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Prevalence of *Escherichia Coli* in District Peshawar: Environmental and Clinical Insights

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ABSTRACT

Background: *Escherichia coli (E. coli)* is a leading cause of urinary tract and Diarrhea diseases in low and center earnings countries, wherein insufficient water sanitation and unregulated antibiotic use exacerbate transmission and resistance. In District Peshawar, Khyber Pakhtunkhwa, restricted incorporated surveillance exists to quantify occurrence of *E.coli*. **Methods:** A cross-sectional study was conducted for detection of *E.coli* in environment and its prevalence in public health settings in Peshawar. Two types of data sets were generated including environmental water sampling and public health statistics regarding E. coli diarrhea and Urinary Tract Infections (UTI). Simultaneously, health information generated was analyzed for *E.coli* related urinary tract infections (UTIs) and diarrhea instances. **Results:** Women constituted ≈40 % of infected instances, while cases in men were recorded to be 59.8 %. Moreover youngsters/kids ≤18 years represented ≈72.6 % of cases and adults of older age represented 27.4 %. Diarrhea and UTIs had been equally established (≈57.6%), reflecting twin transmission routes. Seasonal peaks came about in winter followed by autumn season. Geographic clustering was most prominent in peri-urban settlements (Badber, Mashogagar, Balarzai, ShahidGari, Afridy avenue). A huge percentage of the two hundred water samples tested positive for *E. coli*, corroborating environmental transmission. **Discussion:** These findings align with regional research showing high *E. coli* incidence in water resources. The convergence of environmental infection, and early life burden underscores the multifactorial nature of transmission. **Conclusions:** *E.coli* infection is sizeable in Peshawar's water and medical settings, disproportionately affecting kids in peri-city areas. Integrated surveillance of water, meals, and sanatorium information, coupled with advanced sanitation and antibiotic stewardship, is urgently needed to reduce ailment burden.

INTRODUCTION

Escherichia coli (E. coli) is a diverse group of microorganisms with a complicated relationship to human health and fitness. Contemporaneously as many *E. coli* lines are harmless commensals in the human intestine, a considerable proportion is pathogenic and capable of inflicting excessive disorder [Odonkor & Addo, 2011; WHO, 2018]. *E. coli* stays a primary public health challenge, in particular in low- and middle-income international locations in which sanitation and hygiene infrastructure are insufficient. Infections due to this bacterium range from slight to existence-threatening, with commonplace manifestations such as urinary tract infections (UTIs) and diarrheal diseases such as diarrhea [Prüss-Ustün et al., 2014; WHO, 2018]. The global burden of diarrheal sicknesses is identified as a main cause of morbidity and mortality, mainly among kids in South Asia [WHO, 2017; WHO, 2018]. This highlights an urgent need to apprehend and manage the pathogenicity of *E. coli* in vulnerable populations [Prüss-Ustün et al., 2014; WHO, 2017].

Globally, the *E. coli* health crisis is compounded by an upward push of antimicrobial resistance (AMR), which undermines the effectiveness of existing remedies. Emergence of multidrug-resistant (MDR) *E. coli* strains is often associated with an extensive use of antibiotics [Abdullah et al., 2025; CLSI, 2023; Fawad et al., 2024; Qasim et al., 2024; Ullah T. et al., 2025]. This issue is especially acute in developing regions like Pakistan, where both environmental and clinical settings offer reservoirs for resistant microorganism.

In a changing climate Khyber Pakhtunkhwa (KP) Province, and its capital city Peshawar, are facing environmentally and socio-economically demanding situations that facilitate the spread of waterborne pathogens including *E. coli*. Factors such as insufficient sanitation infrastructure, dependence on untreated groundwater, and seasonal flooding create surroundings that are conducive to infection [Daud et al., 2017; Khan et al., 2025; Naeem et al., 2017]. Preceding studies have documented *E. coli* in a wide range of environmental and

clinical sources in and round Peshawar, including consuming water, sewage, and meal products along with meat and eggs [Tasbihullah et al., 2024/25; Shah et al., 2024; Ullah S. et al., 2024]. Isolation of diarrheagenic *E. coli* strains from meat in nearby Bannu District underscores the wider nearby risk [Shah et al., 2024; Ullah S. et al., 2024].

