Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Risk Factors of Leptospirosis in a District in the Northern State of India: A Case-Control Study

Anurag Dhoundiyal

a.dhoundiyal@safetynet-web.org

National Center for Disease Control

Sushma Choudhary

SAFETYNET

Ankoor Tyagi

Directorate of Medical and Health Services, Rajasthan

Christine Atherstone

Centers for Disease Control and Prevention

Ramesh Chandra

National Center for Disease Control

Deepa Meena

Directorate of Medical and Health Services, Rajasthan

Praveen Aswal

Directorate of Medical and Health Services, Rajasthan

Supriya Gambhir

Microbiologist

Research Article

Keywords: Outbreak, Zoonosis, Climate change, One-health, Rodents

Posted Date: July 28th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-6588951/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background: Leptospirosis is a neglected zoonotic disease caused by *leptospira* bacteria, primarily transmitted through contact with contaminated water or soil. While endemic in several parts of India, its presence in Rajasthan, an arid region, remains underreported. This study investigates the risk factors for leptospirosis in Sawai Madhopur, a district in Rajasthan that has recently reported an increase in cases.

Methods: A hospital-based case-control study was conducted from January to September 2023. Cases were defined as individuals suspected and tested positive for leptospirosis via IgM ELISA, while controls were age-matched inpatients from surgical wards. A structured questionnaire was used to assess sociodemographic and environmental risk factors. Data were analyzed using univariate and multivariate logistic regression.

Results: A total of 42 cases and 80 controls were included. The median age was 26.5 years. Females were 60%. Fever was seen in 96% of cases. Risk factors included exposure to heavy rainfall or flooding (AOR 4.2, CI 1.1-15.6) and contact with sewage or dirty water (AOR 5.8, CI 1.6-20.3). Contact with animals was seen as significant in univariate analysis (OR 3, CI 2-7.3) but not in multiple regression. Rural housing was protective in multivariate analysis (AOR 0.3, CI 0.1-0.9). Housing types were not significantly associated with infection.

Conclusions: Sewage, dirty water contact and flooding were significant risk factors and housing type was not, rural residence was protective. Enhanced surveillance, improved sanitation, and healthcare provider training are essential for early detection and control. Public awareness initiatives should target high-risk populations, particularly women, to prevent further outbreaks.

Background

Leptospirosis is a neglected tropical zoonotic disease caused by the spirochetal bacteria, *Leptospira*, which primarily spreads through contact with water, soil, or food contaminated with the urine of infected animals.[1,2] The disease is suspected in people having direct or indirect contact with animals, contaminated food, water or soil and presenting with acute febrile illness with headache, myalgia and prostration with calf muscle tenderness, conjunctival suffusion, nausea, vomiting, abdominal pain, diarrhoea and in severe cases jaundice, anuria or oliguria and proteinuria and meningeal irritation.[3] IgM ELISA is a screening test, while the confirmatory test is the Microscopic Agglutination Test (MAT), Polymerase Chain Reaction (PCR), Whole Genomic Sequencing (WGS) or the isolation of spirochaete from a sample.

Cattle and domestic animals are particularly susceptible to leptospirosis and late occurrence during gestation can cause stillbirth, abortion and neonatal disease.[4,5] In India, the disease is known to occur in rural populations having frequent cattle interactions, urban slum-dwellers, areas with heavy rainfall, and coastal regions[6–10]. Other risk factors for the disease include environmental exposure, farming, recreational activities in natural water bodies, poor sanitation and hygiene, rodent infestations, and travel

to endemic areas. There is also an increased risk for veterinarians, pet rescuers, pet owners and abattoir workers.[11–13]

The annual global incidence of leptospirosis is estimated to be around 14.77 cases and 0.84 deaths per 100,000 people.[10] Southeast Asia is among the highest-burden areas with an annual incidence rate of around 55 per 100,000 people.[10]The disease is known to occur in the Indian sub-continent in many areas and is present in a sizeable proportion of the cases with acute febrile illness, in country-specific multi-centric trials it is found to be around 12% in all the cases of fever[14,15]. In developing countries like India, most of the outbreaks occur after natural disasters or the post-monsoon period[14], The country has seen outbreaks in the states of Karnataka, Maharashtra, Odisha, West Bengal, Andamans, Gujarat and many other coastal regions.[6,7,9,14,16–20]

The northern part of the Indian sub-continent, however, has reported fewer leptospirosis cases over the years. Despite limited awareness, the prevalence of about 7-11% in patients with acute fever[21–24] in northern India. Rajasthan, a state in the northwestern part of the Indian sub-continent (Figure 1), lies in the arid zone, and most of the regions in the state receive average to low rainfall throughout the year[25], and flooding is infrequent. There have been only a few sporadic cases of the disease in the state, and the level of leptospirosis suspicion in patients is low. There is a shortage of proper surveillance and diagnosis of the disease, which makes estimating the true burden of disease difficult.[26]

Leptospirosis is reported by case-based surveillance in the Integrated Disease Surveillance Program which is a national-level surveillance program reporting infectious diseases and diseases of public health importance.

