Original Article

Clinical Profile, Laboratory Abnormalities, and Systemic Involvement in Children with Rickettsial Infections: A Comparative Study of Scrub Typhus and Indian Tick Typhus

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Abstract

Background: Rickettsial diseases, including scrub typhus and Indian tick typhus, are significant causes of paediatric acute febrile illness. This study evaluates and compares their clinical and laboratory profiles and introduces a novel Multi-Organ Involvement Score (MOIS) to quantify systemic disease burden. **Material and Methods:** A hospital-based retrospective cross-sectional study evaluated 50 children (aged ≤12 years) diagnosed with ST (n=36) and ITT (n=14). Clinical manifestations and laboratory parameters were compared. Systemic involvement was quantified using the MOIS (ranging from 0–5), which assigns points for hepatomegaly, splenomegaly, breathlessness, altered sensorium, and abnormal chest radiography. **Results:** Rash (92%) and organomegaly were highly prevalent in both groups, but altered sensorium was observed exclusively in the Indian tick typhus cohort. Laboratory analysis revealed that children with Indian tick typhus had significantly lower platelet counts (1.09 ± 0.44 vs 1.69 ± 0.53 lakh/mm³, p=0.0003), greater C-reactive protein positivity (85.7% vs 69.4%, p<0.001), and more frequent hypoalbuminemia (50.0% vs 27.8%, p<0.001) than those with scrub typhus. Furthermore, the burden of systemic disease was significantly heavier in Indian tick typhus, reflected by a higher mean MOIS (2.86 ± 1.23) compared to scrub typhus (1.97 ± 0.88) (p=0.0158). **Conclusion:** While scrub typhus and Indian tick typhus share overlapping clinical presentations, paediatric Indian tick typhus exhibits a more aggressive biochemical profile and significantly higher multi-organ involvement. Implementing the MOIS aids in quantifying systemic spread, highlighting the critical need for vigilant monitoring and early targeted therapies in tick-borne rickettsiosis.

Keywords: Rickettsial infections; Scrub typhus; Indian tick typhus; Multi-Organ Involvement Score (MOIS); Acute febrile illness; Thrombocytopenia.

Received: 17 May 2026 **Revised: 05 June 2026** **Accepted: 25 June 2026** **Published: 29 June 2026**

Introduction

Rickettsial diseases are emerging as significant and covert infectious threats globally, and particularly in tropical and subtropical regions of India.[1,2] These zoonotic acute febrile illnesses are caused by obligate intracellular bacteria and are transmitted through ticks and mites. Among most common etiologies in pediatric population are (caused by Orientia tsutsugamushi) and Indian tick typhus (a spotted fever group rickettsiosis caused by Rickettsia conorii).[3] Children with the infection frequently present with non-specific clinical features such as prolonged fever, rash and hepatosplenomegaly. This closely mimics other endemic diseases like malaria, typhoid and dengue.[4,5]

As there are no single early diagnostic test specifically to address Rickettsial infection, this condition is often under diagnosed, and lead to delay in initiation of targeted treatments.[6,7] Such delay may be catastrophic and leads to endothelial destruction, microvascular injury and severe complications, including acute respiratory distress syndrome, meningoencephalitis, and Multiple Organ Dysfunction Syndrome.[8,9] Consequently, rickettsial infections represent a substantial and life-threatening cause of Pediatric Intensive Care Unit (PICU) admissions.

Despite the high burden of morbidity and mortality associated with Rickettsial infections, majority of existing research has predominantly focused on adult populations, leaving significant gap in paediatric-centered data. A growing body of literature describing the clinical profile of scrub typhus in children, there is a striking paucity of comparative data that directly evaluating the differences among scrub typhus and Indian tick typhus. In addition, there is need to quantify the burden of disease among paediatric population and to devise a method that can predict outcomes better. By introducing a multi-organ involvement

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DOI:
10.21276/amit.2026.v13.i2.789

How to cite this article: Reddy AM, Babji NS, Chowdary VS, Amrusha M. Clinical Profile, Laboratory Abnormalities, and Systemic Involvement in Children with Rickettsial Infections: A Comparative Study of Scrub Typhus and Indian Tick Typhus. Acta Med Int. 2026;13(2):890-894.

score, to evaluate the severity of systemic involvement, this study aims to address this critical gap in prognostication.