In addition to environmental infection, the healthcare setting in Peshawar has been a focal point of research on antibiotic susceptibility and ESBL occurrence in *E. coli* isolates. Studies at local hospitals, such as Khyber teaching clinic, have exposed antimicrobial sensitivity patterns and confirmed high occurrence of drug-resistant lines [Fawad et al., 2024; Jamil et al., 2020; Zaman et al., 2025]. Studies from Swabi and different regions of the province document similar developments, highlighting a vast spread antimicrobial resistance [Ullah T. et al., 2025].

Findings on ceftriaxone-resistant *E. coli* in adult UTI populations in Peshawar in addition illustrate the remedy challenges [Jamil et al., 2020]. The detection of multidrug-resistant Shiga toxin-generating E. coli in meat and animal merchandise in Pakistani cities, which includes Peshawar, highlights complex transmission pathways between food, animals, and humans [Tasbihullah et al., 2024/25; Ullah S. et al., 2024].

Whilst previous studies have addressed specific factors of E. coli incidence — which includes antibiotic resistance in medical isolates or contamination of environmental sources — there's a need for integrated studies linking each domain names. Well known laboratory practices, which includes those outlined by Cheesbrough (2010), are essential for reliable statistics series and evaluation. The WHO's guidelines and recommendations also provide a framework for comparing environmental contamination stages [WHO, 2017].

The present study aims to address these gaps by means of investigating the prevalence of *E. coli* in District Peshawar using both medical institution facts and environmental water samples. By way of inspecting demographic factors (gender, age, disease type, seasonality, and vicinity) along with contamination of water sources, this study will offer a comprehensive image of *E. coli* epidemiology within the Peshawar Vale. These findings are anticipated to provide information for public health interventions focused on water and geographic sources of disease burden [WHO, 2017; CLSI, 2023; Cheesbrough, 2010].

The goal of the present study is to quantify the prevalence of *E. coli* in Peshawar and surrounding areas in KP; to evaluate the existing patterns; and to search out demographic factors impacted by the disease.

METHODOLOGY

Study design and setting

A cross sectional study was designed to detect occurrence of *Escherichia coli* in environment and health settings in Peshawar district. For this purpose two forms of data were investigated: (i) Water samples from various regions in Peshawar were analyzed for the presence of *E. coli* and (ii) and patient socio-demographic data generated from Al Noor health center in Peshawar from August 2024 and February 2025. *E. coli* positive Diarrhea and Urinary Tract Infections were included in the study. The hospital caters to the medical needs of city and peri-city populations in Peshawar District, Khyber Pakhtunkhwa, Pakistan. An ethical certificate was issued by the University of Peshawar "Research Ethics Board" (REB).

Water Sampling

About 308 samples were collected from sewage-water interface points. These samples were analyzed according to WHO guidelines.

The samples were acquired throughout urban and peri-urban regions of Peshawar (August 2024–February 2025). Samples had been processed through the use of membrane filtration, MacConkey and EMB agar way of life, IMViC biochemical tests trying out in keeping with CLSI 2023 standards.

Study Population

Approximately 200 patients' records were reviewed ranging from three to 63 years in age and represented multiple regions of Peshawar District, consisting of Badber, Mashogagar, Matani, Balarzai, Shahid Gari, Afridy street, and surrounding areas. All sufferers with diagnostic symptoms underwent stool or urine analysis for *Escherichia coli* infection.

Inclusion and Exclusion criteria

Inclusion criteria: All patients with a stool or urine pattern examined for *Escherichia coli* between August 2024 and February 2025; with a diagnosis of diarrhea or urinary tract contamination (UTI); and with whole demographic facts (name, age, area, and date).

Exclusion Standards: Patients without whole demographic or laboratory test diagnosis for *E. coli* and those examined for pathogens aside from *Escherichia coli.*

Data Collection Procedure

Demographic information had been extracted from medical institution laboratory registers and digitized into a Microsoft Excel sheet. Every entry showcased affected persons' serial number, call number, age, gender, diagnosis, treatment and date. The patients' identity was kept anonymous.

Laboratory Diagnosis of *Escherichia coli*

Specimen collection: Stool samples from patients with suspected diarrhea; and urine samples accrued from UTI suspected sufferers were taken in sterile packing containers.