Sawai Madhopur district is one of the smallest districts in Rajasthan. The district is home to one the largest wildlife sanctuaries in the country, known as “The Ranthambore Tiger Reserve”. Its yearly average temperature is 30.2ºC (86.36ºF), which is 4.23% higher than the national average. Sawai Madhopur typically receives about 92.86 millimetres (3.66 inches) of precipitation and has 79.26 rainy days annually[27] The district reported a sudden surge of leptospirosis cases in 2019 and has been recording cases since then. The district reported 21 cases in 2021, 29 cases in 2022, and continues to report cases in 2023. There is a dearth of studies on leptospirosis in the district and state. The present study attempts to gain insight into the risk factors for leptospirosis infection in this district, which is currently considered non-endemic for the disease.[28,29]

Methodology

We conducted a hospital-based case-control study in the district hospital of Sawai Madhopur district from January to September 2023. A case was defined as a resident of Sawai Madhopur district who tested positive for leptospirosis from January 2021 to September 2023 using IgM Enzyme-Linked Immunosorbent Assay (ELISA). The cases were selected from the patients admitted to the hospital with the complaint of fever or suspected by the physician for leptospirosis and tested positive for

leptospirosis using the Abbott PanBioÔ IgM ELISA kit for leptospirosis (sensitivity 96.5%, specificity 98.5%). A line list of patients who tested positive for leptospirosis in the years 2022 and 2021 was accessed from the hospital and were approached for a telephonic interview. We excluded the patients with other infections like malaria, dengue, typhoid and hepatitis A infection (tested by IgM ELISA, Trustwell©) since it may show cross-reactivity on the Abbott PanBio, leading to false positives.

Informed verbal consent was taken before the interview. We excluded the non-consenting adults and children whose parents did not consent to the interview. Leptospirosis testing was performed by a trained microbiologist of the district hospital. We selected two age-matched (±5yrs) controls per case from the patients admitted in the wards of otorhinolaryngology, general surgery, orthopaedics, burns and obstetrics unit of the district hospital. **We interviewed the study participants using a structured questionnaire adapted from the U.S. Centers for Disease Control and Prevention (CDC)[30]** case record form for reporting leptospirosis. It contained questions about sociodemographic details, including gender, age, type of residence like whether they lived in “pucca house” (houses totally made of cement, concrete and bricks) or kuccha house (houses made fully or partially of grass, bamboo, thatch or muds and with minimal bricks and cement) or mixed house with cement walls and thatched roof, and area of residence whether (urban or rural), type of symptoms, health-seeking behavior and possible risk factors such as contact with dirty water, occupation and contact with animals.

All the data was collected through interviews using Epi-collect and analysed using Epi-info version 7.2.5 (developed by CDC in Atlanta, Georgia, U.S.) and R A descriptive analysis of the data was done. Univariate logistic regression was performed to calculate the odds ratio (OR) with a 95% confidence interval (CI). We did a multivariate logistic regression with potential risk factors mentioned in the literature i.e. rural residence, age and gender, and we also adjusted for known confounders and included the variables which on univariate analysis had an OR >1 and a p-value of ≤0.2.

This ethical clearance for conducting this study was obtained from the Public Health Emergency Operational Research Review Board of National Centre for Disease Control (NCDC), Delhi, India (Approval no. File no. 4-6/2018-EIS cell, GHSA). Permission was also sought from Directorate of Medical and Health Services, Government of Rajasthan, India. All participants provided informed consent prior to their participation in the study. For participants under the age of 18, informed consent was obtained from a parent and/or legal guardian. Strict data protection protocols reviewed by the NCDC were followed while collecting information from cases and controls.

Results

We interviewed 42 leptospirosis case patients who met the case definition. We recruited 80 age-matched control from the surgical wards. The highest number of cases (n=13, 31%) were 20-29 years old and the median age of the cases was 26.5 (18-40) years (Table 1). Females constituted 60% of the cases; 64% of the cases lived in rural areas. Activities like farming, labour and dairy were seen in 42% cases while 21% were homemakers. Fifty-five percent(55%) of the cases lived in a pucca house (made up of brick and

stones) while in 38% of cases, the house in which they lived was made from both brick as well as bamboo and other items like straws. Three cases had kutcha houses (made only of straw, grass and bamboo sticks)

Fever was seen in 96% (40) of cases, followed by joint pain and body aches in 33%(14) of patients. (Figure 2) Nausea and vomiting were seen in 31% (13) of cases, while jaundice was observed in 2% (1) of cases. Symptoms like abdominal pain, cough and chills were also present.

Gender-wise segregation of the cases accessing the first healthcare approach showed that 56% of the females sought healthcare in government health facilities, 29% of cases went first to local practitioners, and only one used home remedies first. (Table 2) In the cases of males, government health facilities were the first point of healthcare contact in 41% (7) cases, and 29% (5) males went to local faith healers also; however, they did not take any home remedies before showing up at health facilities.

