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Scrub Typhus in Telangana: Emerging epidemiology, clinical challenges, environmental drivers and One Health perspectives- A review

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Abstract
Scrub typhus is a re-emerging zoonotic disease caused by *Orientia tsutsugamushi*, an obligate intracellular bacterium transmitted through the bite of infected chigger mites. Over the past decade, it has become an important cause of acute undifferentiated fever in many parts of India, including Telangana, with most cases occurring during the monsoon and post-monsoon seasons. Diagnosis is often challenging because the clinical signs resemble those of dengue, malaria, leptospirosis, typhoid and other febrile illnesses, while the characteristic eschar is not present in every patient. In Telangana, widespread agricultural activities, scrub vegetation, forest margins, abundant rodent hosts, and favourable climatic conditions support the survival of chigger mites and facilitate disease transmission. As a result, scrub typhus is being recognized as an emerging public health concern, particularly among rural and occupationally exposed populations. Timely diagnosis using IgM ELISA or molecular methods, together with early treatment using doxycycline, can prevent severe complications and significantly reduce mortality. This review outlines the current understanding of the epidemiology, risk factors, clinical features, diagnosis, treatment, and prevention of scrub typhus, with special emphasis on Telangana. It also highlights the importance of climate-sensitive surveillance and a One Health approach that integrates human, animal, and environmental health for effective disease control.

Keywords: Scrub typhus, *Orientia tsutsugamushi*, Telangana, acute undifferentiated febrile illness, chigger mites, One Health, climate change

Introduction

Scrub typhus is a re-emerging zoonotic disease caused by *Orientia tsutsugamushi*, an obligate intracellular bacterium transmitted to humans through the bite of infected larval trombiculid mites (chiggers). Small rodents maintain the natural transmission cycle, whereas humans are infected accidentally when they enter mite-infested fields, scrub vegetation, forests or other rural environments during farming and outdoor activities. Although the disease responds well to timely treatment with doxycycline or azithromycin, delayed recognition remains common because its symptoms closely resemble those of other tropical febrile illnesses.

For many years, scrub typhus was believed to occur mainly within the "Tsutsugamushi Triangle," stretching across much of Asia and northern Australia. However, confirmed cases from South America, the Middle East, and parts of Africa have shown that its distribution is wider than previously recognized. Today, nearly one billion people are considered at risk worldwide, with an estimated one million new infections occurring each year (Kelly *et al.*, 2009; Izzard *et al.*, 2010; Weitzel *et al.*, 2016; Mohapatra *et al.*, 2024) [3, 5, 15, 16].

In India, scrub typhus has become an increasingly important cause of acute undifferentiated fever, particularly during the monsoon and post-monsoon months. Studies indicate that it contributes substantially to hospital admissions and may lead to severe complications such as acute respiratory distress syndrome, acute kidney injury, myocarditis, hepatitis, meningoencephalitis and multi-organ dysfunction when diagnosis is delayed (Devasagayam *et al.*, 2021) [2]. Telangana is recognized as one of the emerging endemic regions because its agricultural landscapes, scrub vegetation, forest margins, seasonal rainfall, and abundant rodent populations provide favourable conditions for chigger mites. Hospital-based studies have reported a rising number of cases among farmers, livestock handlers, and other rural residents with frequent exposure to vegetation (Lakshmi *et al.*, 2020; Sowjanya *et al.*, 2020) [8, 9]. However, many infections remain undetected or are initially mistaken for dengue, malaria, leptospirosis, typhoid, and other febrile diseases. Environmental changes, including climate variability, land-use modification, and expanding human interaction with natural ecosystems, are likely contributing to the growing incidence of the disease, emphasizing the need for a coordinated One Health approach that links human, animal, and environmental surveillance (Mohapatra *et al.*, 2024) [5].

This review provides an overview of the current understanding of scrub typhus, covering its epidemiology,

environmental risk factors, clinical features, diagnosis, treatment and prevention with special emphasis on the situation in Telangana and the need for strengthened surveillance and public health preparedness.

Epidemiology: Global Burden, Indian Scenario and Emerging Trends in Telangana

Scrub typhus is a neglected vector-borne zoonotic disease caused by *Orientia tsutsugamushi* and is one of the leading causes of acute undifferentiated febrile illness (AUFI) in the Asia-Pacific region. Although the disease was historically confined to the Tsutsugamushi Triangle, recent reports from South America, the Middle East and Africa indicate that its distribution is much wider than previously believed (Kelly *et al.*, 2009; Izzard *et al.*, 2010[3, 15]; Xu *et al.*, 2017; Mohapatra *et al.*, 2024) [5]. Globally, nearly one billion people are at risk, with an estimated one million new cases reported annually.

