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.

Clinical profile and severity determinants of pediatric scrub typhus in South India: a retrospective study proposing a recognition-sensitive severity model

Hansen Vibin ER

hansenvibin@gmail.com

Pondicherry Institute of Medical Sciences

Nimmy Elizabeth George

Pondicherry Institute of Medical Sciences

Shashikala Nair

Pondicherry Institute of Medical Sciences

Research Article

Keywords: scrub typhus, pediatric, disease severity, eschar, acute febrile illness, India, diagnostic delay

Posted Date: May 22nd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9212670/v1

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

Additional Declarations: No competing interests reported.

Clinical profile and severity determinants of pediatric scrub typhus in South India: a retrospective study proposing a recognition-sensitive severity model

---

Authors

Hansen Vibin ER[1]*, Nimmy Elizabeth George[2], Shashikala Nair[3]

Affiliations

[1] MBBS (3rd Year), Pondicherry Institute of Medical Sciences, Puducherry, India

[2] Assistant Professor, Department of Microbiology, Pondicherry Institute of Medical Sciences, Puducherry, India

[3] Professor and Head of Department, Department of Microbiology, Pondicherry Institute of Medical Sciences, Puducherry, India

---

Corresponding Author

*Correspondence: hansenvibin@gmail.com
Hansen Vibin ER
MBBS (3rd Year)
Pondicherry Institute of Medical Sciences
Puducherry, India

Title

Clinical profile and severity determinants of pediatric scrub typhus in South India: a retrospective study proposing a recognition-sensitive severity model

ABSTRACT

Background

Scrub typhus is a significant cause of acute febrile illness in endemic regions, with the potential to cause severe complications in children. Early diagnosis is challenging due to nonspecific clinical presentation, which may delay appropriate treatment and worsen outcomes. This study aimed to assess the clinical profile, disease severity and factors influencing progression in pediatric scrub typhus, with focus on diagnostic recognition and outcomes.

Methods

A retrospective observational study was conducted at a tertiary care center in South India from January 2019 to December 2024. Pediatric patients aged less than 18 years with laboratory-confirmed scrub typhus based on IgM enzyme-linked immunosorbent assay were included. Clinical, laboratory and epidemiological data were collected from hospital records. Disease severity was categorized as moderate or severe based on predefined criteria. Categorical variables were analyzed using Chi-square or Fisher's exact test, and a p-value of <0.05 was considered statistically significant.

Results

Out of 5666 suspected cases, 203 tested positive and 191 were included in the final analysis. The mean age was 7.07 ± 4.63 years, with 75.4% of cases occurring in children aged ≤ 10 years. A male predominance was observed (62.3%) and most patients were from rural areas (58.6%). The majority required hospitalization (90.6%). Fever was the most common symptom (98.9%), followed by vomiting and cough. Eschar was present in 39.8% of patients and rash in 14.7%. Severe disease occurred in 18.8% of cases. Eschar was significantly associated with moderate disease ($p = 0.004$), whereas rash was associated with severe disease ($p = 0.016$). No mortality was observed.

Conclusion

Pediatric scrub typhus demonstrates considerable clinical heterogeneity, with a substantial proportion progressing to severe disease. The absence of consistent predictors of severity in pediatric population suggests that delayed clinical recognition and treatment may play a key role in disease progression. Early suspicion, thorough clinical examination and prompt initiation of appropriate therapy are essential to improve outcomes in endemic settings. A hypothesis-generating conceptual framework, the Recognition-Sensitive Severity Model, which conceptualizes disease severity as a time-dependent and healthcare-system modifiable outcome, is proposed to further explain these findings.

Keywords

scrub typhus; pediatric; disease severity; eschar; acute febrile illness; India; diagnostic delay

Background

Scrub typhus is an acute febrile illness caused by *Orientia tsutsugamushi*, an obligate intracellular bacterium transmitted to humans through the bite of infected larval mites of the genus *Leptotrombidium* [1]. The disease is endemic to the Asia–Pacific region, particularly within the "tsutsugamushi triangle," which includes South and Southeast Asia, India, China, Japan and northern Australia [2,3]. In recent decades, scrub typhus has re-emerged as an important public health problem in India, with increasing reports from multiple regions [4,5].

Children represent a vulnerable population in endemic areas due to increased environmental exposure and outdoor activities, which raise the risk of chigger bites [5]. Pediatric scrub typhus commonly presents as an acute undifferentiated febrile illness, making early clinical recognition challenging. The nonspecific nature of symptoms, including fever, gastrointestinal and respiratory manifestations, often leads to misdiagnosis as other tropical infections such as dengue, malaria, enteric fever and leptospirosis [2,3]. This overlap frequently results in delays in initiation of appropriate antimicrobial therapy.

The clinical spectrum of scrub typhus ranges from mild illness to severe, life-threatening disease. In children, complications such as acute respiratory distress syndrome (ARDS), central nervous system involvement, shock and multi-organ dysfunction have been reported [8,10]. These manifestations are largely attributed to systemic vasculitis and endothelial dysfunction. Although effective antimicrobial therapy is available and is associated with rapid clinical improvement, delayed diagnosis remains a key contributor to disease severity and adverse outcomes [2,8].

Diagnosis is further complicated by the absence of consistent pathognomonic features. While eschar is considered characteristic, its prevalence varies and it may be absent or overlooked, particularly in children [9]. Laboratory abnormalities such as thrombocytopenia, elevated inflammatory markers and hepatic dysfunction are common but nonspecific and often overlap with other febrile illnesses [1,10]. In many endemic settings, limited access to reliable diagnostic tests further hinders early confirmation [9].

