

Research Article

*Archives of Clinical and Medical Microbiology***Resistance Patterns of Microorganisms in Enteric Fever in Malakand Division, Pakistan****Abdul Jabbar^{1*}**, **Taj Akbar²**, **Sadique Ullah³**, **Amin ul Haq⁴**, **Sabir Rehman⁵** and **Amjad Ali⁶**¹MBBS, FCPS Associate Professor, Department of Medicine Saidu Teaching Hospital, Pakistan***Corresponding Author**

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²MBBS, FCPS (Trainee) Trainee Medical Officer, Department of Medicine Saidu Teaching Hospital, Pakistan**Submitted:** 2026, June 01 **Accepted:** 2026, June 22; **Published:** 2026, Jul 02³Medical Laboratory Technologist Department of Medical Laboratory Sciences Abasyn University, Pakistan⁴MBBS, FCPS (Internal Medicine) Assistant Professor, Department of Internal Medicine Saidu Teaching Hospital, Pakistan⁵MBBS, FCPS Assistant Professor, Department of Medicine Saidu Medical College / Saidu Group of Teaching Hospitals (SMC/SGTH), Pakistan⁶MBBS Medical Officer, Pak International Medical Sciences, Pakistan**Citation:** Jabbar, A., Akbar, T., Ullah, S., Haq, A. U., Rehman, S., et al. (2026). Resistance Patterns of Microorganisms in Enteric Fever in Malakand Division, Pakistan, *Archives Clin Med Microbiol*, 5(1), 01-09.**Abstract****Objective:***To determine the prevalence and antibiotic resistance patterns among patients with enteric fever in the Malakand Division of Pakistan.***Methodology:***This cross-sectional study was conducted at the Department of Medicine, Saidu Group of Teaching Hospitals, Swat, Pakistan, from March 2023 to September 2023. A total of 305 patients aged 15–60 years with suspected enteric fever were enrolled through non-probability consecutive sampling. Patients presenting with fever of $\geq 38^{\circ}\text{C}$ for at least three days along with gastrointestinal symptoms were evaluated using Typhidot IgM/IgG testing and blood culture where indicated. Antibiotic resistance patterns were assessed among laboratory-confirmed *Salmonella* isolates using culture and sensitivity testing.***Results:***The mean age of the participants was 24.9 ± 8.05 years, and 174 (57%) were male. Overall, antibiotic resistance was observed in 157 (51.5%) patients. High resistance rates were noted for cefotaxime (83.7%), ampicillin (81.5%), and chloramphenicol (78.1%). Resistance to cefixime and ciprofloxacin was 67.4% and 42.9%, respectively. Lower resistance rates were observed for ceftriaxone (12.9%), azithromycin (7.7%), and meropenem (5.6%), indicating retained effectiveness of these agents against enteric fever isolates.***Conclusion:***A high burden of antimicrobial-resistant enteric fever was observed in the Malakand Division, with substantial resistance to commonly used first-line antibiotics. Continuous surveillance, rational antibiotic prescribing, and regular revision of treatment guidelines are*

Keywords: Drug Resistance, Microbial, Typhoid Fever, Salmonella Typhi, Anti-Bacterial Agents, Pakistan

1. Introduction

Enteric fever remains a major public health concern, particularly in low- and middle-income countries where inadequate sanitation, unsafe drinking water, and overcrowded living conditions facilitate disease transmission. It is primarily caused by *Salmonella enterica* serovars Typhi and Paratyphi and continues to contribute substantially to morbidity and mortality in South Asia [1,2]. Despite advances in public health measures, enteric fever remains endemic in many regions due to poor infrastructure, limited access to clean water, and inadequate healthcare services [3].

The management of enteric fever has become increasingly challenging because of the growing problem of Antimicrobial Resistance (AMR). Historically, first-line antibiotics such as ampicillin, chloramphenicol, and co-trimoxazole were highly effective in treating enteric fever. However, widespread and inappropriate antibiotic use has led to the emergence of Multidrug-Resistant (MDR) *Salmonella* Typhi strains, reducing the effectiveness of these agents [4]. Consequently, fluoroquinolones and third-generation cephalosporins became the preferred treatment options; however, declining susceptibility to these antibiotics has been increasingly reported [5].

