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Antimicrobial Susceptibility Pattern of Typhoidal *Salmonella* species in Chittagong Medical College Hospital

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Abstract

Background: Typhoid and paratyphoid fevers result from infections from *Salmonella enterica* serovar Typhi and Paratyphi, and the increasing prevalence of antibiotic resistance to these pathogens has raised concerns about incurable infections. It is a serious public health issue in underdeveloped nations. The widespread development of antibiotic resistance is complicating the treatment of enteric fever. **Objectives:** The primary objective of this study was to determine the antimicrobial susceptibility patterns of *Salmonella enterica* serovar Typhi and Paratyphi in clinically suspected enteric fever patients at Chittagong Medical College Hospital. **Methodology:** This cross-sectional study was conducted from July 2023 to June 2024 at the Microbiology laboratory, Chittagong Medical College. A total of 220 clinically suspected enteric fever patients from both the inpatient and outpatient departments of Paediatric and Medicine were enrolled in this study. Blood culture was carried out by the automated method. The isolates of *Salmonella enterica* serovar Typhi and Paratyphi were obtained from blood by culture, Gram staining, relevant biochemical tests and using specific antisera. The antimicrobial susceptibility test was done by the Modified Kirby-Bauer disc diffusion method as per the CLSI guideline of 2024. Levofloxacin sensitivity was detected by MIC as per the CLSI guideline. **Results:** The isolation rate of *Salmonella spp.* from blood was 14.5 %, *Salmonella enterica* serovar Typhi was 14.05%, and Paratyphi A was 0.45%. The isolates showed 49% resistance to azithromycin, 46% to ciprofloxacin, 35% to ampicillin, 25% to chloramphenicol, 22% to cotrimoxazole and 3% to tetracycline and 2% resistant to levofloxacin. No resistance was detected in ceftriaxone and meropenem. MDR strain was detected in 12.5% isolates. The data were analysed by SPSS 29 and the results were summarized by using graphs and tables. **Conclusion:** In vitro susceptibility pattern of *Salmonella spp.* showed the highest sensitivity against ceftriaxone and meropenem, followed by levofloxacin, tetracycline, chloramphenicol and cotrimoxazole, whereas azithromycin resistance was highest.

Keywords: Antimicrobial resistance; Blood culture; Enteric fever; *Salmonella enterica* serovar Typhi; Typhoid fever.

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Introduction

Enteric fever, also known as typhoid and paratyphoid fever, is caused by *Salmonella enterica* serovar Typhi and Paratyphi A, B, and C[1]. This is a common bacterial infection that results in significant death and illness in low to middle-income nations across Asia, Africa and South America. It is directly associated with sanitation, sewage and water treatment systems[2]. South Asia accounted for 69.6% of all deaths worldwide in 2017, with the highest death rates and total number of deaths worldwide due to enteric fever[3]. WHO estimates up to 9 million cases of enteric fever globally with a mortality rate of 1,10000 deaths each year worldwide[4].

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Bangladesh is an endemic country for enteric fever, with an incidence of 252 per 100000 person[5].

Antibiotics serve as the mainstay for the treatment of enteric fever. When the appropriate antibiotics are used, the death rate is reduced from 25.0% to 1.0% cases[6]. Drug-resistant enteric fever poses an increasing threat to public health. The escalating incidence of antibiotic-resistant strains of enteric fever has instigated concerns regarding the possibility of untreatable infections, thereby restricting available treatment alternatives. Irrational antibiotic prescribing, over-the-counter drugs and indiscriminate antibiotic use in farming are also responsible for antimicrobial resistance in enteric fever, which obstructs the efficacious treatment, prolonging the fever duration and placing those who could have additional health issues[7,8]. Failure to treat an infection properly leads to prolonged illness, thus increasing the chance of developing a carrier state in which persons are contagious and able to spread the resistant strain to others[9]. Over the past 30 years, antibiotic susceptibility profiles of *Salmonella* species have changed significantly in Asia due to point mutations and the horizontal acquisition of resistance genes[10]. Multidrug-resistant (MDR) enteric fever isolates, defined as combined resistance to chloramphenicol, ampicillin, and co-trimoxazole, were a common occurrence in the 1990s and necessitated the use of fluoroquinolones, subsequently cephalosporins and azithromycin[11]. Concerningly, cases of extensively drug-resistant (XDR) enteric fever cases (resistant to ampicillin, chloramphenicol, co-trimoxazole, fluroquinolones and third-generation cephalosporine) has been reported from many corners of the world[12]. Resistance to ceftriaxone poses significant local and global health risks because of the limited treatment alternatives. In 2016, an outbreak of typhoidal *Salmonella* resistant to ceftriaxone was documented in Sindh, Pakistan. In addition, Bangladesh, India and Srilanka have reported similar cases[13].

