International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 5, Issue 6, 2026
DOI: https://doi.org/10.38124/ijsrmt.v5i6.1523

Antimicrobial Resistance Profiles of Uropathogens Isolated from UTI Patients in North-Eastern Bangladesh

Mohammad Golam Rob Mahmud[1]; Munif Rahman[2]; Shabnaz Akther[3]; Md. Toasin Hossain Aunkor[4]

[1]Department of Medicine, Sylhet Women's Medical College, Sylhet, Bangladesh.
[2,3]Department of Genetic Engineering and Biotechnology, Shahjalal University of Science and Technology, Sylhet, Bangladesh.
[4]Assistant Professor Department of Genetic Engineering and Biotechnology Shahjalal University of Science and Technology, Sylhet, Bangladesh.

Publication Date: 2026/07/25

Abstract

Antimicrobial resistance (AMR) is a common health concern worldwide, where urinary tract infections (UTIs) being among the most affected conditions due to their extreme prevalence leading to misuse of antibiotics. This study investigated antibiotic resistance profiles of 136 UTI-positive patients admitted to a medical college and hospital in Sylhet, for 3 months. Data were collected from specimen culture and sensitivity reports performed at that private medical college. Some selective antibiotics were analyzed for resistance trends. Results showed higher resistance in females. *Escherichia coli* and *Klebsiella spp.* were identified as the dominant pathogens. Multiple antibiotic resistance was observed across both genders. Males demonstrated slightly higher resistance on average. These findings helped us to understand that, the resistance pattern and spread of multidrug-resistant uropathogens in Sylhet division is concerning, which demonstrates the importance of antibiotic stewardship program, routine surveillance, and specific treatment guidelines for effective antibiotic resistance management in Bangladesh.

Keywords: *Antimicrobial Resistance (AMR), Urinary Tract Infections (UTIs), Multidrug-Resistant, Uropathogens, North-Eastern Bangladesh.*

I. INTRODUCTION

Bangladesh is a South-Asian densely populated country. Sylhet is a North-Eastern division of Bangladesh containing 4 districts (Sylhet, Sunamganj, Habiganj, Moulvibazar). Antimicrobial Resistance (AMR) is listed as one of the biggest threats to public health worldwide (*Antimicrobial Resistance*, 2020). WHO had estimated that each year, infections from resistant bacteria cause around 400,000 deaths globally, including about 200,000 deaths among newborns, which is a very serious issue (*Fight Antimicrobial Resistance: Protect Mothers and Newborns*, 2016). Every year, around 150 million people get affected by urinary tract infections (UTIs). These infections globally cost about US$6 billion and can lead to serious health issues and even death (Carolina et al., 2016). According to another report, resistance to common bacteria has reached dangerous levels in many parts of the world, with some areas facing particularly severe challenges (*Antimicrobial Resistance: Global Report on Surveillance*, 2014). It's a major health issue in Bangladesh (M. M. Rahman et al., 2004) due to the continuous emergence of multidrug resistant pathogens causing UTI (Sanjee et al., 2017). Urinary tract infections (UTIs). It can occur in both men and women, but research shows that women, especially those who are sexually active, are more likely to get UTIs (Karki et al., 2004). Studies show that about 50% of all women experience UTI at least once in their lifetime, while the rate is 20% in men. Also, about 20% of women and 40% of men have repeated infections (Chazan et al., 2004; Litwin et al., 2005; Sood & Gupta, 2012). UTIs are caused by both Gram-positive and Gram-negative bacteria, but most cases are due to Gram-negative bacteria (Renuart et al., 2013). The type of

Mohammad Golam Rob Mahmud, Rahman, M., Akther, S., & Aunkor, M. T. H. (2026). Antimicrobial Resistance Profiles of Uropathogens Isolated from UTI Patients in North-Eastern Bangladesh. *International Journal of Scientific Research and Modern Technology*, *5*(6), 372–384. https://doi.org/10.38124/ijsrmt.v5i6.1523