There was no significant difference in the baseline characteristics of the cases and controls, like age, gender, and sociodemographic features. (Table 3)

Environmental and Occupational factors (Table 1)

Exposure to flooding or heavy rainfall (OR: 7.7, 95% CI: 2.6-23), sewage or dirty water (OR: 5.2, 95% CI: 2.1-13.2), and animal contact (OR: 3.0, 95% CI: 1.2-7.3) were significant risk factors for leptospirosis, while residing in a rural area (OR: 0.6, 95% CI: 0.2-1.2) or having a “Kuccha house” (OR: 0.4, 95% CI: 0.1-1.3) was not associated with increased odds of the disease. (Table 4) Occupations involving contact with soil, animals or dirty water also had an OR of more than 1 (1.3, 95% Confidence Interval: 0.4-3.6); however, this association was not found to be significant.

Multivariate Logistic Regression (Table 4)

A multivariate logistic regression analysis after adjusting for possible confounders like gender and **adjusted odds ratios (AORs)** was calculated. "Heavy rain within one month/flooding near home" (AOR 4.2, 95% CI 1.2-15.6, p=0.028) and "Sewage/dirty water contact" (AOR 7, 95% CI 1.9-26, p=0.006) were found to be significantly associated with increased odds of having leptospirosis, both before and after adjustment. In the regression model, being in rural area had a protective effect on the leptospirosis (AOR 0.28, 95% CI 0.08-0.95, p=0.04). Other factors, including age, animal contact, occupation, untreated water consumption, living in a kaccha house, open defecation, and travel history, were not significantly associated with the outcome after adjustment.

Discussion

This is one of the very few studies describing risk factors for leptospirosis in Rajasthan, a region not typically considered a high-burden or endemic area for the disease.[31] We found that the contact such as waddling through with dirty water or sewage or flood water is one of the independent risk factors for

acquiring leptospirosis, while the animal contact and occupation were not found to be significant independent risk factors. Furthermore the socio-environmental factors like rural residence and type of houses were not risk factors for acquiring, however the rural residence had a significantly protective factor. These findings emphasize that the infection is driven by water contamination which can follow extreme weather events.

Females outnumbered males in our study, a surprising finding when compared to other studies by Kembhavi et al[16], Holla et al[6] , Davoodi et al[32] leptospirosis is more frequently reported in males, likely as a result of males predominating occupations that may put them at risk for infection. This study was conducted in a government healthcare facility, which is the only point of testing and care for leptospirosis in the district. In this district, males primarily seek care at private healthcare facilities, while females seek care at government facilities, where services are free of charge.[33] As a result, a significant number of leptospirosis cases in this study involved female patients, which may reflect healthcare-seeking behavior rather than the true gender distribution of disease incidence.

In our study, the highest number of cases were in individuals aged 20 -39 years, similar to previous studies[10,16,34] Fever was the most common presenting symptom of leptospirosis, observed in nearly all of our cases, with abdominal and joint pain present in about one-third of patients, while jaundice was rare, and no deaths were reported. Previous studies have also seen similar symptoms of leptospirosis. [15,34,38] Due to low clinical suspicion and, non-specific nature of fever, testing for leptospirosis is uncommon. This is further supported by the fact that case patients sought care at multiple facilities before being tested for leptospirosis. Underreporting may occur due to low suspicion in non-endemic areas, the need for acute blood samples for diagnosis, and the fact that only half of the cases initially sought care at the district hospital, the sole testing center, highlighting delays in diagnosis and gaps in public awareness.

We found contact with dirty water or sewage as a significant risk factor, also flooding near the house within the last months was also found to be a significant risk factor for the causation of leptospirosis, dirty water contaminated by the urine of infected animals like cattle, pigs, horses, rodents, dogs and wild animals is a known risk factor for leptospirosis.[7,44] Flood water and dirty standing water have a risk of being contaminated with the urine of rats and domestic animals, standing or wading through this water is a known risk for the causation of leptospirosis Findings like these have also been registered by other studies in the subcontinent.[7,37–39] The risk factors for leptospirosis can be different in rural and urban areas. More people in rural areas might get the disease due to factors like having cattle at home, open canal bathing, and rice farming. [9,16] However, our study found rural residence to be a protective factor for leptospirosis. This can be explained by the presence of sewage, stagnant water and rodent interaction in the unplanned urban areas specially in the settlements which are unplanned. [9,40,40–45] The finding may point towards a failure of urban planning and sanitation which can enhance the rodent and other risk factor interactions with humans.

Exposure to heavy floods and heavy rainfall is a known risk factor for the causation of the disease that has been observed in major studies and the literature available on leptospirosis.[7,16,20,46–49] This finding is particularly important because Sawai Madhopur is a district with high rainfall in a semi-arid state with all the risk factors present in the district favourable for the causation of leptospirosis, which makes it prone to disease outbreaks that might be overlooked due to the assumed low presence of the disease in the state. Apart from this, there is a known absence of focused active surveillance for the disease in the area after heavy rains, coupled with it, limited suspicion by the physicians for the disease, makes the conditions go unnoticed in the population and can result in outbreaks and gross under-reporting.