Despite increasing recognition of scrub typhus in India, pediatric-specific data remain limited. Recent studies from India continue to highlight the clinical variability and diagnostic challenges associated with pediatric scrub typhus [12,14]. Existing studies demonstrate variability in clinical presentation and outcomes, with inconsistent findings regarding predictors of disease severity. In addition, institutional data examining epidemiological trends, co-infections and outcomes in pediatric populations are scarce.

In this context, the present study aimed to evaluate the clinical profile, disease severity and epidemiological patterns of pediatric scrub typhus at a tertiary care centre. Beyond descriptive analysis, this study explores factors influencing disease progression with emphasis on clinical recognition and timing of treatment, and proposes a conceptual framework to interpret these findings. A clearer understanding of these aspects may aid in

improving early diagnosis, guiding timely therapy and reducing complications in children in endemic regions.

Methods

Study design and setting

This retrospective observational study was conducted at the Pondicherry Institute of Medical Sciences (PIMS), a tertiary care teaching hospital in Puducherry, India, from January 2019 to December 2024.

Study population and case definition

The study population comprised pediatric patients aged less than 18 years who were evaluated for acute febrile illness during the study period and subsequently diagnosed with scrub typhus. A confirmed case was defined as a patient with compatible clinical features and a positive IgM antibody test for *Orientia tsutsugamushi*.

Laboratory diagnosis

Scrub typhus was diagnosed using the Scrub Typhus Detect™ IgM enzyme-linked immunosorbent assay (ELISA) (InBios International, Inc.), performed according to the manufacturer's instructions. Each assay run included positive and negative controls along with internal quality control. The assay was considered valid if the optical density (OD) of the positive control was >0.500 and that of the negative control was <0.200. Results were interpreted based on the cut-off values provided by the manufacturer. As IgM ELISA may show cross-reactivity with other infections, results were interpreted in the appropriate clinical context.

Inclusion and exclusion criteria

All pediatric patients (<18 years) with laboratory-confirmed scrub typhus during the study period were included. Patients with incomplete medical records or missing key clinical or laboratory data, those with negative or equivocal serology, and patients aged 18 years or above were excluded.

Data collection

During the study period, 5666 pediatric patients were tested for scrub typhus based on clinical suspicion. Among them, 203 tested positive, of which 191 cases with complete clinical and laboratory data were included in the final analysis. Data were collected retrospectively from the Hospital Information Management System (HIMS), individual patient case records, laboratory reports and structured data extraction forms using a standardized proforma.

Clinical variables included demographic details, presenting symptoms, duration of illness, complications and history of prior treatment. Laboratory parameters recorded included platelet count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), serum

glutamic-oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT), serum albumin and serum creatinine. Data on laboratory-confirmed co-infections, including dengue, malaria and leptospirosis, as well as outcome variables, were also collected.

Outcome measures

Patients were categorized into moderate and severe scrub typhus based on predefined clinical criteria. The primary outcomes assessed were disease severity, presence of complications, co-infections and in-hospital outcomes including intensive care unit (ICU) admission, requirement of mechanical ventilation and mortality.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 26. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Associations between categorical variables were analyzed using Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant. Temporal trends were assessed using month-wise distribution of cases. Missing data were handled using available-case analysis, and variables with incomplete data were analyzed based on the number of observations available.

Operational definitions

Acute Respiratory Distress Syndrome (ARDS) was defined according to the Pediatric Acute Lung Injury Consensus Conference (PALICC) criteria as acute onset respiratory failure within seven days of a known clinical insult, with new pulmonary infiltrates on chest imaging not fully explained by cardiac failure or fluid overload.

Multi-Organ Dysfunction Syndrome (MODS) was defined as dysfunction of two or more organ systems requiring medical intervention or supportive therapy.

Severe scrub typhus was defined as the presence of one or more of the following during hospitalization: ARDS, central nervous system involvement, MODS, shock requiring vasoactive support, need for mechanical ventilation, ICU admission or death.

Moderate scrub typhus was defined as laboratory-confirmed scrub typhus cases that did not meet the criteria for severe disease.

RESULTS

Study Population

During the study period, a total of 5,666 pediatric serum samples were tested for scrub typhus IgM antibodies. Of these, 203 children tested positive and 191 cases with complete clinical and laboratory data were included in the final analysis.

Geographical distribution of scrub typhus cases

A majority of patients belonged to rural areas (112; 58.6%), while 79 (41.4%) were from urban settings. The majority of cases were from Villupuram, Puducherry and Cuddalore districts. (Figure 1)