Transport and storage: All samples had been processed within 2 hours of series on the medical institution's microbiology lab.

Subculture and identity: Stool and urine samples had been cultured on MacConkey agar and Eosin Methylene Blue (EMB) agar following trendy tactics defined by means of Cheesbrough (2010) and CLSI pointers (2023). Colonies showing feature morphology were subjected to Gram staining and preferred biochemical assessments (Indole, Methyl pink, Voges–Proskauer, Citrate usage).

Variables

Established variables: Presence of *Escherichia coli*, diagnosis of diarrhea or UTI.

Independent variables: patient age, area of house, and date of visit.

Data Analysis

Data were summarized by the use of descriptive information in Microsoft Excel.

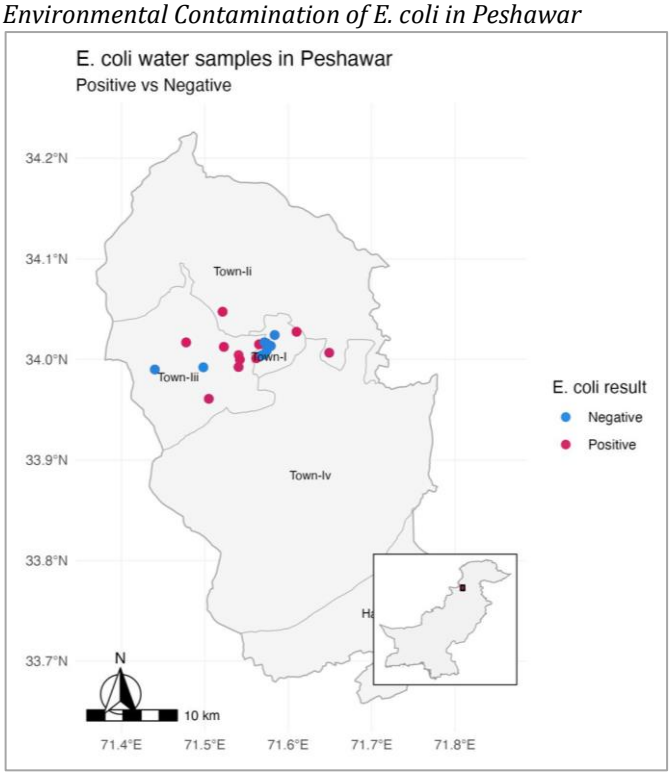
A map was generated through machine learning tools to observe the occurrence of *E. coli* in surface water of district Peshawar. Frequency distributions were calculated for gender, age groups, and seasonality etc. Disease distribution was analyzed through age and gender information and spatio-temporal data (August 2024–February 2025). Pie Graphs were constructed to illustrate prevalence traits.

RESULTS

The present study investigated *E. coli* disease burden and its presence in local environment of district Peshawar. Our results reveal that *E. coli* is well established in urban and peri-urban regions of Peshawar (Figure 1).

Figure 1a

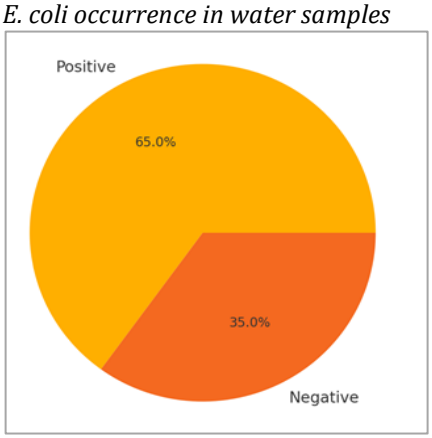
Environmental Contamination of E. coli in Peshawar



Approximately 200 water samples from Peshawar district were diagnosed positive for *E. coli* while 108 samples were negative for *E. coli.*

Figure 1b

E. coli occurrence in water samples



Interpretation: This finding highlights environmental contamination and water as a chief reservoir and transmission pathway for *E. coli* in Peshawar. The water contamination strongly correlates with the excessive diarrhea burden seen in health settings, reaffirming the surroundings-to-human link in disease transmission.