This study had some limitations. Firstly, since it is a hospital-based study, the cases were mainly from the catchment areas of the hospital. Patients included in the study were all clinical cases and subclinical cases or mild cases may have been missed. Furthermore, there may be recall bias amongst the cases and controls. This was mitigated by having accurate case and control definitions and probing questions on the exposures through in-depth interviews. Another limitation was that we recruited cases from the prior year while the controls were recruited from the current year. However, there were no significant natural disasters, major floods, or changes in annual rainfall in the three years before this study. In addition to these, one limitation is due to the ELISA test used as the sole confirmatory test due to logistical and infrastructural constraints in the study district, where it is the only available assay at district and state (Rajasthan) levels which can show positivity up to 5 months post-infection. However, we used the kit with high sensitivity and specificity, and we also tested the patients who had symptoms of Leptospirosis during the study, making the chance of a false positive very low.

This study shows that leptospirosis is present in Rajasthan, despite assumptions that the disease is not endemic. Further research, including sero-surveillance, can be undertaken to accurately assess the true burden of the disease within the district. Exposure to flood water and heavy rainfall was associated with cases. Consequently, public health strategies must be focused on robust drainage system and sanitation protocols for mitigating risk specially during extreme weather events, it also underscores the importance of having effective surveillance for early detection of disease outbreaks and a robust health action plan accounting for climate change. More of our cases were females; therefore, we recommend education outreaches focused on females to prevent infection. Given that case patients sought care at multiple health facilities before being diagnosed, we recommend the education of healthcare professionals to increase clinical suspicion of leptospirosis, improve early case detection and treatment, and ultimately enhance patient outcomes.

In conclusion, the main risks for leptospirosis in Sawai Madhopur were the floods or heavy rainfall and contact with sewage infested or dirty water. Animal contact can also be considered as an independent risk factor. Public health intervention should focus on sanitation and proper drainage of water in urban and rural areas to reduce exposure. Healthcare providers must be trained to recognize symptoms and ensure timely diagnosis, supported by accessible testing protocols. Public awareness campaigns can further educate at-risk populations on preventive measures. A larger study can also be planned out to estimate the true burden of disease in the district and the state.

Declarations

Ethical approval and consent to participate

The ethical clearance was obtained from the Public Health Emergency Operational Research and Review Board of the National Centre of Disease Control (PHEORRB-File No. 4-6/2018-EISCell, GHSA/16/05/2023). Strict data protection protocols reviewed by NCDC, ethical principles and guidelines by the Government of India, and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards were followed during data handling.

Informed verbal consent was taken before the interview. Consent of the parents was taken in participants who were less than 18 years of age. We excluded the non-consenting adults and children whose parents did not consent to the interview.

Availability of data and materials:

The data that support the findings of this study are available from the state health department under the Rajasthan Government. Restrictions apply to the availability of these data. Data are, however, available from the authors upon reasonable request and with permission of the state.

Competing interests

The authors declare that they have no competing interests to declare that are relevant to the content of this article.

Funding

The project was funded by the CDC/TEPHINET through the Sarah Lowther Small Grant 2023. The funding is provided to the trainees under the Advanced Field Epidemiology Training Program and does not involve publication costs or stipend.

Authors contribution

AD, SC and CA conceived the study design. AD, DM and AT acquired on-field data. AD and SG analysed the data and reported the results. AD wrote the original manuscript text and prepared the tables. BLR created the figures. SC, CA, RC and PA substantially revised and edited the manuscript. All authors reviewed the manuscript, approved the submitted version, and agreed to be personally accountable for the manuscript.

Acknowledgements :

We would like to acknowledge the healthcare staff and Principal Medical Officer of the District Hospital of Sawai Madhopur for facilitating the data collection and conduct of this study. The authors

acknowledge the financial support provided by the Sarah Lowther Small Grant from the Centers for Disease Control and Prevention (CDC) for this project.

