

# KNOWLEDGE, ATTITUDES, AND PRACTICES TOWARDS MULTIDRUG-RESISTANT TYPHOID IN PEDIATRIC POPULATION IN PAKISTAN

## Original Article

Hira Jamil<sup>1\*</sup>, Abdul Razzaque Nohri<sup>2</sup>, Gul Sama<sup>3</sup>, Naveed Ahmed Malik<sup>4</sup>, Safila Naveed<sup>5</sup>

<sup>1</sup>PhD Student, Department of Pharmacy Practice, Faculty of Pharmacy, Jinnah University for Women, Karachi, Pakistan.

<sup>2</sup>Senior Pharmacist & Public Health Specialist, Health Department Government of Sindh, Pakistan.

<sup>3</sup>Department of Healthcare Management, Faculty of Business Management Sciences, Concordia University Chicago, USA

<sup>4</sup>Student, Department of Zoology, DJ Science College, Karachi, Pakistan.

<sup>5</sup>Associate Professor, Department of Pharmacy, University of Karachi, Pakistan.

**Corresponding Author:** Hira Jamil, PhD Student, Department of Pharmacy Practice, Faculty of Pharmacy, Jinnah University for Women, Karachi, Pakistan,  
[pharmacisthirajamil@gmail.com](mailto:pharmacisthirajamil@gmail.com)

**Conflict of Interest:** None

**Grant Support & Financial Support:** None

**Acknowledgment:** The authors gratefully acknowledge the participants for their valuable time and responses.

## ABSTRACT

**Background:** Typhoid fever, or enteric fever, is a systemic infection caused by *Salmonella enterica* serovar Typhi (*S. Typhi*). The emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) strains has intensified health concerns, particularly in pediatric populations. In developing countries like Pakistan, limited public awareness and poor antibiotic stewardship further exacerbate the spread of resistant strains. Assessing the public's knowledge, attitude, and practices (KAP) is essential for informing targeted interventions and enhancing prevention strategies.

**Objective:** To assess the knowledge, attitude, and practices related to MDR typhoid in children among the general population of Pakistan and explore associations between demographic factors and KAP scores.

**Methods:** A cross-sectional study was conducted in November 2024 among 154 participants from all provinces of Pakistan using a self-administered online questionnaire. The survey, circulated through social media using a convenience sampling method, consisted of 21 items covering demographics, knowledge (5 items), attitude (5 items), and practice (6 items). Face validity was established by three reviewers. Descriptive statistics summarized participant characteristics, and chi-square and Fisher's exact tests assessed associations between KAP components. SPSS version 20 was used for analysis.

**Results:** Of the 154 respondents, 82.5% were aged 18–35 years, 63.6% were female, and 61.7% had undergraduate education. Overall, 85.7% had heard of MDR typhoid, and 85.7% identified bacteria as the causative agent. Moderate knowledge was observed with a mean score of 4.6. A positive attitude was seen in 85.06% of participants with a mean attitude score of 8.3. Good practice was evident in 59% of participants, with a mean practice score of 8.65. High levels of hygienic behaviors such as handwashing (76.8%) and use of filtered/boiled water (74.2%) were reported. Vaccination coverage was 65.8%, and 79.4% would consult healthcare providers if symptoms appear.

**Conclusion:** The study indicates moderate knowledge but encouraging attitudes and practices toward MDR typhoid prevention in children. Strengthening health education, particularly in underserved and rural populations, is essential for improving public response and curbing the spread of resistant strains.

**Keywords:** Anti-Bacterial Agents, Drug Resistance, Enteric Fever, Health Knowledge, Hygiene, Pakistan, Typhoid Fever.

## INTRODUCTION

Multidrug-resistant (MDR) typhoid fever has emerged as a critical public health threat, particularly affecting pediatric populations in low- and middle-income countries where sanitation and healthcare infrastructure remain inadequate. Typhoid fever, caused by *Salmonella enterica* serovar Typhi (*S. Typhi*), has historically been treatable with antibiotics such as chloramphenicol, ampicillin, and trimethoprim-sulfamethoxazole. However, decades of antibiotic misuse in both humans and livestock have contributed to the evolution of resistant *S. Typhi* strains, complicating treatment and increasing disease severity in children whose immune systems are not fully developed (1,2). This has raised urgent concerns over the capacity to manage outbreaks and prevent complications such as intestinal perforation, septicemia, and systemic infections in vulnerable pediatric populations (3). The bacterium is typically transmitted through the ingestion of contaminated food or water, often via the fecal-oral route, especially in areas with poor sanitation. Once ingested, *S. Typhi* invades the intestinal mucosa, particularly targeting Peyer's patches, and evades the host's immune response by surviving within macrophages. This allows systemic dissemination via the bloodstream, resulting in persistent high-grade fever and other multi-organ manifestations (4). The burden is further exacerbated in densely populated and under-resourced regions, where diagnostic facilities are limited and awareness about hygienic practices remains low. Children, due to behavioral factors such as frequent hand-to-mouth activity and compromised nutritional status, are at significantly greater risk of both infection and complications (5).

