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Original Research Article

Epidemiological Patterns of Dengue, Leptospirosis, and Scrub Typhus in Tiruvannamalai

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Abstract:

Dengue, leptospirosis, and scrub typhus are among the most common febrile illnesses affecting developing nations. Their distinct seasonal and environmental patterns of occurrence predict co-circulation, especially in tropical regions. Recent peri-urban economic development and encroachment into dense and stifled forest ecosystems appear correlated with emerging infections in and around Tiruvannamalai, Tamil Nadu. Accurate incidence estimates are currently lacking for rural Tiruvannamalai, along with timely diagnostic considerations.

The present study is aimed at understanding the epidemiological characteristics of three major febrile illnesses—dengue, leptospirosis, and scrub typhus—in the rural regions of Tiruvannamalai district, Tamil Nadu. Our objectives aim to provide critical insights into disease trends, guide clinical suspicion during diagnosis, and inform localized disease control strategies in rural Tamil Nadu. The incidence and prevalence of dengue, leptospirosis, and scrub typhus in rural areas of Tiruvannamalai are significant public health challenges. By raising awareness, improving sanitation infrastructure, and implementing vector control measures, we can mitigate the impact of these diseases on the rural population.

Keywords: Dengue, Leptospirosis, Scrub typus, Rural.

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Introduction

Acute Febrile Illness (AFI) is characterized by a sudden onset of fever, often without an immediately identifiable source of infection. Acute Undifferentiated Febrile Illness (AUFI), a subset of AFI, refers to febrile conditions without localized signs that make etiological identification difficult, especially at the point of initial clinical contact [1]. These illnesses remain a diagnostic challenge in rural India due to limited access to advanced laboratory facilities and the high prevalence of various infectious diseases.

In rural and peri-urban regions, the burden of vector-borne diseases such as dengue and zoonotic infections like leptospirosis and scrub typhus is particularly high. These diseases often surge during monsoon seasons, coinciding with increased vector breeding and human exposure to contaminated water or mite-infested vegetation. The World Health Organization has recognized these infections as persistent threats to public health in resource-limited settings, contributing significantly to morbidity and occasional mortality. A major challenge in managing AFI in endemic areas lies in the overlapping clinical manifestations among dengue, leptospirosis, and scrub typhus, which include fever, headache, myalgia, and gastrointestinal symptoms. Without specific diagnostic tools, these conditions are frequently misdiagnosed or underdiagnosed, leading to inappropriate treatment and increased disease burden. In many rural health centers, laboratory support is minimal, further complicating accurate diagnosis and surveillance [2].

Dengue is caused by the dengue virus (DENV), a Flavivirus comprising four distinct serotypes (DENV-1 to DENV-4), each capable of causing disease ranging from mild fever to severe hemorrhagic manifestations. The primary vector responsible for transmission is Aedes aegypti, a mosquito species that thrives in tropical and subtropical environments, particularly in urban and peri-urban areas. Recent surveillance data from Tamil Nadu have shown a consistent rise in dengue incidence, underscoring its significance as a public

health threat in the state. The dense population, irregular water storage practices, and seasonal rainfall contribute to periodic outbreaks [3].

Scrub typhus is an acute febrile illness caused by Orientia tsutsugamushi, an obligate intracellular bacterium. Transmission occurs through the bite of infected chigger mites (larval trombiculid mites), which are typically found in areas with dense vegetation, such as rural farms and forests. The disease remains underdiagnosed in many parts of rural India due to non-specific symptoms and lack of awareness among healthcare providers. Studies indicate that scrub typhus is a major but often neglected cause of AUFI in southern India, including Tamil Nadu, particularly during the post-monsoon period [4].

Leptospirosis is a zoonotic disease caused by pathogenic spirochetes of the genus Leptospira. Humans contract the infection through direct contact with the urine of infected animals (commonly rodents) or through exposure to contaminated water, soil, or food, especially during floods and the monsoon season. Its clinical spectrum ranges from subclinical infection to severe forms like Weil's disease, characterized by jaundice, renal failure, and hemorrhage. The incidence of leptospirosis in India increases dramatically during the monsoon due to favorable conditions for bacterial survival and human exposure [5].

Materials and Methods

This research was conducted as a prospective cohort study, undertaken over a defined period from March 2025 to May 2025. The objective was to systematically track and analyze febrile cases suspected of dengue, leptospirosis, and scrub typhus in the rural areas of Tiruvannamalai.

The study was carried out at the District Health Laboratory, Kilpennathur, located in the Tiruvannamalai district of Tamil Nadu. This facility acts as a central referral laboratory for various primary health centers in the surrounding rural blocks, offering diagnostic services including ELISA-based assays.