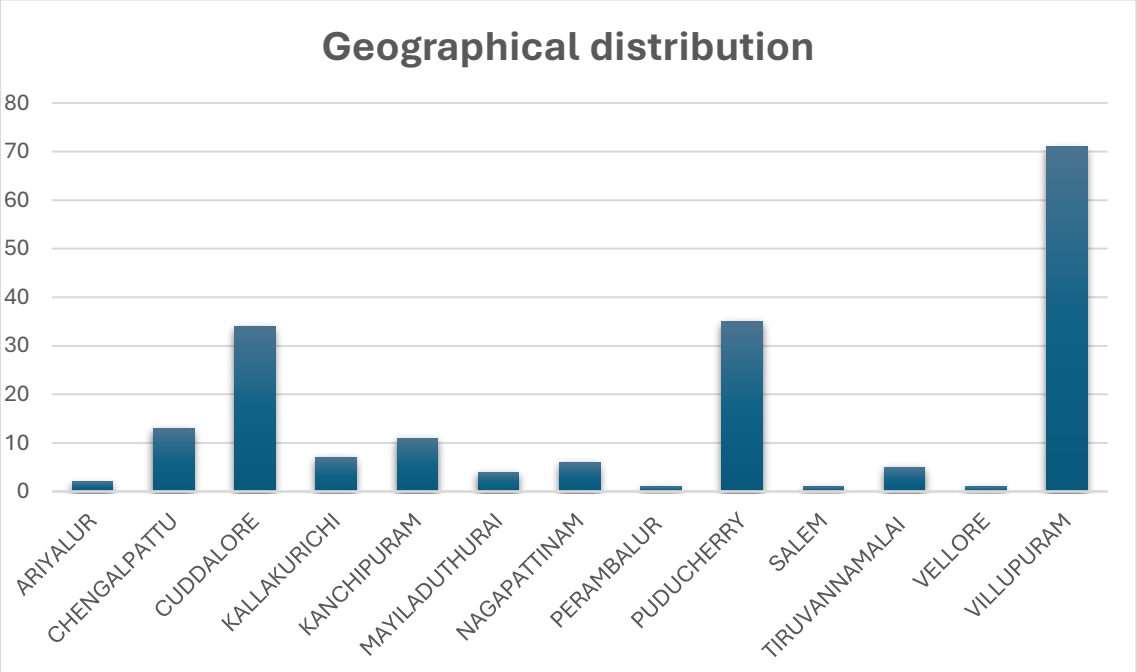


Figure 1. Geographical distribution of scrub typhus cases

Most children required hospitalization, with 173 (90.6%) admitted as inpatients and 18 (9.4%) managed as outpatients.

Age and gender Distribution of Scrub Typhus cases

Children aged ≤5 years constituted the largest group (78/191; 40.8%), followed by those aged 6–10 years (66/191; 34.6%) and >10 years (47/191; 24.6%). The mean age of affected children was 7.07 ± 4.63 years. There was a male predominance, with 119 (62.3%) males and 72 (37.7%) females. (Figure 2)

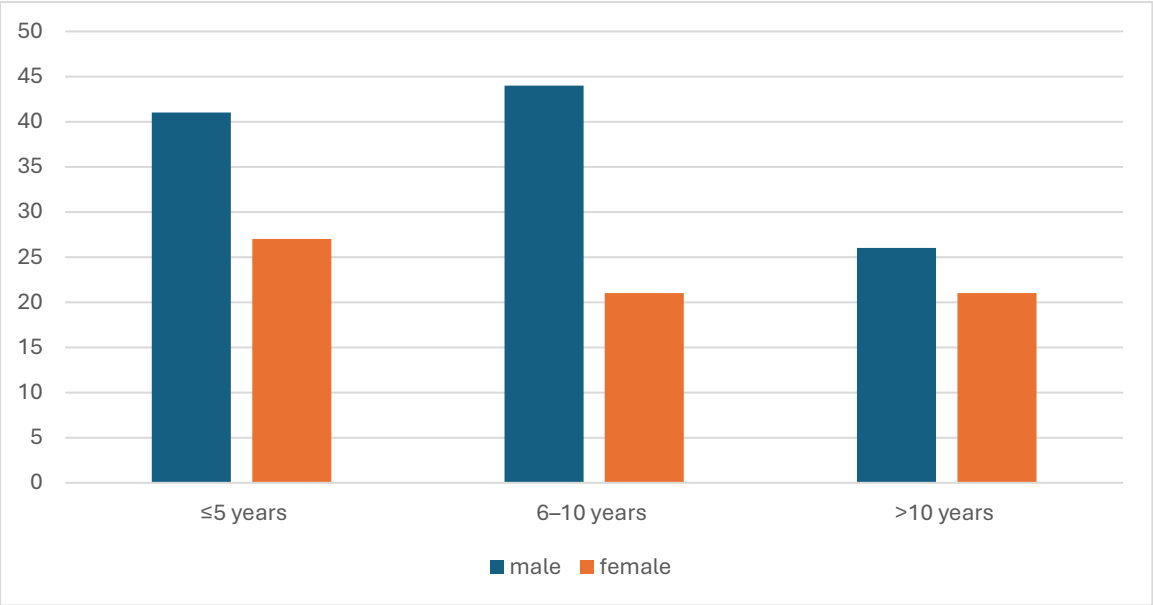


Figure 2. Age and gender distribution of pediatric scrub typhus cases

Year-wise distribution of scrub typhus cases

Year-wise distribution showed the highest number of cases in 2019 (28.8%), followed by a gradual decline in subsequent years. (Figure 3)

