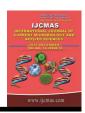


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### **Review Article**

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## Current Evidences and Clinical Perspectives of Pediatric Leptospirosis in India: A Narrative Review

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### ABSTRACT

Keywords

Pediatric leptospirosis, *Leptospira* Species, hemorrhage

### **Article Info**

Received: 20 October 2025 Accepted: 29 November 2025 Available Online: 10 December 2025 Pediatric leptospirosis is an underrecognized yet important cause of acute febrile illness in India, particularly during monsoon seasons. Overlapping clinical features with dengue, malaria, enteric fever, and scrub typhus, coupled with limited access to early diagnostics, contribute to delayed diagnosis and increased morbidity in children. This narrative review synthesizes current Indian evidence on pediatric leptospirosis, focusing on epidemiology, regional prevalence, clinical spectrum, diagnostic strategies, management approaches, complications, mortality, and emerging clinical perspectives. A narrative review approach was adopted to integrate data from Indian pediatric studies, outbreak reports, hospital-based cohorts, and case series, including recent literature highlighting diagnostic and clinical advancements. This approach was justified due to heterogeneity of study designs, regional variability, and limited pediatric-specific randomized trials. Pediatric leptospirosis in India demonstrates marked regional and seasonal variation, with highest burden in southern and coastal states. Clinical presentation ranges from mild febrile illness to severe multisystem disease with renal, hepatic, pulmonary, cardiac, and neurological involvement. Advances in molecular diagnostics, particularly PCR, have improved early detection, while prompt antimicrobial therapy and intensive supportive care have reduced mortality in tertiary centers. Early clinical suspicion, improved diagnostic access, and timely multidisciplinary management are crucial to improving outcomes in pediatric leptospirosis. Strengthening surveillance and pediatric-focused research is essential to address this neglected tropical disease in India.

### Introduction

Leptospirosis is a neglected zoonotic disease of global public health importance caused by pathogenic *Leptospira* species. In India, it has emerged as a

significant cause of acute undifferentiated febrile illness, particularly during the monsoon and post-monsoon seasons. However, pediatric leptospirosis remains underrecognized and underreported, frequently misdiagnosed as dengue, malaria, enteric fever, or scrub

typhus due to overlapping clinical features and limited routine diagnostic testing. (1, 2 &3) This diagnostic overlap contributes to delayed treatment and increased risk of complications in children.

Children constitute a vulnerable and distinct population owing to unique exposure patterns such as outdoor play, contact with contaminated water, and suboptimal sanitation, especially in urban slums and flood-prone regions. Indian pediatric studies have demonstrated a wide clinical spectrum ranging from mild self-limiting illness to severe disease with multiorgan involvement, including acute kidney injury, pulmonary hemorrhage, myocarditis, hepatic dysfunction, and central nervous system manifestations. (4 & 5) Increasing reports of atypical, immune-mediated, and neurological complications further highlight evolving clinical challenges. (6 & 7)

Despite growing evidence, pediatric data from India remain fragmented across regional studies and case series. Therefore, this narrative review aims to synthesize current Indian evidence on pediatric leptospirosis, integrating epidemiology, regional prevalence, clinical manifestations, diagnostic strategies, management approaches, complications, mortality, and emerging clinical perspectives to aid clinicians and policymakers in improving early recognition and outcomes.

### Causes

Leptospirosis is caused by pathogenic species of the genus *Leptospira*, which are aerobic, motile, spirochete-shaped bacteria belonging to the family *Leptospiraceae*.

