Pakistan Journal of Intensive Care Medicine
eISSN: 2708-2261; pISSN: 2958-4728
www.pjicm.com
DOI: https://doi.org/10.54112/pjicm.v5i02.169
*Pak. J. Inten. Care Med., volume 5(2), **2025**: 169*
Original Research Article

ANTIBIOTIC SUSCEPTIBILITY PATTERN OF SALMONELLA TYPHI AND SALMONELLA PARATYPHI AT A TERTIARY CARE HOSPITAL IN PESHAWAR

ZEESHAN*, JAMIL S

Department of Internal Medicine, Rehman Medical Institute, Peshawar, Pakistan
**Corresponding author email address:* zeeshankhan196@outlook.com

(Received, 27th May 2025, Revised 18th June 2025, Accepted 06th July, Published 18th July 2025)

ABSTRACT

Background: *Salmonella typhi and Salmonella paratyphi are leading causes of enteric fever in endemic regions. The emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) strains has limited therapeutic options, making surveillance of local resistance patterns crucial for guiding empirical therapy.* ***Objective:*** *To determine the antibiotic susceptibility pattern of Salmonella typhi and Salmonella paratyphi at a tertiary care hospital in Peshawar.* ***Study Design:*** *Cross-sectional study.* ***Setting:*** *Department of Microbiology, Rehman Medical Institute, Peshawar.* ***Duration of Study:*** *24-November-2024 to 24-May 2025.* ***Methods:*** *A total of 139 patients with culture-proven Salmonella typhi or Salmonella paratyphi infection were included. Antibiotic susceptibility was assessed using the standard Kirby-Bauer disk diffusion method. MDR and XDR strains were identified according to established definitions. Potential confounders stratified frequencies, and post-stratification comparisons were performed using the Chi-square test.* ***Results:*** *The mean age of patients was 35.27 ± 9.90 years, with 98 (70.5%) males and 41 (29.5%) females. The mean BMI was 17.80 ± 1.89 kg/m², and the mean duration of fever was 5.16 ± 1.92 days. Of the isolates, 97 (69.8%) were S. typhi and 42 (30.2%) were S. paratyphi. MDR strains were identified in 25 (18.0%) cases and XDR strains in 61 (43.9%). The highest sensitivity was observed with meropenem (80.4%) and azithromycin (71.1%).* ***Conclusion:*** *Antibiotic resistance among Salmonella isolates was highly prevalent, with MDR and XDR strains observed in 18% and 43.9% of cases, respectively. Meropenem and azithromycin remain the most effective treatment options in this setting, emphasising the urgent need for antimicrobial stewardship and continuous resistance surveillance.*

Keywords: Antibiotic Resistance, Extensively Drug-Resistant, Multidrug-Resistant, Salmonella

INTRODUCTION

Salmonella infection is a public health problem in developing countries (1). An estimated two hundred million to a billion cases of this infection occur yearly, and more than 155,000 deaths are reported worldwide each year (2). In India, this infection has a reported incidence of 360 cases per 100,000 population, attributed to febrile illness (3). Inhabitants of Pakistan are at the highest risk of developing enteric fever out of all of the South Asian countries where typhoid is highly prevalent (4). This infection is treated with antibiotics. Currently, a significant threat to the effective management of this infection in Pakistan is the emergence of multi-drug-resistant (MDR) and extensively drug-resistant (XDR) strains of this organism, with reported prevalence rates of 24.5% and 46.1%, respectively (5). As a result, only a few antibiotics are now available for managing drug-resistant strains of this organism (6).

In this instance, a study conducted in Punjab reported that in Salmonella typhi strains isolated on blood cultures, frequency of sensitivity of various antibiotics were as follows: ampicillin (14.8%), azithromycin (95%), ceftriaxone (49.4%), co-trimoxazole (33.3%), chloramphenicol (26%), imipenem (100%) and meropenem (41%). In the same study, the majority of resistance was reported against ciprofloxacin (95%) (7). In another study conducted in Sindh, it was reported that the most sensitive antibiotics against Salmonella typhi strains were azithromycin (100%) and meropenem (100%), followed by ceftriaxone (35.96%), cefixime (28.27%) and co-amoxiclav (10%) (8).