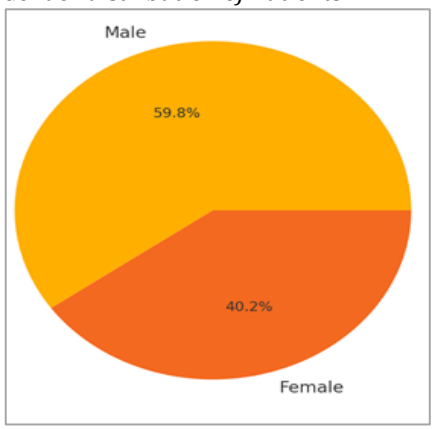
Gender Wise Distribution of Patients

The gender distribution indicated that male accounted for most of the cases which was 59.8% while Female represented as 40.2%.

Interpretation: This skew may be because of a higher chance of males to be infected with diarrheal disease, probably due to more outdoor activities including indulgence in food and beverages.

Figure 2

Gender distribution of Patients



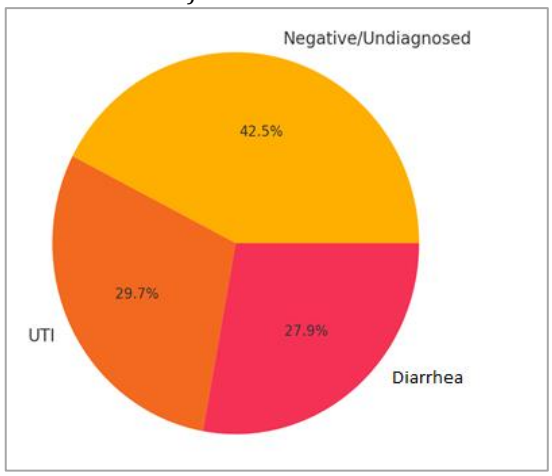
Disease Burden

The results revealed that amongst suspected patients, Diarrhea and UTI accounted for about57.6 %. Among the suspected patientsa small proportion (≈42.5%) remained undiagnosed for *E. coli* assessments.

Interpretation: This shows a twin burden of *E.coli*-related illnesses in Peshawar: including waterborne diarrheal outbreaks and UTIs.

Figure 3

Disease burden of E. coli



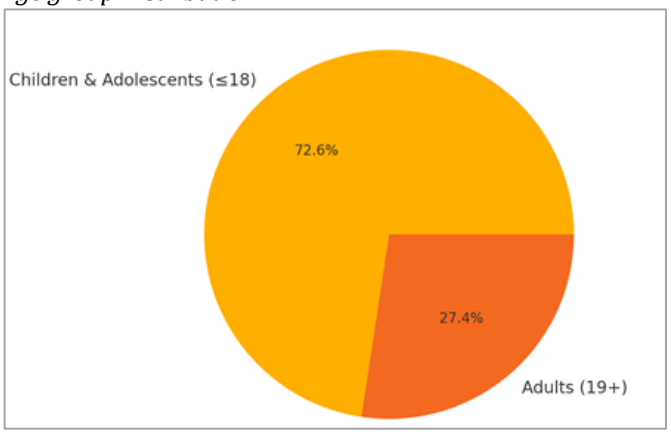
Age Group Distribution

Most of the diagnosed patients (≈72.6%) happened to be youngsters and teenagers (≤18 years), while a small proportion of patients 19 plus %were adults (≥19 years).

Interpretation: children are more liable to *E. coli* infections due to weaker immunity, better exposure through hazardous water/food, and less-advanced hygiene practices. The high formative years burden is consistent with WHO reviews figuring out diarrheal ailment as a leading cause of morbidity among youngsters in South Asia.

Figure 4

Age group Distribution



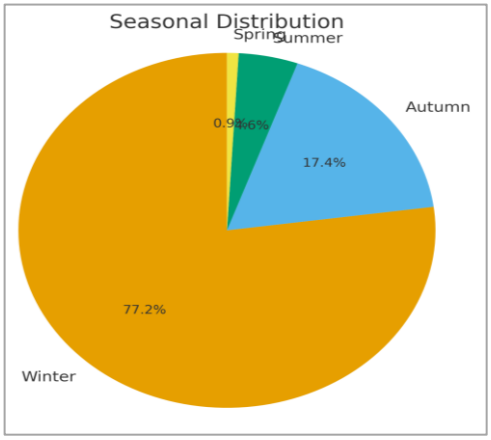
Seasonal Distribution

Analysis across seasons confirmed that prevalence was high during the winter months accounting for about 77.2 % cases, followed by autum (17.4 %) summer (4.6 %) and spring season (0.9 %).