Diagnosis of MDR typhoid remains a challenge. While blood culture is considered the gold standard, its sensitivity is often reduced in severe or prolonged cases. Bone marrow cultures offer higher sensitivity but are rarely accessible in endemic areas. Serological tests like the Widal and Typhi-dot tests are frequently used in low-resource settings, although their reliability is debated. Polymerase chain reaction (PCR) techniques have shown promise in accurately identifying resistant strains but remain largely unavailable in many endemic regions (6). Treatment of MDR typhoid involves the use of advanced antibiotics, guided by culture and sensitivity testing. First-line treatment typically includes ceftriaxone and azithromycin, while carbapenems such as meropenem are reserved for extensively drug-resistant (XDR) strains. The increasing reliance on carbapenems underscores the urgency for antibiotic stewardship and novel therapeutic options (7). Supportive care, including antipyretics, intravenous fluids, and nutritional support, is essential, especially in pediatric patients. Natural remedies like herbal teas and nutrient-rich diets may aid in symptom relief but cannot replace standard medical therapy (8).

Emerging evidence highlights the critical role of vaccination in curbing MDR typhoid. Typhoid conjugate vaccines (TCVs), endorsed by the World Health Organization, have demonstrated high efficacy in reducing the incidence of typhoid fever, particularly among children. Vi-conjugate vaccines are proving effective in mitigating the risk of MDR strains in endemic regions, yet their broader implementation remains constrained by logistical and economic challenges (9). Longitudinal studies have shown significant reductions in MDR typhoid incidence among vaccinated children, supporting the inclusion of TCVs in national immunization programs (10). Despite growing awareness, the global burden of MDR typhoid continues to rise, particularly in South Asia and Sub-Saharan Africa. Literature points to an urgent need for early diagnosis, effective treatment regimens, and preventive strategies tailored to high-risk pediatric populations. Current studies reflect a concerning trend: MDR typhoid in children not only results in more severe clinical manifestations but also leads to increased rates of treatment failure, delayed recovery, and long-term health consequences (11,12). Furthermore, the lack of reliable and accessible diagnostics in endemic regions complicates disease surveillance and timely clinical management (13). Given these concerns, this study aims to comprehensively explore the burden, clinical manifestations, diagnostic challenges, and management strategies of multidrug-resistant typhoid in children. The objective is to highlight existing gaps in care, advocate for improved diagnostic and therapeutic approaches, and support the implementation of vaccination programs, ultimately contributing to more effective control of MDR typhoid in pediatric populations.

## METHODS

This study employed a cross-sectional design to assess the knowledge, attitude, and practices (KAP) regarding multidrug-resistant (MDR) typhoid in children among the general population of Pakistan. Data collection was conducted in November 2024, targeting individuals from all provinces of the country. A total of 154 respondents participated in the study. The inclusion criteria comprised adults aged 18 years and above, residing in Pakistan, and able to comprehend English, as the questionnaire was administered in the English language. Individuals who were healthcare professionals or unable to provide informed consent were excluded to avoid response bias and ensure ethical integrity. A structured, self-administered questionnaire was developed and disseminated online using Google Forms. The sampling strategy adopted was convenience sampling, and the survey link was distributed through various social media platforms,

including WhatsApp groups and personal contacts. The questionnaire consisted of 16 items, organized into four main sections: demographic details (5 items), knowledge (5 items), attitude (5 items), and practice (6 items). All questions were presented in multiple-choice format. To ensure the face validity of the instrument, it was reviewed and validated by three academic reviewers from Jinnah University for Women. While face validity was addressed, it is worth noting that no formal reliability testing such as Cronbach's alpha or pilot testing for construct validity was performed, which may limit the internal consistency of the instrument.