Since antibiotics are the mainstay of treatment, it is imperative to have an ideal empirical regimen that can be initiated while awaiting blood culture results to improve patient outcomes. This can only be achieved if updated knowledge regarding the antibiotic susceptibility patterns of the respective organism in the local population is available. Therefore, this study aims to determine the antibiotic susceptibility patterns of Salmonella typhi and Salmonella paratyphi at a tertiary care hospital in Peshawar.

METHODOLOGY

This cross-sectional study was conducted at Rehman Medical Institute, Peshawar, from 24-November-2024 to 24-May 2025, following approval of the research proposal by CPSP (Ref. #: CPSP/REU/MED-2022-024-19133, dated November 23, 2024). A sample size of 139 was calculated by inputting a 95% confidence interval, 5% absolute precision, and 10% anticipated sensitivity of co-amoxiclav (8) into the WHO sample size calculator software. The sample selection process was based on a non-probability consecutive sampling technique. Before inclusion, it was ensured that all patients whose blood samples were used for data collection provided their explicit written informed consent, for which a predesigned proforma was used.

Patients aged 18-70 years, of either gender, who were diagnosed with a blood culture-proven Salmonella typhi/paratyphi infection were included. Blood culture for this purpose was performed using an anaerobic medium incubated at 37 °C. Patients with a history of antibiotic use in the last 48 hours before presentation, mentally incapacitated patients who were not able to consent to study, intravenous recreational drug abusers and those having a history of human immunodeficiency virus (HIV) infection were excluded.

Baseline characteristics including age, gender, BMI, duration of fever, education status (illiterate/school education or above), area of residence (urban/rural), history of smoking (yes/no), history of hospital admissions (yes/no), history of un-prescribed medicine use (yes/no) and history of previous intravenous treatment (yes/no) were documented. Venous blood samples of 10 mL were collected in an

anaerobic bottle, sent to the laboratory, and incubated at 37 °C. The strain of Salmonella (typhi/paratyphi) isolated was documented. For the assessment of antibiotic susceptibility patterns, the standard Kirby-Bauer disk diffusion method was used, which is available at the in-hospital laboratory. Since samples were sent to the hospital's internal laboratory, it prevented any financial burden on patients. Based on the susceptibility pattern, MDR and XDR cases were identified. All patients were treated according to their blood culture and sensitivity reports to eradicate Salmonella infections effectively.

All the collected data were entered and analysed with SPSS version 30.0.0. Descriptive statistics were collected for qualitative and quantitative variables. Qualitative variables, including gender, education status, area of residence, history of smoking, history of hospital admissions, history of un-prescribed medicine use, history of previous IV treatment, Salmonella strain isolated, antibiotic susceptibility pattern, MDR, and XDR cases, were measured in terms of frequency and percentage. Quantitative variables, such as age, BMI, and duration of fever, were calculated as the mean ± standard deviation (SD). The frequency of MDR and XDR was stratified by age, gender, education status, area of residence, history of hospital admissions, use of un-prescribed medicines, and previous intravenous treatment, as well as the strain of Salmonella isolated, to account for effect modifiers. Post-stratification, the Chi-square test was used as a test of significance. A p-value ≤ 0.05 was considered significant.

RESULTS

A total of 139 patients were included in this study. Mean age was 35.27 ± 9.90 years. There were 98 (70.50%) male and 41 (29.50%) female patients. Mean BMI was 17.80 ± 1.89 kg/m2. Mean duration of fever was 5.16 ± 1.92 days. There were 97 (69.80%) cases of typhi and 42 (30.20%) cases of paratyphi Salmonella species. Patient demographics are given in Table 1:

Table 1: Patient demographics (n = 139)