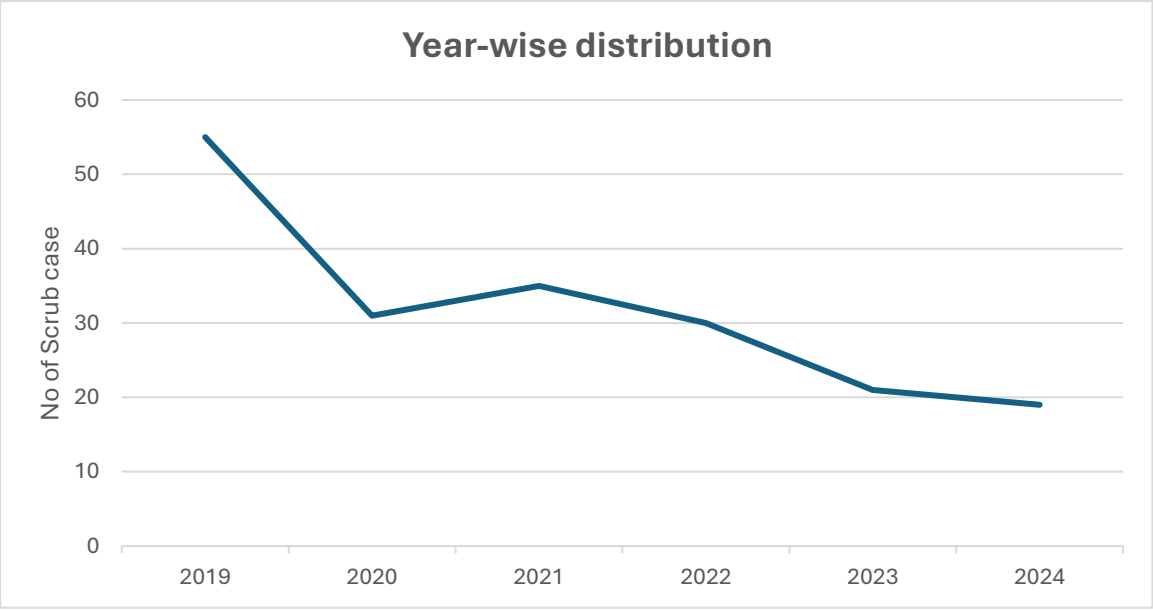


Figure 3. Year-wise distribution of scrub typhus cases

Seasonal Distribution of Scrub Typhus cases

Month-wise analysis demonstrated a clear clustering of cases during the post-monsoon and winter months, particularly between October and January. (Figure 4)

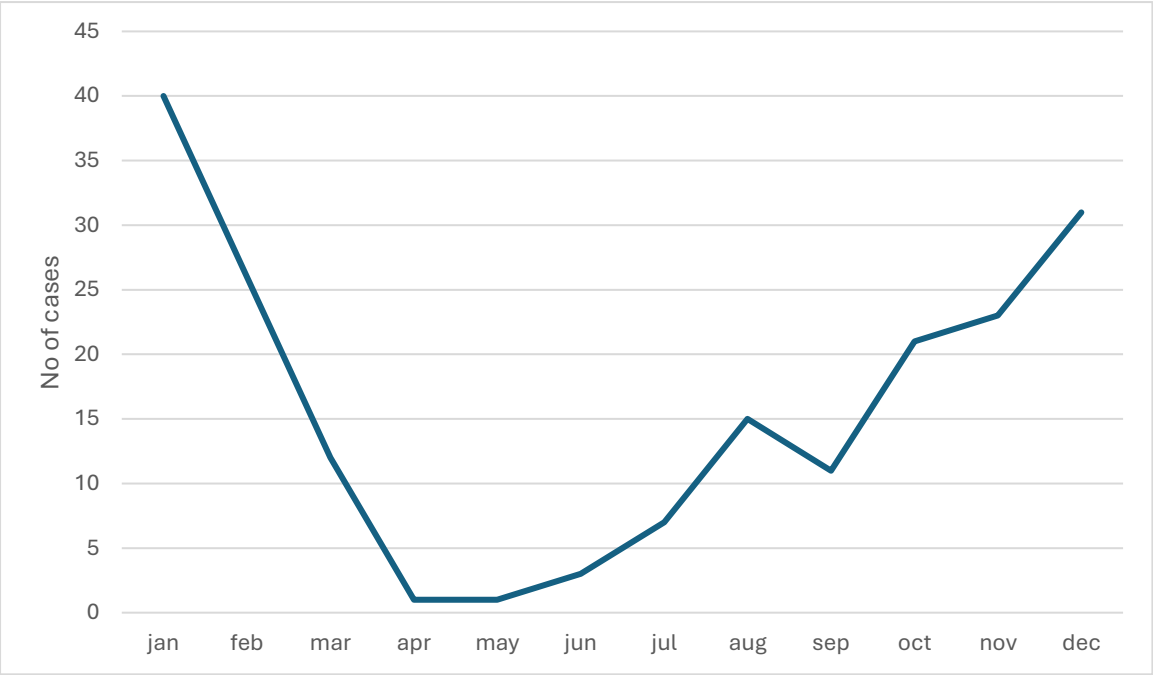


Figure 4. Month-wise distribution of scrub typhus cases demonstrating clustering during post-monsoon and winter month.

Clinical Presentation

Fever was the predominant presenting symptom (98.9%). Other common symptoms included vomiting, cough and headache. Lymphadenopathy, hepatomegaly and splenomegaly were frequent clinical findings. Eschar was identified in 39.8% of patients, while rash was noted in 14.7%. Neurological manifestations were uncommon. (Table 1)

Table 1: Clinical presentation of Scrub Typhus.

Feature	Count	Percentage
Fever	186	98.9
Cough	72	37.7
Rash	28	14.7
Eschar	76	39.8
Vomiting	75	39.3
Hepatomegaly	84	44.0
Splenomegaly	64	33.5
Lymphadenopathy	94	49.2
Headache	30	16.0
Altered Sensorium	2	1.0
Seizure	4	2.1

Distribution of Eschar

Among the 76 children with eschar, the most common sites were the trunk (chest, abdomen, or back) in 18 cases, followed by the inguinal or groin region (15 cases). Other sites included

the neck or post-auricular region (12 cases), upper and lower limbs (12 cases), axillae (10 cases) and the scrotal region (9 cases).

Laboratory Findings

Thrombocytopenia was observed in 40.3% of cases. Elevated inflammatory markers (CRP and ESR) were observed in the majority of tested patients. Liver enzyme abnormalities were common, and hypoalbuminemia and elevated creatinine were observed in a subset of patients. (Table 2)

Table 2: Laboratory findings in Scrub Typhus

Laboratory Parameter	**Statistic / Category**	**Value**
Platelet count (cells/mm^3)	Thrombocytopenia	77 (40.3%)
	Normal	106(55.5%)
	Missing	8(4.2%)
C-reactive protein	Tested patients	156
	Increased(>10mg/dl)	139(89.1%)
	Normal(<10mg/dl)	17(10.9%)
Erythrocyte sedimentation rate	Tested patients	83
	Increased(>10mm/hr)	71(85.5%)
	Normal(0-10mm/hr)	12(14.5%)
SGOT	Increased(>40IU/L)	100 (52.4%)
	Normal(10-40IU/L)	83 (43.5%)
	Missing	8 (4.2%)
SGPT	Normal(8-32U/L)	116 (60.7%)
	Increased(>32U/L)	66 (34.6%)
	Missing	9 (4.7%)
Serum albumin	Normal (3.8-5.4g/dl)	140 (73.3%)
	Decreased(<3.8g/dl)	40 (20.9%)
	Missing	11 (5.8%)