UTI depends on where the infection occurs in the body, and they are categorized as Pyelonephritis (infection of the kidneys), Cystitis (infection of the bladder), and Bacteriuria (presence of bacteria in the urine). UTI can either have symptoms or not. When someone with a high level of bacteria in the urine also has symptoms related to the urinary tract, it is called symptomatic bacteriuria. If someone doesn't have typical symptoms, they are said to have asymptomatic bacteriuria, and more diagnosis is needed to confirm the UTI. 20–40-year age group are 50% more likely to have recurrent infections within a year. This study also showed similarity with the overall pattern of antibiotic resistance in terms of age and gender with our study which indicates that our study result aligns with other research data. However, the rate of UTIs in males decreases after age of one year and remains low until around 60 years of age when an enlarged prostate can interfere with bladder emptying (Singh Randhir et al., 2016). It leads to urine stagnation and provides a favorable environment for harmful bacteria to grow (Niccodem et al., 2024). Based on the severity of infection, UTI is divided into two main types: complicated and uncomplicated. Uncomplicated UTI means the person does not have any structural or neurological abnormalities in the urinary tract. Cystitis and pyelonephritis fall under this category. Complicated UTI means there is some kind of abnormality in the urinary tract, making the person more likely to get infected (H. J. Woodford, 2011). UTIs can be classified based on the site of acquisition, where hospital-acquired UTIs occur in healthcare settings or during medical care. On the other hand, community-acquired UTIs occur outside of healthcare facilities or within 48 hours of being admitted to the hospital (Odoki et al., 2019). The regular bacterial flora that live in the body are linked to factors that increase the risk of UTI (Iacovelli et al., 2014). In our study, 61.76% of the isolates were resistant *E. coli* followed by *Klebsiella spp.* at 30.15%, while the rest (8.09%) were too few to consider. This is similar to another study where *E. coli* was the most considerable pathogen, with about 61.8% of the identified pathogens, followed by 18.4% *Klebsiella spp.* Over the past 50 years, it has been clearly seen that using antibiotics to treat diseases caused by common gram-negative bacteria like *Escherichia coli, Salmonella enterica, and Klebsiella spp.* is closely linked to the rise of antibiotic resistance (Davies & Davies, 2010). In our study, more women (77.94%) were affected than men (22.06%), which aligns with the same study's findings. Antibiotic resistance may occur due to bacterial change in a way that gives bacteria the ability to survive and defeat the drugs used to kill them. Resistance to antimicrobial agents can vary based on age, gender, and location especially in bacteria like *E. coli*, a gut bacterium, which can move to the urinary tract and cause UTI (Akther et al., 2023). Usually, bacteria enter the urinary tract through the urethra from the skin or rectum, though it is very rare for them to get there through the bloodstream. UTI is not a sexually transmitted disease, and the infection itself is not contagious (Sabih & Leslie, 2025). Antibiotics are used to treat infections, where overuse and improper use of these have led to the rise of superbugs, which are a major global health problem (Mohammad et al., 2017). Extensively drug-resistant (XDR) bacteria are those that are only susceptible to one or two types of antibiotics, while pan-drug resistance of bacteria refers to those strains that are resistant to all types of antibiotics (Magiorakos et al., 2011). A European survey on antibiotic use found that multidrug-resistant bacteria were responsible for about 25,000 deaths among Europeans each year due to complications from UTIs (Öztürk & Murt, 2020). Antibiotic resistance refers to the ability of bacteria to live and multiply even when exposed to antibiotics that are meant to kill them or prevent their growth (Zaman et al., 2017). Resistant bacterial strains can easily cause infections in the body even after antibiotics are used. Uropathogens (Bacteria causing urinary tract infections) are becoming resistant to effective drugs through various genetic changes and mutations (Lisa et al., 2015). The number of bacteria producing Extended-Spectrum Beta-Lactamases (ESBL) has risen sharply in recent years. These infections frequently occur in outpatient areas, with urinary tract infections (UTIs) being a primary concern. As a result, the effectiveness of standard antibiotics has become significantly limited now (Bradford, 2001). Besides, the misuse of antibiotics by doctors is a serious threat to public health. A study reviewed 58,512 antibiotic prescriptions from county hospitals in China and found that over 60% of these prescriptions did not follow standard guidelines (Guan et al., 2019). Another study from rural China showed that unnecessary antibiotic use occurred in more than 77% of patient visits (Chang et al., 2019). If a technologically advanced country like China struggles to follow proper guidelines, it's hard to imagine how a third world country like Bangladesh can manage this issue. Often, wide-spectrum antibiotics are prescribed for urinary tract infections when a narrower-spectrum antibiotic would have been enough for an effective treatment (Vaccheri & Favero, 2000). A recent study in the UK found that antibiotic prescriptions in primary care are decreasing, but this trend is not seen in Bangladesh (Glover et al., 2019). Additionally, high levels of poverty, lack of awareness, poor hygiene practices, and the widespread availability of fake and counterfeit drugs in the market all contribute to the problem (Khameneh & Afshar, 2009). Another study conducted in the African region claimed that factors like being educated, not being admitted into a hospital and not using catheter due to surgery, drinking over 2 liters of water daily and flushing out residing bacteria with frequent urination, changing underwear at least once a week, lower the chances of UTI while factors like drinking less than 2 liters of water and holding urine for too long which leads bacteria to reside at bladder for too long and grow, not changing underwear for at least once a week, hospital admission, recurrent UTI, use of catheters due to surgery increase the chances of UTI (Fekadu et al., 2025). However, a recent report of 2022 from the Bangladesh Bureau of Statistics (BBS) shows that 18.7% of the country's population lives below poverty line (*Poverty Map of Bangladesh*, 2022). In another report of 2023, the social class was defined by monthly household income, where families with <12,500 BDT earning were classified as lower-class family (Fidah, 2024). For these families, even a simple test costing 200 BDT could be a financial struggle. About 62% of Bangladeshis live in rural areas