Interpretation: The incident height can be connected to contaminated water storage practices at some stage in chillier months, reduced water waft in pipelines leading to higher bacterial masses, and higher affected person health center attendance throughout winter weather. Though it is possible that summer season might have a microbial increase due to warm conditions and an accelerated risk of waterborne outbreaks.

Figure 5

Seasonal Distribution



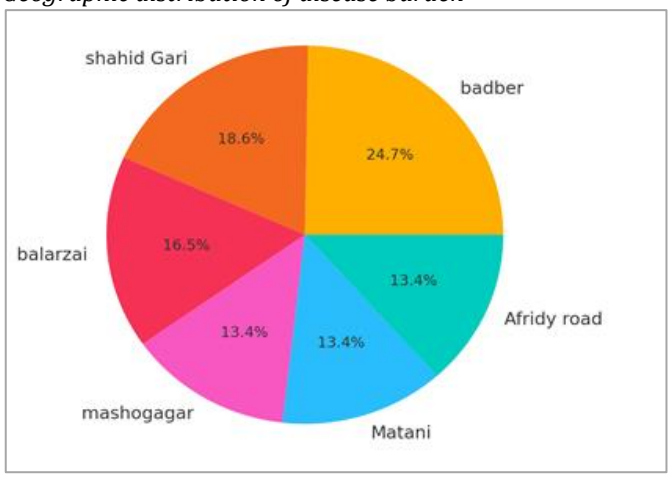
Geographical Distribution (Place-wise)

The spatial distribution of disease burden was as follow
- Badber (24.7 %)
-ShahidGari (18.6 %)
- Balarzai (16.5 %)
- Mashogagar (13.4%)
- Matani (13.4 %)
- Afridy street (13.4 %)

Interpretation: These areas are peri-urban settlements with inadequate sanitation infrastructure, heavy reliance on groundwater, and common flooding occasions. The clustering of cases suggests localized environmental threat factors, which includes hazardous water sources and terrible sewage disposal.

Figure 6

Geographic distribution of disease burden



Summary of Key Findings

- Children under 18 years constituted the majority of cases, reflecting higher vulnerability.
- Diarrhea and UTIs were equally common, showing both waterborne and community-acquired transmission routes.
- Winter season showed the highest burden, followed by autumn.
- Badber, Mashogagar, Balarzai, ShahidGari, and Afridy Road emerged as hotspots for *E.coli*
- Water contamination with *E. coli* confirmed the strong link between unsafe drinking water and disease prevalence.

DISCUSSION

The evidence from District Peshawar continuously shows that *Escherichia coli* (*E. coli*) remain a dominant pathogen in each clinical and environmental settings. Hospital-based research (Fawad et al. 2024, Zaman et al. 2025, and Jamil et al. 2020) displays that *E. coli* is the main reason of urinary tract infections (UTIs) with ESBL strains' resistance to third-technology cephalosporins. Qasim et al. (2024) and Ullah et al. (2025) mentioned comparable resistance developments in Swabi, while Abdullah et al. (2025) demonstrates the emergence of colistin-resistant strains, posing a primary undertaking to remedy alternatives.

Food and animal products constitute another full-size reservoir. Tasbihullah et al. (2024/25) stated an excessive occurrence of multidrug-resistant *E. coli* in eggs and among human contacts, suggesting a food-chain transmission pathway. Shah et al. (2024) detected diarrheagenic*E. coli* strains in meat from Bannu District, while Ullah et al. (2024) observed Shiga toxin-generating *E. coli* in animal merchandise from multiple cities including Peshawar. These findings indicate inadequate hygiene and regulatory oversight in food manufacturing and handling.

Environmental contamination amplifies the risk. Khan et al. (2025) revealed that untreated sewage and poor waste management introduce antimicrobial-resistant *E. coli* into drinking water systems. Daud et al. (2017) and Naeem et al. (2017) documented vast *E. coli* contamination in each urban and rural consuming water samples. The usage of sewage water for irrigation, as described by way of Khan et al. (2015), may additionally spread resistant *E. coli* to crops and soils, continuing the cycle of exposure. This mirrors worldwide observations, such as Wispriyono et al. (2021) in Indonesia and Odonkor & Addo (2011) globally, which link negative sanitation to environmental *E. coli* dissemination.