Therefore, this study was undertaken with objectives to evaluate and compare the clinical profile, laboratory abnormalities, and systemic involvement among children aged up to 12 years diagnosed with scrub typhus and Indian tick typhus and to compare hematological and biochemical abnormalities between children with scrub typhus and Indian tick typhus. In addition, there was also an attempt to compare complications and clinical outcomes between children with scrub typhus and Indian tick typhus, to compare the severity of systemic involvement between scrub typhus and Indian tick typhus using MOIS categories and to identify factors associated with significant systemic involvement (MOIS ≥2) among children with rickettsial infections.

Materials and Methods

Study design and setting: A hospital-based retrospective cross-sectional study was conducted in the Department of Paediatrics of a tertiary care teaching hospital. Medical records of children diagnosed with rickettsial infection were reviewed to assess the clinical profile, laboratory abnormalities, complications, outcomes, and comparative systemic involvement between scrub typhus and Indian tick typhus.

Study population: The study population comprised children aged up to 12 years who were admitted with a diagnosis of rickettsial infection during the study period.

Case definition: Rickettsial infection was diagnosed based on compatible clinical features supported by serological evidence. Children were classified as having scrub typhus or Indian tick typhus based on the documented clinical diagnosis and laboratory confirmation available in the case records.

Sample size: All eligible children diagnosed with rickettsial infection during the study period and having complete clinical and laboratory records were included. Consecutive sampling of available hospital records was employed.

Eligibility criteria: Children aged up to 12 years with clinically suspected and serologically supported rickettsial infection were included in the study. Records were included only if sufficient clinical, laboratory, complication, and outcome data were available for analysis.

Children with incomplete medical records, mixed infections, alternative confirmed diagnoses explaining the clinical presentation, or missing serological classification into scrub typhus or Indian tick typhus were excluded.

Data collection: Data were extracted retrospectively from inpatient records, laboratory reports, treatment charts, and discharge summaries using a structured data extraction form. Demographic variables included age and sex. Clinical variables included fever duration, rash, eschar, headache, vomiting, abdominal pain, edema, breathlessness, altered sensorium, lymphadenopathy, hepatomegaly, and splenomegaly.

Laboratory variables included hemoglobin, total leukocyte count, platelet count, liver function tests, renal function tests, and other available biochemical parameters. Radiological findings, including chest X-ray abnormalities where available, were recorded.

Complications such as respiratory involvement, neurological involvement, hepatic dysfunction, renal dysfunction, shock, and other documented systemic complications were recorded. Outcome variables included recovery, requirement of intensive care, duration of hospital stay where available, and mortality.

Classification of Rickettsial infection: Patients were classified into two groups based on final documented diagnosis as scrub typhus and Indian tick typhus. Clinical manifestations, laboratory abnormalities, complications, and outcomes were compared between the two groups.

Derived variables: To strengthen assessment of systemic disease burden, a composite variable termed the Multi-Organ Involvement Score (MOIS) was developed. One point was assigned for the presence of each of the following organ/system involvement markers – hepatomegaly, splenomegaly, breathlessness, altered sensorium and abnormal chest X-ray. The total MOIS score ranged from 0 to 5, with higher scores indicating greater systemic involvement.

For categorical analysis, patients were classified as mild systemic involvement (MOIS 0–1), moderate systemic involvement (2-3), and severe systemic involvement (≥4).

In addition, a simplified Systemic Involvement Status variable was created. Children with MOIS ≥2 were classified as having significant systemic involvement, whereas children with MOIS 0–1 were classified as having absent or mild systemic involvement.