The present study was undertaken to assess the current antimicrobial sensitivity pattern and reevaluate the trends of antibiogram of typhoidal *Salmonella* isolates, so that the therapeutic value of common drugs and the empirical treatment of enteric fever can be rationalized.

Methodology

Study Setting and Design: This cross-sectional study was conducted in the Department of Microbiology of Chittagong Medical College from July 2023 to June 2024. Prior to commencement, the study protocol was approved by the Institutional Review Board and the concerned authority. Blood samples were collected aseptically from 220 suspected enteric fever patients irrespective of age and sex, who attended the laboratory of the Department of Microbiology from inpatient and outpatient departments of Paediatric and Medicine of Chittagong Medical College Hospital.

Identification of Typhoidal *Salmonella* species: Blood culture was carried out by automated method (BD BACTEC™ FX 40, Becton, Dickinson and Company, Sparks, MD 21152, USA), which was followed by subculture on Blood agar and MacConkey agar media (procured from Oxoid Ltd. UK). The identification was made by relevant biochemical tests such as oxidase test, followed by inoculation into KIA media, MIU media and citrate utilization test. Later confirmed by *Salmonella*-specific antisera (Deben Diagnostic, UK).

Antimicrobial Susceptibility testing: Antimicrobial Susceptibility was assessed by the modified Kirby-Bauer disc diffusion method, and the discs were procured from commercial sources (Oxoid Ltd, UK). The zone of inhibition was interpreted according to the Clinical and Laboratory Standards Institute. Antimicrobial agents were selected according to CLSI guideline, 2024. Ampicillin (10µg), cotrimoxazole (25µg), Tetracycline (30µg), Chloramphenicol (30µg), Ciprofloxacin (5µg), Azithromycin (15µg), Ceftriaxone (30µg), Meropenem (10µg). (Azithromycin is indicated for *Salmonella enterica* Serovar Typhi only). *Escherichia coli* ATCC 25922 was used as control strain to assess the performance of the method. Within 30 minutes of the placement of antibiotic discs, inoculated plates were incubated aerobically 37° C for overnight.

Detection of Multidrug-Resistant *Salmonella*: *Salmonella* strains that were resistant to all three first-line anti-typhoidal drugs, namely ampicillin, chloramphenicol, and cotrimoxazole, were detected as MDR organisms.

Determination of MIC of Levofloxacin: The MIC of levofloxacin was determined using the agar dilution method, where Mueller-Hinton agar plates were prepared with varying concentrations of levofloxacin (0.008 µg/ml to 4 µg/ml). After preparing the agar, it was stored at 2-8°C. Bacterial colonies from blood agar were standardized to a 0.5 McFarland standard and diluted to achieve a final concentration of approximately 10^4 CFU per spot on the agar plates, which were then inoculated and incubated overnight at

37°C.14 The MIC was assessed based on the lowest concentration that inhibited growth, with sensitive defined as MIC ≤0.125 µg/ml, intermediate sensitive as 0.25-1 µg/ml, and resistant as ≥2 µg/ml, as per CLSI guidelines for 2024.

Quality Control: *Salmonella* ATCC 700931 was used for different biochemical tests. Reference strains of Escherichia coli (ATCC 25922) was used as a control reference strain for identification and antimicrobial susceptibility testing.

Statistical Analysis: Statistical analysis was performed following standard procedures utilizing SPSS (version 29.0) and Microsoft Excel.