References

1. Crecelius EM, Burnett MW. Leptospirosis. J Spec Oper Med Peer Rev J SOF Med Prof 2020;20(4):121–2.
2. Bharti AR, Nally JE, Ricaldi JN, Matthias MA, Diaz MM, Lovett MA, et al. Leptospirosis: a zoonotic disease of global importance. Lancet Infect Dis 2003;3(12):757–71.
3. National-Guidelines-Diagnosis-Case-Management-Prevention-control-of-leptospirosis.pdf [Internet]. [cited 2024 June 14];Available from: https://ncdc.mohfw.gov.in/wp-content/uploads/2024/05/National-Guidelines-Diagnosis-Case-Management-Prevention-control-of-leptospirosis.pdf
4. Ellis WA. Animal Leptospirosis [Internet]. In: Adler B, editor. Leptospira and Leptospirosis. Berlin, Heidelberg: Springer Berlin Heidelberg; 2015 [cited 2023 Apr 27]. page 99–137.Available from: https://link.springer.com/10.1007/978-3-662-45059-8_6
5. Ellis WA. Leptospirosis as a cause of reproductive failure. Vet Clin North Am Food Anim Pract 1994;10(3):463–78.
6. Holla R, Darshan B, Pandey L, Unnikrishnan B, Kumar N, Thapar R, et al. Leptospirosis in Coastal South India: A Facility Based Study. BioMed Res Int 2018;2018:1759125.
7. Bhardwaj P, Kosambiya JK, Desai VK. A case control study to explore the risk factors for acquisition of leptospirosis in Surat city, after flood. Indian J Med Sci 2008;62(11):431–8.
8. Beri D, Moola S, Jagnoor J, Salam A, Bhaumik S. Prevention, control and management of leptospirosis in India: an evidence gap map. Trans R Soc Trop Med Hyg 2021;115(12):1353–61.
9. Vikram K, Agarwala P, Bhargava A, Jain Y, Jagzape T, Wasnik P. Scrub typhus and leptospirosis in rural and urban settings of central India: a preliminary evaluation. Trop Doct 2020;50(2):111–5.
10. Costa F, Hagan JE, Calcagno J, Kane M, Torgerson P, Martinez-Silveira MS, et al. Global Morbidity and Mortality of Leptospirosis: A Systematic Review. PLoS Negl Trop Dis 2015;9(9):e0003898.
11. Wynwood SJ, Graham GC, Weier SL, Collet TA, McKay DB, Craig SB. Leptospirosis from water sources. Pathog Glob Health 2014;108(7):334–8.
12. Garba B, Bahaman AR, Bejo SK, Zakaria Z, Mutalib AR, Bande F. Major epidemiological factors associated with leptospirosis in Malaysia. Acta Trop 2018;178:242–7.
13. Bovet P, Yersin C, Merien F, Davis CE, Perolat P. Factors associated with clinical leptospirosis: a population-based case-control study in the Seychelles (Indian Ocean). Int J Epidemiol 1999;28(3):583–90.
14. Victoriano AFB, Smythe LD, Gloriani-Barzaga N, Cavinta LL, Kasai T, Limpakarnjanarat K, et al. Leptospirosis in the Asia Pacific region. BMC Infect Dis 2009;9:147.

15. Sehgal SC, Sugunan AP, Vijayachari P. Leptospirosis disease burden estimation and surveillance networking in India. Southeast Asian J Trop Med Public Health 2003;34 Suppl 2:170–7.
16. Kembhavi RS, Velhal GD, Shah AK. Epidemiological determinants of leptospirosis in rural and urban districts of Maharashtra, India. J Fam Med Prim Care 2021;10(9):3361–7.
17. Narayanan R, Sumathi G, Prabhakaran SG, Shanmughapriya S, Natarajaseenivasan K. Paediatric leptospirosis: A population based case-control study from Chennai, India. Indian J Med Microbiol 2016;34(2):228–32.
18. Parveen SMA, Suganyaa B, Sathya MS, Margreat AAP, Sivasankari K, Shanmughapriya S, et al. Leptospirosis Seroprevalence among Blue Metal Mine Workers of Tamil Nadu, India. Am J Trop Med Hyg 2016;95(1):38–42.
19. Sachu A, Madhavan A, Vasudevan A, Vasudevapanicker J. Prevalence of dengue and leptospirosis co-infection in a tertiary care hospital in south India. Iran J Microbiol 2018;10(4):227–32.
20. Sarkar U, Nascimento SF, Barbosa R, Martins R, Nuevo H, Kalofonos I, et al. Population-based case-control investigation of risk factors for leptospirosis during an urban epidemic. Am J Trop Med Hyg 2002;66(5):605–10.
21. Sethi S, Sood A, Pooja null, Sharma S, Sengupta C, Sharma M. Leptospirosis in northern India: a clinical and serological study. Southeast Asian J Trop Med Public Health 2003;34(4):822–5.
22. Bhatia M, Kumar P, Gupta P, Gupta PK, Dhar M, Kalita D. Serological evidence of human leptospirosis in patients with acute undifferentiated febrile illness from Uttarakhand, India: A pilot study. J Lab Physicians 2019;11(1):11–6.
23. Dhanashree B, Shenoy S. Seropositivity for dengue and Leptospira IgM among patients with acute febrile illness: an indicator of co-infection? Germs 2021;11(2):155–62.
24. Sethi S, Sharma N, Kakkar N, Taneja J, Chatterjee SS, Banga SS, et al. Increasing Trends of Leptospirosis in Northern India: A Clinico-Epidemiological Study. PLoS Negl Trop Dis 2010;4(1):e579.
25. Garg KK, Akuraju V, Anantha KH, Singh R, Whitbread AM, Dixit S. Identifying potential zones for rainwater harvesting interventions for sustainable intensification in the semi-arid tropics. Sci Rep 2022;12(1):3882.
26. Agarwal RG, Gupta KD, Bharadwaj TP. Leptospirosis in Bikaner (Rajasthan). A case report. J Assoc Physicians India 1971;19(1):53–4.
27. Sawai Madhopur, Rajasthan, IN Climate Zone, Monthly Averages, Historical Weather Data [Internet]. [cited 2024 Feb 23];Available from: https://weatherandclimate.com/india/rajasthan/sawai-madhopur#
28. Antima, Banerjee S. Modeling the dynamics of leptospirosis in India. Sci Rep 2023;13(1):19791.
29. National Centre for Disease Control. DISEASE SURVEILLANCE UNDER IDSP: MANUAL FOR HEALTH WORKERS. 2015;