In India, scrub typhus has re-emerged over the last two decades as a major cause of seasonal fever, especially during the monsoon and post-monsoon months. It is now recognized across almost all states and contributes substantially to hospital admissions for AUFI. A systematic review estimated that scrub typhus accounts for nearly one-fourth of hospitalized AUFI cases, with an overall case-fatality rate of about 6%, which increases considerably in patients who develop severe complications (Devasagayam *et al.*, 2021) [2]. However, the actual disease burden is likely much higher because many cases remain undiagnosed or are mistaken for dengue, malaria, leptospirosis, or typhoid.

In Telangana, scrub typhus has become an increasingly important public health concern. Favourable environmental conditions such as rain-fed agriculture, scrub vegetation, forest fringes, abundant rodent populations, and seasonal humidity support the survival of chigger mites. Certain pockets with dense scrub growth and persistent mite activity function as "typhus islands", were repeated human exposure results in localized clusters of infection. Hospital-based studies from Hyderabad and Karimnagar have confirmed scrub typhus as an important cause of seasonal fever, with patients commonly presenting with prolonged fever, lymphadenopathy, hepatosplenomegaly, and gastrointestinal signs (Lakshmi *et al.*, 2020; Sowjanya *et al.*, 2020) [8, 9].

People with frequent exposure to vegetation are at greatest risk. Farmers, livestock handlers, forestry workers, field labourers, and shepherds are particularly vulnerable because they spend long hours in grasslands, scrublands and grazing areas where infected chigger mites are abundant. In Telangana, shepherd communities involved in extensive sheep and goat grazing may experience a higher risk of exposure, especially during and immediately after the rainy season. Confirmed cases have been reported from Hyderabad, Karimnagar, Jagtial, Nizamabad, Medak, Warangal, Khammam, Bhadradri Kothagudem, Adilabad, Mulugu and surrounding districts. The rising number of reported cases likely reflects both improved diagnostic awareness and expanding transmission, highlighting the need for stronger surveillance, early diagnosis, and targeted public health interventions in high-risk areas.

Table 1: Epidemiological Overview of Scrub Typhus

Region	Key epidemiological features
Global	~1 million cases annually; ~1 billion people at risk; expanding distribution beyond the Tsutsugamushi Triangle
India	>18,700 confirmed cases; ~25% of hospitalized AUFI; monsoon predominance; ~6% overall case-fatality rate
Telangana	Seasonal increase during July–November; 13.7% positivity among suspected cases in a Hyderabad tertiary-care study; increasing reports from multiple districts

Ecology, Transmission and Environmental Drivers

Scrub typhus is maintained in nature through a cycle involving *Orientia tsutsugamushi*, chigger mites (larval trombiculid mites), and small mammals, especially rodents. The larval stage is the only stage that feeds on vertebrates and transmits the infection. Unlike many other vector-borne diseases, infected mites can pass the organism to their offspring (transovarial transmission) and retain it throughout their life cycle (transstadial transmission), allowing the pathogen to persist in nature without repeated infection from animals (Traub and Wisseman, 1974; Kelly *et al.*, 2009) [3]. Rodents such as *Rattus*, *Bandicota*, and *Mus* species serve as the main hosts for chigger mites, while humans are accidental hosts. Infection occurs when people come into contact with mite-infested vegetation during farming, livestock grazing, forestry work, military training, or other outdoor activities (Devasagayam *et al.*, 2021) [2].

The ecology of Telangana is well suited for scrub typhus transmission. Rain-fed agriculture, paddy, cotton and maize fields, scrub vegetation, forest margins, irrigation canals, and abundant rodent populations provide ideal habitats for chiggers. The risk increases during the monsoon and post-monsoon period (July–November), particularly among farmers, shepherds, livestock handlers, veterinarians, forestry workers, and other rural residents who spend prolonged periods in the field (Lakshmi *et al.*, 2020; Sowjanya *et al.*, 2020) [8, 9].

Climate change, changing land-use patterns, agricultural expansion, and increasing human activity near natural habitats are likely contributing to the spread of scrub typhus into new areas (Mohapatra *et al.*, 2024) [5]. These changing ecological conditions highlight the need for a One Health approach that combines human, animal, and environmental surveillance to improve early detection and disease prevention.