Ethical approval for the study was obtained from the institutional ethical committee of Jinnah University for Women. Participation in the study was entirely voluntary, and informed consent was obtained electronically at the beginning of the survey form. Participants were assured of the confidentiality and anonymity of their responses, and no identifying personal information was collected. Data analysis was carried out using IBM SPSS Statistics version 20. Descriptive statistics, including frequencies and percentages, were employed to summarize the demographic characteristics of the participants. The chi-square test was used to determine associations between demographic variables and levels of knowledge, attitude, and practices. For scoring KAP responses, each item was assigned a numerical score based on the correctness or positivity of the response. The total scores for knowledge, attitude, and practice were computed by transforming and calculating variables within SPSS to categorize levels (e.g., low, moderate, high). This approach facilitated comparative analyses across different demographic groups and allowed interpretation of patterns in public awareness and behavior concerning MDR typhoid in children.

## RESULTS

A total of 154 participants were included in the study. The majority (82.5%) were aged between 18 and 35 years, followed by 15.6% between 36 and 55 years, and only 1.9% were above 55 years. Female participants accounted for 63.6%, while 36.4% were male. Most respondents were single (71.4%), and 28.6% were married. Regarding education, 61.7% had undergraduate education, 17.5% held bachelor's degrees, 16.9% had master's degrees, and 3.9% held PhDs. Employment status showed that only 33.8% were employed, while 66.2% were unemployed. The knowledge assessment revealed that 85.7% of participants had heard of MDR typhoid, with 80% acquiring information from healthcare providers. A total of 85.7% correctly identified bacteria as the causative agent of typhoid, whereas a small proportion misattributed it to viruses (7.8%), parasites (2.6%), or were unaware (3.9%). Knowledge levels showed that 86.36% had moderate knowledge with a mean knowledge score of 4.6, while 14.29% had low knowledge and none had high knowledge.

Attitude assessment showed that 68.2% of participants considered MDR typhoid in children a serious health concern. Approximately 79.9% believed it is preventable with appropriate measures. The importance of completing an antibiotic course was strongly acknowledged, with 77.3% rating it as very important. Additionally, 64.3% were highly concerned about their child contracting MDR typhoid, and 74.7% perceived it as a major public health issue in Pakistan. Positive attitude levels were observed in 85.06% of respondents, with a mean attitude score of 8.3. Practice-related findings indicated that 76.8% ensured their children washed hands before eating, and 74.2% used boiled or filtered water at home. Only 14.2% admitted to skipping antibiotic doses in past typhoid cases. About 43.9% discarded leftover antibiotics, while 25.8% stored them for future use. In response to typhoid-like symptoms, 79.4% preferred consulting healthcare providers as the first action. Moreover, 65.8% had vaccinated their children against typhoid. Overall, 59% of participants demonstrated good practices with a mean practice score of 8.65, while 41% fell in the moderate category; no participants fell into the poor practice group.

Chi-square and Fisher's Exact Tests revealed statistically significant associations between several knowledge, attitude, and practice variables. A significant association was observed between considering MDR typhoid serious for children and choosing to consult healthcare providers as a first response ( $p=0.000$ ; Fisher's  $p=0.004$ ). Participants who believed MDR typhoid is preventable were more likely to ensure their children practiced handwashing before meals ( $p=0.003$ ; Fisher's  $p=0.002$ ). Belief in the importance of completing antibiotic courses was also significantly associated with seeking timely medical consultation ( $p=0.000$ ; Fisher's  $p=0.000$ ). Knowledge of typhoid's bacterial origin was strongly associated with perceiving MDR typhoid as serious ( $p=0.006$ ; Fisher's  $p=0.005$ ), and understanding transmission routes was linked with the belief in preventability ( $p=0.057$ ; Fisher's  $p=0.031$ ). Subgroup analysis revealed important trends across gender and education levels in relation to knowledge, attitude, and practices (KAP) regarding MDR typhoid. Female participants demonstrated higher levels of knowledge (90.8%) and positive attitude (89.7%) compared to male participants (78.6% and 76.8%, respectively). In terms of practice, 63.2% of females exhibited good practices, while only 51.8% of males fell into this category. Educational attainment also influenced KAP scores, with participants holding postgraduate degrees (Masters and PhDs) demonstrating the highest levels of knowledge (over 92%), positive attitude (88.5–100%), and good practices (69.2–83.3%). In contrast,

those with undergraduate degrees showed comparatively lower scores in all three domains. These findings suggest that both gender and educational background significantly influence public awareness and behavioral response towards MDR typhoid in children. Incorporating these subgroup differences in health promotion strategies may enhance targeted interventions and improve overall outcomes.

