

PEDIATRIC ENTERIC *SALMONELLA* IN PESHAWAR, PAKISTAN:
HIGH FIRST-LINE AND THIRD-GENERATION CEPHALOSPORIN
RESISTANCE IN A 2024 TERTIARY-CARE HOSPITAL SURVEILLANCE
COHORT

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Abstract

Enteric fever has continued to be a significant pediatric bloodstream infection in low- and middle-income countries where the ability of antimicrobials to treat this infection continues to be undermined by the rising resistance of the organism. A cross-sectional study was carried out with 704 patients (pediatric) who were admitted to the Pediatric Unit of Hayatabad Medical Complex, Peshawar between January and December 2024. Blood samples underwent culture in tryptone soya broth and subculture on MacConkey agar followed by biochemical tests and serological confirmation and antimicrobial agent tests by the KirbyBauer disk diffusion test on MuellerHinton agar. Among 704 patients, 447 were male and 257 were female. The recorded isolates comprised *S. Typhi* in 526 patients (74.71%), *S. Paratyphi* in 110 (15.62%), and other *Salmonella* species in 68 (9.65%). *S. Typhi* showed substantial resistance to amoxicillin (96.83% in males; 96.73% in females), ampicillin (95.56% and 97.75%, respectively), cefotaxime (93.50% and 91.66%), and ceftriaxone (90.21% and 95.23%). Resistance to chloramphenicol and cefepime was also high. Carbapenems, tigecycline, colistin, and polymyxin-B remained largely active. Overall MDR was recorded in 141 of 704 patients (20.02%), including 95 of 447 males (21.25%) and 46 of 257 females (17.89%). MDR ranged from 17.24% to 22.48% across sex-specific age groups. The high prevalence of *S. Typhi*, marked resistance to first-line agents and third-generation cephalosporins, and substantial MDR burden demonstrate a serious therapeutic and public-health challenge in pediatric patients in Peshawar.

INTRODUCTION

Enteric fever, comprising typhoid and paratyphoid fever, remains a major cause of febrile illness and bloodstream infection in low- and middle-income countries. Updated Global Burden of Disease estimates attributed approximately 9.3 million cases and 107,500 deaths to enteric fever in 2021, with South Asia

contributing the largest share of the global burden. Enteric fever had a disproportionate impact during early childhood as children younger than 5 years constituted about 40% of the number of deaths and 47% of years of life lost (Piovani *et al.*, 2024). Despite the decrease in incidence and mortality of the disease in most parts of the world in the last few decades, it is

still found to be concentrated in environments where access to safe water, sanitation, hygiene facilities and access to reliable diagnostic services are poor (Liu *et al.*, 2025).

Pediatric burden of disease is of clinical significance as children can have invasive disease even when there are nonspecific early symptoms, whereas the lack of access to culture-based diagnosis can often promote empirical use of antibiotics. Children in endemic settings are an important reservoir in further transmission as well. Recent genomic epidemiological studies showed that the resistant lineages of *S. Typhi* may be locally transmitted across the ages, and may be sustained in the urban population over years, not just as occasional imported cases (Dyson *et al.*, 2024).

The resistance of the antimicrobials has significantly reduced the available treatment. In the past, ampicillin, chloramphenicol and cotrimoxazole have been used as central agents in treating enteric fever; the development of resistance to these agents resulted in the traditional MDR phenotype. The non-susceptibility of fluoroquinolone later became common all over South Asia. A 2024 modelling study estimated that fluoroquinolone non-susceptibility among *S. Typhi* in South Asia reached 95.2% in 2019 and that third-generation cephalosporin resistance in Pakistan reached 61.0% (Browne *et al.*, 2024). A 2025 systematic review and meta-analysis of Pakistani studies reported pooled resistance in *S. Typhi* of 80% to ampicillin, 64% to ciprofloxacin, 7% to azithromycin, and 2% to meropenem; MDR and XDR were estimated at 29% and 25%, respectively, although substantial geographic heterogeneity was observed (Ullah *et al.*, 2025). The emergence of XDR *S. Typhi* in Pakistan in 2016 marked a further escalation. The XDR phenotype is resistant to the principal first-line agents, fluoroquinolones, and third-generation cephalosporins, leaving azithromycin and carbapenems among the most important therapeutic options. The lineage has subsequently been detected outside Pakistan, including among children and adults who acquired infection during travel, creating a global health-security concern (Posen *et al.*, 2022; Walker *et al.*, 2023). Pediatric data from

Karachi showed that azithromycin alone or in combination with meropenem was effective in many children with culture-proven XDR infection (Shahid *et al.*, 2021). XDR *S. Typhi* has also been documented in Peshawar, where complete or near-complete resistance to several first-line and cephalosporin agents was reported among pediatric isolates (Khan *et al.*, 2022).