Table 2: Environmental and Occupational Risk Factors Associated with Scrub Typhus in Telangana

Risk factor	Role in disease transmission
Monsoon rainfall and high humidity	Promote chigger survival and breeding
Dense scrub vegetation and forest fringes	Natural habitat for chiggers and rodents
Paddy, cotton and maize cultivation	Increase occupational exposure
Rodent abundance	Maintains the enzootic transmission cycle
Livestock farming and grazing	Enhance human contact with mite-infested habitats
Outdoor occupations	Farmers, veterinarians, forestry workers and laborers are at highest risk
Climate change and land-use modification	Expand vector habitats and transmission potential

Pathogenesis and Clinical Manifestations

After the bite of an infected chigger, *Orientia tsutsugamushi* multiplies at the site of inoculation and then spreads through the lymphatic system and bloodstream. The organism primarily infects endothelial cells, monocytes and macrophages, causing widespread vasculitis and increased vascular permeability. This leads to inflammation, tissue injury and in severe cases, dysfunction of multiple organs (Kelly *et al.,* 2009[3]; Paris *et al.,* 2012).

The incubation period is usually 6–21 days. Patients typically present with sudden fever, headache, body aches, malaise, and gastrointestinal symptoms. Although an eschar is considered the hallmark lesion, it is absent in many Indian patients, making diagnosis difficult. Because the clinical picture closely resembles dengue, malaria, leptospirosis and typhoid, scrub typhus is often overlooked during the early stage (Devasagayam *et al.,* 2021) [2].

As the illness progresses, lymphadenopathy, hepatosplenomegaly, and a maculopapular rash may appear. Laboratory findings Commonly include thrombocytopenia, elevated liver enzymes, and mild renal dysfunction. If untreated, widespread vasculitis can result in serious complications such as acute respiratory distress syndrome (ARDS), acute kidney injury (AKI), myocarditis, hepatitis, meningoencephalitis, septic shock and multiple organ dysfunction syndrome (MODS), all of which are associated with increased mortality (Bonell *et al.,* 2017; Devasagayam *et al.,* 2021) [1, 2].

Hospital-based studies from Telangana show that prolonged fever is the most consistent clinical feature, followed by lymphadenopathy, hepatosplenomegaly, vomiting, cough, and elevated liver enzymes. Severe complications including pneumonitis, ARDS, myocarditis, and AKI have also been reported, particularly in patients presenting late. Fortunately, early treatment with doxycycline or azithromycin usually produces rapid clinical improvement and markedly reduces complications. Therefore, maintaining a high index of suspicion during the monsoon season in endemic areas is essential for early diagnosis and improved patient outcomes.

Table 3: Clinical Manifestations and Major Complications of Scrub Typhus

System	Manifestations
General	Fever, headache, myalgia, malaise
Skin	Eschar, maculopapular rash
Lymphoreticular	Lymphadenopathy, hepatosplenomegaly
Respiratory	Pneumonitis, pleural effusion, ARDS
Cardiovascular	Myocarditis, hypotension, shock
Neurological	Meningoencephalitis, seizures, altered sensorium
Renal	Acute kidney injury
Hepatic	Hepatitis, elevated AST/ALT, jaundice
Hematological	Thrombocytopenia, coagulopathy
Severe disease	Multiple organ dysfunction syndrome (MODS)

Diagnosis and Differential Diagnosis

Diagnosing scrub typhus can be difficult because its symptoms closely resemble other causes of acute undifferentiated febrile illness (AUFI). In endemic areas such as Telangana, the disease should be suspected in patients with persistent fever, headache, myalgia, thrombocytopenia, elevated liver enzymes and a history of exposure to agricultural fields, scrub vegetation, forests, or grazing areas, especially during the monsoon and post-monsoon seasons (Varghese *et al.,* 2014; Devasagayam *et al.,* 2021) [2, 14].

Although an eschar is considered a characteristic lesion, it is seen in only a small proportion of Indian patients and its absence does not exclude the disease. Common laboratory abnormalities include thrombocytopenia, elevated hepatic transaminases, mild renal impairment and leukocyte changes, but these findings are not specific (Lakshmi *et al.,* 2020) [8].

Laboratory confirmation relies mainly on IgM ELISA, which is the preferred diagnostic test in India because it is reliable, affordable and widely available. Indirect immunofluorescence assay (IFA) remains the reference standard but is largely confined to specialized laboratories. PCR is useful during the early stage of illness, before antibodies develop, while rapid immunochromatographic tests can aid initial screening. The Weil–Felix test has poor sensitivity and specificity and is no longer recommended as the sole diagnostic method (Kelly *et al.,* 2009; Devasagayam *et al.,* 2021) [2, 3].

The differential diagnosis includes dengue, malaria, leptospirosis, typhoid fever, chikungunya and other rickettsial infections. Because delayed treatment markedly increases the risk of complications, empirical doxycycline therapy should be considered in clinically suspected cases from endemic areas while awaiting laboratory confirmation (Varghese *et al.,* 2014) [14].