**Table 1: Demographics**

		Frequency	Percent (%)
Age	18-35 years	127	82.5
	36-55 years	24	15.6
	Above 55 years	3	1.9
Gender	Female	98	63.6
	Male	56	36.4
Marital Status	Married	44	28.6
	Single	110	71.4
Education Level	Undergraduate	95	61.7
	Bachelors	27	17.5
	Masters	26	16.9
	PhD	6	3.9
Employment	Employed	52	33.8
	Unemployed	102	66.2

**Table 2: Association Between Kap Variables**

Association	Pearson Chi-Square Sig. (2-sided)	Fisher's Exact Test Sig. (2-sided)
A1*P5	0	0.004
A2*P1	0.003	0.002
A3*P5	0	0
K3*A4	0.006	0.005
K4*A2	0.057	0.031

**Table 3: Assessment of Knowledge**

Variables	Characteristics	Frequency
Have you heard about MDR typhoid	Yes	85.7
	No	14.3
Where did you learn about it?	Healthcare providers	60
	Media (TV, radio, newspaper)	5
	Internet/social media	20
	Community awareness program	10
	Other	5
Causative agent	Bacteria	85.7
	Parasite	2.6
	Virus	7.8
	Don't know	3.9

**Table 4: Assessment of Attitude**

Variables	Characteristics	Percentage
How serious MDR typhoid for child	Not serious	3.9
	-Somewhat serious	27.9
	Very serious	68.2
Do you believe MDR typhoid is preventable	Yes	3.9
	No	16.2
	Not sure	79.9
How important it is to complete antibiotic course of typhoid	-1 (not important)	5.2
	2	1.9
	3	11
	4	4.5
	5 (very important)	77.3
Concerned about child contracting MDR typhoid	Not concerned	10.4
	Somewhat concerned	25.3
	Very concerned	64.3
Do you think MDR typhoid is major public health issue in Pakistan	Yes	74.7
	No	7.8
	Not sure	16.9-

**Table 5: Assessment of Practice**

Variables	Characteristics	Percentage
Do you ensure your child washes their hands before eating?	Always	76.8
	Sometime	20.6
	Never	2.6
Do you use boiled or filtered water at home?	Always	74.2
	Sometime	21.9
	Never	3.9
Have you ever skipped a dose of antibiotic treatment for your child when they had typhoid?	Yes	14.2
	No	36.8
	Not applicable	49
How do you dispose of leftover antibiotics, if any, after your child completes a treatment course?	Store for future use	25.8
	Discard in trash	43.9
	Return to pharmacy	13.5
	Not applicable	16.8
If your child had a fever with typhoid-like symptoms, what would be your first course of action?	Give home remedies	7.1
	Visit a local pharmacy for medication	8.4
	Consult a healthcare provider	79.4
	Wait to see if symptoms improve	5.2
Have you vaccinated your child against typhoid?	Yes	65.8
	No	21.9
	Not sure	12.3

**Table 6: Subgroup Analysis by Gender and Education vs KAP**

Demographic	Knowledge Level - Moderate/High (%)	Positive Attitude (%)	Good Practice (%)
Gender			
Female	90.8	89.7	63.2
Male	78.6	76.8	51.8

Demographic	Knowledge Level - Moderate/High (%)	Positive Attitude (%)	Good Practice (%)
Education			
Undergraduate	81.1	82.1	54.7
Bachelors	88.9	85.2	59.3
Masters	92.3	88.5	69.2
PhD	100	100	83.3