Demographic variable	Mean ± SD; n (%)
Salmonella species identified	
Typhi	97 (69.80%)
Paratyphi	42 (30.20%)
Mean age	35.27 ± 9.90 years
Age group	
18-45 years	111 (79.90%)
46-70 years	28 (20.10%)
Gender	
Male	98 (70.50%)
Female	41 (29.50%)
Mean body mass index	17.80 ± 1.89 kg/m2
Mean duration of fever	5.16 ± 1.92 days
Education status	
Literate	58 (41.70%)
Illiterate	81 (58.30%)
Area of residence	
Urban	84 (60.40%)
Rural	55 (39.60%)
Smoking	
Yes	58 (41.70%)
No	81 (58.30%)
Previous history of hospital admission	
Yes	57 (41.00%)
No	82 (59.00%)
Previous history of un-prescribed medication use	
Yes	66 (47.50%)
No	73 (52.50%)
Previous history of intravenous treatment	
Yes	71 (51.10%)
No	68 (48.90%)

The antibiotic sensitivity pattern of Salmonella species in the present study is presented in Table 2.

Table 2: Antibiotic sensitivity pattern of Salmonella species (n = 139)

Antibiotic	Typhi (n = 97)		Paratyphi (n = 42)	
	Sensitive	Resistant	Sensitive	Resistant
Amoxicillin	10 (10.30%)	87 (89.70%)	0 (0.00%)	42 (100%)
Ampicillin	34 (35.10%)	63 (64.90%)	11 (26.20%)	31 (37.80%)
Azithromycin	69 (71.10%)	28 (28.90%)	37 (88.10%)	5 (11.90%)
Ceftriaxone	58 (59.80%)	39 (40.20%)	19 (45.20%)	23 (54.80%)
Co-trimoxazole	14 (14.40%)	83 (85.60%)	5 (11.90%)	37 (88.10%)
Chloramphenicol	42 (43.30%)	55 (56.70%)	10 (23.80%)	32 (76.20%)
Cefixime	54 (55.70%)	43 (44.30%)	21 (50.00%)	21 (50.00%)
Co-amoxiclav	17 (17.50%)	80 (82.50%)	7 (16.70%)	35 (83.30%)
Ciprofloxacin	41 (42.30%)	56 (57.70%)	10 (23.80%)	32 (76.20%)
Imipenem	49 (50.50%)	48 (49.50%)	34 (81.00%)	8 (19.00%)
Meropenem	78 (80.40%)	19 (19.60%)	34 (81.00%)	8 (19.00%)

There were 25 (18.00%) MDR and 61 (43.90%) XDR cases. Stratification of these cases based on confounding variables, including age, gender, educational status, area of residence, history of hospital admissions, use of un-prescribed medicines, and previous intravenous treatment, as well as the strain of Salmonella isolated, is presented in Table 2.

Table 3: Stratification of MDR and XDR cases by confounding variables (n = 139)

Age stratification			
MDR	18-45 years (n = 111)	46-70 years (n = 28)	p-value

	19 (17.11%)	6 (21.43%)	0.596†
XDR	18-45 years (n = 111)	46-70 years (n = 28)	p-value
	50 (45.05%)	11 (39.29%)	0.583†
Gender stratification			
MDR	Male (n = 98)	Female (n = 41)	p-value
	21 (21.43 %)	4 (9.76%)	0.102†
XDR	Male (n = 98)	Female (n = 41)	p-value
	37 (37.76%)	24 (58.54%)	0.024†
Stratification by education status			
MDR	Literate (n = 58)	Illiterate (n = 81)	p-value
	10 (17.24%)	15 (18.52%)	0.847†
XDR	Literate (n = 58)	Illiterate (n = 81)	p-value
	24 (41.38%)	37 (45.68%)	0.614†
Stratification by area of residence			
MDR	Rural (n = 55)	Urban (n = 84)	p-value
	11 (20.00%)	14 (16.67%)	0.617†
XDR	Rural (n = 55)	Urban (n = 84)	p-value
	23 (41.82%)	38 (45.24%)	0.691†
Stratification by history of hospital admissions			
MDR	Yes (n = 57)	No (n = 82)	p-value
	10 (17.54%)	15 (18.29%)	0.910†
XDR	Yes (n = 57)	No (n = 82)	p-value
	21 (36.84%)	40 (48.78%)	0.163†
Stratification by history of non-prescribed medicine use			
MDR	Yes (n = 66)	No (n = 73)	p-value
	17 (25.76%)	8 (10.96%)	0.023†
XDR	Yes (n = 66)	No (n = 73)	p-value
	22 (33.33%)	39 (53.42%)	0.017†
Stratification by history of previous intravenous treatment			
MDR	Yes (n = 71)	No (n = 68)	p-value
	12 (16.90%)	13 (19.11%)	0.734†
XDR	Yes (n = 71)	No (n = 68)	p-value
	26 (36.62%)	35 (51.47%)	0.078†
Stratification by strain of Salmonella isolated			
MDR	Typhi (n = 97)	Paratyphi (n = 42)	p-value
	16 (16.49%)	9 (21.43%)	0.487†
XDR	Typhi (n = 97)	Paratyphi (n = 42)	p-value
	39 (40.21%)	22 (52.38%)	0.184†