More recently, the emergence and global spread of Extensively Drug-Resistant (XDR) *Salmonella* Typhi have further complicated treatment strategies. First identified in Pakistan, XDR strains demonstrate resistance to multiple antibiotic classes, including fluoroquinolones and third-generation cephalosporins, leaving limited therapeutic options such as azithromycin and carbapenems [6,7]. Reports of reduced susceptibility to azithromycin have also raised concerns regarding the future effectiveness of oral treatment regimens [8]. Antimicrobial resistance has been associated with prolonged illness, increased hospitalization, and greater healthcare costs [4,8]. The World Health Organization recognizes antimicrobial resistance as a major global health threat and emphasizes the importance of continuous surveillance and rational antibiotic use [9]. In South Asia, surveillance studies have documented increasing resistance trends, highlighting the need for effective antimicrobial stewardship and stricter regulation of antibiotic use [2,3]. Unrestricted access to antibiotics, self-medication, and inappropriate prescribing practices remain important contributors to the development and spread of resistant *Salmonella* strains [10].

Pakistan bears a substantial burden of enteric fever, and outbreaks of XDR typhoid have been reported in several regions, particularly in urban centers such as Karachi [6,7]. The spread of resistant strains beyond major cities underscores the need for region-specific data to guide empirical treatment decisions and public health interventions.

The Malakand Division of Khyber Pakhtunkhwa is a predominantly rural and mountainous region characterized by limited healthcare

resources, inadequate sanitation, and widespread antibiotic use. In such settings, empirical treatment is frequently initiated without microbiological confirmation, increasing the risk of inappropriate antibiotic selection and further development of antimicrobial resistance. Moreover, access to diagnostic facilities and culture-based surveillance systems remains limited.

Although several national and international studies have investigated antimicrobial resistance patterns in enteric fever, most have been conducted in urban tertiary-care hospitals. Therefore, available evidence may not accurately reflect the epidemiological characteristics and resistance patterns of rural populations such as those residing in the Malakand Division. Regional data from this area remain scarce despite the increasing burden of antimicrobial resistance across Pakistan [6,7,10].

Therefore, this study was conducted to determine the prevalence and antibiotic resistance patterns among patients with enteric fever in the Malakand Division, Pakistan. The findings are expected to provide locally relevant evidence to support empirical treatment decisions, antimicrobial stewardship initiatives, and public health strategies aimed at controlling enteric fever.

2. Methodology

This cross-sectional study was conducted at the Department of Medicine, Saidu Group of Teaching Hospitals, Swat, Pakistan, from 1st March 2023 to 30th September 2023. Ethical approval was obtained from the Institutional Ethics Review Committee of Saidu Medical College/Saidu Group of Teaching Hospitals before commencement of the study (Approval No. ERB-61/SMC/025). Written informed consent was obtained from all participants prior to enrollment.

The study population comprised patients presenting to the Department of Medicine with clinical features suggestive of enteric fever during the study period. A non-probability consecutive sampling technique was used. The sample size was calculated using a 95% confidence level, 5% margin of error, and a previously reported prevalence of ciprofloxacin resistance of 27.3% among enteric fever patients.¹¹ Based on these parameters, a sample size of 305 participants was obtained.

Patients aged 15–60 years with a documented fever of $\geq 38^{\circ}\text{C}$ for at least three days and accompanying gastrointestinal symptoms, including nausea, vomiting, diarrhea, constipation, or severe weakness, were eligible for inclusion. Enteric fever was confirmed through positive Typhidot immunoglobulin M/immunoglobulin G (IgM/IgG) testing and/or isolation of *Salmonella Typhi* or *Salmonella Paratyphi* on culture. Patients who had received any antibiotic therapy within seven days before presentation and those who declined participation were excluded from the study.

Demographic and clinical information, including age, gender, residential area, socioeconomic status, body mass index, and duration of symptoms, was collected using a structured proforma. Venous blood samples were obtained under aseptic conditions and transported to the Department of Pathology, Saidu Group of Teaching Hospitals, for microbiological analysis. Blood cultures were performed according to standard laboratory procedures.

Antimicrobial susceptibility testing of culture-positive *Salmonella* isolates was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar following standard laboratory protocols. After incubation under recommended laboratory conditions, the zones of inhibition were measured and interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines. The antimicrobial agents tested included ampicillin, amoxicillin, chloramphenicol, cefixime, ceftriaxone, cefotaxime, ciprofloxacin, meropenem, and azithromycin. Antibiotic resistance was defined as resistance to one or more tested antimicrobial agents on culture and sensitivity testing.

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0 (IBM Corp., Armonk, NY, USA). Continuous variables, including age, body mass index, and duration of symptoms, were expressed as mean ± standard deviation, whereas categorical variables, including gender, residential area, socioeconomic status, and antibiotic resistance patterns, were presented as frequencies and percentages. Stratification was performed for age and gender to assess their potential effect on antibiotic resistance. Post-stratification associations were evaluated using the chi-square test. A p-value of less than 0.05 was considered statistically significant.