### **Epidemiology of Pediatric Leptospirosis in India**

Leptospirosis is endemic in several regions of India, particularly in areas characterized by heavy rainfall, seasonal flooding, and close human—animal interaction. Children are commonly exposed through contact with water or soil contaminated with the urine of infected animals such as rodents, dogs, and cattle. Behavioral factors including outdoor play, barefoot walking, water-related activities, poor sanitation, and limited caregiver awareness contribute to increased pediatric vulnerability. (1) Urban slums and peri-urban settlements further amplify risk due to overcrowding, inadequate drainage, and rodent infestation, making leptospirosis an important cause of acute febrile illness in children. (8)

A marked seasonal pattern is observed, with incidence peaking during the monsoon and post-monsoon months (June–October), when flooding and water stagnation facilitate transmission. (2 & 3) High-burden states such as Kerala, Maharashtra, Tamil Nadu, and Gujarat frequently report over 500 confirmed cases annually. National surveillance estimates approximately 4,700–5,000 laboratory-confirmed cases and 80–90 deaths per year, though underreporting is likely.

Pediatric seroprevalence studies from Chennai reported antileptospiral antibodies in 30.8% of febrile children and laboratory confirmation in 26.1% of suspected cases, indicating substantial endemic transmission. (9 & 10) Urban outbreak investigations from Mumbai documented positivity rates of up to 32% among hospitalized children during post-monsoon periods. (11) Overall, prevalence is highest in southern and coastal regions compared with northern and central India, reflecting climatic and environmental determinants rather than true absence of disease.

## Prevalence and Regional Distribution in India

Pediatric leptospirosis in India demonstrates a clear geographical gradient, with the highest burden in southern, western coastal, and flood-prone regions, while emerging evidence suggests increasing recognition in central and northern India. Climatic conditions, rainfall intensity, sanitation infrastructure, and diagnostic access largely determine regional patterns.

Southern India constitutes the core endemic belt for pediatric leptospirosis, with sustained transmission and a higher burden of severe disease. Urban regions of western India experience recurrent monsoon-associated outbreaks, particularly in flood-prone settings. In contrast, central and northern India are increasingly reporting pediatric cases, reflecting improved recognition rather than true epidemiological absence. Island and coastal regions show high exposure rates, with clinical severity ranging from mild illness to life-threatening complications. (Table-1)

## **Clinical Spectrum of Pediatric Leptospirosis**

**Uncomplicated Disease:** Children with mild leptospirosis typically present with an acute febrile illness characterized by fever, headache, myalgia (often involving calf muscles), vomiting, abdominal pain, and

conjunctival suffusion. Transient cough, diarrhea, and mild hepatomegaly may also be observed. Because rash and lymphadenopathy are uncommon, the illness is frequently misdiagnosed as viral fever, dengue, malaria, or enteric fever in endemic Indian settings, leading to delayed suspicion and testing. (1 & 2)

Severe Disease and Multisystem Involvement: A subset of children progress to severe leptospirosis with multisystem involvement and significant morbidity. Indian pediatric studies consistently report renal involvement ranging from mild azotemia to acute kidney injury with oliguria or anuria, often accompanied by electrolyte disturbances. (3)

Hepatic dysfunction commonly manifests as jaundice with disproportionately mild transaminase elevation, helping distinguish leptospirosis from viral hepatitis. Pulmonary involvement includes acute respiratory distress syndrome and pulmonary hemorrhage, which is a major predictor of mortality in children. (1)

Cardiovascular manifestations such as myocarditis, arrhythmias, and refractory shock have been reported in severe cases, particularly in pediatric intensive care unit cohorts. (3) Hematological abnormalities, including thrombocytopenia and coagulopathy, further contribute to bleeding risk.

Neurological and Immune-Mediated Manifestations: Neurological involvement is increasingly recognized in Indian children. Leptospirosis has been identified as an etiological agent in acute encephalitis syndrome,

etiological agent in acute encephalitis syndrome, presenting with altered sensorium, seizures, aseptic meningitis, and meningoencephalitis (AES cohort study). Recent case reports and series describe post-infectious immune-mediated complications, such as basal ganglia autoimmune encephalitis and other neuroinflammatory syndromes, expanding the clinical spectrum beyond classical descriptions (These emerging observations highlight the evolving and heterogeneous presentation of pediatric leptospirosis in India. (6 & 7)

