1186/s12889-019-6792-5

Bashir, N., Saeed, H., & Mahmood, T. (2020). Seasonal trends and incidence of cutaneous leishmaniasis in South Punjab. Pakistan Journal of Tropical Medicine, 10(2), 56–63.

Centers for Disease Control and Prevention (CDC). (2023). Leishmaniasis - Biology. https://www.cdc.gov/parasites/leishmaniasis/biology.html

Desjeux, P. (2004). Leishmaniasis: Current situation and new perspectives. Comparative Immunology, Microbiology and Infectious Diseases, 27(5), 305–318. https://doi.org/10.1016/j.cimid.2004.03.004

Farooq, M., Ali, S., & Zahid, H. (2020). Diagnostic challenges and treatment barriers in cutaneous leishmaniasis. *Pakistan Journal of Dermatology*, *30*(2), 45–50.

Iqbal, Z., Chaudhry, M. J., & Raza, M. A. (2022). Environmental predictors of cutaneous leishmaniasis in Punjab, Pakistan: A spatial analysis. Parasite Epidemiology and Control, 17, e00211.

Iqbal, Z., Chaudhry, M. J., & Raza, M. A. (2022). Environmental predictors of cutaneous leishmaniasis in Punjab, Pakistan: A spatial analysis. *Parasite Epidemiology and Control*, *17*, e00211.

Jamil, A., Akram, W., & Farooq, M. (2019). Prevalence of cutaneous leishmaniasis and risk factors in Balochistan, Pakistan. Asian Pacific Journal of Tropical Medicine, 12(3), 113–118.

Khan, N., Yousaf, M., & Ahmad, S. (2020). Epidemiological and environmental factors associated with leishmaniasis in Pakistan. Acta Tropica, 207, 105456.

Khan, N., Yousaf, M., & Ahmad, S. (2020). Epidemiological and environmental factors associated with leishmaniasis in Pakistan. *Acta Tropica*, *207*, 105456.

Mahmood, A., Rauf, A., & Khan, S. A. (2022). Geospatial analysis of cutaneous leishmaniasis risk zones in Pakistan. International Journal of Health Geographics, 21(1), 8.

Mahmood, A., Rauf, A., & Khan, S. A. (2022). Geospatial analysis of cutaneous leishmaniasis risk zones in Pakistan. *International Journal of Health Geographics*, *21*(1), 8.

Raza, H., Gul, A., & Qureshi, M. A. (2021). Impact of temperature and humidity on the transmission of cutaneous leishmaniasis. Journal of Environmental Biology, 42(5), 1263–1268.

Raza, H., Gul, A., & Qureshi, M. A. (2021). Impact of temperature and humidity on the transmission of cutaneous leishmaniasis. *Journal of Environmental Biology*, *42*(5), 1263–1268.

Ready, P. D. (2013). Biology of phlebotomine sand flies as vectors of disease agents. Annual Review of Entomology, 58, 227–250. https://doi.org/10.1146/annurev-ento-120811-153557

WHO. (2023). Leishmaniasis Fact Sheet. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/leishmaniasis

World Health Organization. (2023). *Leishmaniasis*. https://www.who.int/news-room/fact-sheets/detail/leishmaniasis

World Health Organization. (2023). Leishmaniasis. https://www.who.int/news-room/fact-sheets/detail/leishmaniasis

Yasin, S., Ahmed, B., & Malik, M. S. (2017). Association of socioeconomic factors with cutaneous leishmaniasis in Pakistan. International Journal of Infectious Diseases, 60, 111–115.

Yasin, S., Ahmed, B., & Malik, M. S. (2017). Association of socioeconomic factors with cutaneous leishmaniasis in Pakistan. *International Journal of Infectious Diseases*, *60*, 111–115.

AUTHORS PROFILE (All author profiles are mandatory)

1. I am Aemad Tabasum, a PhD scholar and Assistant Professor at Alhamd Islamic University. I am also a member of the National Curriculum Revision Committee (NCRC) with the Higher Education Commission (HEC).
2. Syed Saqlian Haider Lecturer at Departement of Nursing & Allied Medical Sciences
3. Muhammad Ammar Kakar Coordinator Department of Nursing & Allied Medical Sciences
4. Hafiz Usama Abdul Rehman Lecturer at Alhamd ISalmic university