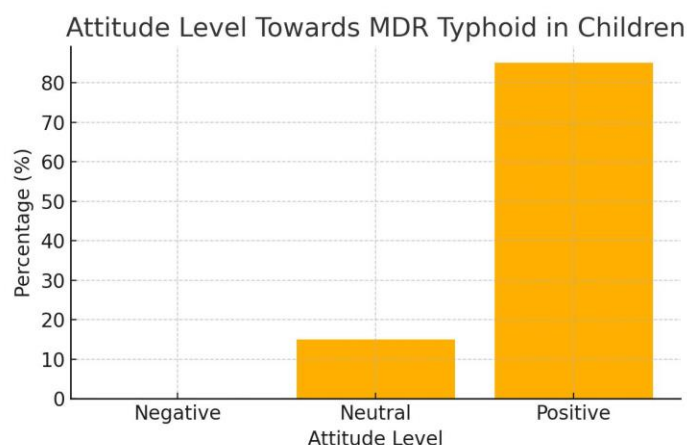


Figure 1 Attitude Level Towards MDR Typhoid in Children

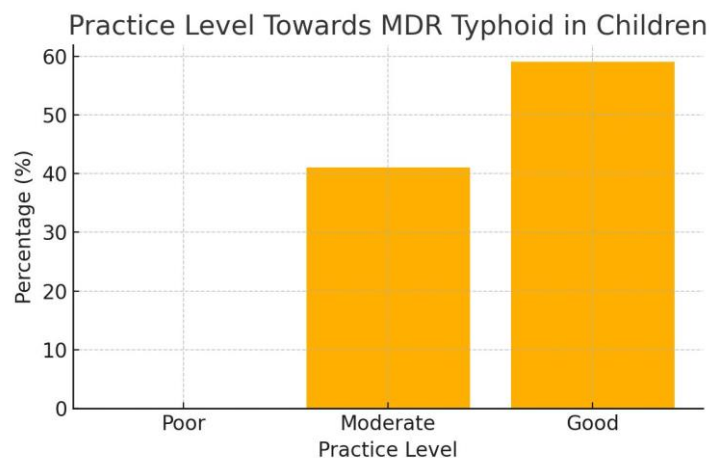
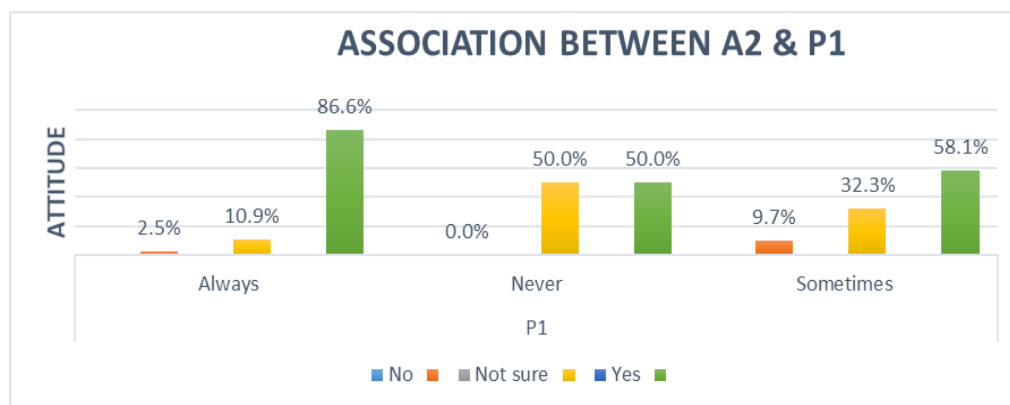
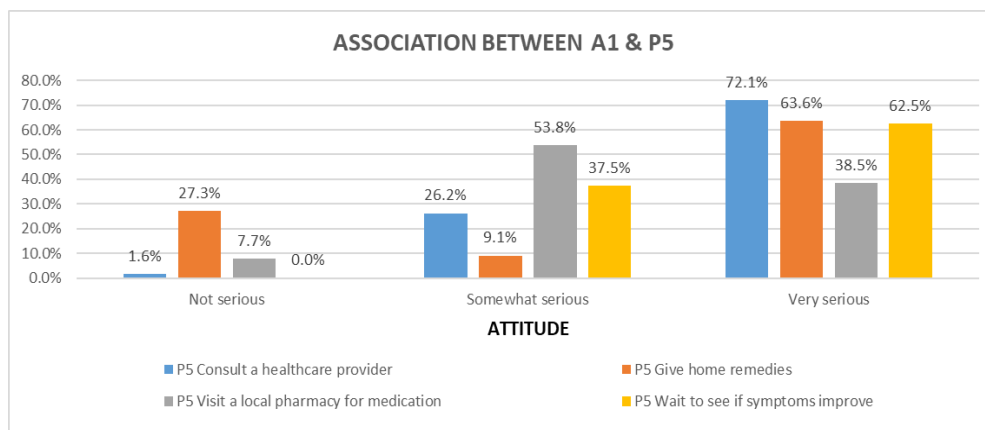
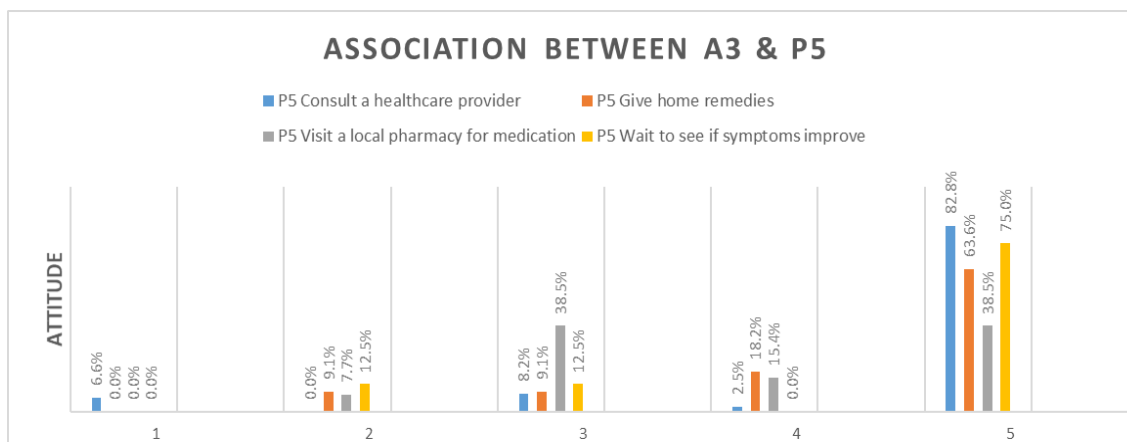