30. CDC. Leptospirosis Case Definition and Reporting [Internet]. Leptospirosis2025 [cited 2025 May 21];Available from: https://www.cdc.gov/leptospirosis/php/surveillance/index.html
31. Manjunathachar HV, Barde PV, Chouksey V, Tiwari P, Mathapati B, Shrivastava S, et al. Leptospirosis in central India: A retrospective study to explore burden of tropical illness. Indian J Med Microbiol 2024;51:100689.
32. Davoodi L, Razavi A, Jafarpour H, Heshmati M, Soleymani E, Ghasemian R. Relationship Between the Prevalence of Blood Groups and Severity of Leptospirosis: A Case-Control Study. Infect Dis 2020;13:1178633720936273.
33. Singh H, Singh RA. Gender and Inequality in Access to Healthcare Facilities in India: Evidence from NSSO's 75th Round on Health. Millenn Asia 2023;09763996231195663.
34. Udayar SE, Chengalarayappa NB, Madeshan A, Shivanna M, Marella K. Clinico Epidemiological Study of Human Leptospirosis in Hilly Area of South India-A Population Based Case Control Study. Indian J Community Med Off Publ Indian Assoc Prev Soc Med 2023;48(2):316–20.
35. Yang HY, Hsu PY, Pan MJ, Wu MS, Lee CH, Yu CC, et al. Clinical distinction and evaluation of leptospirosis in Taiwan--a case-control study. J Nephrol 2005;18(1):45–53.
36. Yanagihara Y, Villanueva SYAM, Yoshida SI, Okamoto Y, Masuzawa T. Current status of leptospirosis in Japan and Philippines. Comp Immunol Microbiol Infect Dis 2007;30(5–6):399–413.
37. Deodhar D, John M. Leptospirosis: experience at a tertiary care hospital in northern India. Natl Med J India 2011;24(2):78–80.
38. Desai KT, Patel F, Patel PB, Nayak S, Patel NB, Bansal RK. A case-control study of epidemiological factors associated with leptospirosis in South Gujarat region. J Postgrad Med 2016;62(4):223–7.
39. Chauhan V, Mahesh DM, Panda P, Mokta J, Thakur S. Profile of patients of leptospirosis in sub-Himalayan region of North India. J Assoc Physicians India 2010;58:354–6.
40. Felzemburgh RDM, Ribeiro GS, Costa F, Reis RB, Hagan JE, Melendez AXTO, et al. Prospective Study of Leptospirosis Transmission in an Urban Slum Community: Role of Poor Environment in Repeated Exposures to the Leptospira Agent. PLoS Negl Trop Dis 2014;8(5):e2927.
41. Lau C. Urbanisation, climate change, and leptospirosis: environmental drivers of infectious disease emergence. Clim Change 2009;
42. Lau CL, Smythe LD, Craig SB, Weinstein P. Climate change, flooding, urbanisation and leptospirosis: fuelling the fire? Trans R Soc Trop Med Hyg 2010;104(10):631–8.
43. Loganathan N, Shivakumar S. Epidemiological Risk Factors of Urban Leptospirosis in North Chennai (Tamil Nadu) - A South India Study. Int J Infect Dis 2008;12:e447–8.
44. Reis RB, Ribeiro GS, Felzemburgh RDM, Santana FS, Mohr S, Melendez AXTO, et al. Impact of environment and social gradient on Leptospira infection in urban slums. PLoS Negl Trop Dis 2008;2(4):e228.
45. Sahimin N, Sharif SA, Mohd Hanapi IR, Nai Chuan S, Lewis JW, Douadi B, et al. Seroprevalence of Anti-Leptospira IgG and IgM Antibodies and Risk Assessment of Leptospirosis among Urban Poor

Communities in Kuala Lumpur, Malaysia. Am J Trop Med Hyg 2019;101(6):1265–71.
46. Moola S, Beri D, Salam A, Jagnoor J, Teja A, Bhaumik S. Leptospirosis prevalence and risk factors in India: Evidence gap maps. Trop Doct 2021;51(3):415–21.
47. Schønning MH, Phelps MD, Warnasekara J, Agampodi SB, Furu P. A Case-Control Study of Environmental and Occupational Risks of Leptospirosis in Sri Lanka. EcoHealth 2019;16(3):534–43.
48. Haake DA, Levett PN. Leptospirosis in humans. Curr Top Microbiol Immunol 2015;387:65–97.
49. Guerra MA. Leptospirosis. J Am Vet Med Assoc 2009;234(4):472–8, 430.