Ethical Consideration: Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study, written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

Results

A total 220 blood samples were collected from clinically suspected enteric fever cases in the study period of one year of which, 44 (20%) samples yielded positive growth and the remaining 176 (80%) showed no growth. (Figure I)

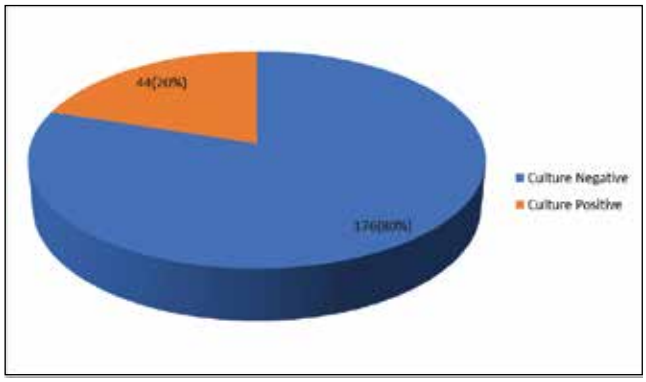

Figure I: Culture Positive Specimens among the Study Population (N=220)

Among cultures positive isolates that included 31(14.09%) *Salmonella* Typhi, 1(0.45%) *Salmonella* Paratyphi A and 12 (5.4%) growth of other organisms. (Figure II)

Among the 44 isolated bacteria, 31(70.5%) were *Salmonella* Typhi, 1 (2.3%) was *Salmonella* Paratyphi A followed by *Staphylococcus aureus* 6 (13.6%), *Acinetobacter spp*. 4 (9.0%) and *Klebsiella species* 2 (4.54%). (Figure III)

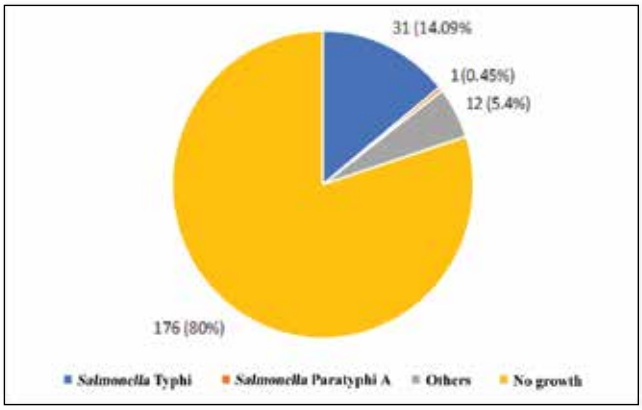

Figure II: Distribution of *Salmonella* species and Other Organisms among the Study Population (N=220)

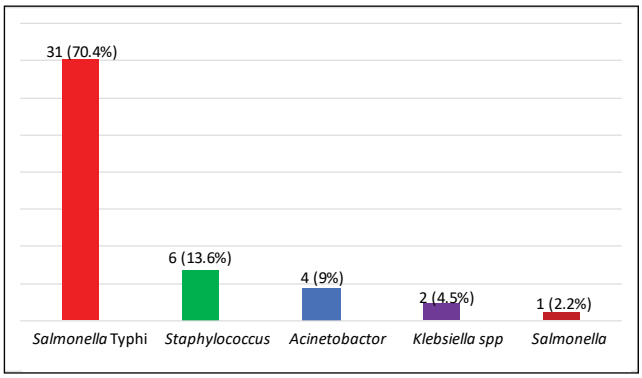

Figure III: Distribution of Isolated Bacteria among Culture-Positive Specimens (n=44)

Among 32 *Salmonella* Typhi and Paratyphi isolates, highest 100% sensitivity found to meropenem and ceftriaxone followed by tetracycline 91%, levofloxacin 91%, chloramphenicol 75%, cotrimoxazole 72%, ampicillin 62% and azithromycin 51%. ciprofloxacin was 54% intermediate sensitive and 46% resistant.

Table-I: Antimicrobial susceptibility pattern of isolated S. Typhi and Paratyphi (n=32)

Antibiotics	Sensitive	Intermediate	Resistant
Ampicillin	20 (62.0%)	1 (3.0%)	11 (35.0%)
Chloramphenicol	24 (75.0%)	-	8 (25.0%)
Cotrimoxazole	23 (72.0%)	2 (6.0%)	7 (22.0%)
Ciprofloxacin	0 (0.0%)	17(54.0%)	15 (46.0%)
Levofloxacin	29 (91.0%)	1 (3.0%)	2 (6.0%)
Ceftriaxone	32 (100.0%)	0 (0.0%)	0 (0.0%)
Azithromycin	16 (51.0%)	-	15 (49.0%)
Tetracycline	29 (91.0%)	2 (6.0%)	1 (3.0%)
Meropenem	32 (100.0%))	0 (0.0%)	0 (0.0%)

Sensitivity to azithromycin was detected in *Salmonella enterica* serovar Typhi only as per CLSI guideline, 2024. Table-II shows the distribution of MDR strains among isolated *Salmonella spp*. Among 32 isolated Salmonella strains 4 (12.5%) were MDR and 28 (87.5%) were non-MDR (Table 1).