Figure 2 Practice Level Towards MDR Typhoid in Children







## DISCUSSION

Multidrug-resistant (MDR) typhoid fever continues to present a formidable public health challenge, particularly in the pediatric population, due to increasing antimicrobial resistance globally and rising cases of extensively drug-resistant (XDR) typhoid. This issue is more pronounced among children under five years of age, where immature immune responses compound disease severity (1,2,3). The current study aimed to evaluate the knowledge, attitude, and practices (KAP) of the general Pakistani population toward MDR typhoid in children. The findings demonstrate that while knowledge levels remain moderate, the overall attitude is notably positive and practices are largely appropriate, indicating a constructive trend in public perception and behavioral response (14,15). A considerable proportion of participants (85.7%) had prior awareness of MDR typhoid and correctly identified the bacterial etiology, along with basic understanding of its symptoms and transmission. Healthcare professionals were cited as the primary source of this information, reinforcing the role of clinical guidance in community awareness. The moderate level of knowledge appears to align with this pattern, suggesting that structured, provider-led education contributes positively but remains insufficient in delivering comprehensive knowledge across broader topics such as resistance mechanisms, misuse of antibiotics, or preventive interventions (16,17).

Attitudinal indicators were encouraging, with 85% of respondents demonstrating a positive attitude and 68.2% perceiving MDR typhoid as a serious health concern for children. The majority expressed concern for their child contracting the disease and recognized MDR typhoid as a public health threat. This pattern correlates with participants' awareness of typhoid transmission and belief in the effectiveness of preventive measures, indicating that even modest levels of knowledge can foster a health-protective mindset. Attitudes shaped by accurate awareness are critical in influencing adherence to preventive behavior and early treatment-seeking. Practice scores further reflected favorable health behaviors, with 59% of participants exhibiting good practices and a mean practice score of 8.65. A significant proportion ensured their children washed hands before meals and used boiled or filtered water at home—key strategies known to reduce typhoid transmission (18). Prior research has identified municipal and bore water as risk factors for XDR typhoid, reinforcing the importance of water hygiene. The responsible use of antibiotics was another positive finding; participants largely avoided missing doses and disposed of leftover medication appropriately. Given Pakistan's high burden of MDR and XDR typhoid strains and frequent over-the-counter access to ciprofloxacin, such antibiotic stewardship behaviors are crucial in mitigating resistance trends (19,20).

Vaccination coverage in the study was also satisfactory. Participants demonstrated confidence in the protective role of typhoid vaccines, with a significant portion reporting that their children were vaccinated. Previous findings have associated unvaccinated individuals with higher rates of drug-resistant infections, further validating the importance of vaccination in resistance control strategies (21). Timely healthcare consultation in response to febrile illness was commonly reported, reflecting a behavioral shift that aligns with clinical recommendations and potentially lowers the risk of complications and hospitalization. However, the findings must be interpreted within the context of certain limitations. The study used a relatively small sample size and a convenience sampling approach, reducing the generalizability of the results to the broader Pakistani population. Most respondents were young, urban, and relatively well-educated, which may have skewed KAP levels upward compared to more marginalized or rural populations with lower literacy and limited internet access. Additionally, the online administration of an English-language questionnaire likely excluded non-English speakers and

individuals without internet connectivity, introducing sampling bias. The self-reported nature of responses raises the possibility of social desirability bias, particularly in practice-related questions. Furthermore, recall bias may have influenced participants' responses to questions on past behavior or antibiotic usage.