(*Rural Population (% of Total Population) - Bangladesh*, 2021). In many of these areas, there are few or no diagnosis facilities. For instance, when multiple urine cultures or imaging tests are needed, the cost and effort involved can greatly affect a person's quality of life (QoL) and cause serious financial burden. The costs include visits to medical professionals, prescriptions for antibiotics, hospital costs, transportation expenses, lost workdays due to illness, and treatment cost for related health issues (Medina & Castillo-pino, 2019). A report of 2007 found that, there are more unqualified village medical practitioners (8.5%) than qualified doctors (MBBS or higher) (3.7%) in Bangladesh ("The State of Health in Bangladesh 2007 : Health Workforce in Bangladesh, Who Constitutes the Healthcare System?," 2007). As a result, people might often visit pharmacies for advice from untrained shopkeepers, leading to self-medication and overuse of antibiotics (Li & Webster, 2017; S. Rahman et al., 2011). Bacterial resistance has become a major public health issue and is linked to risk factors that can be life-threatening (Alam et al., 2017). This resistance can make certain infections difficult to treat with antibiotics (M. Rahman & Sarker, 2020). Additionally, the lack of newer drugs means that resistance must be controlled before we run out of treatment options. Using drugs that are not often prescribed by doctors could help control these infections. People living in slums are exposed to a very polluted environment filled with harmful microorganisms. Because of this, the health of slum residents is constantly at risk of infection from various dangerous microbes. *E.coli* is a major aerobic bacteria found in the intestines and a common contaminant in feces (F. M. Khan & Gupta, 2020). *E. coli* can quickly multiply in the urinary tract of someone with a UTI. (S. R. Rahman et al., 2014). UTIs are often connected to age and gender (Hossain et al., 2020). Due to these factors, UTIs can show different patterns in how they spread and what causes them (Conway et al., 2015). They are a major cause of illness and death, especially among the elderly, where UTIs are most common (G. Bonkat et al., 2016; Nicolle et al., 2013). Available data including age and gender nature of infected patients, as well as the pathogens involved and their antibiotic resistance, is insufficient in Bangladesh as well as in the North-Eastern region of the country. Proper knowledge about antimicrobial resistance pattern of uropathogens in the country remains very scarce (Jahan & Anwer, 2025). Although there have been many studies on antibiotic resistance in Bangladesh, there has been no effort to bring them together in a systematic way and multidrug resistance in Bangladesh not been taken into that much consideration. There might also be bias in some studies due to the lack of information about the source of infections, as hospital-acquired infections are typically more resistant to antibiotics than those acquired in the community. The high rate of hospital-acquired UTIs may be because the infection control practices in the hospitals were not very good (Stewart et al., 2021). The high rate of community-acquired UTIs could be due to poor personal and environmental hygiene, heterogeneous population study, and their habitat (Vasudevan, 2014). The goal of this study was to examine most common microbes causing UTIs, their resistance patterns (single or multiple antibiotic resistance), age and gender wise comparative assessment among patients visiting a private medical college and hospital in the North-Eastern region of Bangladesh. The study revealed a high prevalence of multidrug-resistant uropathogens. Significant variation in their resistance patterns across age and gender groups highlight reduced effectiveness of commonly used antibiotics. The findings provide region-specific resistance data that can guide rational antibiotic prescribing, reduce treatment failure and healthcare costs, and support national efforts to combat antimicrobial resistance in Bangladesh.

II. MATERIALS AND METHODS

➢ *Antibiotic Sensitivity Testing*

Based on clinical examination and presence of signs and symptoms, physicians recommended Urine Culture and Sensitivity testing. A positive urine culture confirming urinary tract infection (UTI) was defined by bacterial growth of $\geq 1\times10^5$ colony-forming units (CFU)/ml. The urine samples were incubated aerobically on culture media at 37 °C for 18–24 hours. Positive cases were confirmed by observation of cells/hpf under microscopic examination. The incubation period continued for 48 hours for negative cases. Then the positive reports were taken into consideration for further age and gender-wise comparative assessment, result analysis and data interpretation.