Local surveillance is therefore essential. National and international estimates may obscure important differences between provinces, cities, hospitals, patient populations, and laboratory practices. Hospital-level susceptibility data can support rational empirical therapy, identify changing resistance patterns, reduce unnecessary broad-spectrum antibiotic exposure, and inform public-health interventions. Vaccination is a particularly important prevention strategy. Randomized trials in Nepal and Malawi found durable protection from a single typhoid conjugate vaccine dose in children, while a 2024 meta-analysis estimated pooled two-year efficacy of 83% for typhoid conjugate vaccines (Batoool *et al.*, 2024; Patel *et al.*, 2024; Shakya *et al.*, 2021). This study aimed to characterize the distribution of *S. Typhi*, *S. Paratyphi*, and other *Salmonella* species and to describe their antimicrobial susceptibility and MDR patterns among pediatric patients with suspected enteric fever at Hayatabad Medical Complex, Peshawar, during 2024.

MATERIALS AND METHODS

Study design and setting

A hospital-based cross-sectional study was conducted in the Pediatric Unit of Hayatabad Medical Complex, Peshawar, and Khyber Pakhtunkhwa, Pakistan. Hayatabad Medical Complex is a tertiary-care hospital and medical training centre that receives pediatric referrals from Peshawar, other districts of Khyber Pakhtunkhwa, and elsewhere in Pakistan.

Study population and period

The study included 704 pediatric patients clinically suspected of having typhoid fever who were admitted between January 2024 and December 2024. The study included 704 pediatric patients: 447 males and 257 females.

Patients were assessed clinically and investigated using blood culture.

Patients were eligible if they had high-grade fever lasting more than 5 days without an identifiable alternative source and clinical features suggestive of enteric fever, including coated tongue, loss of appetite, vomiting, diarrhea, abdominal pain, pallor, headache, hepatomegaly, or splenomegaly. Patients with persistent fever and clear evidence of upper or lower respiratory tract infection or otitis media were excluded. The analytic dataset included patients with recorded *S. Typhi*, *S. Paratyphi*, or other *Salmonella* culture results.

Specimen collection and culture

A 5 mL of blood was taken off each patient using suitable methods of skin sterilization and inoculated into blood-culture bottles with tryptone soya broth that contained sodium polyanethol sulfonate. Bottles were observed to see signs of growth. Subcultures on the MacConkey agar were made on positive cultures. The study considered blood culture as the diagnostic reference method, which is consistent with its use as the main confirmatory method of invasive enteric fever; nevertheless, timing and amount of specimen collection that could lead to a decrease in culture sensitivity might be part of the study (Batoool *et al.*, 2024).

Identification and confirmation

Biochemical tests were done to characterize presumptive *Salmonella* isolates, such as triple sugar iron agar, urease, indole, citrate, motility, lysine decarboxylase, methyl red, oxidase, catalase and Vibrio-Proskauer. The serological confirmation was done with the help of *S. Typhi* antisera. The biochemical profiles obtained were in line with the laboratory results of *S. Typhi*, *S. Paratyphi* and other *Salmonella* species.

Antimicrobial susceptibility testing

The KirbyBauer disk-diffusion method on MuellerHinton agar was conducted to do the antimicrobial susceptibility testing. The antimicrobial agents that were tested were: amikacin, amoxicillin, ampicillin, azithromycin, cefepime, cefoperazone/sulbactam, cefotaxime, ceftazidime, ceftriaxone, chloramphenicol, ciprofloxacin, co-amoxiclav, co-trimoxazole, colistin, ertapenem, gentamicin, imipenem, meropenem, piperacillin/tazobactam, polymyxin/bacitracine, polymyxin-B and tigecycline.

MDR assessment

MDR has been reported based on the classification of the study that was recorded and summarized based on sex and age group.

Ethical approval

The study was approved by the ethical committee of Hayatabad Medical Complex, Peshawar.

RESULTS

Participant distribution and pathogen profile

The study included 704 pediatric patients: 447 males (63.49%) and 257 females (36.51%). The age-distribution table had a total of 199 patients, 306 patients, and 199 patients aged 1-5 years, 6-10 years, and 11-15 years, respectively. The biggest age bracket was thus 610 years and this accounted to 43.46% of the data.