3. Results

A total of 305 patients with enteric fever were enrolled in the study. The mean age of the participants was 24.92 ± 8.05 years. Males constituted 174 (57.0%) of the study population, while females accounted for 131 (43.0%). The mean body mass index was 24.10 ± 3.20 kg/m², and the mean duration of symptoms was 8.75 ± 2.60 days. More than half of the participants belonged to

the poor socioeconomic group (52.5%), followed by the middle-income (40.0%) and high-income groups (7.5%). The baseline demographic and clinical characteristics of the study participants are presented in **Table 1**.

Participants were recruited from different districts of the Malakand Division. The highest proportion of patients belonged to Swat District (32.5%), followed by Shangla District (26.9%), whereas Chitral contributed the lowest proportion of cases (3.6%). The distribution of participants according to residential area is shown in **Table 2**.

The pattern of antibiotics prescribed during hospital management of enteric fever is presented in Table 3. Cefixime, amoxicillin, and cefotaxime were among the most frequently prescribed antibiotics, whereas meropenem was prescribed less frequently. Overall, antibiotic resistance was observed in 157 (51.5%) patients, while 148 (48.5%) patients showed no evidence of resistance **Table 4**.

Analysis of antimicrobial susceptibility patterns demonstrated high resistance rates against cefotaxime (83.7%), ampicillin (81.5%), and chloramphenicol (78.1%). Considerable resistance was also observed for cefixime (67.4%), whereas ciprofloxacin exhibited moderate resistance (42.9%). In contrast, lower resistance rates were noted for ceftriaxone (12.9%), azithromycin (7.7%), and meropenem (5.6%), indicating comparatively better effectiveness against *Salmonella* isolates. Detailed antibiotic resistance patterns are presented in **Table 5**.

Stratification analysis revealed no statistically significant association between antibiotic resistance and age group (P = 0.564). Similarly, no significant association was observed between antibiotic resistance and gender (P = 0.809). Although minor variations in resistance proportions were observed across age categories and between males and females, these differences were not statistically significant. The association of antibiotic resistance with age and gender is shown in **Table 6**.

Variable		Value
Age (years), Mean ± SD		24.924±8.05
Body Mass Index BMI (Kg/m ²), Mean ± SD		24.104±3.20
Duration of Symptoms (days), Mean ± SD		8.75 ± 2.60
Gender	Male n (%)	174 (57%)
	Female n (%)	131 (43%)

Socioeconomic Status	n (%)	
	Poor n (%)	160 (52.5%)
	Middle n (%)	122 (40%)
	Rich n (%)	23 (7.5%)

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n = 305)

Table 2. Distribution of Study Participants According to Residential Area (n = 305) The geographical distribution of study participants is presented in

Residential Area	n (%)
Swat	99 (32.5)
Shangla	82 (26.9)
Malakand	35 (11.5)
Dir	37 (12.1)
Buner	27 (8.9)
Bajaur	14 (4.6)
Chitral	11 (3.6)

Table 2: Most participants were from Swat District (32.5%), followed by Shangla District (26.9%), while Chitral Contributed the Smallest Proportion of Cases (3.6%)

The distribution of antibiotics prescribed during hospital management of enteric fever is presented in Table 3. Cefixime, amoxicillin, and cefotaxime were among the most frequently prescribed antibiotics, whereas meropenem was prescribed least frequently.

Table 3. Antibiotics Prescribed During Hospital Management of Enteric Fever (n = 305)

Antibiotic	n (%)
Ampicillin	27 (8.9)
Amoxicillin	43 (14.1)
Chloramphenicol	32 (10.5)

Chloramphenicol	32 (10.5)
Cefixime	43 (14.1)
Cefotaxime	43 (14.1)
Ceftriaxone	31 (10.2)
Ciprofloxacin	42 (13.8)
Meropenem	18 (5.9)
Azithromycin	26 (8.5)

Table 3: Antibiotics Prescribed During Hospital Management of Enteric Fever (n = 305)

Antibiotic resistance was observed in 157 (51.5%) patients, whereas 148 (48.5%) patients showed no evidence of resistance. The prevalence of antibiotic resistance is presented in Table 4.

Antibiotic Resistance	N	%
Yes	157	51.5
No	148	48.5
Total	305	100.0

Table 4: Prevalence of Antibiotic Resistance Among Study Participants (n = 305)

The highest resistance rates were observed against cefotaxime (83.7%), ampicillin (81.5%), and chloramphenicol (78.1%). Considerable resistance was also noted for cefixime (67.4%), whereas ciprofloxacin demonstrated moderate resistance (42.9%). Lower resistance rates were observed for ceftriaxone (12.9%), azithromycin (7.7%), and meropenem (5.6%). The antibiotic resistance pattern is presented in Table 5.