Laboratory Parameter	Statistic / Category	Value
Serum creatinine	Normal (0.3-0.7mg/dl)	135 (70.7%)
	Increased(>0.7mg/dl)	44 (23.0%)
	Decreased(<0.3mg/dl)	2 (1.0%)
	Missing	10 (5.2%)

Complications and Disease Severity

Based on predefined criteria, 36 children (18.8%) were classified as having severe disease, while 155 (81.2%) had moderate disease.

The most frequent complication was pneumonitis in 15 (7.9%). ARDS occurred in 14 (7.3%) and shock in 5 (2.6%) children. Central nervous system involvement in the form of meningitis was observed in 4 (2.1%) cases. Acute hepatic failure and acute renal failure were each noted in 3 (1.6%) children. No mortality was recorded. (Figure 5)

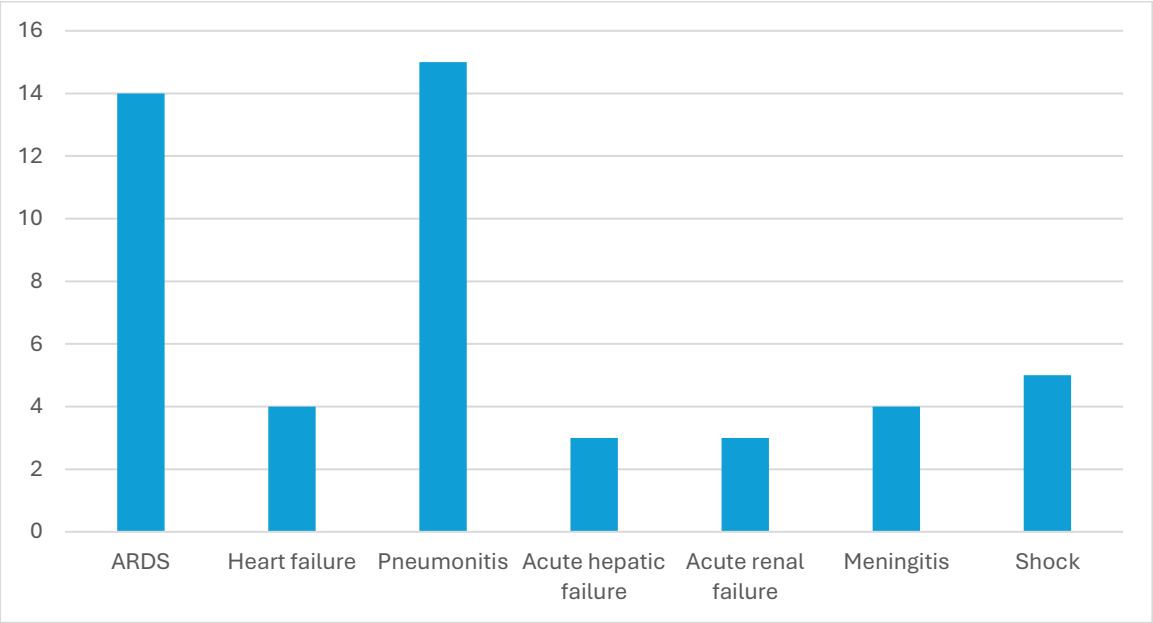


Figure 5. Spectrum of complications observed among children with scrub typhus, with acute respiratory distress syndrome being the most frequent.

Age-wise Distribution of Disease Severity

Study participants were categorized into three age groups: ≤5 years, 6–10 years and >10 years. The proportion of severe disease was 23.1% among children aged ≤5 years, 10.6% among those aged 6–10 years and 23.4% among children aged >10 years. (Figure 6)

Severe disease was observed across all age groups, the association between age group and disease severity was not statistically significant (Pearson $\chi^2 = 4.48$, df= 2, $p = 0.106$).

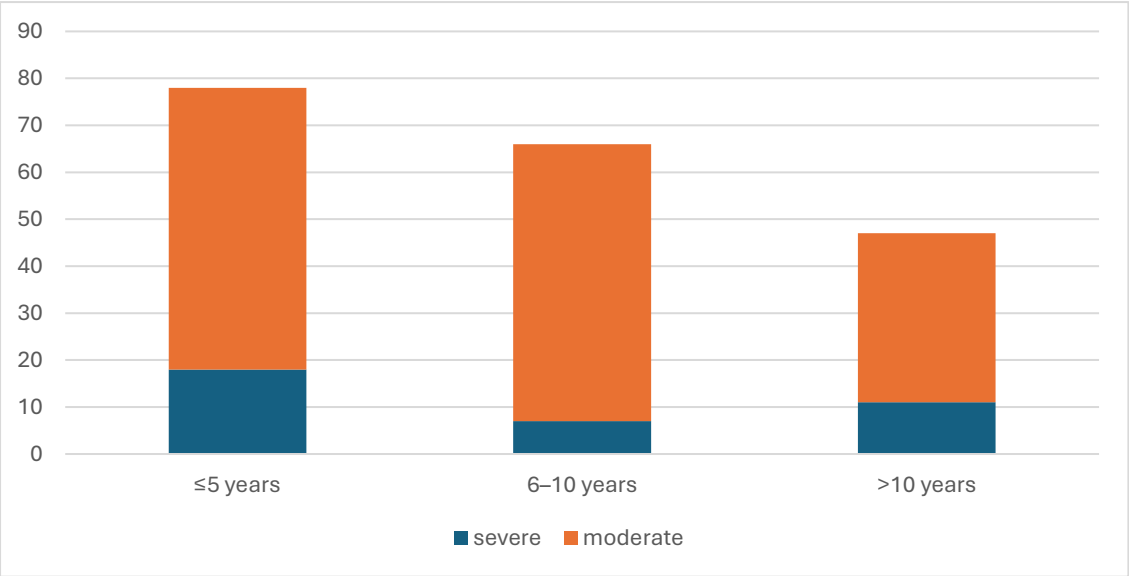


Figure 6. Distribution of disease severity across age groups.