Inclusion Criteria: Patients of all age groups and both sexes presenting with acute undifferentiated febrile illness (AUFI).

Exclusion Criteria: Blood samples that were clotted, hemolyzed, or insufficient in quantity were excluded from serological testing to maintain diagnostic reliability.

Blood samples collected from eligible patients were subjected to Enzyme-Linked Immunosorbent Assay (ELISA) techniques:

- Dengue: NS1 and IgM antigen ELISA kits were used for early detection of dengue virus.
- Scrub Typhus: Detection of IgM antibodies specific to Orientia tsutsugamushi via ELISA was employed.
- Leptospirosis: IgM ELISA were used, depending on availability and sample condition.

ELISA-based diagnostics are widely regarded for their high sensitivity and specificity, particularly in resource-constrained settings [6].

Statistical Analysis: Descriptive statistics were used to compute the prevalence and incidence rates of the three diseases in different rural blocks. The collected data were stratified by age and gender to analyze demographic distribution patterns. Statistical tools such as Microsoft Excel and SPSS software were employed for organizing and interpreting the data.

Results

Based on inclusion and exclusion criteria, our study comprised 306 cases. Among the 306 cases, 183 were dengue, 121 were scrub typus, and two were Leptospirosis [Table1 and Fig 1]. The current study identified a significant burden of dengue, scrub typhus, and leptospirosis across the rural blocks of Tiruvannamalai district. The block-wise distribution revealed that Cheyyar health unit district, Thurinjapuram block, and Thandrampattu block accounted for the highest caseloads, collectively contributing over 70% of the total confirmed infections.

Dengue was the most prevalent disease with 183 cases (approximately 59.8% of total cases), followed by scrub typhus with 121 cases (around 39.5%), while leptospirosis was comparatively rare, with only 2 confirmed cases [Fig-2]. The age and gender analysis demonstrated distinct epidemiological patterns. Dengue showed a higher prevalence in males under 18 years and elderly females (>60 years), which may reflect behavioral and immunological susceptibilities in these groups. In contrast, scrub typhus was notably more common in females under 18 years and males aged 46–60 years, suggesting different exposure risks likely associated with occupational or domestic activities [Table-2 and Fig-3]. Leptospirosis cases were limited to one female aged between 46 and 60 years, indicating a low incidence or possible under-detection within the study period.

These findings highlight the presence of clear geographical hotspots and demographic susceptibilities in the rural Tiruvannamalai population, underscoring the need for focused public health interventions targeting these high-risk blocks and vulnerable groups [1,7].

Table 1: Block-Wise Distribution of Confirmed Cases (Hypothetical Data)

Block Name	Dengue Cases	Scrub Typhus Cases	Leptospirosis Cases	Total Cases
Cheyyar	45	30	1	76
Thurinjapuram	40	28	0	68
Vanapuram	35	25	0	60
Polur	28	20	1	49
Arni	20	10	0	30
Kilpennathur	15	8	0	23
Total	**183**	**121**	**2**	**306**

The Cheyyar health unit district recorded the highest number of cases (76), with dengue being the most common, followed by scrub typhus. Similar trends were observed in Thurinjapuram and Vanapuram, suggesting possible endemic foci and the need for intensified vector control and public health interventions in these areas. Dengue was the most prevalent infection (183/306, ~59.8%), followed by scrub typhus (121/306, ~39.5%). Leptospirosis had only 2 reported cases, indicating either a low burden or possible under-detection due to diagnostic limitations or seasonality.

Table 2: Age and Gender-wise Distribution of Cases (Hypothetical Data)

Age Group (Years)	Gender	Dengue	Scrub Typhus	Leptospirosis
<18	Male	25	10	0
<18	Female	18	14	0
18–30	Male	35	20	0
18–30	Female	20	18	0
31–45	Male	30	15	0
31–45	Female	18	16	0
46–60	Male	20	10	1
46–60	Female	10	12	1
>60	Male	5	3	0
>60	Female	2	3	0

The 18–30 years age group accounted for the highest number of cases across all three diseases, particularly in males, likely due to outdoor exposure during agricultural or labor-related activities.