Tables

Table 1: Sociodemographic characteristics of the cases of Leptospirosis, Sawai Madhopur, Rajasthan 2023 (N=42)

Variables	Female(n=25) n(%)	Male(n=17) n(%)	Total(n=42) n(%)
Age group			
0-9	2 (8)	1 (6)	3 (7)
10-19	4 (16)	4 (24)	8 (19)
20-29	8 (32)	5 (29)	13 (31)
30-39	6 (24)	0	6 (14)
40-49	3 (12)	2 (12)	5 (12)
50-59	1 (4)	4 (24)	5 (12)
More than 60	1 (4)	1 (6)	2 (5)
Residence			
Rural	15 (60)	12 (71)	27 (66)
Urban	10 (40)	5 (29)	15 (34)
Occupation			
Farmer	4 (16)-	7 (41)	11 (26)
Pvt Job	9 (36)	5 (29)	14 (33)
Housewife	9 (36)	0 (0)	9 (21)
Labourer	2 (8)	4 (23)	6 (14)
Dairy worker	0 (0)	1 (6)	1 (2)
Nurse	1 (4)	0 (0)	1 (2)
Type of House			
Pucca House	15 (60)	8 (47)	23 (55)
Mixed	9 (36)	7 (41)	16 (38)
Kuccha House	1 (4)	2 (12)	3 (7)

Table 2: First Healthcare Contact by Leptospirosis Cases, Sawai Madhopur, Rajasthan 2023 (N=42)

Health seeking	Male n (%)	Female n (%)	Count
Government Health Facility	7 (41)	14 (56)	21 (50)
Local Practitioners	5 (29)	7 (28)	12 (29)
Local Faith Healers/Quacks	5 (29)	3 (12)	8 (19)
Home Remedy	0 (0)	1 (4)	1 (2)
Total	17 (100)	25 (100)	42 (100)

Table 3: Comparison of baseline characteristics of cases and controls (N=122)

Characteristic	Case (n=42)	Control (n=80)	P-value
Mean Age (yrs)	29.8±15.9	30.6±14.4	0.5386
Sex			
Male	17	32	0.93
Female	25	48	
Sociodemographic			
Urban	15	18	0.1
Rural	27	62	
Education			
Illiterate	9	24	0.5
Primary	18	28	
Secondary	8	14	
Graduate & above	6	11	
Other	1	3	

Table 4: Possible Risk Factors of Leptospirosis cases in the study Sawai Madhopur, Rajasthan 2023 (N=42)

Risk Factor	OR (CI)	p-value	AOR (CI)	p-value
Gender (Female)	0.4(0.2-2.4)	0.6	0.5 (0.1-1.4)	0.3
Heavy rain/flooding within one month	**7.7 (2.6-23)**	**0.0002**	4.2(1.2-15.6)	**0.028**
Sewage/dirty water contact	**5.9(2.2-16)**	**0.0004**	5.8(1.6-20.3)	**0.006**
Animal Contact	3(1.2-7.3)	0.01	3.2(0.9-10.7)	0.06
Rural residence	**0.6 (0.3-1.2)**	**0.1**	**0.3(0.1-0.9)**	**0.04**
Open Defecation	3.7(0.9-15)	0.06	1.4(0.7-1.9)	0.22
Kaccha House	1.2 (0.6-2.6)	0.6	-	
Consumption of untreated water	1.2(0.4-3.6)	0.7	-	
Travel History	2 (0.4-9.1)	0.4	-	
Occupation*	1.3(0.6-3)	0.5	-	

Abbreviations: CI = Confidence Interval, OR = Odds Ratio, AOR = Adjusted Odds Ratio