Antibiotic	Resistant n (%)
Ampicillin	22 (81.5)
Amoxicillin	20 (46.5)
Chloramphenicol	25 (78.1)
Cefixime	29 (67.4)

Cefotaxime	36 (83.7)
Ceftriaxone	4 (12.9)
Ciprofloxacin	18 (42.9)
Meropenem	1 (5.6)
Azithromycin	2 (7.7)

Table 5: Antibiotic Resistance Patterns Among Enteric Fever Isolates

Stratification analysis revealed that typhoid antibiotic resistance showed no statistically significant association with age groups or gender. Although minor variations in resistance proportions were

observed across different age categories and between males and females, these differences were not statistically significant. Table 6.

Variable	Resistant n (%)	Non-Resistant n (%)	P-value
Age Groups			<i>P</i> = 0.564
15–30 years	49 (51.6%)	46 (48.4%)	
31–45 years	63 (54.8%)	52 (45.2%)	
46–60 years	45 (47.4%)	50 (52.6%)	
Gender			<i>P</i> = 0.809
Male	87 (52.4%)	79 (47.6%)	
Female	70 (50.4%)	69 (49.6%)	

Table 6: Stratification of Typhoid Resistance with Respect to Age and Gender (n = 305)

4. Discussion

The present study evaluated the prevalence and antimicrobial resistance patterns of enteric fever among patients presenting to a tertiary care hospital in the Malakand Division of Pakistan. The findings demonstrated a substantial burden of antibiotic-resistant enteric fever, with more than half of the laboratory-confirmed cases exhibiting resistance to one or more commonly used antimicrobial agents. These findings support the study hypothesis that antimicrobial resistance among enteric fever patients is highly prevalent in the study region and represents an important public health concern.

The high frequency of antibiotic resistance observed in this study is consistent with the growing body of evidence from Pakistan and other South Asian countries, where enteric fever remains endemic and antimicrobial resistance continues to compromise treatment effectiveness. Reported a considerable burden of antibiotic-resistant enteric fever in the local population, highlighting the increasing difficulty in managing the disease using conventional therapeutic agents [11]. Similarly, regional surveillance studies have documented a persistent rise in resistant *Salmonella* isolates, emphasizing the urgent need for continuous monitoring and evidence-based treatment strategies [12,13]. The high prevalence

of resistance observed in the present study may be attributed to widespread empirical antibiotic use, self-medication, and inadequate antimicrobial stewardship practices in resource-limited settings.

An important finding of the present study was the poor susceptibility of *Salmonella* isolates to traditionally used first-line antibiotics. This observation is in agreement with previous reports from Pakistan and neighboring countries that have demonstrated increasing multidrug resistance among *Salmonella* Typhi isolates [12,13]. Documented substantial resistance to conventional antityphoid drugs, while more recent investigations have shown that multidrug-resistant strains continue to circulate in the region [13]. The persistence of resistance to these agents suggests that their empirical use should be reconsidered in areas with similar epidemiological characteristics. The emergence and spread of resistant strains are likely driven by prolonged antibiotic exposure and inadequate regulation of antimicrobial use.

The findings of the present study also align with reports describing the emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) typhoid strains in Pakistan. Highlighted the considerable burden of enteric fever in South Asia and emphasized the challenges posed by resistant infections [14]. Furthermore, reported the emergence of XDR *Salmonella* Typhi strains carrying resistance determinants against multiple antibiotic classes, including fluoroquinolones and third-generation cephalosporins [15]. These developments have significantly narrowed available treatment options and underscore the importance of local resistance surveillance to guide empirical therapy. In contrast, relatively low resistance was observed against azithromycin and meropenem, suggesting that these agents remain effective treatment options for enteric fever in the study population. Similar findings have been reported by ,who observed preserved susceptibility to these antibiotics despite increasing resistance to other antimicrobial classes [16]. Also reported favorable sensitivity patterns for advanced therapeutic agents among patients with multidrug-resistant typhoid fever [17]. The maintained effectiveness of azithromycin and meropenem may be explained by their comparatively restricted use and limited community availability. Nevertheless, the continued effectiveness of these drugs should not encourage indiscriminate prescribing, as inappropriate use may accelerate the development of resistance and further restrict available treatment alternatives.