Table 2: Distribution of MDR strains among isolated Typhoidal Salmonella (n=32)

Resistance	S. Typhi (n=31)	S. Paratyphi A (n=1)	Total (n=32)
MDR	4 (12.9%)	0 (0.0%)	4 (12.5%)
Non-MDR	27 (87.1%)	1 (100.0%)	28 (87.5%)
Total	**31 (100.0%)**	**1 (100.0%)**	**32 (100%)**

Azithromycin is indicated in *Salmonella enterica* serovar Typhi only as per CLSI guideline, 2024. Levofloxacin sensitivity was detected by MIC (Minimum inhibitory concentration).

Discussion

Widespread abuse of antibiotic in enteric fever is rampant in Bangladesh. The emergence of non-susceptibility among the commonly used antibiotics for enteric fever has been associated with a worse clinical response, higher rate of complications and death, as well as prolonged fecal shedding, which sustains transmission and propagates secondary cases within the community. So, drug-resistant enteric fever is becoming a cause of concern in enteric fever[15-17].

In this study, out of 220 samples, 44 samples (20%) were found to be culture positive, similar to the findings of the studies conducted by Dola et al[18] which is 25.6% in Bangladesh. Out of 44 culture-positive cases, 31 (70.4%) were *Salmonella* Typhi and 1 (2.2%) was *Salmonella* Paratyphi A. Dola et al[18] also reported a study in which *Salmonella* Typhi were 80.0% and Paratyphi A were 20.0%. Begum et al[19] reported similar findings in which 73.0% *Salmonella* Typhi and 27% *Salmonella* Paratyphi A were isolated in Uttara Adhunik Medical College. The differences may be related to a variety of factors, including location, differences in climate as well as environmental and ecological factors[20].

In the present study, nine different antibiotics representing different categories were tested on isolated *Salmonella* spp. to perceive the antimicrobial susceptibility pattern. Among 32 *Salmonella* isolates, the highest 100% sensitivity were seen in meropenem and ceftriaxone, followed by tetracycline 91% and levofloxacin 91%. Haque et al[21] also reported 100% meropenem sensitivity and Chowdhury et al[22] stated 96.5% tetracycline sensitivity. Khanam et al[23] (2022) also reported 80% tetracycline sensitivity, which is slightly lower than the present study. Other studies showed 100% sensitivity of ceftriaxone by Dola et al[18] and Akhtar et al[24] in Dhaka. A study by Begum et al[25] showed 2% ceftriaxone resistance in United Hospital, Dhaka, which is a matter of concern regarding treatment of enteric fever. On the other hand, 32% ceftriaxone resistance was seen in Pakistan, which is much higher than the present study. Ceftriaxone remains the preferred treatment for enteric fever; however, it is important to use it with caution due to the emergence of resistance in various regions globally[26].

A comparatively higher sensitivity rate was exhibited by chloramphenicol 75%, cotrimoxazole 72% and ampicillin 62%, which is almost similar to the study conducted by Rahman et al[27]. A study from Iraq reported 61.5% resistance to ampicillin and 51.2% to chloramphenicol[28]. Mutai et al[29] from Kenya reported that 72% were resistant to both ampicillin and chloramphenicol with 70% resistant to cotrimoxazole. This variation of resistance may be due to different geographical areas and samples.

In this study, 54% of *Salmonella* strains were intermediate sensitive to ciprofloxacin and 46% were resistant; no sensitive strain was found which is correlated with the study of Rahman et al[27]. Akhtar et al[25] showed only 4.4% sensitivity against ciprofloxacin, which is also similar to the present study. But Hasan et al[30] and Jha et al[31] showed 81% and 86% sensitivity rates of ciprofloxacin in Bangladesh and India, respectively. The resistance patterns of typhoidal *Salmonella* have shown variability over time and across different geographical regions. This pattern is also probably due to the indiscriminate and over-the-counter use of this drug in countries with large populations in the treatment of typhoid and other unrelated infections[32].