Our study highlights three important results. Firstly, *E. coli* occurrence is persistently dominant in medical subjects. Secondly *E. coli* is disseminated excessively at water sewage interfaces in Urban areas. Thirdly, the disease load appears to be greater in kids and teens. According to Daud et al. (2017) and Jamil et al. (2020) this underage disease burden is possibly due to more exposure and vulnerability.

The consequences of these results are profound for public health. Coordinated "One fitness" techniques integrating human, animal, and environmental surveillance are urgently required. Enhancing water and sanitation infrastructure, as encouraged by WHO (2017), can reduce fecal infection. Food protection laws especially concerning with hen, meat, and eggs, ought to be tightened, with ordinary microbiological monitoring following CLSI (2023) requirements. Rationalizing antibiotic use in healthcare and agriculture is crucial to slowing the emergence of resistance. Community-level training campaigns about hygiene, secure water storage, and meals can break transmission chains, as emphasized by WHO (2018) and Prüss-Ustün et al. (2014).

CONCLUSION

In summary a high prevalence of *E. coli* in District Peshawar represents a great public health challenge spanning clinical, food, and environmental domains. The convergence of high incidence, water contamination, and inadequate infrastructure highlights the urgency for integrated surveillance, policy reforms, and public engagement. With the aid of implementing these measures, District Peshawar can mitigate the growing burden of *E. coli* and antimicrobial resistance.

REFERENCES

1. Abdullah, S., Mushtaq, M. A., Ullah, K., Hassan, B., Azam, M., Zahoor, M. A., Wang, J., Xu, J., Toleman, M. A., & Mohsin, M. (2025). Dissemination of clinical escherichia coli harboring the mcr-1 gene in Pakistan. *Frontiers in Microbiology*, *15*. https://doi.org/10.3389/fmicb.2024.1502528
2. Cheesbrough, M. (2006). District laboratory practice in tropical countries. https://doi.org/10.1017/cbo9780511543470
3. Clinical and Laboratory Standards Institute (CLSI). (2023). Performance Standards for Antimicrobial Susceptibility Testing. CLSI Supplement M100. 33rd ed. Wayne, PA: CLSI.
4. Daud, M. K., Nafees, M., Ali, S., Rizwan, M., Bajwa, R. A., Shakoor, M. B., Arshad, M. U., Chatha, S. A., Deeba, F., Murad, W., Malook, I., & Zhu, S. J. (2017). Drinking water quality status and contamination in Pakistan. *BioMed Research International*, *2017*, 1-18. https://doi.org/10.1155/2017/7908183
5. Fawad, M., Abdel-razik, N. E., Alhindi, Z., Usman Amin, M., Abu-Seer, E. A., S Alfaifi, M., ... & Alghamdi, S. (2024). Antibiotic Susceptibility Pattern And Esbl Prevalence In Nosocomial Escherichia Coli From Urinary Tract Infection In Kpk, Peshawar. *Journal of Bioresource Management*, *11*(3), 12. https://corescholar.libraries.wright.edu/jbm/vol11/iss3/12/
6. Ullah, U., Javed, K., Khan, M. A., Ullah, I., & Iman, N. U. (2020). Prevalence, distribution and determinants of escherichia coli resistance to ceftriaxone in adult indoor uti population of district Peshawar, Pakistan. *Gomal Journal of Medical Sciences*, *18*(2), 45-53. https://doi.org/10.46903/gjms/18.02.869
7. Khan, A., Zakki, S. A., ul Haq, I., & Shahzad, M. (2025). Environmental Pathways and Drivers of Antimicrobial Resistance in Waterborne Escherichia coli in Pakistan: A One Health Perspective. *Journal of Biosafety and Biosecurity*. https://doi.org/10.1016/j.jobb.2025.08.001
8. Ullah, H., & Khan, I. (2015). Effects of sewage water irrigation of cabbage to soil geochemical properties and products safety in Peri-urban Peshawar, Pakistan. *Environmental Monitoring and Assessment*, *187*(3). https://doi.org/10.1007/s10661-015-4344-6
9. Naeem, M., Danish, Z., Sufian, M., & Saleem, W. (2017). Bacteriological analysis of drinking water in urban areas of district Peshawar, Khyber Pakhtunkhwa. *Journal of Medical Sciences*, *25*(1 Suppleme), 107-109. https://jmedsci.com/index.php/Jmedsci/article/view/93
10. Ishii, S., & Sadowsky, M. J. (2008). Escherichia coli in the environment: implications for water quality and human health. *Microbes and environments*, *23*(2), 101-108. https://doi.org/10.1264/jsme2.23.101
11. Prüss-Ustün, A., Bartram, J., Clasen, T., Colford Jr, J. M., Cumming, O., Curtis, V., ... & Cairncross, S. (2014). Burden of disease from inadequate water, sanitation and hygiene in low-and middle-income settings: a retrospective analysis of data from 145 countries. *Tropical medicine & international health*, *19*(8), 894-905. https://doi.org/10.1111/tmi.12329
12. Fawad, M., Abdel-razik, N. E., Alhindi, Z., Usman Amin, M., Abu-Seer, E. A., S Alfaifi, M., ... & Alghamdi, S. (2024). Antibiotic Susceptibility Pattern And Esbl Prevalence In Nosocomial Escherichia Coli From Urinary Tract Infection In Kpk, Peshawar. *Journal of Bioresource Management*, *11*(3), 12. https://corescholar.libraries.wright.edu/jbm/vol11/iss3/12/
13. Shah, M. S., Khan, F. U., Wali, M., Mangi, A. H., Rehman, Z., Ullah, Z., Ali, J., Ullah, A., Hashim, M., Khan, A., Khan, A. Z., Khan, M. S., Sehar, S., Muzzafar, F., & Rani, S. S. (2024). The isolation and characterization of diarrheagenic escherichia coli strains from sources of meat in Bannu, KP, Pakistan. *Journal of Xiangya Medicine*, *9*, 15-15. https://doi.org/10.21037/jxym-24-8
14. Tasbihullah, T., Rahman, S. U., Ali, T., Saddique, U., Ahmad, S., Shafiq, M., Ayaz, S., Khan, H., Ahmad, I., Asadullah, A., Taj, R., Nidaullah, H., & Khan, A. (2020). High occurrence rate of multidrug-resistant ESBL-producing E. coli recovered from table eggs in district Peshawar, Pakistan. *Pakistan Journal of Zoology*, *52*(4). https://doi.org/10.17582/journal.pjz/20190513220514