Association Between Seasonal distribution and Disease Severity

Comparison of disease severity across seasons showed no statistically significant association ($\chi^2 = 0.75$, $p = 0.86$), with severe cases proportionately distributed across all seasons.

Association Between Clinical Features and Disease Severity

On comparison between moderate and severe disease groups, eschar was significantly more common among children with moderate disease (45.4% vs 19.4%; $p = 0.004$). In contrast, rash was significantly associated with severe disease (11.8% vs 27.8%; $p = 0.016$). (Figure 7)

Although lymphadenopathy (53.3% vs 36.1%; p=0.064) was more frequently observed in moderate disease and co-infections (4.9% vs 11.1%; p=0.169) was more frequently observed among children with severe disease, these associations did not reach statistical significance. (Figure 7)

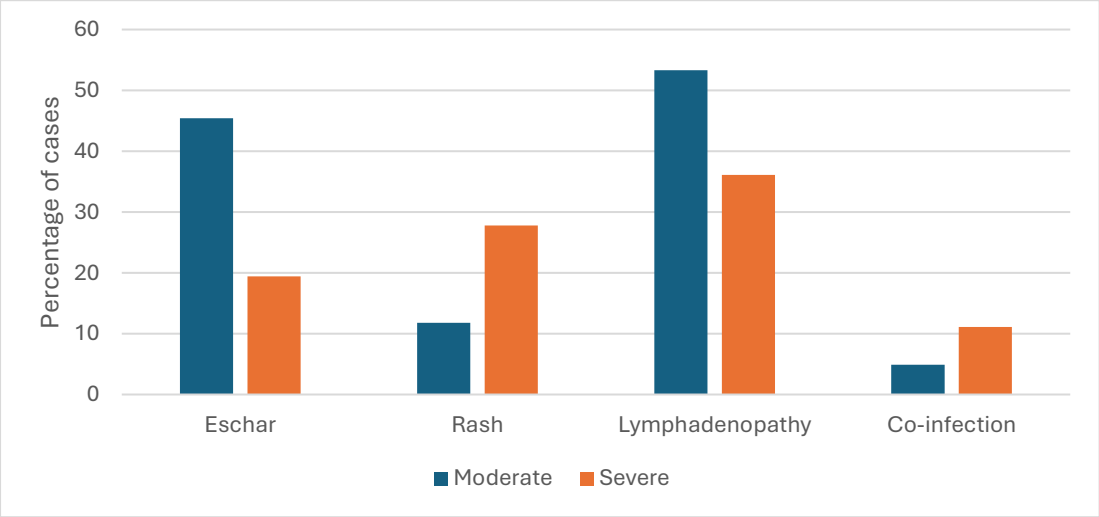


Figure 7. Association Between Clinical Features and Disease Severity

Comparison of Laboratory Parameters by Severity

Inflammatory markers tended to be higher in severe disease compared to those with moderate disease; however, these differences were not statistically significant.

Treatment and Outcomes

The majority of children (181; 94.8%) received doxycycline monotherapy. Combination antibiotic therapy (doxycycline and azithromycin) was required in 8 (4.2%) cases, while 1 (0.5%) child required an alternative antibiotic.

Most children recovered completely (170; 89.0%). A small proportion had delayed recovery (2; 1.0%) or relapse (1; 0.5%). No deaths were reported.

Discussion

This study presents a detailed clinical, laboratory and epidemiological profile of pediatric scrub typhus in an endemic region, highlighting its disease burden, variability in presentation and potential for severe complications.

A predominance of cases was observed among younger children, with 75.4% of cases occurring in those aged ≤10 years and a mean age of 7.07 ± 4.63 years. This finding is consistent with previous pediatric studies, including Rathi and Rathi (2010), and likely reflects increased environmental exposure rather than immunological immaturity. The observed male predominance (62.3%) also aligns with earlier reports, such as Pal et al. (2014), suggesting that behavioral and socio-cultural factors may influence exposure risk.

The higher burden among rural and peri-rural populations (58.6%) is in line with findings from Kundavaram et al. (2013) and reflects the ecological distribution of the vector and ongoing agricultural exposure. Seasonal clustering during monsoon and post-monsoon months corresponds with favorable conditions for mite survival and transmission, emphasizing the need for heightened clinical awareness during high-risk periods.

Clinical presentation in this cohort was varied, with fever present in 98.9% of cases. Other symptoms, such as vomiting (39.3%) and cough (37.7%) were common but nonspecific, often overlapping with other tropical infections. The relatively low prevalence of rash (14.7%) further highlights that its absence should not exclude the diagnosis.

Eschar was identified in 39.8% of patients and was most commonly located in concealed anatomical sites. This finding, consistent with Lee et al. (2006) [7], may contribute to under-recognition, particularly in children. These observations underline the importance of careful and thorough clinical examination in suspected cases.