Table 4: Comparison of Diagnostic Tests for Scrub Typhus

Test	Principle	Advantages	Limitations
IgM ELISA	Detects IgM antibodies	High sensitivity and specificity; widely available	Positive after 5–7 days of illness
IFA	Detects specific antibodies	Reference standard	Expensive; requires specialized laboratory
PCR	Detects *Orientia* DNA	Early diagnosis; highly specific	Costly; limited availability
Rapid ICT	Detects antibodies	Rapid, point-of-care	Variable sensitivity; confirmatory testing recommended
Weil–Felix test	Cross-reacting antibodies	Inexpensive	Poor sensitivity and specificity; not recommended alone

Treatment, Prevention and One Health Perspective

Early recognition and prompt initiation of appropriate antimicrobial therapy are the cornerstones of scrub typhus management. Delayed treatment is strongly associated with severe complications, including acute respiratory distress syndrome (ARDS), acute kidney injury, myocarditis, meningoencephalitis and multiple organ dysfunction syndrome. In endemic regions such as Telangana, empirical

therapy should be considered in patients with suspected scrub typhus presenting with acute undifferentiated febrile illness after exclusion of common infections such as malaria and dengue (Varghese *et al.,* 2014; Devasagayam *et al.,* 2021) [2, 14].

Doxycycline remains the first-line treatment for uncomplicated scrub typhus and usually produces rapid defervescence within 24–48 hours. Azithromycin is an effective alternative for pregnant women, children, and patients with contraindications to tetracyclines, while chloramphenicol is now used infrequently because of its adverse effects. Patients with severe disease require hospitalization, supportive care, and management of complications, including fluid resuscitation, oxygen therapy or mechanical ventilation for ARDS, renal replacement therapy for acute kidney injury and vasopressor support in septic shock (Kelly *et al.,* 2009; Bonell *et al.,* 2017) [1, 3].

Currently, no licensed vaccine is available because of the extensive antigenic diversity of *O. tsutsugamushi*. Consequently, prevention relies primarily on reducing exposure to infected chigger mites. Recommended measures include wearing protective clothing during agricultural and forestry activities, using insect repellents containing DEET or permethrin, avoiding sitting or sleeping on scrub vegetation, maintaining personal hygiene after outdoor exposure and implementing rodent and vegetation control around human settlements (Kelly *et al.,* 2009; Mohapatra *et al.,* 2024) [3, 5].

Given the ecological complexity of scrub typhus, effective prevention requires a One Health approach that integrates human, animal and environmental health. Surveillance of rodent populations, vector monitoring, clinician awareness, laboratory strengthening, community education and coordinated reporting between medical, veterinary, and public health sectors are essential for early outbreak detection and disease control. In Telangana, strengthening integrated surveillance during the monsoon season, particularly in high-risk agricultural and forest-fringe districts, would improve early diagnosis and reduce disease burden.

Despite increasing recognition, important knowledge gaps remain regarding the true incidence, reservoir ecology, molecular epidemiology and environmental determinants of scrub typhus in Telangana. Future research should focus on statewide surveillance, genomic characterization of circulating *Orientia* strains, ecological studies of vector and reservoir populations and climate-based risk prediction models to support evidence-based public health interventions.

Table 6: Prevention and One Health Strategies for Scrub Typhus

Component	Key interventions
Personal protection	Protective clothing, DEET/permethrin repellents, avoid scrub vegetation
Environmental management	Vegetation clearance around houses, rodent control, habitat management
Clinical surveillance	Early recognition of AUFI, rapid laboratory diagnosis, prompt treatment
Public health	Seasonal awareness campaigns, outbreak reporting, strengthened laboratory networks
One Health	Integrated surveillance involving human health, veterinary services, entomologists and environmental agencies

Conclusion

Scrub typhus has re-emerged as a significant public health concern in Telangana, particularly during the monsoon and post-monsoon seasons. Favorable ecological conditions, expanding agricultural activities, climate variability and increased human exposure to chigger habitats have contributed to its growing incidence. Because the disease closely mimics other tropical febrile illnesses, delayed diagnosis remains a major challenge, often resulting in preventable complications and mortality. Early clinical suspicion, timely laboratory confirmation and prompt doxycycline therapy are essential for improving patient outcomes.

Strengthening surveillance, expanding access to reliable diagnostics and increasing awareness among healthcare professionals are critical to reducing disease burden. Adoption of a One Health approach integrating medical, veterinary, entomological and environmental surveillance will enhance understanding of disease ecology and support effective prevention and control strategies. Continued research on vector ecology, molecular epidemiology and climate-associated transmission will be essential for developing sustainable interventions and improving preparedness against this neglected but increasingly important zoonotic disease in Telangana.

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