An overall resistance of 49% for azithromycin was observed in the present study. Dola et al[18]. found 30% azithromycin resistance at Dhaka, which was similar to the present study. 81.5% and 95% azithromycin resistance reported by Sazzad et al[33] and Ahsan and Rahman[34] in Bangladesh, which were much higher than the findings of the present study. Narasanna et al[35] showed 0% resistance in India, which was lower than the present study. In Bangladesh, the widespread

resistance to azithromycin can be linked to factors such as improper prescribing practices and the irrational use of the drug by healthcare professionals. Moreover, availability and incomplete treatment due to many reasons may also be the factors contributing to the development of resistance to this drug[36,37].

MDR strain was found in 12.5% *Salmonella* isolates. Similar reductions in MDR rates have been documented in enteric fever surveillance studies, including India, Nepal, Indonesia, Vietnam, Laos[38]. Whereas in Iraq reported 43.5% MDR *Salmonella* strains which is much higher than this study[28].

In the present study, levofloxacin showed 91% sensitivity, whereas 1 (3.1%) was intermediate sensitive and 2 (6.2%) were resistant. In India, study found 21 (53%) intermediate sensitive, 15 (38%) resistant and 3 (7.6%) sensitive which is dissimilar to the present study[14].

Conclusion

This study highlights the growing public health concern of drug-resistant enteric fever in Chittagong. Increasing azithromycin resistance has limited oral treatment options, and rising resistance to both ciprofloxacin and azithromycin may force a shift toward injectable therapies, adding pressure on already strained healthcare systems. Third-generation cephalosporins remain effective, but their judicious use is crucial to prevent further resistance. Notably, sensitivity to first-line antibiotics has rebounded to over 70%, suggesting a possible return of their effectiveness. To address these challenges, region-specific antibiotic guidelines, improved public awareness, and development of new therapeutics are needed. Ongoing antimicrobial resistance surveillance is essential to sustain effective treatment strategies and reduce the public health impact of enteric fever.

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Conflict of Interest

The authors declare no conflict of interest.

Financial Disclosure

This study was not funded.

Authors' contributions

Masuma Jannat: conceptualized and designed the study, analyzed the data, interpreted the results, and wrote up the draft manuscript. Pompy Dey, Md Gias Uddin and Ayesha Ahmed Khan contributed to the data analysis, interpretation of the results, and critical review of the manuscript. Abu Hena Md. Saiful Karim Chowdhury, Ripon Barua contributed to the analysis of the data. All authors read and approved of the final manuscript.

Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval for the study was obtained from the Institutional Review Board. All methods were performed in accordance with the relevant guidelines and regulations.

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References

1. Harris JB, Brooks WA. Typhoid and paratyphoid (enteric) fever. In Hunter's tropical medicine and emerging infectious diseases. 2020;608-16.
2. Ochiai RL, Acosta CJ, Danovaro-Holliday MC, Baiqing D, Bhattacharya SK, Agtini MD et al. A study of typhoid fever in five Asian countries: disease burden and implications for controls. Bulletin of the World Health Organisation. 2008;86(4):260-8.
3. Stanaway JD, Reiner RC, Blacker BF, Goldberg EM, Khalil IA, Troeger CE et al. The global burden of typhoid and paratyphoid fevers: a systematic analysis for the Global Burden of Disease Study. The Lancet Infectious Diseases. 2019;19(4):369-81.
4. World Health Organization. Typhoid and other invasive Salmonellosis. Geneva: World Health Organization; 2018. Available from: https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillance-standards-typhoid [accessed: 2025 Oct 2]

