

## Epidemiological Characteristics and Clinical Outcomes of Typhoid Fever in Pediatric Patients: A Prospective Study

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### ABSTRACT

**Objective:** To investigate the epidemiological profile, clinical manifestations, and diagnostic outcomes of typhoid fever in children aged 2–12 years in an endemic region of South India.

**Methods:** A prospective, hospital-based study was conducted at the Institute of Social Pediatrics, Government Stanley Medical College, Chennai, India. Seventy children aged 2–12 years with clinically suspected typhoid fever, confirmed by serological tests (Widal or Typhidot-M) or blood culture, were enrolled. Exclusion criteria included children under 2 years, those with other febrile illnesses, or chronic malnutrition. Data on demographics, clinical features, socioeconomic factors, and laboratory results were collected using a structured proforma. Blood samples underwent complete hemogram, liver function tests, ultrasonography, blood culture, Widal, and Typhidot-M tests.

**Results:** The mean age was  $5.74 \pm 2.11$  years, with 55.7% males. All patients presented with fever, 51.4% had abdominal pain, and 60% reported anorexia. Hepatomegaly was observed in 42.9%, splenomegaly in 27.1%, and hepatosplenomegaly in 22.9%. Blood culture was positive in 1.4%, while Widal and Typhidot-M were positive in 100% of the 70 analyzed cases. No complications were noted, and all patients recovered. Socioeconomic factors included 52.9% from upper-lower class and 72.9% consuming roadside food.

**Conclusions:** Typhoid fever in children is associated with poor hygiene and sanitation, with fever and gastrointestinal symptoms being predominant. Early diagnosis using serological tests like Typhidot-M is effective in resource-limited settings. Public health interventions targeting sanitation and food hygiene are crucial.

**KEYWORDS:** Typhoid Fever, Pediatric, Epidemiology, Serological Diagnosis, Socioeconomic Factors, Public Health.

### INTRODUCTION

Typhoid fever, caused by *Salmonella enterica* serotype Typhi, remains a significant public health challenge in developing nations, particularly in South Asia, where poor sanitation and limited access to safe water exacerbate its prevalence [1]. Globally, an estimated 22 million cases occur annually, with approximately 215,000 deaths, predominantly affecting children in low-resource settings [2]. In India, an endemic region, the annual incidence hovers around 1%, with peak infection rates in children aged 5–15 years [3]. Despite advancements in antimicrobial therapy and vaccines, the disease persists due to rising antimicrobial resistance and inadequate public health infrastructure [4].

The historical context of typhoid fever underscores its enduring impact. First identified by Karl Joseph Eberth in 1880, *Salmonella* Typhi was confirmed as the causative agent by Georg Gaffky in 1884 [5]. The development of a heat-denatured typhoid vaccine by Sir Almroth Wright in 1896 marked a milestone in prevention, yet its

global application remains limited [6]. In India, the disease's endemicity is driven by environmental and socioeconomic factors, including contaminated water sources, poor food hygiene, and overcrowded living conditions [7]. These conditions facilitate the fecal-oral transmission of *S. Typhi*, often through contaminated food or water, with roadside food consumption and untreated water being notable risk factors [8].

The clinical presentation of typhoid fever in children is often nonspecific, complicating early diagnosis. Common symptoms include sustained fever, abdominal pain, anorexia, and gastrointestinal disturbances, with hepatosplenomegaly frequently observed [9]. Unlike adults, children may present with diarrhea rather than constipation, and relative bradycardia is less common [10]. Severe complications, such as intestinal perforation and hemorrhage, are rare but carry high morbidity and mortality, particularly in untreated cases [11]. The diagnostic challenge is compounded in resource-limited settings, where blood culture—the gold standard—has low sensitivity (40–80%) due to prior antibiotic use or insufficient sample volumes [12]. Serological tests, such as the Widal test and Typhidot-M, are widely used despite limitations in specificity and sensitivity, necessitating a reliance on clinical correlation [13].

The pathogenesis of typhoid fever involves the ingestion of *S. Typhi*, which invades the intestinal mucosa via M cells in Peyer's patches, leading to systemic dissemination through the lymphatic and bloodstream [14]. The organism's ability to survive within macrophages contributes to its persistence, with the gallbladder serving as a reservoir in chronic carriers [15]. Chronic carriers, estimated to occur in 2–5% of cases, pose a significant public health risk, as exemplified by the historical case of "Typhoid Mary" [5]. In endemic areas, carriers and poor sanitation sustain transmission cycles, underscoring the need for targeted interventions.