Laboratory abnormalities were common, with thrombocytopenia observed in 40.3% of cases and elevated inflammatory markers in the majority of patients tested. However, these parameters did not show consistent association with disease severity, limiting their value as

early predictors. Similar variability in laboratory predictors has been reported in previous pediatric studies, including those by Khemka et al. and Panda et al. [11,13]

Complications such as pneumonitis (7.9%), acute respiratory distress syndrome (7.3%) and shock (2.6%) highlight the potential for severe disease, as also described in earlier studies, including Rajapakse et al. (2017) [6]

Nearly one-fifth of children (18.8%) developed severe disease. This was observed across all age groups without significant association with age ($p = 0.106$) or season ($p = 0.86$). Eschar was more frequent in moderate disease (45.4% vs 19.4%; $p = 0.004$), possibly reflecting earlier recognition and treatment. In contrast, rash was significantly associated with severe disease (27.8% vs 11.8%; $p = 0.016$), suggesting greater systemic involvement. Laboratory parameters showed trends toward severity but were not statistically significant.

The lack of consistent demographic or laboratory predictors suggests that disease progression may be more closely related to delays in clinical recognition and initiation of therapy rather than intrinsic host factors. This has important implications for clinical practice in endemic settings.

No mortality was observed in this cohort, likely reflecting timely initiation of appropriate antimicrobial therapy. Delayed recovery (1.0%) and relapse (0.5%) were uncommon, supporting the effectiveness of standard treatment when given early.

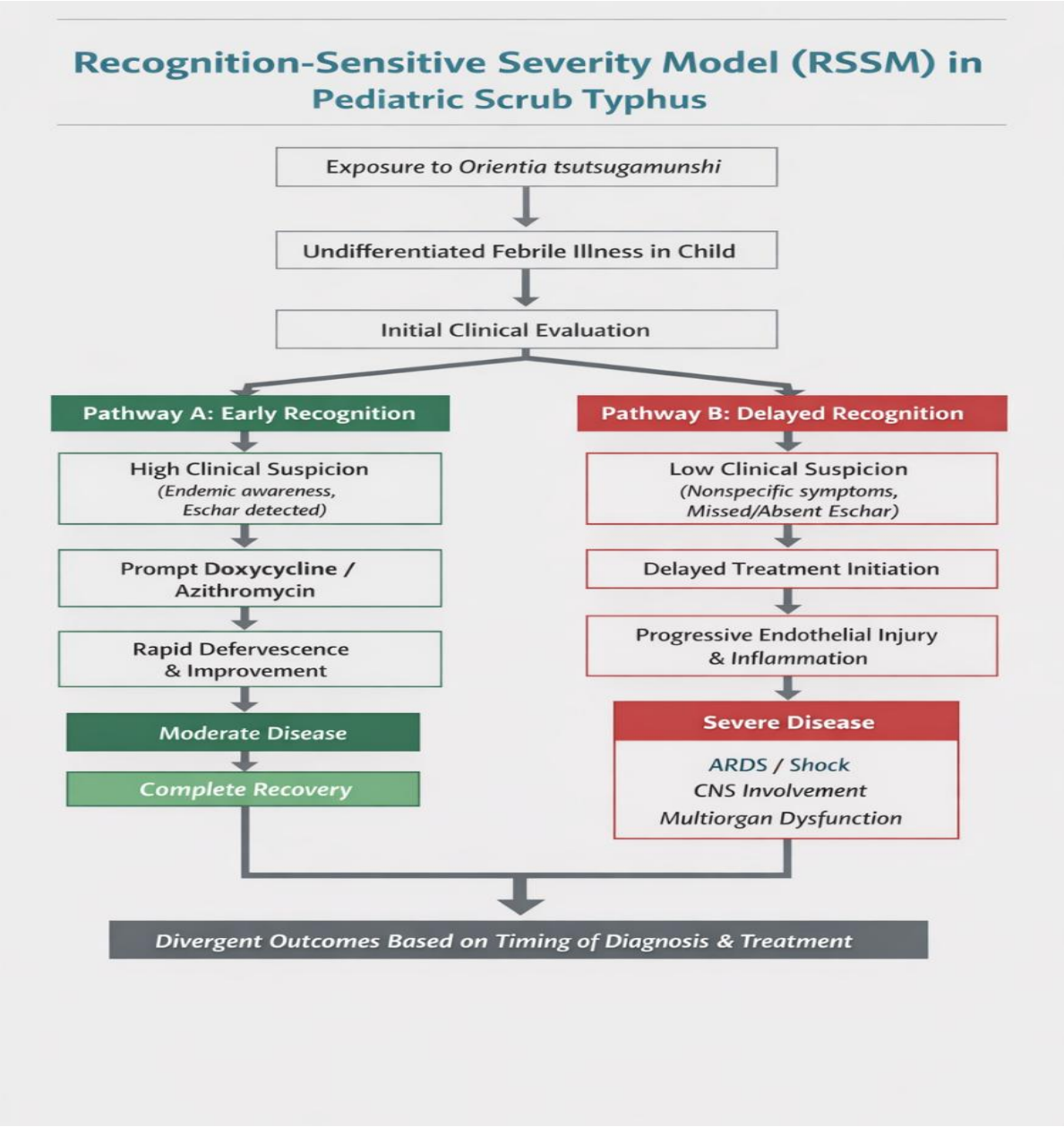
Based on these findings, we propose a hypothesis-generating conceptual framework, the Recognition-Sensitive Severity Model (RSSM), which views disease severity as a time-dependent and healthcare-system–modifiable outcome. Early clinical recognition and prompt treatment lead to favorable outcomes, whereas delayed or missed recognition may result in disease progression and severe complications. These findings are summarized in the Recognition-Sensitive Severity Model (Figure 8).

RSSM offers a possible explanation for the observed inconsistency in severity predictors and the occurrence of severe disease across different age groups and seasons. By focusing on diagnostic vigilance and timing of treatment rather than fixed host characteristics, this framework highlights modifiable factors within the healthcare system. This is particularly relevant in pediatric populations, where nonspecific presentations may delay diagnosis.