5. Forster DP, Leder K. Typhoid fever in travellers: estimating the risk of acquisition by country. Journal of Travel Medicine. 2021;28(8):150.
6. Maurice J. A first step in bringing typhoid fever out of the closet. The Lancet. 2012;379(9817):699-700.
7. Saha S, Sayeed KI, Saha S, Islam MS, Rahaman A, Islam M et al. Hospitalization of pediatric enteric fever cases, Dhaka, Bangladesh, 2017–2019: incidence and risk factors. Clinical Infectious Diseases. 2020;71(3):196-204.
8. Qamar FN, Yousafzai MT, Dehraj IF, Shakoor S, Irfan S, Hotwani A et al. Antimicrobial resistance in typhoidal Salmonella: surveillance for enteric fever in Asia project, 2016–2019. Clinical Infectious Diseases. 2020;71(3):276-84.
9. Singhal L, Gupta PK, Kale P, Gautam V, Ray P. Trends in antimicrobial susceptibility of Salmonella Typhi from North India (2001-2012). Indian journal of medical microbiology. 2014;32(2):149-52.
10. Zellweger RM, Basnyat B, Shrestha P, Prajapati KG, Dongol S, Sharma PK et al. A 23-year retrospective investigation of Salmonella Typhi and Salmonella Paratyphi isolated in a tertiary Kathmandu hospital. PLoS Neglected Tropical Diseases. 2017;11(11):e0006051.
11. Azmatullah A, Qamar FN, Thaver D, Zaidi AK, Bhutta ZA. Systematic review of the global epidemiology, clinical and laboratory profile of enteric fever. Journal of Global Health. 2015;5(2):020407.
12. Klemm EJ, Shakoor S, Page AJ, Qamar FN, Judge K, Saeed DK, Wong VK, Dallman TJ, Nair S, Baker S, Shaheen G. Emergence of an extensively drug-resistant Salmonella enterica serovar Typhi clone harbouring a promiscuous plasmid encoding resistance to fluoroquinolones and third-generation cephalosporins. MBio. 2018;9(1):10-128.
13. Jabeen K, Saleem S, Jahan S, Nizamudin S, Arshad F, Huma ZE et al. Molecular characterization of extensively drug-resistant Salmonella enterica Serovar Typhi clinical isolates from Lahore, Pakistan. Infection and Drug Resistance. 2023 16(23):2987-3001.
14. Bhawna, M. and Kadambari. Determination of the minimum inhibitory concentration of Quinolones for Salmonella Typhi and Salmonella Paratyphi. Journal of Pharmacy and Biological Sciences, 2014(3), 1-4.
15. Yan M, Li X, Liao Q, Li F, Zhang J, Kan B. The emergence and outbreak of multidrug-resistant typhoid fever in China. Emerg Microbes Infect 2016;5(6): e62.
16. Van Boeckel TP, Gandra S, Ashok A, Caudron Q, Grenfell BT, Levin SA et al. Global antibiotic consumption 2000 to 2010: an analysis of national pharmaceutical sales data. The Lancet infectious diseases. 2014;14(8):742-50.
17. Veeraraghavan B, Pragasam AK, Bakthavatchalam YD, Ralph R. Typhoid fever: issues in laboratory detection, treatment options & concerns in management in developing countries. Future science OA. 2018;4(6):312.
18. Dola NZ, Shamsuzzaman SM, Islam S, Rahman A, Mishu NJ, Nabonee MA. Distribution of ciprofloxacin-and azithromycin-resistant genes among Salmonella Typhi isolated from human blood. International Journal of Applied and Basic Medical Research. 2022 ;12(4):254-9.
19. Begum M, Mosaddek A, Alamgir F, Alim R, Karim R, Nasrin M. Isolation of Salmonella in bloodstream infections and antibiogram in a tertiary care setting in Dhaka, Bangladesh. Ann Clin Pharmacol Toxicol. 2018;1:1-4.
20. Crump JA, Sjölund-Karlsson M, Gordon MA, Parry CM. Epidemiology, clinical presentation, laboratory diagnosis, antimicrobial resistance, and antimicrobial management of invasive Salmonella infections. Clinical microbiology reviews. 2015;28(4):901-37.
21. Haque MA, Sharmin LS, Alam KF, Hoque MM, Miah MM, Alam MS. Antibiotic sensitivity and resistance patterns of Salmonella typhi in Rajshahi Medical College Hospital. TAJ: Journal of Teachers Association. 2020;33(2):10-4.
22. Chowdhury SR, Ahamed Z, Roy K, Al Noman A, Haroon RM, Mondol KC. Emerging threats of antibiotic resistance in Salmonella typhi and Salmonella paratyphi A among enteric fever cases of Dhaka, Bangladesh. African Journal of Bacteriology Research. 2022 ;14(1):8-15.
23. Khanam J, Paul SK, Kobayashi N, Nasreen SA, Ahmed S, Haque N, Paul A, et al. Detection of Quinolone Resistance Pattern and Presence of qnr Genes in Human Salmonella Isolates at Mymensingh, Bangladesh. Mymensingh Medical Journal: MMJ. 2022;31(1):94-8.
24. Akhtar R, Kismat S, Afroz F, Setu SK, Anwar S, Ahmed S. Antimicrobial susceptibility pattern of multidrug resistant typhoidal Salmonella isolates at Bangabandhu Sheikh Mujib Medical University. Bangladesh Journal of Medical Microbiology. 2021;15(2):19-22.
25. Begum A, Bari MS, Chowdhury FR, Ahmed N, Sayeed KA. Pattern of antimicrobial sensitivity and resistance against Salmonella Species in a Tertiary Hospital in Dhaka. Journal of Enam Medical College. 2015;5(2):88-92.
26. Ghani I, Hussain W, Niaz Z, Zaman G, Khurshaid U, Mirza IA. Antimicrobial susceptibility pattern and genotypic characterisation of quinolone and ceftriaxone resistant genes among Salmonella typhi from various regions of Pakistan. JPMA. The Journal of the Pakistan Medical Association. 2022;72(11):2166-9.
27. Rahman F, Jhora ST, Paul S, Sarkar D, Sadia I. Antimicrobial susceptibility pattern of typhoidal Salmonella species in tertiary hospitals of Dhaka City. Int J Res Innovation Social Sci. 2024;8(2):2552-63.
28. Aljanaby AA, Medhat AR. Research article prevalence of some antimicrobial resistance-associated genes in Salmonella typhi isolated from patients infected with typhoid fever. J. Biol. Sci. 2017;17(4):171-84.
29. Mutai WC, Muigai AW, Waiyaki P, Kariuki S. Multi-drug resistant Salmonella enterica serovar Typhi isolates with reduced susceptibility to ciprofloxacin in Kenya. BMC microbiology. 2018;18(1):187.
30. Hasan B, Nahar SG, Akter L, Saleh AA. Antimicrobial sensitivity pattern of Salmonella typhi isolated from blood culture in a referral hospital. Bangladesh Journal of Medical Microbiology. 2011;5(1):16-20.
31. Jha AK, Rajak KC, Ahmad I, Gupta SD, Poddar CK, Pappu RK, Singh MN, Shahi SK. Antimicrobial Sensitivity Pattern of Salmonella Enterica Serovar Typhi and Paratyphi a Isolated from Blood Culture in a Tertiary Care Hospital, Bettiah, Bihar, India. Vaccine. 2019;5(1):119-27.
32. Nagshetty K, Manjula NG, Math GC, Mohan AS, Shivannavar CT, Gaddad SM. Resistance to fluoroquinolones and other antimicrobials in culture-positive Salmonella typhi isolates in Gulbarga, South India. Advances in Microbiology. 2021;11(1):16-26.
33. Sazzad J, Alam MS, Das HS, Rahman N, Haque QT, Rahman KM. Diagnosis of Enteric Fever Cases: Current Challenges of Azithromycin Resistant R717Q Gene in Rajshahi, Bangladesh.