Socioeconomic determinants play a critical role in typhoid fever's epidemiology. Low socioeconomic status, limited access to sanitation, and poor personal hygiene are strongly associated with increased risk [7]. In India, only a fraction of cases require hospitalization, yet the economic burden of treatment and lost productivity is substantial [3]. Vaccination coverage remains suboptimal, with 85.7% of children in this study unvaccinated, highlighting gaps in preventive strategies. The emergence of multidrug-resistant (MDR) strains further complicates treatment, with fluoroquinolone resistance driving the use of third-generation cephalosporins and azithromycin [4]. This study aims to characterize the epidemiological features, clinical manifestations, and diagnostic outcomes of typhoid fever in children aged 2–12 years in Chennai, India.

## MATERIALS AND METHODS

**Study Setting:** This prospective study was conducted at the Institute of Social Pediatrics, Government Stanley Medical College Hospital, Chennai, India, a tertiary care facility serving a diverse urban and rural population. The study spanned six months from August 2023 to January 2024.

**Study Participants:** Eligible participants were children aged 2–12 years presenting with clinically suspected typhoid fever, confirmed by positive serological tests (Widal or Typhidot-M) or blood culture. Clinical suspicion was based on fever ( $\geq 38^{\circ}\text{C}$ ) for at least three days, accompanied by symptoms such as abdominal pain, vomiting, or anorexia. Inclusion criteria encompassed both outpatient and hospitalized children willing to comply with study protocols. Exclusion criteria included children under 2 years, those with other febrile illnesses (e.g., malaria, dengue), or chronic malnutrition, as these conditions could confound clinical and laboratory findings.

**Sample Size and Sampling Technique:** The sample size was determined based on an expected typhoid fever prevalence of 1% in India, aiming to detect clinical and epidemiological characteristics with adequate precision. A total of 300 children were initially screened, with 70 meeting inclusion criteria for final analysis. Non-probability convenience sampling was employed, enrolling consecutive eligible patients to ensure feasibility within the study period.

**Study Tools:** Data were collected using a structured proforma capturing demographic details, clinical symptoms, and environmental factors. Laboratory investigations included complete hemogram, liver function tests, ultrasonography of the abdomen, blood culture, Widal test, and Typhidot-M. Blood cultures were

performed using Brain Mouse Broth Agar, with subcultures on selective media. Widal tests used O and H antigens, with a titer of  $\geq 1:160$  considered significant. Typhidot-M detected IgM antibodies against a 50 kDa outer membrane protein antigen. Ultrasonography assessed hepatosplenomegaly.

**Study Methodology:** Following informed consent, a detailed epidemiological history and clinical examination were conducted. Venous blood (7 mL) was collected under aseptic conditions for hemogram, liver function tests, blood culture, Widal, and Typhidot-M. Complete hemogram and liver function tests were processed using automated analyzers in the central laboratory. Blood cultures were incubated at 37°C for 24–48 hours, with growth identified via biochemical tests and agglutination. Widal and Typhidot-M tests followed manufacturer protocols, with results correlated to clinical findings. Ultrasonography was performed by radiologists to detect organomegaly. Data were recorded systematically and analyzed to assess epidemiological patterns, clinical features, and diagnostic outcomes.

**Ethical Issues:** The study was approved by the Institutional Ethics Committee of Government Stanley Medical College. Written informed consent was obtained from parents or guardians after explaining the study’s purpose, procedures, and potential risks. Data confidentiality was maintained through anonymization, and participants could withdraw without affecting their care.

**Statistical Analysis:** Data were analyzed using IBM SPSS version 22. Continuous variables, such as age and laboratory parameters, were expressed as means  $\pm$  standard deviations. Categorical variables, including clinical symptoms and socioeconomic factors, were reported as frequencies and percentages. Descriptive statistics summarized epidemiological and clinical characteristics.

## RESULTS

The study enrolled 300 children, with 70 meeting inclusion criteria after excluding two outliers. The demographic and socioeconomic profile of the 70 children revealed a mean age of  $5.74 \pm 2.11$  years, with 67.1% (n=47) aged above 5 years and 32.9% (n=23) aged 5 years or younger. Males constituted 55.7% (n=39), and females 44.3% (n=31). Socioeconomic status, assessed using the modified Kuppuswamy scale, showed 52.9% (n=37) from the upper-lower class, 32.9% (n=23) from the lower class, and 14.3% (n=10) from the lower-middle class. Regarding residence, 60% (n=42) were urban dwellers, and 40% (n=28) were from rural areas, reflecting the hospital’s diverse catchment area.