Statistical analysis: Data were entered into Microsoft Excel and analyzed using JASP version 0.19.3 or appropriate statistical software. Continuous variables were assessed for normality and summarized as mean ± standard deviation or median with interquartile range, depending on distribution. Categorical variables were expressed as frequencies and percentages. Clinical manifestations, laboratory abnormalities, complications, and outcomes were compared between scrub typhus and Indian tick typhus using the Chi-square test or Fisher's exact test for categorical variables. Continuous laboratory parameters and MOIS scores were compared between the two groups using the independent Student's t-test or Mann–Whitney U test, as appropriate. The association between type of rickettsial infection and significant systemic involvement was assessed using Chi-square or Fisher's exact test. Odds ratios with 95% confidence intervals were calculated where applicable. A p-value less than 0.05 was considered statistically significant.

Ethical considerations: Institutional Ethics Committee approval was obtained before commencement of the study. As this was a retrospective record-based study with no direct patient contact or intervention, waiver of informed consent was obtained. Patient confidentiality was maintained by anonymizing all data before analysis. No personal identifiers were included in the study database, tables, figures, presentations, or publications.

Results

Demographic characteristics: A total of 50 children with rickettsial infection were included in the study. Of these, 36 were diagnosed with scrub typhus and 14 with Indian tick typhus [Figure 1].

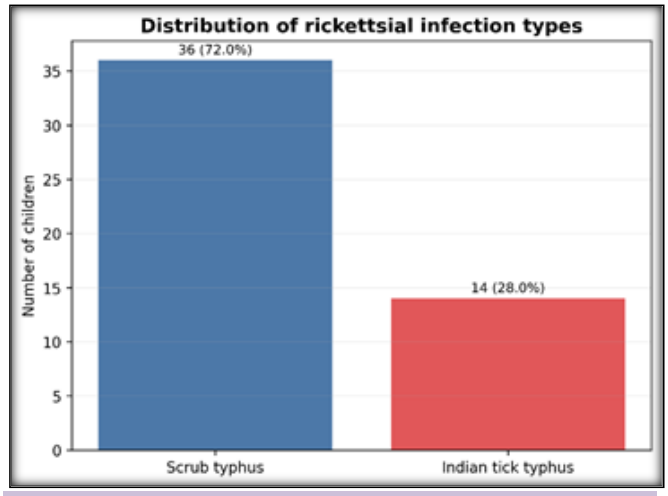

Figure 1: Distribution of rickettsial infection types (Scrub Typhus vs Indian Tick Typhus)

Clinical profile of children with Rickettsial infection

Rash was the most common clinical manifestation, observed in 46 children (92%), followed by splenomegaly in 44 (88.0%), hepatomegaly in 37 (74%), lymphadenopathy in 46 (92%), cough in 26 (52%). Other symptoms are compiled in [Figure 2].

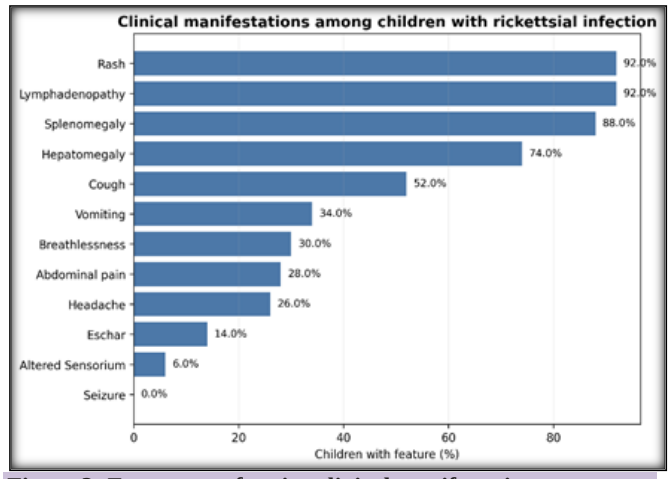

Figure 2: Frequency of major clinical manifestations

Comparison of clinical manifestations between scrub typhus and Indian tick typhus

Rash was common in both groups, being present in 91.7% of scrub typhus cases and 92.9% of Indian tick typhus cases. Other differences are compiled in [Figure 3]. Altered sensorium was documented only among children with Indian tick typhus.