TAJ: Journal of Teachers Association. 2022;35(2):67-73.
34. Ahsan S, Rahman S. Azithromycin resistance in clinical isolates of Salmonella enterica serovars Typhi and Paratyphi in Bangladesh. Microbial Drug Resistance. 2019 ;25(1):8-13.
35. Narasanna R, Chavadi M, Chandrakanth K. Prevalence of multidrug-resistant Salmonella typhi in typhoid patients and detection of blaCTX-M2 and blaCTX-M9 genes in cefetoxime-mediated extended spectrum β-lactamase-producing Salmonella typhi isolates. Biomedical Research. 2018;29(14):3015-3021.
36. Banumathy M, Viji S, Theeba VM. Mutational Analysis of gyrA, gyr B and par C Genes Encoding for Fluoroquinolones Resistance in Salmonella typhi and Salmonella paratyphi a Isolated from Blood Culture of Enteric Fever Patients in a Tertiary Care Hospital. Int. J. Trop. Med. 2023;18(2):6-11.
37. Rahman MA. Antimicrobial resistance patterns of Salmonella typhi isolated from stool culture. Chattagram Maa-O-Shishu Hospital Medical College Journal. 2015;14(1):26-30
38. Tanmoy AM, Hooda Y, Sajib MS, Rahman H, Sarkar A, Das D, Islam N, Kanon N, Rahman MA, Garrett DO, Endtz HP. Trends in antimicrobial resistance amongst Salmonella Typhi in Bangladesh: A 24-year retrospective observational study (1999–2022). PLoS neglected tropical diseases. 2024;18(10): e0012558