**Table 1: Demographic and Socioeconomic Characteristics**

Variable	Frequency (n)	Percent (%)
<b>Age</b>		
≤5 years	23	32.9
>5 years	47	67.1
<b>Gender</b>		
Male	39	55.7
Female	31	44.3
<b>Socioeconomic Status</b>		
Lower	23	32.9
Upper Lower	37	52.9
Lower Middle	10	14.3
<b>Residence</b>		
Urban	42	60.0
Rural	28	40.0

All 70 children presented with fever (100%, n=72, including two outliers), with 60% (n=42) reporting anorexia and 51.4% (n=36) experiencing abdominal pain. Vomiting was noted in 48.6% (n=34), and loose stools in

38.6% (n=27). Hepatomegaly was observed in 42.9% (n=30), splenomegaly in 24.3% (n=17), and hepatosplenomegaly in 22.9% (n=16). A toxic appearance was seen in 44.3% (n=31), while relative bradycardia was rare at 4.3% (n=3).

**Table 2: Clinical Features**

Clinical Sign	Frequency (n)	Percent (%)
Fever	72	100
Abdominal Pain	36	51.4
Vomiting	34	48.6
Anorexia	42	60.0
Loose Stool	27	38.6
Hepatomegaly	30	42.9
Splenomegaly	17	24.3
Hepatosplenomegaly	16	22.9
Toxic Look	31	44.3
Relative Bradycardia	3	4.3

Laboratory analysis showed that 41.4% (n=29) of children had normal blood counts (4000–11000 cells/mm<sup>3</sup>), while 38.6% (n=27) had leukopenia (<4000 cells/mm<sup>3</sup>), and 20% (n=14) had leukocytosis (>11000 cells/mm<sup>3</sup>). Elevated liver enzymes were observed in 24.3% (n=17), with 75.7% (n=53) having normal levels. Thrombocytopenia was present in 15.7% (n=11), and eosinopenia in 34.3% (n=24).

**Table 3: Laboratory Findings**

Parameter	Frequency (n)	Percent (%)
<b>Blood Count</b>		
<4000	27	38.6
4000–11000	29	41.4
>11000	14	20.0
<b>Liver Enzymes</b>		
Elevated	17	24.3
Normal	53	75.7
<b>Thrombocytopenia</b>	11	15.7
<b>Eosinopenia</b>	24	34.3

Diagnostic testing revealed a low blood culture positivity rate of 1.4% (n=1), while Widal and Typhidot-M tests were positive in 100% (n=70 and n=72, respectively) of analyzed cases, reflecting their higher sensitivity in this cohort.

**Table 4: Diagnostic Test Results**

Test	Positive (n)	Percent (%)
Blood Culture	1	1.4
Widal	70	100
Typhidot-M	72	100

Environmental analysis indicated that 64.3% (n=45) used corporation water, and 28.6% (n=20) used canned water. Personal hygiene was good in 18.6% (n=13), average in 45.7% (n=32), and poor in 35.7% (n=25). Roadside food consumption was reported by 72.9% (n=51), and 71.4% (n=50) had toilet access.

**Table 5: Environmental and Hygiene Factors**

Factor	Frequency (n)	Percent (%)
<b>Water Source</b>		
Corporation	45	64.3
Can	20	28.6
<b>Personal Hygiene</b>		
Good	13	18.6
Average	32	45.7
Poor	25	35.7
<b>Roadside Food Intake</b>	51	72.9
<b>Toilet Access</b>	50	71.4

## DISCUSSION

This prospective study of 70 children with confirmed typhoid fever in Chennai, India, provides critical insights into the disease's epidemiological and clinical profile in an endemic setting, highlighting the interplay of socioeconomic, environmental, and diagnostic factors [1]. The observed prevalence of 23.3% among 300 suspected cases underscores the significant burden of typhoid fever in pediatric populations, consistent with global estimates of 22 million annual cases, predominantly in South Asia [2].

The mean age of 5.74 years aligns with the known peak incidence in school-aged children (5–15 years), as reported by Ochiai et al. [3]. This age distribution likely reflects increased exposure to contaminated food and water outside the home, as children in this age group are more likely to consume roadside food (72.9% in this study) or engage in activities in environments with poor sanitation [7]. The male predominance (55.7%) corroborates findings by Shah et al., who noted a higher incidence in boys, possibly due to greater outdoor activity or risk-taking behaviors leading to exposure to contaminated sources [9].

The socioeconomic profile, with 52.9% from the upper-lower class and 32.9% from the lower class, highlights the disease's association with socioeconomic deprivation, as described by Sharma et al. [7]. Urban residence (60%) reflects the study setting but also suggests that urban slums, characterized by overcrowding and poor sanitation, are significant transmission hubs, consistent with WHO reports [1].