This study has certain limitations. Being a retrospective single-center study, the findings may be subject to selection bias and may not be generalizable to all settings. Missing data for certain laboratory parameters may have influenced the analysis. Additionally, the relatively small number of severe cases may have limited the ability to identify statistically significant predictors of severity. Prospective multicentric studies are required to validate these findings.

From a clinical and public health perspective, these findings emphasize the need to include scrub typhus in the routine evaluation of undifferentiated febrile illness in endemic regions. Improving clinical awareness and ensuring early treatment are likely to have the greatest impact on outcomes. RSSM is proposed as a conceptual framework derived from observational findings and requires validation in future prospective studies.

Figure 8. Recognition-Sensitive Severity Model (RSSM) illustrating clinical pathways in pediatric scrub typhus.
Following exposure to *Orientia tsutsugamushi*, children typically present with an undifferentiated febrile illness. The model describes two clinical trajectories determined by diagnostic recognition and timing of therapy. In Pathway A, early clinical suspicion and careful examination facilitate prompt initiation of appropriate antimicrobial treatment, leading to rapid recovery and moderate disease. In Pathway B, delayed or missed recognition results in delayed treatment, progressive endothelial injury, systemic inflammation, and severe complications including acute respiratory distress syndrome, shock, central nervous system involvement and multiorgan dysfunction. RSSM conceptualizes disease severity as a time-dependent and healthcare-system–modifiable outcome rather than a fixed host-determined trait.



Conclusion

This study highlights scrub typhus as an important cause of pediatric morbidity in endemic regions, with a substantial proportion of children developing severe disease. The findings suggest that disease severity is less influenced by demographic or seasonal factors and more closely related to delays in clinical recognition and initiation of appropriate therapy. In the absence of reliable early predictors, early clinical suspicion, thorough examination and prompt empirical antimicrobial treatment remain critical to improving outcomes. The proposed Recognition-Sensitive Severity Model provides a conceptual framework emphasizing the role of diagnostic timing in disease progression. Strengthening clinician awareness and incorporating scrub typhus into routine evaluation of undifferentiated febrile illness may help reduce disease burden and improve outcomes in endemic settings.

List of Abbreviations

ARDS: Acute Respiratory Distress Syndrome
CRP: C-reactive protein
ELISA: Enzyme-linked immunosorbent assay
ESR: Erythrocyte sedimentation rate
HIMS: Hospital Information Management System
ICU: Intensive Care Unit
MODS: Multi-Organ Dysfunction Syndrome
PIMS: Pondicherry Institute of Medical Sciences
RSSM: Recognition-Sensitive Severity Model
SGOT: Serum glutamic-oxaloacetic transaminase
SGPT: Serum glutamic-pyruvic transaminase

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Institutional Ethics Committee of Pondicherry Institute of Medical Sciences, Puducherry, India (IEC: RC/2025/13). The study was conducted in accordance with the principles of the Declaration of Helsinki. As this was a retrospective study based on review of hospital records, the requirement for informed consent was waived by the ethics committee.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

Funding

No external funding was received for this study.

Authors' contributions

HV conceived the study, collected and analysed the data, and drafted the manuscript. NEG supervised the study, contributed to study design and critically revised the manuscript. SN contributed to study design, data interpretation and manuscript review. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. Richards AL, Jiang J. Scrub typhus: historic perspective and current status. Trop Med Infect Dis. 2020;5(1):49.
2. Watt G, Parola P. Scrub typhus and tropical rickettsioses. Curr Opin Infect Dis. 2003;16(5):429–436.
3. Kumar S, Sharma R, Gupta N. Scrub typhus: risks, diagnostic issues, and management challenges. Trop Med Infect Dis. 2017;2(4):30.
4. Rathi N, Rathi A. Rickettsial infections: Indian perspective. Indian Pediatr. 2010;47(2):157–164.

5. Varghese GM, Trowbridge P, Janardhanan J, et al. Clinical profile and improving mortality trend of scrub typhus in South India. Am J Trop Med Hyg. 2014;90(6):1143–1148.

6. Rajapakse S, Weeratunga P, Sivayoganathan S, Fernando SD. Clinical manifestations of scrub typhus. Trans R Soc Trop Med Hyg. 2017;111(2):43–54.

7. Lee CS, Hwang JH, Lee HB, Kwon KS. Distribution of eschars on the body of scrub typhus patients. Am J Trop Med Hyg. 2006;76(5):806–809.

8. Li J, Zhang L, Ren H, et al. Diagnosing scrub typhus without eschar: a case report. IDCases. 2021;25:e01181.

9. Kim DM, Kim SW, Choi SH, Yun NR. Clinical and laboratory findings associated with severe scrub typhus. BMC Infect Dis. 2010;10:108.

10. Varghese GM, Janardhanan J, Trowbridge P, et al. Molecular epidemiology and genetic diversity of *Orientia tsutsugamushi* from patients in South India. Clin Infect Dis. 2015;60(10):1473–1480.

11. Khemka A, Dutta S, Saha A, et al. Predictors of severity of scrub typhus in children requiring intensive care. Indian J Pediatr. 2021;88(7):657-662.

12. Sethy G, Mohanty S, Behera B, et al. Clinical profile and outcome of pediatric scrub typhus in Eastern India. J Trop Pediatr. 2024;70(2):fmad012.

13. Panda S, Mishra S, Nayak S, et al. Predictors of severity and outcome in scrub typhus: a prospective observational study. J Vector Borne Dis. 2025;62(1):45-52.

14. Goyal C, Sharma A, Singh P, et al. Predictors of mortality in scrub typhus: a hospital-based study. Infect Dis (Lond). 2024;56(3):210-217.