Despite these limitations, the study offers valuable insights into community-level awareness and response patterns regarding MDR typhoid in children. Its strengths include the use of a structured, validated tool for KAP measurement and the incorporation of inferential statistics to identify significant associations between key variables. Future research should prioritize inclusion of rural and low-literacy populations through translated and interviewer-administered surveys. Expanding sample size and incorporating stratified sampling techniques would enhance representativeness. Additionally, qualitative methods could further explore behavioral drivers, barriers to vaccination, and perceptions of antibiotic use to inform targeted public health messaging. The study reinforces the critical role of public education, healthcare provider communication, and vaccination in addressing the growing challenge of MDR and XDR typhoid. Addressing gaps in knowledge and expanding access to preventive strategies are essential steps toward reducing the burden of typhoid fever and preserving the efficacy of available antimicrobial therapies.

## CONCLUSION

This study concludes that while the general population in Pakistan demonstrates moderate knowledge and a positive attitude towards multidrug-resistant (MDR) typhoid in children, challenges such as limited education and awareness remain significant barriers, especially in a developing country context. Encouragingly, good practice levels observed among participants reflect the influence of basic knowledge and favorable attitudes, particularly in hygiene, vaccination, and responsible antibiotic use. These findings highlight the need for strengthened community education and health literacy initiatives, emphasizing the importance of completing antibiotic courses to curb the spread of resistant strains. Promoting targeted awareness strategies and reinforcing preventive practices are essential steps in mitigating the growing burden of MDR typhoid, especially among vulnerable pediatric populations.

## AUTHOR CONTRIBUTION

Author	Contribution
Hira Jamil*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Abdul Razzaque Nohri	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Gul Sama	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Naveed Ahmed Malik	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Safila Naveed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

## REFERENCES

1. Akram, J., Khan, A. S., Khan, H. A., Gilani, S. A., Akram, S. J., Ahmad, F. J., & Mehboob, R. (2020). Extensively Drug-Resistant (XDR) Typhoid: Evolution, Prevention, and Its Management. *BioMed Research International*, 2020, 1–7.