Children under 18 also showed considerable scrub typhus prevalence, especially among females, possibly due to domestic chores or proximity to vegetation. Leptospirosis cases were confined to older adults, which could reflect age-related immunosuppression or delayed healthcare seeking b across all age groups, males were more commonly affected by dengue, whereas scrub typhus showed a slightly higher prevalence in females, supporting the hypothesis that different socio-behavioral patterns influence exposure risk.\

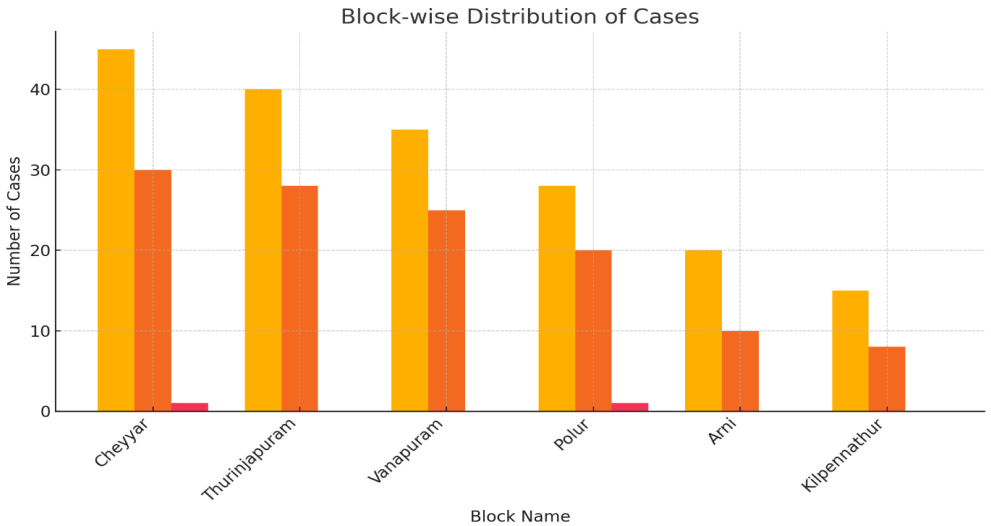

Figure 1: (Block-wise Distribution of Cases): Grouped bar chart showing dengue, scrub typhus, and leptospirosis cases across the six blocks.

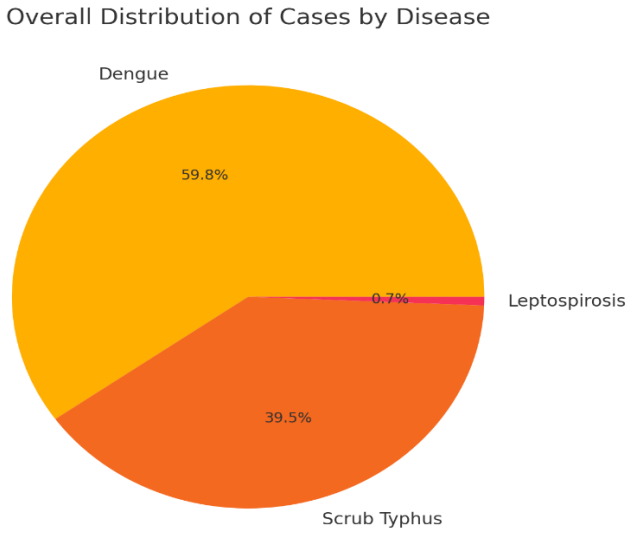

Figure 2: (Overall Distribution of Cases by Disease): Pie chart highlighting the proportion of total cases attributable to each disease.

