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Antimicrobial Resistance Pattern of *Salmonella Typhi* Isolated from Pediatric Population in Lahore

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Abstract

Salmonella typhi is a Gram-negative pathogen that causes typhoid fever in people. Antibiotics have played crucial role in the mitigation of typhoid and its fatality risk. However, rising multidrug-resistance (MDR) and extensively drug-resistance (XDR) in Pakistan has reduced the effectiveness of treatment. This study aimed to determine the antimicrobial resistance pattern of *Salmonella typhi* isolated from pediatric population in Lahore. A descriptive cross-sectional study was conducted on 100 clinically suspected typhoid patients from March 2024 to January 2025. Blood samples were collected and cultured on blood and MacConkey agar to identify *S. Typhi*. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method. Demographic data were also collected and analyzed using SPSS version 24. Out of 100 patients, 53 (53%) were male and 47 (47%) were female. The most affected age group was 5-10 years. Antibiotic sensitivity testing revealed alarming resistance patterns: 37% resistance to Chloramphenicol and Azithromycin, 35% to Ciprofloxacin, 28% to Ceftriaxone, and 34% to Ampicillin and Trimethoprim-Sulfamethoxazole. All *S. typhi* isolates were found to be multidrug-resistant, with resistance to at least three first-line antibiotics. This study concluded that an alarming increase in antibiotic drug resistance among the children with enteric fever, highlighting the need for fast antibiotic stewardship and contamination control techniques, as well as advanced studies on *S. typhi* to prevent extreme outcomes.

Keywords: Salmonella Typhi, Multidrug Resistance, Typhoid Fever, Antibiotic Susceptibility, Blood Culture, Antimicrobial Resistance.

Introduction:

Salmonella typhi (*S. typhi*) and *Salmonella paratyphi* (*S. paratyphi*) are gram negative bacteria from the *enterobacteriacae* family. Typhoid fever is caused by *S. typhi*, whereas *paratyphoid* fever is caused by *S. paratyphi* serotypes A, B, and C.[1] Typhoid fever and other invasive salmonellosis are expected to produce 14.8 million illnesses and over 200,000 fatalities worldwide in 2020, in children with low- and middle-income countries being the most affected.[2]

In 2020, Pakistan was estimated to have the third-highest typhoid rate in the world. The 5274 cases of XDR *S. typhi* were recorded by the WHO in Sindh between 2016 and 2018, with 27% occurring in Hyderabad and 76% in Karachi.[3] Symptoms of enteric fever include high-grade fever, headache, nausea, anorexia, diarrhea, constipation, and malaise. The fecal-oral route, specifically through contaminated water and food, is the mode of transmission for enteric fever.[4] Pathogenic *Salmonella* penetrate the gastric acid barrier, enter the mucosa of the small and large intestines, and start producing toxins. Anti-*Salmonella* antibody identification via an immune chromatographic test or ICT can help with the quick and early immune diagnosis of typhoid fever. The Widal test, which quantifies the agglutination of bacterial O and H antigens using antisera specific for these antigens, is the most widely used serological assay in the endemic context.[5] The culture of a causal bacterium from a biological specimen is now the only reliable technique for identifying febrile individual who have typhoid.[6] The primary treatment for typhoid is antibiotics; however, *S. typhi* and *S. paratyphi* are now exhibiting resistance to the traditional antimicrobial.[7] The first-line treatments for typhoid fever were thought to be ampicillin, co-trimoxazole, and chloramphenicol; however, over the past few decades, there has been an increase in the formation of multidrug resistance (MDR) in *S. typhi* strains. This study will determine the status of drug resistance of *S. typhi* in pediatric patients with septicemia in Lahore, Pakistan.

Material and Methods

A cross sectional study was conducted at Social Security and Sheikh Zayed Hospitals of Lahore from March 2024 to January 2025. Blood samples were collected from one hundred pediatric patients (males:53, females: 47) suspected with typhoid fever using aseptic techniques. Microscopy was performed for gram-negative, rod shaped bacteria. Blood cultures were incubated and monitored for signs of bacterial growth, streaked onto MacConkey agar. These agar plates were then incubated at 37°C for 18–24 hours to allow bacterial colonies to develop. Further confirmation was done using biochemical tests, including the Triple Sugar Iron (TSI) and Urease test. Bacterial isolates were subjected to antimicrobial susceptibility testing (AST) using the Kirby-Bauer Disc Diffusion Method. A Mueller-Hinton agar plate was inoculated with the bacterial suspension, and antibiotic discs containing Ceftriaxone, Ciprofloxacin, Azithromycin, Ampicillin, Trimethoprim-Sulfamethoxazole and Chloramphenicol were placed onto the surface. The plates were incubated at 37°C for 18–24 hours, after which the zones of inhibition around each antibiotic disc were measured. Based on the size of these zones, the bacterial isolates were categorized as sensitive, intermediate, or resistant to each antibiotic.