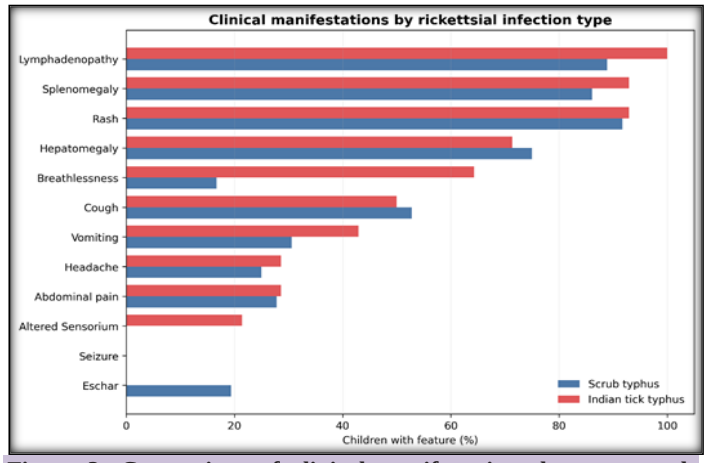

Figure 3: Comparison of clinical manifestations between scrub typhus and Indian tick typhus.

Laboratory Profile

The laboratory evaluation demonstrated varying degrees of haematological and biochemical abnormalities. Detailed comparisons of hemoglobin concentration, total leukocyte count, platelet count, serum albumin, liver enzymes (AST and ALT), C-reactive protein, and serum creatinine between scrub typhus and Indian tick typhus should be presented in [Table 1] using descriptive statistics (mean ± SD or median [IQR]) and appropriate comparative tests.

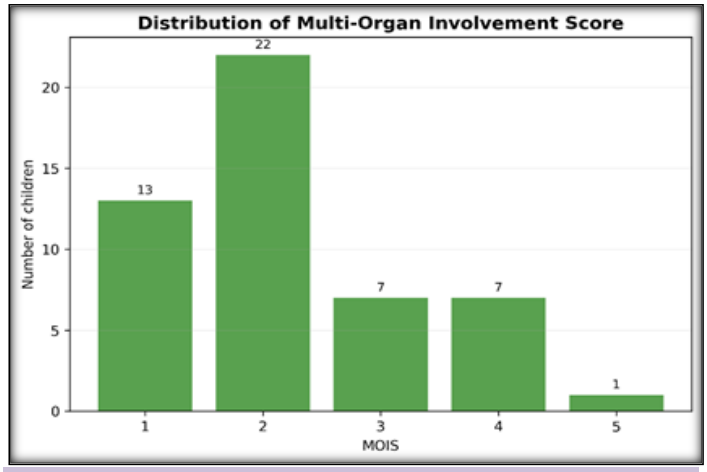

Figure 4: Distribution of Multi-Organ Involvement Scores (MOIS).

Table 1: Comparison of laboratory parameters between scrub typhus and Indian tick typhus

Parameter	Scrub Typhus (n = 36)	Indian Tick Typhus (n = 14)	p-value*
Hemoglobin (g/dL), Mean ± SD	9.05 ± 0.73	9.31 ± 1.08	0.32
Total leukocyte count (cells/mm³), Mean ± SD	6236.11 ± 1608.4	6578.57 ± 1365.61	0.48
Platelet count (lakh/mm³), Mean ± SD	1.69 ± 0.53	1.09 ± 0.44	0.0003
CRP Positive	25 (69.4%)	12 (85.7%)	<0.001
Hypoalbuminemia	10 (27.8%)	7 (50.0%)	<0.001
Elevated AST	7 (19.4%)	3 (21.4%)	<0.05
Elevated ALT	7 (19.4%)	3 (21.4%)	<0.05
Elevated Creatinine	0	0	NA

Multi-Organ Involvement Score (MOIS): The Multi-Organ Involvement Score ranged from 1 to 5. Most children

demonstrated moderate systemic involvement. Children with Indian tick typhus demonstrated a higher burden of systemic involvement than children with scrub typhus. The mean MOIS in scrub typhus was 1.97 ± 0.88 and 2.86 ± 1.23 [Figure 5].