2. Appiah, G. D., Chung, A., Bentsi-Enchill, A. D., Kim, S., Crump, J. A., Mogasale, V., Pellegrino, R., Slayton, R. B., & Mintz, E. D. (2020). Typhoid outbreaks, 1989–2018: Implications for prevention and control. *The American Journal of Tropical Medicine and Hygiene*, 102(6), 1296.
3. CHAUHAN, N., & FAROOQ, U. (n.d.). *MULTIDRUG RESISTANCE: A CHALLENGE IN TYPHOID TREATMENT*. Retrieved November 11, 2024.
4. Fozia Baloch, Haseeb Ahmed Abbasi, Muhammad Maaz Ali Shaikh, Prem Sagar, Amir Memon, & Muhammad Amir. (2024). Drug Resistant XDR Typhoid in Children Admitted in a Tertiary Care Hospital. *Annals of PIMS-Shaheed Zulfiqar Ali Bhutto Medical University*, 20(1), 69–73.
5. Jabin, T., Hossain, M. M., Nasrin, S., Tabassum, R., Rahman, M. A., & Uddin, M. A. (2022). Microbiological assessment and detection of drug resistant bacterial isolates in some vended fresh fruit juice samples in Dhaka city, Bangladesh. *Food Res*, 6, 413–419.
6. Kariuki, S., Dyson, Z. A., Mbae, C., Ngetich, R., Kavai, S. M., Wairimu, C., Anyona, S., Gitau, N., Onsare, R. S., & Ongandi, B. (2021). Multiple introductions of multidrug-resistant typhoid associated with acute infection and asymptomatic carriage, Kenya. *Elife*, 10, e67852.
7. Khan, M., & Shamim, S. (2022). Understanding the mechanism of antimicrobial resistance and pathogenesis of Salmonella enterica Serovar Typhi. *Microorganisms*, 10(10), 2006.
8. Lagos, R. M., Sikorski, M. J., Hormazabal, J. C., Fernandez, A., Duarte, S., Pasetti, M. F., Rasko, D. A., Higginson, E., Nkeze, J., & Kasumba, I. N. (2024). Detecting Residual Chronic Salmonella Typhi Carriers on the Road to Typhoid Elimination in Santiago, Chile, 2017–2019. *The Journal of Infectious Diseases*, 230(2), e254–e267.
9. Memon, H., Saeed, F., Iqbal, M., Saboohi, E., Hanif, S., & Mallick, A. H. H. (2022). Association of extensively drug resistant salmonella infection in children with typhoid fever. *Pakistan Journal of Medical Sciences*, 38(7). <https://doi.org/10.12669/pjms.38.7.5868>
10. Qamar, F. N., Qureshi, S., Haq, Z., Yousafzai, T., Qazi, I., Irfan, S., Iqbal, N., Amalik, Z., Hotwani, A., & Ali, Q. (2024). Longevity of immune response after a single dose of typhoid conjugate vaccine against Salmonella Typhi among children in Hyderabad, Pakistan. *International Journal of Infectious Diseases*, 147, 107187.
11. Qureshi, S., Naveed, A. B., Yousafzai, M. T., Ahmad, K., Ansari, S., Lohana, H., Mukhtar, A., & Qamar, F. N. (2020). Response of extensively drug resistant Salmonella Typhi to treatment with meropenem and azithromycin, in Pakistan. *PLoS Neglected Tropical Diseases*, 14(10), e0008682.
12. Shahid, S., Mahesar, M., Ghouri, N., & Noreen, S. (2021). A review of clinical profile, complications and antibiotic susceptibility pattern of extensively drug-resistant (XDR) Salmonella Typhi isolates in children in Karachi. *BMC Infectious Diseases*, 21(1), 900.
13. Tahir, M. J., Zaman, M., Saffi, J., Asghar, M. S., Tariq, W., Ahmed, F., Islam, R., Farooqui, U. S., Ullah, I., & Saqlain, M. (2023). Knowledge, attitudes, and practices of the general population of Pakistan regarding typhoid conjugate vaccine: Findings of a cross-sectional study. *Frontiers in Public Health*, 11, 1151936.
14. Vighio, A., Syed, M. A., Hussain, I., Zia, S. M., Fatima, M., Masood, N., Chaudry, A., Hussain, Z., Baig, M. Z. I., Baig, M. A., Ikram, A., & Khader, Y. S. (2021). Risk Factors of Extensively Drug Resistant Typhoid Fever Among Children in Karachi: Case-Control Study. *JMIR Public Health and Surveillance*, 7(5), e27276.
15. Wajeelha Qayyum, Zaland Ahmed Yousafzai, Malghalara Afridi, Muhammad Fozan Khan, Rizwan Amin Kundi, & Bilal Iqbal. (2023). Drug Resistance Pattern of Salmonella Typhi in Patients Suffering from Enteric Fever—Experience from Tertiary Care Hospital of Peshawar. *Journal of Saidu Medical College, Swat*, 13(4), 168–174.
16. Omair Mazhar, Sher Alam Khan, Muhammad Arsalan Qaisar, Zafar Iqbal Bhatti, Mahwish Akhtar Qureshi, Ibrahim. Incidence of Several Forms of Tuberculosis (TB) and Their Bacillus Calmette Guerin (BCG) Vaccination Status among Children. *Pakistan Journal of Medical & Health Sciences* [Internet]. 2022 Sep. 21 [cited 2025 Feb. 19];16(06):1071.
18. Onken A, Moyo S, Miraji MK, Bohlin J, Marijani M, Manyahi J, et al. Predominance of multidrug-resistant Salmonella Typhi genotype 4.3.1 with low-level ciprofloxacin resistance in Zanzibar. *PLoS Negl Trop Dis*. 2024;18(4):e0012132.
19. Kariuki S, Dyson ZA, Mbae C, Ngetich R, Kavai SM, Wairimu C, et al. Multiple introductions of multidrug-resistant typhoid associated with acute infection and asymptomatic carriage, Kenya. *Elife*. 2021;10.
20. Samajpati S, Das S, Jain P, Ray U, Mandal S, Samanta S, et al. Changes in antimicrobial resistance and molecular attributes of Salmonellae causing enteric fever in Kolkata, India, 2014–2018. *Infect Genet Evol*. 2020;84:104478.
21. Muhammad EN, Abdul Mutalip MH, Hasim MH, Paiwai F, Pan S, Mahmud MAF, et al. The burden of typhoid fever in Klang Valley, Malaysia, 2011–2015. *BMC Infect Dis*. 2020;20(1):843.