*work involving interaction with animals or dirty water,

Nagelkerke's R2: 0.471048, concordance: 0.8

Figures

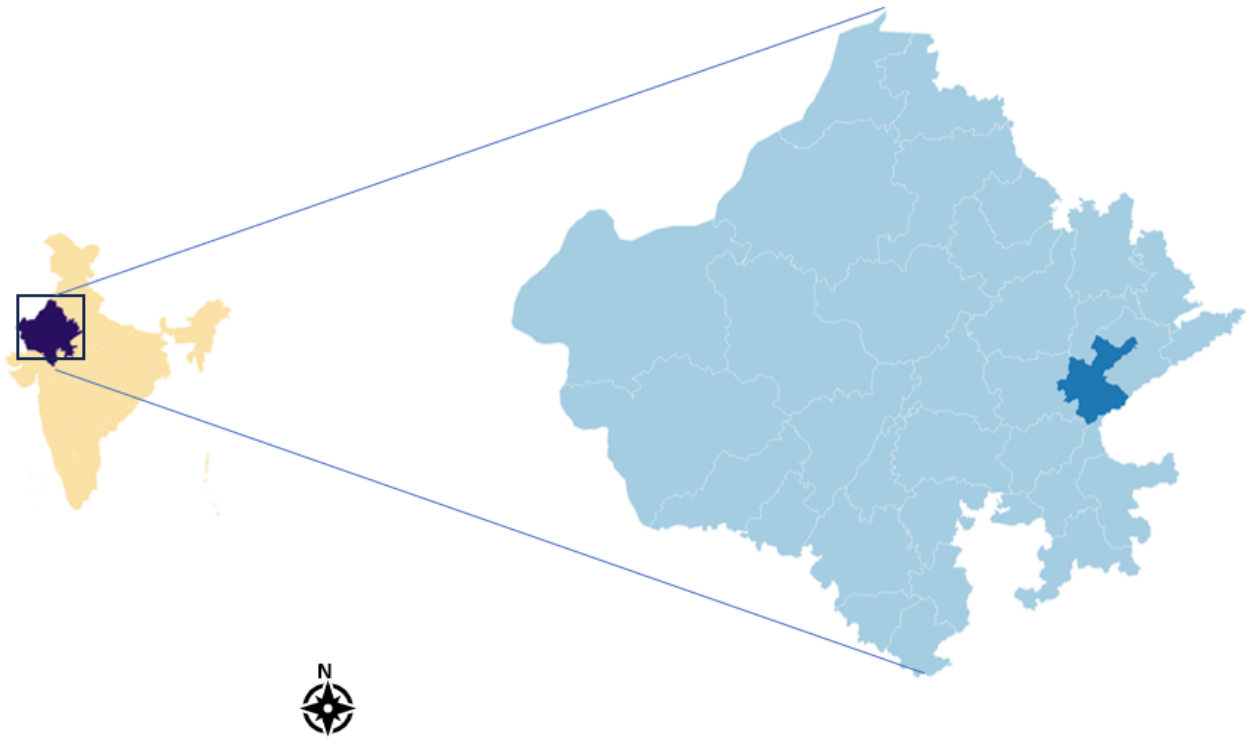


Figure 1

An overview of the location of Sawai Madhopur District in the state of Rajasthan, India

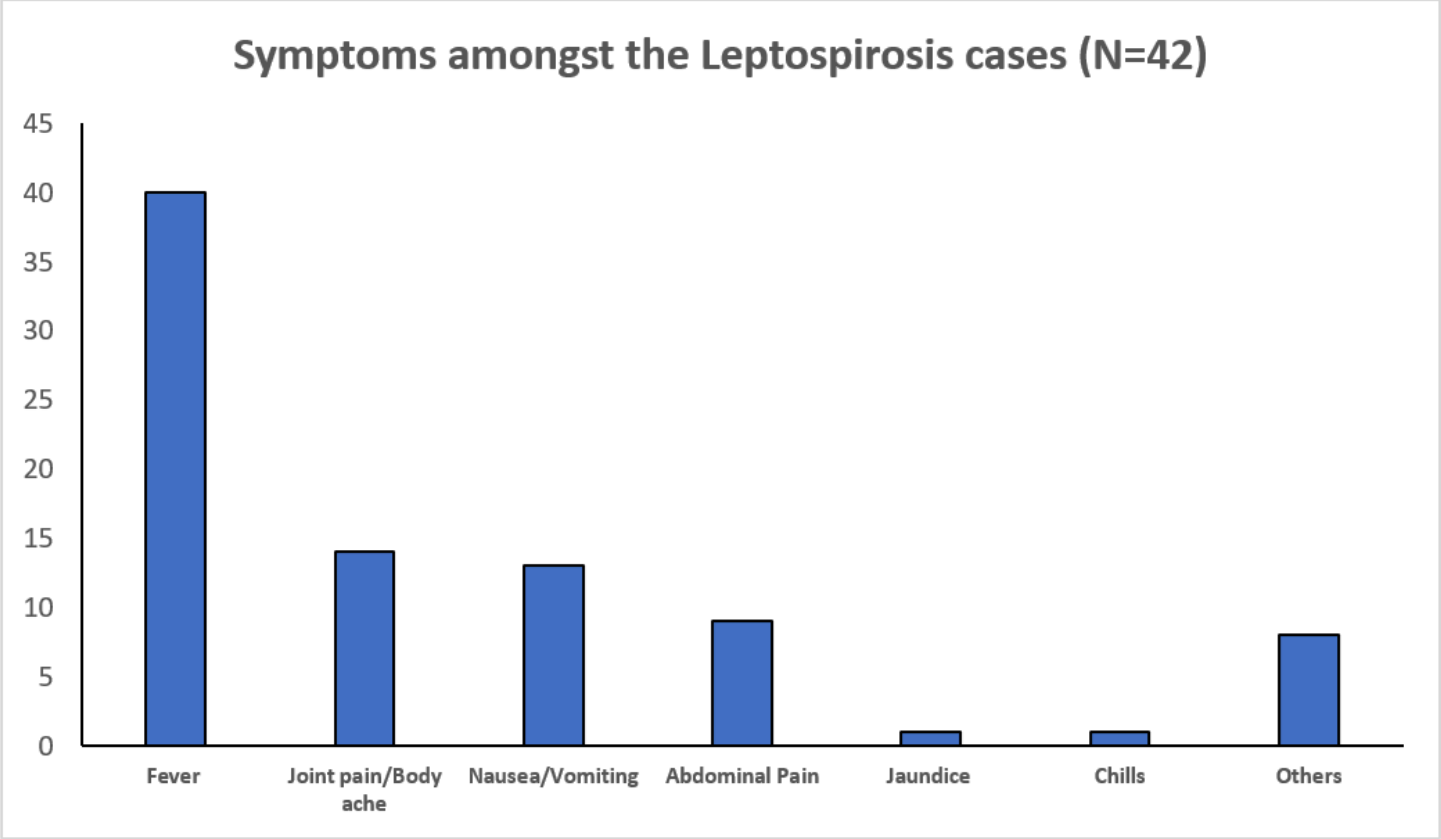


Figure 2

Symptomatology of cases of leptospirosis, Sawai Madhopur, Rajasthan (N=42)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AnnexureCRF.pdf
- modellepto22jan26.r