## **Diagnostic Strategies in India**

**Serological Testing**: Serological assays remain the backbone of pediatric leptospirosis diagnosis in India. Immunoglobulin M enzyme-linked immunosorbent assay (IgM ELISA) is the most widely used test because of its affordability, ease of performance, and suitability for peripheral and district-level hospitals. IgM antibodies

usually become detectable after 5–7 days of illness, making the test more reliable in the second week of fever. However, false-negative results are common in the early leptospiremic phase, and cross-reactivity with other endemic infections such as dengue and scrub typhus has been reported, potentially affecting specificity, (3 & 18)

Microscopic Agglutination Test (MAT): The Microscopic Agglutination Test is considered the reference standard for laboratory confirmation. It allows serovar-level identification and is valuable for epidemiological surveillance in India.

However, its routine use in children is limited due to the need for live cultures, paired sera, technical expertise, and delayed reporting.

Consequently, its application is largely confined to national and regional reference laboratories and research settings. (2)

Molecular Diagnostics and Recent Advancements: Polymerase chain reaction (PCR)-based assays have

emerged as a major advancement in early diagnosis. These tests detect leptospiral deoxyribonucleic acid in blood or cerebrospinal fluid during the first week of illness, before antibody production. In a pediatric cohort from Chennai, polymerase chain reaction identified infection in 28.4% of cases, many of whom were seronegative by IgM enzyme-linked immunosorbent assay, underscoring its value in early febrile illness. (18) Despite high sensitivity and specificity, widespread use is constrained by cost, infrastructure, and limited availability outside tertiary centers.

Rapid Diagnostic **Tests** and **Supportive** Investigations; Rapid immunochromatographic tests are increasingly used as point-of-care screening tools in outbreak and resource-limited settings, though their diagnostic accuracy varies widely across brands. (3) laboratory findings—such Supportive thrombocytopenia, elevated serum creatinine, mild transaminase elevation with disproportionate hyperbilirubinemia, and aseptic cerebrospinal fluid changes—play an important adjunctive role in raising clinical suspicion, particularly in endemic Indian regions.

These diagnostic challenges highlight the continued need for a syndromic approach combined with timely laboratory support in pediatric leptospirosis across India. (Table-2)

# **Management Strategies in Indian Pediatric Practice**

Management of pediatric leptospirosis in India focuses on early antimicrobial therapy, vigilant supportive care, and multidisciplinary management to reduce complications and mortality. (1 & 3) Severity based antibiotic given in the table -3. Early initiation of antibiotics is crucial, with Penicillin G preferred for severe cases, Ceftriaxone or Cefotaxime as alternatives, Azithromycin for mild disease in younger children, and Doxycycline for older children or adolescents. Therapy should be tailored according to disease severity, renal function, and local resistance patterns, with transition from intravenous to oral therapy once improvement is observed.

Supportive care is central, including careful fluid and electrolyte management to prevent overload, renal replacement therapy for acute kidney injury, mechanical ventilation for acute respiratory distress syndrome (ARDS) or pulmonary hemorrhage, and vasopressor support in shock.

Additional measures involve correction of hematologic nutritional abnormalities, support, gastrointestinal protection, and strict infection control to prevent secondary infections. Early recognition of warning signs such as jaundice, oliguria, hypotension, or hemorrhage facilitates timely ICU referral. Multidisciplinary collaboration among pediatricians, intensivists, nephrologists, and infectious disease specialists is critical, and adjunctive therapies such as corticosteroids may be considered in severe pulmonary involvement under specialist guidance. Overall, combining prompt antimicrobial therapy with intensive supportive care and early specialist intervention significantly improves outcomes in Indian pediatric practice.