The most common reported pathogen was *S. Typhi* (526 isolates (74.71%)) then *S. Paratyphi* (110 isolates (15.62%)) and other *Salmonella* species (68 isolates (9.65%)). The sex-stratified distribution was similar. Among males, 334 isolates were *S. Typhi* (74.72%), 66 were *S. Paratyphi* (14.76%), and 47 were other *Salmonella* species (10.51%). Among females, 192 isolates were *S. Typhi* (74.70%), 44 were *S. Paratyphi* (17.12%), and 21 were other *Salmonella* species (8.17%).

Table 1. Demographic distribution of the study population

Age group	Male, n	Female, n	Total, n	Percentage of total
1-5 years	128	71	199	28.26%
6-10 years	190	116	306	43.46%
11-15 years	129	70	199	28.26%
Total	447	257	704	100%

Table 2. Distribution of recorded *Salmonella* isolates

Organism	Male, n (%)	Female, n (%)	Overall, n (%)
<i>Salmonella</i> species	47 (10.51)	21 (8.17)	68 (9.65)
<i>S. Paratyphi</i>	66 (14.76)	44 (17.12)	110 (15.62)
<i>S. Typhi</i>	334 (74.72)	192 (74.70)	526 (74.71)
Total	447 (100)	257 (100)	704 (100)

Antimicrobial susceptibility of *S. Typhi* isolates**Male patients**

Among male-associated *S. Typhi* susceptibility tests, the greatest resistance was recorded for amoxicillin (96.83%), ampicillin (95.56%), cefotaxime (93.50%), cefepime (92.10%), chloramphenicol (91.30%), ceftriaxone (90.21%), and ceftazidime (89.04%). Resistance to co-trimoxazole was 51.33%.

Susceptibility was preserved for ertapenem and polymyxin/bacitracin, each at 100%. High activity was also recorded for imipenem (99.66%), meropenem (99.61%), tigecycline (99%), polymyxin-B (98.37%), colistin (98.03%), amikacin (96.11%), gentamicin (93.60%), and azithromycin (87.42%). Ciprofloxacin susceptibility was 61.18%, corresponding to 38.81% resistance.

Female patients

Female-associated *S. Typhi* isolates showed the highest resistance to ampicillin (97.75%), amoxicillin (96.73%), ceftriaxone (95.23%), cefotaxime (91.66%), chloramphenicol (90.90%), cefepime (89.83%), and ceftazidime (89.74%). Resistance to co-trimoxazole was 46.59%.

Tigecycline showed 100% susceptibility. Other highly active agents included polymyxin-B (99.44%), colistin (99.41%), imipenem (99.40%), meropenem (99.27%), amikacin (97.17%), gentamicin (96.03%), and azithromycin (89.61%). Ciprofloxacin susceptibility was 65.66%, corresponding to 34.33% resistance.

Table 3. Antimicrobial susceptibility of *S. Typhi* isolates

Antimicrobial	Male tested	Male susceptible (%)	Male resistant (%)	Female tested	Female susceptible (%)	Female resistant (%)
Amikacin	309	96.11	3.88	177	97.17	2.82
Amoxicillin/amoxacillin	158	3.16	96.83	92	3.2	96.73
Ampicillin	158	4.43	95.56	89	2.24	97.75
Azithromycin	318	87.42	12.57	183	89.61	10.38
Cefepime	304	7.89	92.10	177	10.16	89.83
Cefoperazone/sulbactam	281	55.51	44.48	156	58.33	41.66
Cefotaxime	231	6.49	93.50	120	8.33	91.66
Ceftazidime	283	10.95	89.04	156	10.25	89.74
Ceftriaxone	92	9.78	90.21	63	4.76	95.23
Chloramphenicol	299	8.69	91.30	187	9.09	90.90
Ciprofloxacin	286	61.18	38.81	166	65.66	34.33
Co-amoxiclav	310	54.83	45.16	175	60.57	39.42
Co-trimoxazole	300	48.66	51.33	176	53.40	46.59
Colistin	306	98.03	1.96	171	99.41	0.58