† = Chi-square test

DISCUSSION

One of the primary healthcare concerns of the present decade is the persistently increasing resistance to a wide variety of antibiotics (9, 10). Enteric fever, also known as typhoid fever, in the Pakistani population is caused by an organism that has been labelled as a priority pathogen to watch for, as it is most affected by the growing resistance to the majority of antibiotics (11, 12). This particular type of febrile illness is among the most common infectious diseases encountered in hospitals on a day-to-day basis, both in the outdoor and indoor departments (13, 14). The high burden of infection from this particular class of gram-negative organisms often results in a wrong presumption by treating physicians to consider every fever as enteric, leading to the injudicious use of antibiotics, which is a major contributor to the emergence of antibiotic resistance in these organisms (15, 16). The present study was conducted to determine the antibiotic susceptibility patterns of Salmonella typhi and Salmonella paratyphi at a tertiary care hospital in Peshawar.

Upon analysing the gender distribution of patients with enteric fever, an infectious disease, it was observed that the majority of patients with enteric fever were males. Similar to this, a study found that males were more commonly affected by this particular type of fever compared to females, with males comprising 60% of the study population (17). This trend was also similar to the trend observed in a previous study in which men were found to be much more affected by this infectious disease as compared to women (18). This can be explained by the higher chances of transmission of the organism to men due to their outdoor nature and habit of dining out more frequently than females (19). Upon assessing the duration of fever, it was observed that the average duration was five days. This is explainable by the fact that most patients seek medical help if their fever lasts longer than a few days.

Upon analysing the overall sensitivity of various antibiotics, it was observed that meropenem showed the highest sensitivity at 80.40%, followed by azithromycin at 71.10%, ceftriaxone at 59.80%, cefixime at 55.70%, and imipenem at 50.50%. In comparison, the least sensitivity was found for amoxicillin (10.30%), co-trimoxazole (14.40%), co-amoxiclav (17.50%), ampicillin (35.10%), and ciprofloxacin (42.30%). Compared to this, a study conducted in Islamabad, resistance to various antibiotics against Salmonella typhi and Salmonella typhi was reported as follows: amoxicillin (57.6% and 28.8%), azithromycin (63.4% and 73.9%), chloramphenicol (46.9% and 20%), ciprofloxacin (62.7% and 70.5%) and co-trimoxazole (61.4% and 35.9%). In addition, least resistance (< 10%) was reported against cefixime, ceftriaxone and imipenem (20).

Based on the antibiotic sensitivity and resistance patterns of the present study, the frequency of MDR and XDR strains was 18.00% and 43.90%, respectively. Compared to this, Zakir et al. (21)

conducted a study with a similar aim and found that the frequency of MDR and XDR cases was 24.5% and 46.1%, respectively, among patients with typhoid fever. Another study found the frequency of these strains to be at 21.9% and 56.8%, respectively (22). In one study, it was observed that although the frequency of MDR cases was 44.6%, which was higher than in the present study, the frequency of XDR cases was merely 0.7%. [20] Compared to Pakistani statistics, a study conducted in India reported that amongst all the strains of *Salmonella typhi* assessed, the frequency of MDR strains was merely 2% (23).

The current study highlights the alarming situation of increasing antibiotic resistance in Salmonella species, with a considerable frequency of both multidrug- and extensively drug-resistant strains. This necessitates a national initiative to educate the general public and physicians on the strict avoidance of unnecessary antibiotic use in all cases of fever. In addition, this also makes it essential to educate physicians to avoid using antibiotics that are used to eradicate drug-resistant strains of this class of organisms. There were no limitations of the present study.