Results:

Statistical Analysis

The data of 100 pediatric patients was analyzed through various statistical tests, including descriptive statistics, mean age, frequency distribution, and gender distribution to assess trends and relationships in the dataset.

Demographic Data:

The 100 pediatric patients that were part of the study had an average age of 8.58 years. The age distribution was 27, 42 and 31 in the patients with age group from 1 to 5, 6 to 10 and 11 to 14.

There was a higher prevalence in males (53%) as compared to females (47%) among the 100 patients as mentioned in the following table 1.

Table: 1: Descriptive statistics of patients

Age groups	Numbers	Percentage
1-5	27	27%
6-10	42	42%
11-14	31	31%
Gender		
Male	53	53%
Female	47	47%

According to the bacteriological analysis, *S. typhi* was responsible for the majority of illnesses (65%), followed by *S. paratyphi* A (24%), and *S. paratyphi* B (11%). The distribution was consistent with a well-known trend as shown in following table 2.

Table: 2: Prevalent species of *Salmonella* among patients

Organisms	Frequency	Percentage
S. typhi	65	65%
***S. paratyphi* A**	24	24%
***S. paratyphi* B**	11	11%

The study assessed antibiotics resistance in pediatric patients with enteric fever. Ampicillin was found to be resistant (34%), chloramphenicol (37%), Trimethoprim-sulfamethoxazole (34%), ceftriaxone (28%), ciprofloxacin (35%) and azithromycin showed a 37% resistivity as shown in following table 3.

Table: 3 Antibiotic resistance patterns of *Salmonella* among patients

Antibiotics	Resistance Status	Frequency	Percentage
Ampicillin	Resistant	34	34.0%
Chloramphenicol	Resistant	37	37.0%
Trimethoprim-Sulfamethoxazole	Resistant	34	34.0%
Ceftriaxone	Resistant	28	28.0%
Ciprofloxacin	Resistant	35	35.0%
Azithromycin	Resistant	37	37.0%

Discussion:

The study explores the resistance patterns of Salmonella typhi isolates from pediatric patients in Lahore, revealing that most cases occur among school-aged children aged 6-10 years old, with an average age of 8.58 years. This aligns with previous research showing 70% of enteric fever

cases in Karachi were in children aged 5-14.[8] A 2019 Indian Journal of Pediatrics study highlighted children's increased susceptibility to tainted food and water due to their weak immune systems, increased exposure, and poor hygiene habits.[9] The study found males dominate pediatric typhoid cases (53%), attributed to behavioral and cultural factors like increased exposure to outdoor activities and street food in traditional homes and rural areas.[10] Siddique, F.J *et al.*,(2017) Recent research in India and Nepal has reported a balanced or female-dominant pattern, possibly due to changing societal norms, increased school attendance, and similar outdoor activities among girls.[11]

S. typhi is the primary cause of enteric fever in Pakistan, accounting for 60-75% of all culture-confirmed cases, according to NIH Pakistan statistics and WHO surveillance reports.[12] The study found *S. paratyphi* A (24%) and B (11%) present, with a slow rise in prevalence in India, with cases increasing to 20-30% in certain metropolitan regions.[13]Antibiotic resistance is a significant concern, with first-line antibiotics like Ampicillin, Chloramphenicol, and Cotrimoxazole experiencing resistance rates of 34-37% in 2023, indicating unreliability in empirical administration.[14] So these results point toward the regular sensitivity and culture tests are crucial for antibiotics, especially for school-age children, and funding for updated *paratyphi* vaccines and public health education is essential.

Conclusion

An alarming antibiotic drug resistance pattern was observed among children suffering from enteric fever in Lahore. Current study results have shown that there is an increase in the pattern of antibiotic resistance. Hence, these findings have warranted an immediate implementation of antibiotic stewardship and infection control strategies. Furthermore, advanced research on *S. typhi* should be done because if it is left unchecked, it can have serious consequences.

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