Ertapenem	11	100	0	11	90.90	9.09
Gentamicin	219	93.60	6.39	126	96.03	3.96
Imipenem	296	99.66	0.33	168	99.40	0.59
Meropenem	257	99.61	0.38	137	99.27	0.72
Piperacillin/tazobactam	313	62.93	37.06	179	67.03	32.96
Polymyxin/bacitracine	1	100	0	Not reported	Not reported	Not reported
Polymyxin-B	307	98.37	1.62	179	99.44	0.55
Tigecycline	301	99	0.99	179	100	0

Antimicrobial susceptibility of *S. Paratyphi* isolates

Male patients

Among male-associated *S. Paratyphi* isolates, susceptibility was highest for tigecycline (98.46%), imipenem (96.66%), piperacillin/tazobactam (96.61%), meropenem (96.55%), and cefoperazone/sulbactam (96.29%). The greatest resistance was observed for ampicillin (48%), cefotaxime (28.57%), ceftazidime (25.86%), amoxicillin (25%), cefepime (22.95%), and ceftriaxone (22.22%).

Female patients

Female-associated *S. Paratyphi* isolates showed highest susceptibility to tigecycline (97.67%), meropenem (95.23%), imipenem (95%), piperacillin/tazobactam (94.73%), cefoperazone/sulbactam (94.73%), polymyxin-B (91.66%), and colistin (90.90%). Resistance was highest for ampicillin (60%), ceftaroline (50%), amoxicillin (40%), ceftriaxone (36.36%), cefotaxime (31.03%), and ceftazidime (28.20%).

Table 4. Antimicrobial susceptibility data for *S. Paratyphi*

Antimicrobial	Male susceptible (%)	Male resistant (%)	Female susceptible (%)	Female resistant (%)
Ampicillin	52	48	40	60
Amoxicillin/amoxacillin	75	25	60	40
Cefotaxime	71.42	28.57	68.96	31.03
Ceftazidime	74.13	25.86	71.79	28.20
Ceftriaxone	77.77	22.22	63.63	36.36
Ciprofloxacin	84.31	15.68	83.78	16.21
Azithromycin	80.64	19.35	83.33	16.66
Imipenem	96.66	3.33	95	5
Meropenem	96.55	3.44	95.23	4.76
Piperacillin/tazobactam	96.61	3.38	94.73	5.26
Colistin	94.33	5.66	90.90	9.09
Polymyxin-B	94.64	5.35	91.66	8.33
Tigecycline	98.46	1.5	97.67	2.32

Antimicrobial susceptibility of other *Salmonella* species

Male patients

Other *Salmonella* species isolated from males were fully susceptible to colistin, polymyxin-B, and tigecycline. Susceptibility was also high for azithromycin (97.73%), meropenem (95.83%), cefoperazone/sulbactam (94.12%),

piperacillin/tazobactam (93.33%), and imipenem (92.68%). Resistance was highest to amoxicillin (100%), ampicillin (77.5%), cefotaxime (68.29%), cefepime (60.53%), chloramphenicol (60.47%), ceftazidime (50%), and ceftriaxone (50%).

Female patients

Among other *Salmonella* species isolated from females, susceptibility was 100% for azithromycin, imipenem, meropenem, and piperacillin/tazobactam. Tigecycline, polymyxin-

B, and colistin remained highly active, with susceptibility of 95.24%, 94.74%, and 94.44%, respectively. Resistance was greatest to ampicillin (90%), cefotaxime (76.47%), chloramphenicol (75%), cefepime (68.42%), ceftazidime (60%), and ciprofloxacin (58.82%).

Table 5. Antimicrobial susceptibility data for other *Salmonella* species

Antimicrobial	Male susceptible (%)	Male resistant (%)	Female susceptible (%)	Female resistant (%)
Amoxicillin/amoxacillin	0	100	Not reported	Not reported
Ampicillin	22.5	77.5	10	90
Cefotaxime	31.71	68.29	23.53	76.47
Cefepime	39.47	60.53	31.58	68.42
Chloramphenicol	39.53	60.47	25	75
Ceftazidime	50	50	40	60
Ceftriaxone	50	50	50	50
Ciprofloxacin	59.38	40.63	41.18	58.82
Azithromycin	97.73	2.27	100	0
Imipenem	92.68	7.32	100	0
Meropenem	95.83	4.17	100	0
Piperacillin/tazobactam	93.33	6.67	100	0
Colistin	100	0	94.44	5.56
Polymyxin-B	100	0	94.74	5.26
Tigecycline	100	0	95.24	4.76

MDR Distribution

MDR was recorded in 141 of 704 patients (20.02%). The proportion was higher among males, 95 of 447 (21.25%), than among females, 46 of 257 (17.89%). Among males, MDR was recorded in 27 of 128 patients aged 1–5 years (21.09%), 39 of 190 aged 6–10 years (20.52%), and 29 of 129 aged 11–15 years (22.48%). Among females, the corresponding values were 13 of 71 (18.30%), 20 of 116 (17.24%), and 13 of 70 (18.57%), respectively.