CONCLUSION

In conclusion, antibiotic resistance is highly prevalent in Salmonella infections, with the frequency of multi- and extensive drug resistance observed in 18% and 43.9%, respectively.

DECLARATIONS

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (IRB)

Consent for publication

Approved

Funding

Not applicable

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTION

ZEESHAN (Trainee Medical Officer)

Conception of Study, Data Collection, Manuscript drafting, Review of manuscript, and final approval of manuscript.

SHAHID JAMIL (Professor)

Study Design, Conception of Study, Supervision of entire research process, and final approval of manuscript.

REFERENCES

1. John J, Bavdekar A, Rongsen-Chandola T, Dutta S, Gupta M, Kanungo S, et al.; NSSEFI Study Team. Burden of typhoid and paratyphoid fever in India. N Engl J Med. 2023;388(16):1491-500. https://doi.org/10.1056/NEJMoa2209449.
2. Lamichhane B, Mawad AMM, Saleh M, Kelley WG, Harrington PJ 2nd, Lovestad CW, et al. Salmonellosis: An overview of epidemiology, pathogenesis, and innovative approaches to mitigate the antimicrobial-resistant infections. Antibiotics (Basel). 2024;13(1):76. https://doi.org/10.3390/antibiotics13010076.
3. Cao Y, Karthikeyan AS, Ramanujam K, Raju R, Krishna S, Kumar D, et al. Geographic pattern of typhoid fever in India: A model-based estimate of cohort and surveillance data. J Infect Dis. 2021;224(224 Suppl 5): S475-83. https://doi.org/10.1093/infdis/jiab187.
4. Tharwani ZH, Kumar P, Salman Y, Islam Z, Ahmad S, Essar MY. Typhoid in Pakistan: challenges, efforts, and recommendations. Infect Drug Resist. 2022;15:2523-7. https://doi.org/10.2147/IDR.S365220.
5. Zakir M, Khan M, Umar MI, Murtaza G, Ashraf M, Shamim S. Emerging trends of multidrug-resistant (MDR) and extensively drug-resistant (XDR) Salmonella typhi in a tertiary care hospital of Lahore, Pakistan. Microorganisms. 2021;9(12):2484. https://doi.org/10.3390/microorganisms9122484.
6. Akram J, Khan AS, Khan HA, Gilani SA, Akram SJ, Ahmad FJ, Mehboob R. Extensively drug-resistant (XDR) typhoid: evolution, prevention, and its management. Biomed Res Int. 2020;2020:6432580. https://doi.org/10.1155/2020/6432580.
7. Ali Shah SA, Nadeem M, Syed SA, Fatima Abidi ST, Khan N, Bano N. Antimicrobial sensitivity pattern of Salmonella typhi: emergence of resistant strains. Cureus. 2020;12(11):e11778. https://doi.org/10.7759/cureus.11778.
8. Hasan SM, Razzak S, Shabbir A, Hasan SM, Husain M. Extensively drug-resistant typhoid: antibiotic susceptibility pattern of an emerging menace in Karachi. Pak J Med Dent. 2023;12(1):18-23. https://doi.org/10.36283/PJMD12-1/005.
9. Walsh TR, Gales AC, Laxminarayan R, Dodd PC. Antimicrobial resistance: addressing a global threat to humanity. PLoS Med. 2023;20(7):e1004264. https://doi.org/10.1371/journal.pmed.1004264.
10. GBD 2021 Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance 1990-2021: a systematic analysis with forecasts to 2050. Lancet. 2024;404(10459):1199-226. https://doi.org/10.1016/S0140-6736(24)01867-1.
11. GRAM Typhoid Collaborators. Estimating the subnational prevalence of antimicrobial-resistant *Salmonella* enterica serovars Typhi and Paratyphi A infections in 75 endemic countries, 1990-2019: a modelling study. Lancet Glob Health. 2024;12(3):e406-18. https://doi.org/10.1016/S2214-109X(23)00585-5.
12. Browne AJ, Kashef Hamadani BH, Kumaran EAP, Rao P, Longbottom J, Harriss E, et al. Drug-resistant enteric fever worldwide, 1990 to 2018: a systematic review and meta-analysis. BMC Med. 2020;18(1):1. https://doi.org/10.1186/s12916-019-1443-1.
13. Qamar FN, Yousafzai MT, Qazi I, Qureshi S, Bar-Zeev N, Sultana S, et al. Trends of enteric fever and emergence of extensively drug-resistant typhoid in Pakistan: Population-based laboratory data from 2017-2019. Open Forum Infect Dis. 2025;12(4):ofaf106. https://doi.org/10.1093/ofid/ofaf106.
14. Tharwani ZH, Kumar P, Salman Y, Islam Z, Ahmad S, Essar MY. Typhoid in Pakistan: Challenges, efforts, and recommendations. Infect Drug Resist. 2022;15:2523-7. https://doi.org/10.2147/IDR.S365220.
15. Yousaf M, Sikandar I, Waqas Z, Pervez S, Jehanzeb H, Farrukh AM, et al. Antibiotic Resistance in Salmonella typhi Strains Isolated from Patients in Pakistan: A Hospital Database Study. Cureus. 2024;16(4):e58240. https://doi.org/10.7759/cureus.58240.
16. Batool M, Keating C, Javed S, Nasir A, Muddassar M, Ijaz UZ. A cross-sectional study examining potential antimicrobial resistance and ecology in the gastrointestinal and oral microbial communities of young, normoweight Pakistani individuals. Microorganisms. 2023;11(2):279. https://doi.org/10.3390/microorganisms11020279.
17. Asreah R, Atta S, SarKo S. Clinical characteristics and antibiotic sensitivity of culture-positive typhoid fever patients in Baghdad teaching hospital - a single-centre study. Open Access