## **Recent Clinical Advancements Identified From** the Provided Literature

Although randomized pediatric trials are lacking, several recent clinical advancements have been reported. There is expanded recognition of atypical and immunemediated manifestations in children, including macrophage activation syndrome, autoimmune encephalitis, and other inflammatory complications. (4 & 6) The use of molecular diagnostics, particularly polymerase chain reaction (PCR), has improved early

case confirmation, allowing timely initiation of therapy and better prognostication. (18) Advances in supportive care, including early ICU referral, fluid optimization, and renal replacement therapy, have contributed to reduced mortality in tertiary centers. (3) Furthermore, leptospirosis is increasingly recognized in the differential diagnosis of acute encephalitis syndrome (AES), improving diagnostic yield in pediatric encephalitis cohorts. Recent literature also highlights the importance of risk stratification tools and early warning scores to identify children at higher risk of severe disease, although these remain to be validated in large Indian cohorts.

## **Complications of Pediatric Leptospirosis**

Renal involvement is the most frequent complication in pediatric leptospirosis, ranging from mild azotemia to oliguric renal failure requiring dialysis. (3) Hepatic dysfunction, manifesting as jaundice and elevated transaminases, is commonly observed. Hematologic complications, including thrombocytopenia, coagulopathy, and bleeding manifestations, significant contributors to morbidity. Pulmonary complications, such as pneumonitis and pulmonary hemorrhage, markedly increase mortality risk. Cardiac involvement, including myocarditis, pericardial effusion, and rarely pericardial tamponade, has been reported in severe pediatric cases. (4) Other complications include neurological manifestations such as aseptic meningitis, seizures, and encephalopathy, as well as ocular involvement and secondary bacterial infections, which can further complicate clinical management.

## **Mortality and Prognostic Factors**

Mortality in pediatric leptospirosis in India varies depending on severity, with overall mortality reported at approximately 11% and pediatric-specific mortality ranging from 6% to 13%. (3) Several prognostic factors are consistently associated with poor outcomes, including dysfunction, pulmonary multiorgan hemorrhage. hypotensive shock, and delayed diagnosis or initiation of appropriate antimicrobial therapy. Additional predictors of adverse outcomes include severe jaundice, oliguric renal failure, coagulopathy, and secondary bacterial infections. Early recognition, prompt initiation of antibiotics, and timely ICU-based supportive care are critical in reducing mortality and improving long-term outcomes in affected children.

Figure.1 Leptospira

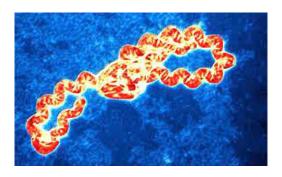


Table.1 Regional Distribution of Pediatric Leptospirosis in India

Geographical Zone (Map Reference)	States / Regions	Epidemiological Characteristics	Key Pediatric Findings
Southern India (High endemic zone) (3, 8 & 9)	Tamil Nadu, Kerala, Karnataka, Andhra Pradesh	Hyperendemic; year- round transmission with monsoon peaks	Seroprevalence up to 30.8%; laboratory confirmation in 26.1% of suspected children; frequent renal, hepatic, and pulmonary involvement
Western India (Urban outbreak zone) (2, 10 & 11)	Maharashtra, Gujarat	Seasonal outbreaks linked to flooding and urban slums	Acute kidney injury, jaundice, pulmonary hemorrhage common; pediatric outbreaks reported in Mumbai slums
Central India (Emerging recognition zone) (12 & 13)	Madhya Pradesh, Chhattisgarh, Vidarbha region	Previously underreported; increasing detection in recent years	Contribution to acute encephalitis syndrome cases (~3%); multiorgan dysfunction in severe cases
Northern India (Low reporting but emerging zone) (14 & 15)	Delhi, Uttar Pradesh, Haryana, Punjab	Lower reported prevalence; diagnostic gaps	Approximately 8–10% positivity among febrile children in tertiary centers; increasing trend
Eastern & Northeastern India (Localized endemic pockets) (16 & 17)	Odisha, West Bengal, Andaman & Nicobar Islands	Outbreak-prone coastal and island regions	Pediatric cases with lower mortality but high exposure rates during epidemics