The highest sex-specific MDR proportion was observed among males aged 11–15 years (22.48%), whereas the lowest was observed among females aged 6–10 years (17.24%). The overall age-specific proportions were 20.10% in children aged 1–5 years, 19.28% in those aged 6–10 years, and 21.10% in those aged 11–15 years.

All patients reportedly responded to antibiotics prescribed after culture reports, most recovered without complications, and no deaths were reported.

Table 6. MDR isolates from male and female patients with different age groups

Age group	Male tested	MDR in male patient, n (%)	Female tested	MDR in female patient, n (%)	Total tested	Total MDR, n (%)
1–5 years	128	27 (21.09)	71	13 (18.30)	199	40 (20.10)
6–10 years	190	39 (20.52)	116	20 (17.24)	306	59 (19.28)
11–15 years	129	29 (22.48)	70	13 (18.57)	199	42 (21.10)
Total	447	95 (21.25)	257	46 (17.89)	704	141 (20.02)

DISCUSSION

This study documents a substantial pediatric burden of culture-recorded *S. Typhi* and a concerning local antimicrobial-resistance profile in Peshawar. *S. Typhi* accounted for 74.71% of the 704 recorded isolates, while *S. Paratyphi* and other *Salmonella* species accounted for 15.62% and 9.65%, respectively. This is in line with *S. Typhi* prevalence, as the global burden of typhoid continues to be concentrated in South Asia (Liu *et al.*, 2025; Piovani *et al.*, 2024).

The best clinical result was the widespread resistance to older first-line agents by *S. Typhi*. Amoxicillin and ampicillin had a resistance rate of around 95-98 percent in both genders and chloramphenicol had a resistance rate of over 90 percent. These result in agreement with the established MDR phenotype and are greater than the pooled national estimates of ampicillin resistance have been reported in a recent meta-analysis in Pakistan, which estimated the resistance to be at 80% (Ullah *et al.*, 2025). The differences can be based on the local epidemiology, referral patterns, the practices used to perform laboratory tests, antimicrobial exposure, or hospital population makeup. They also strengthen the risk of using national averages to the individual hospitals that lack local antibiograms.

Of concern was resistance to the third generation cephalosporins. Cefotaxime resistance was 93.50 and 91.66 in male and female-associated isolates of *S. Typhi* respectively, and ceftriaxone was 90.21 and 95.23, respectively. This is in agreement with the XDR threat of typhoid, but in the current study there was no molecular testing or a formal XDR determination. Above all, the phenotypic resistance to ceftriaxone and other agents is a strong indication of a clinically significant resistant phenotype but XDR status must be confirmed against the entire relevant antimicrobial profile, preferably standardized laboratory standards. Massive Pakistani laboratory-network data revealed resistance in 63.3% and 64.6% of *S. Typhi* isolates to ceftriaxone and cefixime, respectively, and 66.4% and around 80% to a variety of classical first-line agents, respectively (Qamar *et al.*, 2025). This cohort of Peshawar could be revealing a

highly resistant hospital catchment population because of the higher cephalosporin resistance.

The findings are also important in the context of Pakistan's 2016 XDR outbreak. XDR *S. Typhi* emerged in Pakistan and subsequently spread through travel to multiple countries, including Canada, the United States, Spain, Italy, Australia, and Norway (Posen *et al.*, 2022). Modelling studies indicate that international travel volume from Pakistan is associated with the movement of the H58 lineage and that countries with both strong travel links and conditions supporting local transmission are at greatest risk of sustained XDR outbreaks (Walker *et al.*, 2023). The high cephalosporin resistance recorded in this study therefore has implications beyond the individual hospital: resistant lineages can be disseminated through population movement, and undiagnosed infection can facilitate transmission.