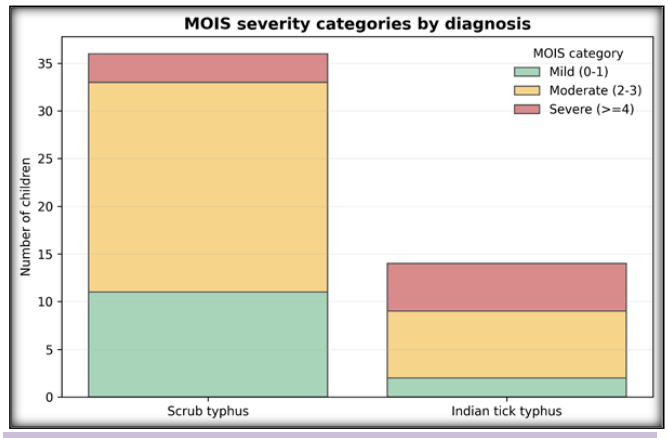

Figure 5: Multi-Organ Involvement Score (MOIS) severity categories by diagnosis of scrub typhus (n=36) and Indian tick typhus (n=14).

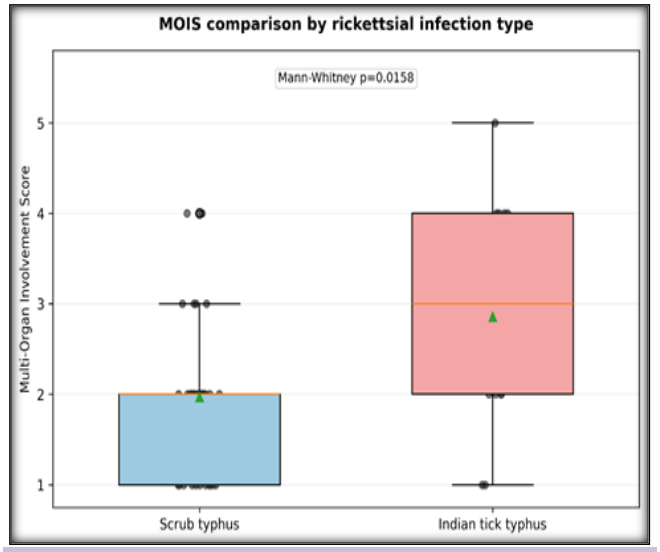

Figure 6: Box plot comparing Multi-Organ Involvement Score (MOIS) between children with scrub typhus and Indian tick typhus. Indian tick typhus showed a higher burden of systemic involvement, with a higher median and wider distribution of MOIS compared with scrub typhus. Individual points represent patient-level MOIS values, the horizontal line within each box represents the median, the box represents the interquartile range, and the green triangle represents the mean. The difference between groups was statistically significant by Mann-Whitney U test (p=0.0158).

Organ-System Involvement: Abnormal chest radiography was observed in 12 children (24 %), while breathlessness was present in 30 %. Neurological involvement, represented by altered sensorium, occurred in 6 % of cases. The increasing MOIS reflected progressively greater systemic involvement, with Indian tick typhus demonstrating a greater burden of multi-organ involvement than scrub typhus.