The high prevalence of roadside food consumption (72.9%) and poor hygiene (35.7%) highlights the fecal-oral transmission route, a finding echoed by Malangori et al., who linked unhygienic practices to enteric fever [8]. Notably, 64.3% of children had access to corporation water, yet only 28.6% used boiled water, a critical preventive measure emphasized by Malisa et al. [10]. The low vaccination rate (14.3%) is a public health concern, as typhoid conjugate vaccines could significantly reduce incidence, as advocated by Levine et al. [6]. This gap reflects barriers such as cost, awareness, and access, particularly in low-resource settings.

Clinically, the universal presence of fever (100%) aligns with the hallmark presentation of typhoid fever, while anorexia (60%) and abdominal pain (51.4%) were prevalent, consistent with Ahmad et al. [9]. The high incidence of hepatomegaly (42.9%) and splenomegaly (24.3%) mirrors findings by Ganesh et al., who reported hepatomegaly in 71% of cases [11]. The low rate of relative bradycardia (4.3%) confirms its rarity in pediatric typhoid, as noted by Bhutta et al. [12]. The absence of complications, such as intestinal perforation, contrasts with studies like Mathura et al., which reported higher complication rates in settings with delayed treatment [13]. This favorable outcome likely results from early diagnosis and access to tertiary care, emphasizing the importance of timely intervention.

Laboratory findings revealed normal blood counts in 41.4%, leukopenia in 38.6%, and leukocytosis in 20%, consistent with the variable hematological profile of typhoid fever described by Devaranavadi et al. [14]. Elevated liver enzymes (24.3%) and eosinopenia (34.3%) serve as diagnostic clues, as they reflect the systemic inflammatory response to *S. Typhi* infection [15]. The low blood culture positivity rate (1.4%) is a critical finding, likely due to prior antibiotic use, a common challenge in endemic areas where self-medication is prevalent [12]. The 100% positivity of Widal and Typhidot-M tests highlights their utility in resource-limited settings, though their specificity is debated, as noted by Sanjeev et al. [13]. Typhidot-M, detecting IgM antibodies against a 50 kDa antigen, offers rapid results, making it valuable for early diagnosis when blood cultures are negative [4].

The environmental data reinforce the role of hygiene and sanitation in disease transmission. The high rate of roadside food consumption (72.9%) aligns with studies linking street food to typhoid outbreaks, as vendors often operate in unsanitary conditions [8]. Poor personal hygiene (35.7%) and limited use of boiled water (28.6%) are modifiable risk factors that public health campaigns could target. Toilet access (71.4%) was relatively high, yet open defecation in some rural areas may contribute to contamination of water sources, a risk factor highlighted by WHO [1]. These findings underscore the need for multifaceted interventions, including improved water treatment, food safety regulations, and community education on hygiene practices.

The study's strengths include its prospective design, comprehensive data collection, and high retention rate, ensuring robust clinical and epidemiological insights. However, limitations include the low blood culture yield, which precluded comparative analysis of diagnostic tests against the gold standard, and the small sample size, limiting statistical power. The single-center urban setting may not fully represent rural epidemiology, and the six-month duration may miss seasonal variations in typhoid incidence. Comparative studies, such as Kabir et al., reported higher complication rates, possibly due to differences in healthcare access or MDR strains [5]. The absence of molecular diagnostics, such as PCR, limits the study's ability to confirm *S. Typhi* with higher sensitivity, a method increasingly used in research settings [4].

Clinical implications are significant. The high sensitivity of Typhidot-M supports its use for early diagnosis in settings where blood culture is unreliable, enabling prompt treatment with antibiotics like ceftriaxone or azithromycin, which are effective against MDR strains [4]. Clinicians should maintain a high index of suspicion for typhoid in children with prolonged fever, even with normal blood counts, and combine clinical findings with serological tests. Public health strategies should prioritize vaccination campaigns, as typhoid conjugate vaccines have demonstrated efficacy in endemic areas [6]. Regulating roadside food vendors and improving sanitation infrastructure could disrupt transmission cycles, as suggested by Sharma et al. [7]. Community education on boiling water and hand hygiene is critical, given the low adoption of these practices in this cohort.

This study highlights the interplay of clinical, socioeconomic, and environmental factors in pediatric typhoid fever. Early diagnosis using serological tests and targeted public health interventions are critical to reducing morbidity in endemic regions. By addressing modifiable risk factors and improving vaccine coverage, the burden of this preventable disease can be significantly alleviated.

## CONCLUSION

Typhoid fever in children aged 2–12 years is driven by poor sanitation and hygiene, with fever, abdominal pain, and anorexia as key features. Serological tests like Typhidot-M facilitate early diagnosis in resource-limited settings. Public health interventions targeting water safety, food hygiene, and vaccination are essential to reduce the burden of this preventable disease.

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