Table.2 Diagnostic approaches in Pediatric Leptospirosis

Test	Role in Indian Practice	Key Limitations		
IgM ELISA	Primary diagnostic tool in most hospitals	Low sensitivity in early illness; cross-reactivity		
MAT	Reference standard; epidemiological use	Limited access; delayed results		
PCR	Early-phase detection	Cost; infrastructure requirements		
Rapid tests	Screening during outbreaks	Variable sensitivity and specificity		

**Table.3** Severity-based antibiotic therapy and ICU interventions:

Severity of Disease	Recommended	Supportive / ICU Interventions	Additional Care
Mild Disease (outpatient, no organ dysfunction)	Antibiotic Therapy - Azithromycin (young children) - Doxycycline (older children/adolescents)	- Oral hydration - Symptomatic management (fever, myalgia) - Monitor for warning signs	Early recognition of progression is key; follow-up within 24–48 hrs recommended
Moderate Disease (hospitalized, mild organ involvement)	- Ceftriaxone or Cefotaxime (IV) - Penicillin G (IV, if available)	<ul> <li>IV fluids (careful monitoring)</li> <li>Monitoring renal and hepatic function</li> <li>Analgesia and antipyretics</li> </ul>	Close monitoring for AKI, jaundice, thrombocytopenia
Severe Disease (organ dysfunction, shock, pulmonary involvement, AKI)	- Penicillin G (IV, high dose) - Ceftriaxone or Cefotaxime (alternative)	<ul> <li>Intensive care monitoring</li> <li>Renal replacement</li> <li>therapy for AKI</li> <li>Mechanical ventilation for</li> <li>ARDS or pulmonary</li> <li>haemorrhage</li> <li>Vasopressor support in shock</li> <li>Blood product support for coagulopathy</li> </ul>	Early ICU referral and multidisciplinary care improve outcomes; adjunctive therapies may be considered (e.g., corticosteroids for severe pulmonary involvement)
Complicated / Life- threatening (multi- organ failure, severe hemorrhage, refractory shock)	- High-dose IV Penicillin or Ceftriaxone (as per ICU protocol)	- Full ICU support: ventilation, RRT, vasopressors, transfusions - Close hemodynamic and laboratory monitoring - Multidisciplinary consultation (pediatrics, nephrology, critical care, infectious diseases)	

Early recognition, prompt initiation of antibiotics, and timely ICU-based supportive care are critical in reducing mortality and improving long-term outcomes in affected children.

In conclusion, Pediatric leptospirosis represents a significant yet underappreciated public health concern in India, particularly in monsoon-affected, flood-prone, and socioeconomically vulnerable regions. This narrative review highlights the diverse epidemiological patterns, wide clinical spectrum, and evolving diagnostic and therapeutic challenges associated with pediatric leptospirosis across the country. Children often present with nonspecific febrile illness, leading to frequent misdiagnosis and delayed treatment, which substantially increases the risk of severe complications and mortality.

Indian pediatric data demonstrate that renal dysfunction, hepatic involvement, pulmonary hemorrhage, and neurological manifestations are key determinants of disease severity and prognosis. Emerging evidence of immune-mediated and atypical neurological complications further expands the clinical spectrum and underscores the need for heightened awareness among clinicians. While serological testing remains the mainstay of diagnosis, molecular techniques such as PCR have significantly enhanced early detection, particularly during the leptospiremic phase. Timely initiation of appropriate antibiotics, early recognition of warning signs, and access to intensive supportive care have been shown to improve outcomes in severe cases. However, gaps persist in surveillance, diagnostic pediatric-specific availability. and evidence.

Strengthening laboratory capacity, integrating leptospirosis into febrile illness algorithms, and promoting pediatric-focused research are essential to reduce disease burden and improve outcomes in Indian children.

### **Author Contributions**

Shyamala Ravikoti: Investigation, formal analysis, writing—original draft. Sekkulandai Kuppuswamy Mohanasundari: Validation, methodology, writing—reviewing. Priya Mani:—Formal analysis, writing—review and editing. K. Sravanthi: Investigation, writing—reviewing.

## **Data Availability**

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

### **Declarations**

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

**Conflict of Interest** The authors declare no competing interests.

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