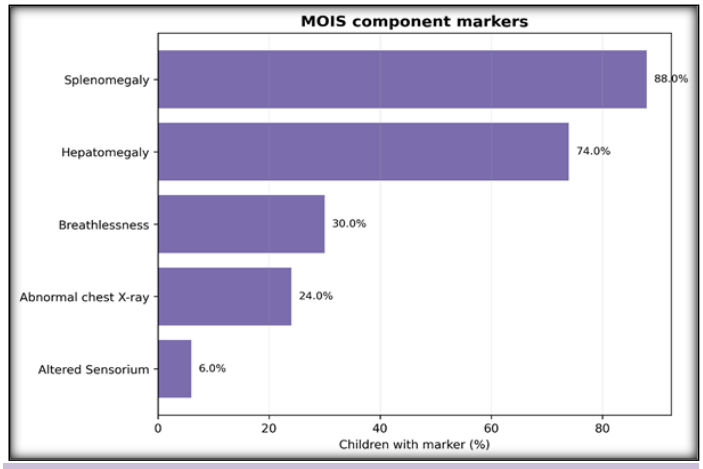

Figure 7: Frequency of component markers included in the Multi-Organ Involvement Score (MOIS) among children with rickettsial infections. Splenomegaly and hepatomegaly were the most common systemic involvement markers, followed by breathlessness and abnormal chest radiography. Altered sensorium was the least frequent MOIS component, indicating neurological involvement in a smaller subset of children.

Discussion

This study comparatively evaluated the clinical and laboratory profiles of children diagnosed with scrub typhus and Indian tick typhus, and introduced a novel Multi-Organ Involvement Score (MOIS) to quantify and compare the burden of systemic disease between the two aetiologies. The clinical manifestations observed in our cohort, rash (92%), lymphadenopathy (92%), splenomegaly (88%) align with previous studies. Azam[10] from Telangana (83.3%) and Smriti et al,[6] from Patna (72%) reports similar high incidence of skin rash. A notably higher rate of 43.7% reported by Shashidhara et al. in Kerala.[11]

Altered sensorium was documented exclusively among children with Indian tick typhus in our study. Central nervous system involvement is a well-known severe complication of rickettsial infections.[12-14] Giri et al. reported encephalopathy in 43% of severe scrub typhus cases admitted to a Intensive Care Unit in Kolkata,[15] and Aroor et al. noted altered sensorium in 31.3% of ICU-admitted scrub typhus patients in Manipal.[4] The exclusive presence of altered sensorium in our Indian tick typhus cohort highlights the critical need for heightened neurological surveillance when tick-borne rickettsiosis is suspected.[16,17] Furthermore, respiratory involvement was seen in 30% of our cases, mirroring patterns seen across Indian PICUs where respiratory distress and Acute Respiratory Distress Syndrome are leading causes for intensive care admission.[18] Thrombocytopenia is a ubiquitous marker of rickettsial infection, reported in up to 68% of cases, and is strongly correlated with disease severity and the need for intensive care.

Rickettsial infections target endothelial cells, leading to widespread microvascular injury, leading to MODS.[19] While scrub typhus is widely documented as a major driver of pediatric MODS in India accounting for 18.29% of all MODS admissions in a Kolkata PICU,[15] our data indicates that Indian tick typhus may precipitate an even heavier systemic toll. The mean MOIS was significantly higher in Indian tick typhus (2.86 ± 1.23) compared to scrub typhus (1.97 ± 0.88) (p=0.0158). Most

children with Indian tick typhus fell into the moderate-to-severe systemic involvement categories.

Limitations of the study: study utilized hospital based data in a cross sectional design, relying heavily on the existing medical records.

While this study provides valuable comparative insights and introduces the novel Multi-Organ Involvement Score (MOIS) for pediatric rickettsial infections, several limitations must be acknowledged. Sample size of 50 children and Indian tick typhus cases of 14, limits statistical power of comparative analyses. Findings of single centre study generally limits generalizability. Lack of advanced molecular diagnostics, such as polymerase chain reaction, may limit the ability to confirm cases with the highest possible specificity.

Conclusion

Through this cohort analysis, we conclude that Indian tick typhus, in particular, is associated with a more aggressive clinical and biochemical profile, marked by exclusive neurological manifestations (altered sensorium) and significantly more profound laboratory derangements. MOIS index was significantly higher in Indian tick typhus cohort emphasize the propensity of this specific rickettsiosis to precipitate widespread systemic complications and organ dysfunction. Relying solely on clinical presentation is often insufficient for differentiating these aetiologies; however, utilizing practical clinical tools like the MOIS alongside routine laboratory markers can aid in the early recognition of impending multi-organ dysfunction.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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