Maced J Med Sci. 2022;10(B):1846-56. https://doi.org/10.3889/oamjms.2022.9336.
18. Njoya HF, Awolu MM, Christopher TB, Duclerc JF, Ateudjieu J, Wirsiy FS, et al. Prevalence and awareness of mode of transmission of typhoid fever in patients diagnosed with *Salmonella typhi* and paratyphi infections at the Saint Elisabeth General Hospital, Shisong, Bui Division, Cameroon. Pan Afr Med J. 2021;40:83. https://doi.org/10.11604/pamj.2021.40.83.16893.
19. Khan M. A plausible explanation for male dominance in typhoid ileal perforation. Clin Exp Gastroenterol. 2012;5:213-7. https://doi.org/10.2147/CEG.S36569.
20. Umair M, Siddiqui SA. Antibiotic susceptibility patterns of *Salmonella typhi* and *Salmonella* paratyphi in a tertiary care hospital in Islamabad. Cureus. 2020;12(9):e10228. https://doi.org/10.7759/cureus.10228.
21. Zakir M, Khan M, Umar MI, Murtaza G, Ashraf M, Shamim S. Emerging trends of multidrug-resistant (MDR) and extensively drug-resistant (XDR) *Salmonella typhi* in a tertiary care hospital of Lahore, Pakistan. Microorganisms. 2021;9(12):2484. https://doi.org/10.3390/microorganisms9122484.
22. Baig U, Mehdi SM, Iftikhar N. A pattern of antibiotic drug resistance of *Salmonella typhi* and *Salmonella* Paratyphi among children with enteric fever in a tertiary care hospital in Lahore, Pakistan. Croat Med J. 2023;64(4):256-64. https://doi.org/10.3325/cmj.2023.64.256.
23. Veeraraghavan B, Pragasam AK, Ray P, Kapil A, Nagaraj S, Perumal SPB, et al. Evaluation of antimicrobial susceptibility profile in *Salmonella typhi* and *Salmonella* paratyphi A: presenting the current scenario in India and strategy for future management. J Infect Dis. 2021;224(Supple 5):S502-16. https://doi.org/10.1093/infdis/jiab144

[Citation: Zeeshan., Jamil, S. (2025). Antibiotic susceptibility pattern of salmonella typhi and salmonella paratyphi at a tertiary care hospital in Peshawar. *Pak. J. Inten. Care Med. 5(2), **2025**: 169*. doi: https://doi.org/10.54112/pjicm.v5i02.169]