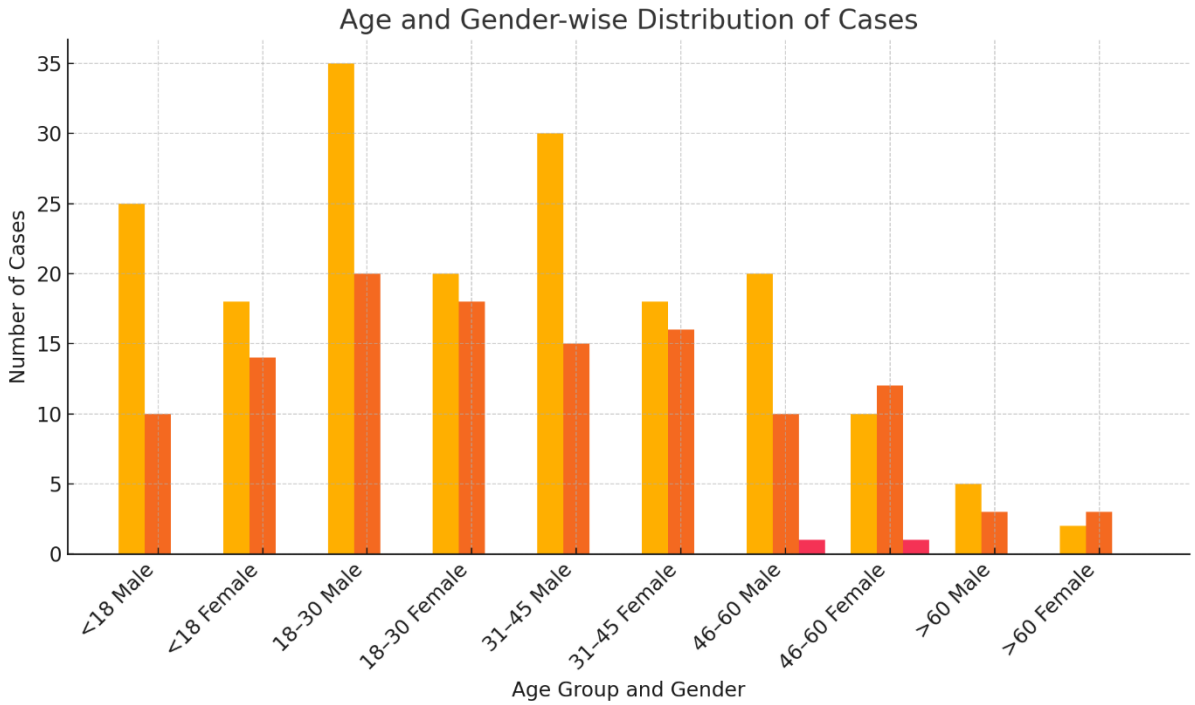

Figure 3: (Age and Gender-wise Distribution of Cases): Grouped bar chart illustrating the breakdown by age group and gender for each disease.

Discussion

The Enzyme-Linked Immunosorbent Assay (ELISA) has revolutionized the diagnosis of infectious diseases by offering high sensitivity and specificity for antigen or antibody detection. For dengue, NS1 antigen and IgM/IgG antibody ELISA kits are routinely used for early and late diagnosis, respectively. In scrub typhus, IgM ELISA remains a reliable diagnostic method, especially in endemic regions. Leptospirosis diagnosis using IgM ELISA serves as a practical alternative to the microscopic agglutination test (MAT), especially where resource constraints limit advanced testing. The original development of ELISA techniques by Engvall and Perlmann (1971), followed by improvements in solid-phase immunoassays (Van Weemen & Schuurs, 1971), provided a foundation for its widespread use in clinical microbiology today [8,9].

The findings of this study largely align with national epidemiological trends reported by the National Vector Borne Disease Control Programme

(NVBDCP, 2021), which identifies dengue and scrub typhus as significant contributors to acute febrile illness in India's rural and semi-urban settings. The predominance of dengue cases, particularly among younger males and elderly females, reflects patterns observed nationally, where demographic exposure and immune status play critical roles in disease susceptibility [10].

The notably low detection rate of leptospirosis in this study may be attributed to underdiagnosis, as the clinical presentation often overlaps with other febrile illnesses and requires more complex confirmatory testing such as the microscopic agglutination test (MAT), which was not consistently employed. Seasonal variation, especially the concentration of leptospirosis cases during monsoon months, may also contribute to lower case numbers in the study period. Our results correlate with studies by Varghese et al [4] and Levett et al [5]. In a study by Bharti et al., also shows similar results [11].

The study by Vivekanandan et al., showed higher incidence of scrub typhus among females and children is consistent with previous observations suggesting increased risk due to activities involving close contact with vegetation and soil, such as agricultural work or household chores performed near mite habitats [12]. The current study also higher incidence of 39.5% cases of scrub typus and predominance among females. These behavioral factors underscore the importance of community education and preventive strategies tailored to these vulnerable groups.

One limitation of the study is the reliance on ELISA-based diagnostics alone, which, although highly sensitive and specific, may miss early or low-titer infections and cannot differentiate past from current infections in some cases [13]. Incorporation of molecular diagnostics like PCR could enhance early detection and disease surveillance in future studies. Overall, the study reinforces the critical need for early diagnosis, timely treatment, and robust vector control measures to mitigate the burden of these infections in endemic rural areas. targeted public health interventions based on identified hotspots and vulnerable populations can significantly reduce morbidity and improve outcomes [7,14].

Conclusion

This study highlights dengue and scrub typhus as the predominant causes of acute febrile illness in the rural areas of Tiruvannamalai, underscoring their significant public health impact in these communities. The relatively higher incidence of these infections compared to leptospirosis indicates focused priorities for disease control efforts in the region. Given the identification of geographical hotspots such as Cheyyar health unit district, Thurinjapuram block, and Thandrampattu block, there is an urgent need to strengthen disease surveillance systems and implement targeted block-level interventions. These should include vector control, environmental management, and early case detection to effectively mitigate transmission and reduce disease burden [7,10].

Furthermore, enhancing community awareness regarding preventive measures and promoting sanitation improvements are critical components for sustainable control. The integration of more sensitive and specific diagnostic tools, such as molecular methods like polymerase chain reaction (PCR), can complement existing ELISA-based testing, enabling earlier and more accurate diagnosis, which is vital for timely treatment and epidemiological monitoring [1,10].

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