Despite the high resistance to conventional agents, carbapenems retained substantial activity against *S. Typhi*. Male-associated isolates were susceptible to imipenem at 99.66% and meropenem at 99.61%, while female-associated isolates showed susceptibility of 99.40% and 99.27%, respectively. Tigecycline, colistin, and polymyxin-B also showed high recorded activity. These results are broadly consistent with Pakistani national data, in which meropenem susceptibility was reported for 99.8% of *S. Typhi* isolates and both *S. Typhi* and *S. Paratyphi* remained susceptible to azithromycin and imipenem (Qamar *et al.*, 2025). The recent Pakistani meta-analysis similarly reported only 2% pooled meropenem resistance and 7% azithromycin resistance among *S. Typhi* isolates (Ullah *et al.*, 2025).

However, preserved in-vitro activity should not automatically translate into indiscriminate clinical use. Carbapenems are critically important antibiotics, and their unnecessary use may select for carbapenem-resistant organisms. Azithromycin remains a valuable oral option in appropriate cases, particularly where susceptibility is demonstrated or when the clinical context is consistent with XDR typhoid. Pediatric data from Karachi found that children with XDR infection commonly recovered with azithromycin alone or in combination with

meropenem (Shahid *et al.*, 2021). Tigecycline and polymyxins should be interpreted cautiously: their role in pediatric enteric fever is constrained by pharmacological, toxicity, and clinical-evidence considerations and disk-diffusion results for these agents may not directly establish optimal treatment. The decisions made regarding treatment should thus include use of standardized minimum inhibitory concentration test, clinical severity, age, organ functioning, previous antibiotic exposure and consultation with the infectious-disease.

The MDR burden stands at 20.02% which is high. MDR was more common in males as compared to females- 21.25% versus 17.89% and highest in males aged 11-15 years-22.48%. The proportions by the age were more or less comparable with the highest proportions of 19.28:21.10 indicating that MDR was not limited to a particular age group of children. The proportion is lower than the 29% pooled MDR estimate reported in the recent Pakistani meta-analysis but remains clinically important (Ullah *et al.*, 2025). Direct comparison is limited because the meta-analysis combined studies from multiple locations and periods, whereas this study represents one tertiary-care centre during 2024.

The reported susceptibility of *S. Paratyphi* was generally better than that of *S. Typhi*, although resistance to ampicillin remained notable at 48% in males and 60% in females. Female-associated *S. Paratyphi* also showed 36.36% ceftriaxone resistance. This supports the need to test each isolate rather than assume that all enteric fever can be treated according to a single organism-level pattern. Other *Salmonella* species showed marked resistance to ampicillin and several cephalosporins but retained high activity of azithromycin, carbapenems, tigecycline, colistin, and polymyxin-B. Because species-level identification of non-typhoidal isolates was limited, these findings should be interpreted cautiously and confirmed through standardized species-level laboratory methods.

Prevention is essential because antimicrobial treatment alone cannot control the transmission of resistant enteric fever. Typhoid conjugate vaccines provide an important opportunity to reduce disease incidence and antibiotic consumption. Randomized trials have shown

approximately 79% efficacy at two years in Nepali children and durable protection through more than four years in Malawian children (Patel *et al.*, 2024; Shakya *et al.*, 2021). A systematic review and meta-analysis found pooled two-year efficacy of 83% for a single dose of typhoid conjugate vaccine (Batoool *et al.*, 2024). These data support continued implementation of typhoid conjugate vaccination in endemic populations, especially children, alongside routine immunization, catch-up campaigns, and improved coverage monitoring.

Antimicrobial stewardship should be integrated into hospital and community practice. Empirical treatment before culture results, followed by adjustment after susceptibility reporting, should be strengthened through timely blood-culture collection before antibiotics whenever clinically safe, hospital-specific antibiograms, restriction of empiric third-generation cephalosporins where local resistance is high, review and de-escalation of carbapenem therapy, and improved access to pediatric infectious-disease expertise. In Pakistan, unregulated antibiotic sales, self-medication, and treatment by inadequately trained providers have been identified as drivers of resistant *S. Typhi* (Shaikh *et al.*, 2023). Stewardship must therefore extend beyond hospitals to pharmacies, private clinics, prescribers, and communities.

CONCLUSION

Among children evaluated at Hayatabad Medical Complex in 2024, *S. Typhi* was the dominant recorded pathogen, and resistance to amoxicillin, ampicillin, chloramphenicol, cefotaxime, cefepime, ceftazidime, and ceftriaxone was very high. MDR was recorded in 20.02% of the study population, with a higher proportion among males than females. Carbapenems, tigecycline, colistin, polymyxin-B, and, particularly in the broader *Salmonella* groups, azithromycin retained substantial in-vitro activity, but these agents should be used judiciously and guided by culture results.

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