15. Ullah, S., Khan, S. U. H., Khan, M. J., Khattak, B., Fozia, F., Ahmad, I., ... & Goyal, S. M. (2024). Multiple-drug resistant Shiga toxin-producing E. coli in raw milk of dairy bovine. *Tropical Medicine and Infectious Disease*, *9*(3), 64. https://doi.org/10.3390/tropicalmed9030064
16. Ullah, T., Zaman, N., Shah, S., Ullah, S., Sheraz, A., Toru, M. U. K., & Ahmad, W. (2025). CURRENT TRENDS IN ANTIMICROBIAL SUSCEPTIBILITY PATTERNS OF ESCHERICHIA COLI ISOLATES AT BACHA KHAN MEDICAL COMPLEX SWABI, KPK, PAKISTAN. *Kashf Journal of Multidisciplinary Research*, *2*(08), 11-22. https://doi.org/10.71146/kjmr574
17. WHO. (2018). *E. coli Fact Sheet*. World Health Organization.
18. Wispriyono, B., Arsyina, L., Ardiansyah, I., Pratiwi, L. D., Arminsih, R., Hartono, B., ... & Novirsa, R. (2021). The role of hygiene and sanitation to the Escherichia coli contamination in drinking water in Depok City, Indonesia. *Open Access Macedonian Journal of Medical Sciences*, *9*(E), 641-644. https://oamjms.eu/index.php/mjms/article/view/6152
19. World Health Organization (WHO). (2017). Guidelines for Drinking-Water Quality, 4th Edition. Geneva: WHO.
20. Zaman, M., Ahmad, S., Idrees, N., Ahmad, F., Naseer, S., &Gul, R. (2025). Antimicrobial Sensitivity Pattern with Urinary Tract Infection at Khyber Teaching Hospital, Peshawar. Pakistan Journal of Health Sciences, 6(5), 141-146.