The stratified analysis demonstrated no statistically significant association between antibiotic resistance and demographic variables such as age and gender. This finding suggests that antimicrobial resistance is broadly distributed across the population and may be more strongly influenced by microbial characteristics and patterns of antibiotic exposure than by host-related factors. Although some previous studies have reported variations in resistance patterns across demographic groups, the absence of significant associations in the present study indicates that resistant enteric fever is a widespread problem affecting diverse patient populations. Additional factors such as prior antibiotic exposure,

healthcare-seeking behavior, and duration of illness may have influenced resistance patterns and warrant further investigation.

Variations in resistance patterns between studies may be explained by differences in geographical location, healthcare infrastructure, prescribing practices, antimicrobial availability, and study methodologies. International studies have similarly documented increasing resistance to fluoroquinolones and other commonly prescribed antibiotics, reinforcing the global nature of antimicrobial resistance in *Salmonella* species [18]. The consistency of these observations across different regions highlights the urgent need for coordinated public health interventions aimed at preserving antibiotic effectiveness. The present study contributes valuable regional data from the Malakand Division, an area where published information regarding antimicrobial resistance in enteric fever remains limited. The findings emphasize the importance of strengthening antimicrobial stewardship programs, promoting rational antibiotic prescribing, and implementing regular resistance surveillance systems. In addition, preventive strategies such as improving sanitation, ensuring access to safe drinking water, and expanding vaccination coverage remain essential components of enteric fever control and may help reduce the transmission of resistant *Salmonella* strains.

The findings of this study should be interpreted in light of certain limitations. The cross-sectional design limits the ability to establish causal relationships between potential risk factors and antimicrobial resistance. Furthermore, information regarding previous antibiotic exposure and duration of illness was not comprehensively assessed, although these factors may influence resistance patterns. Future multicenter longitudinal studies incorporating these variables would provide a more comprehensive understanding of the determinants and temporal trends of antimicrobial resistance in enteric fever.

Recent epidemiological studies have demonstrated that antimicrobial resistance among *Salmonella* Typhi isolates continues to increase across Pakistan. Reported the sustained circulation of extensively drug-resistant (XDR) typhoid strains in several regions of the country, posing significant challenges for empirical treatment and public health control measures [19]. Similarly, regional surveillance data from South Asia have shown increasing resistance to fluoroquinolones and third-generation cephalosporins, reducing the effectiveness of previously recommended treatment regimens [20]. These findings are consistent with the present study and suggest that antimicrobial resistance has become an entrenched problem requiring urgent intervention.

The high resistance observed against commonly prescribed antibiotics in the present study may reflect the widespread availability of antibiotics without prescription, inappropriate prescribing practices, and poor antimicrobial stewardship. A systematic review by demonstrated that drug-resistant enteric fever has increased substantially over the last decade, particularly in low- and middle-income countries where regulation of antibiotic

use remains limited [21]. Likewise, reported that antimicrobial resistance is now one of the major contributors to enteric fever-related morbidity and healthcare burden globally [22].

The relatively preserved susceptibility of azithromycin and meropenem observed in the present study is encouraging and corresponds with findings from recent Pakistani studies. However, emerging reports of reduced azithromycin susceptibility in South Asia indicate that these treatment options may also become threatened if antimicrobial stewardship efforts are not strengthened [23]. Therefore, preservation of the efficacy of these agents should be considered a priority through rational prescribing and continuous resistance monitoring.

From a public health perspective, the findings of this study emphasize the need for integrated preventive strategies. Recent evidence suggests that typhoid conjugate vaccination programs, improvements in water quality, sanitation, and hygiene practices can substantially reduce disease transmission and decrease dependence on antibiotic therapy [24]. In combination with robust surveillance systems and evidence-based treatment guidelines, these interventions may help curb the emergence and spread of resistant *Salmonella* strains in endemic settings.

Overall, the findings support the study hypothesis and confirm that antimicrobial-resistant enteric fever represents a significant and growing healthcare challenge in the Malakand Division. These results reinforce the need for evidence-based treatment policies, ongoing surveillance, and comprehensive antimicrobial stewardship efforts to mitigate the further spread of resistant *Salmonella* infections.

5. Conclusion

A high prevalence of antibiotic-resistant enteric fever was observed among patients in the Malakand Division. Resistance was particularly high against ampicillin, chloramphenicol, and cefotaxime, while azithromycin and meropenem remained largely effective. These findings highlight the need for regular antimicrobial resistance surveillance, rational antibiotic use, and evidence-based treatment strategies to improve the management of enteric fever in the region.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Contributions

All authors contributed to the study conception and design, data collection, analysis and interpretation, manuscript preparation, critical revision, and final approval of the manuscript. All authors agree to be accountable for all aspects of the work.

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Informed Consent

Written informed consent was obtained from all participants before enrollment in the study.

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