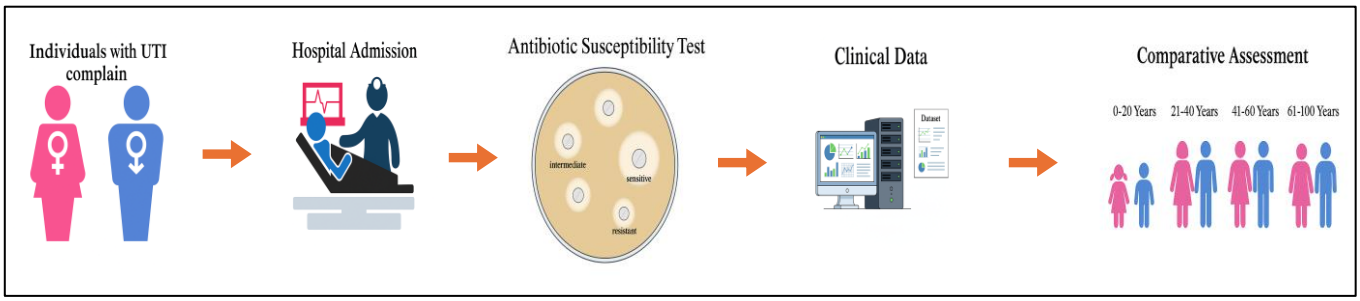

Fig 1 Schematic Design of the Steps Involved in the Study of Antibiotic Resistance Patterns in UTI Positive Patients.

➢ *Clinical Data Collection*

The antibiotic resistance test results were collected from 136 individuals coming from four districts of Sylhet Division admitted to Jalalabad Ragib-Rabeya Medical College and Hospital (JRRMC), Sylhet, between December 2024 and February 2025. The tests were conducted independently by the patients at that medical college. Clinical reports were obtained directly from the patients upon receiving their informed consent for the use of the data in this research. Significantly, the hospital

authority declares no conflict of interest in relation to this investigation and assisted in sharing additional relevant treatment data for all 136 participants to support the study.

The study population comprised both male and female patients (106 females and 30 males) ranging in age from under 1 year to 85 years.

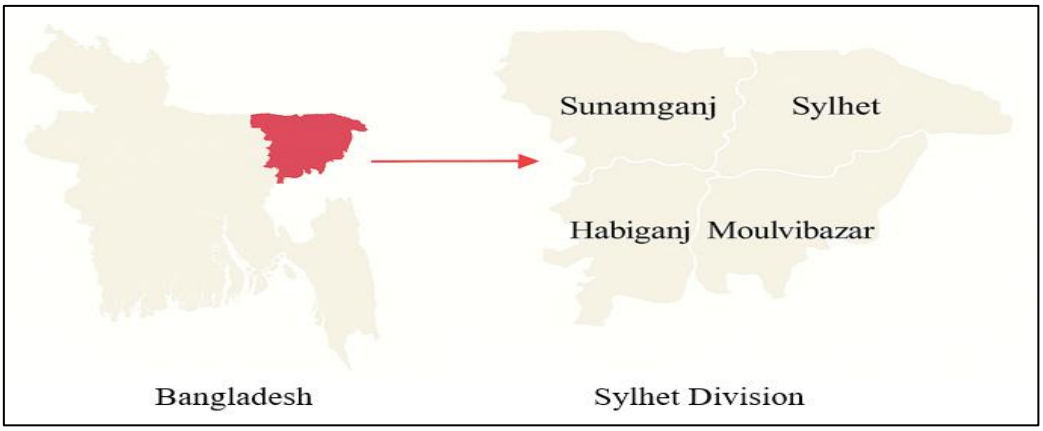

Fig 2 Study Area and Location of Sampling sites in Bangladesh. The Red Highlighted Region of the Map Represents the Sylhet Division Which Includes 4 Districts (Sylhet, Moulvibazar, Habiganj, Sunamganj)

➢ *Statistical Analysis*

All analysis of clinical data including Pie chart, Clustered column was done using Microsoft Excel.'n' is considered as number of resistant individuals. The heatmap was done using Chiplot (https://www.chiplot.online/).

III. RESULTS

Figure 3 represents the distribution of several specific antibiotic resistance pattern among the specimens including male and female. However, Cefepime, Ciprofloxacin, Ceftriaxone, Cefixime, Azithromycin, Cefuroxime accounted for 11-15% of total resistance in total population (Figure 3a). On the other hand, in the same diagram (Figure 3a), rest of the antibiotics, Levofloxacin, Amoxiclav and Co-trimoxazole showed almost half of 11-15% resistance. In case of gender specific resistance (Figure 3b-c) it showed similar pattern.

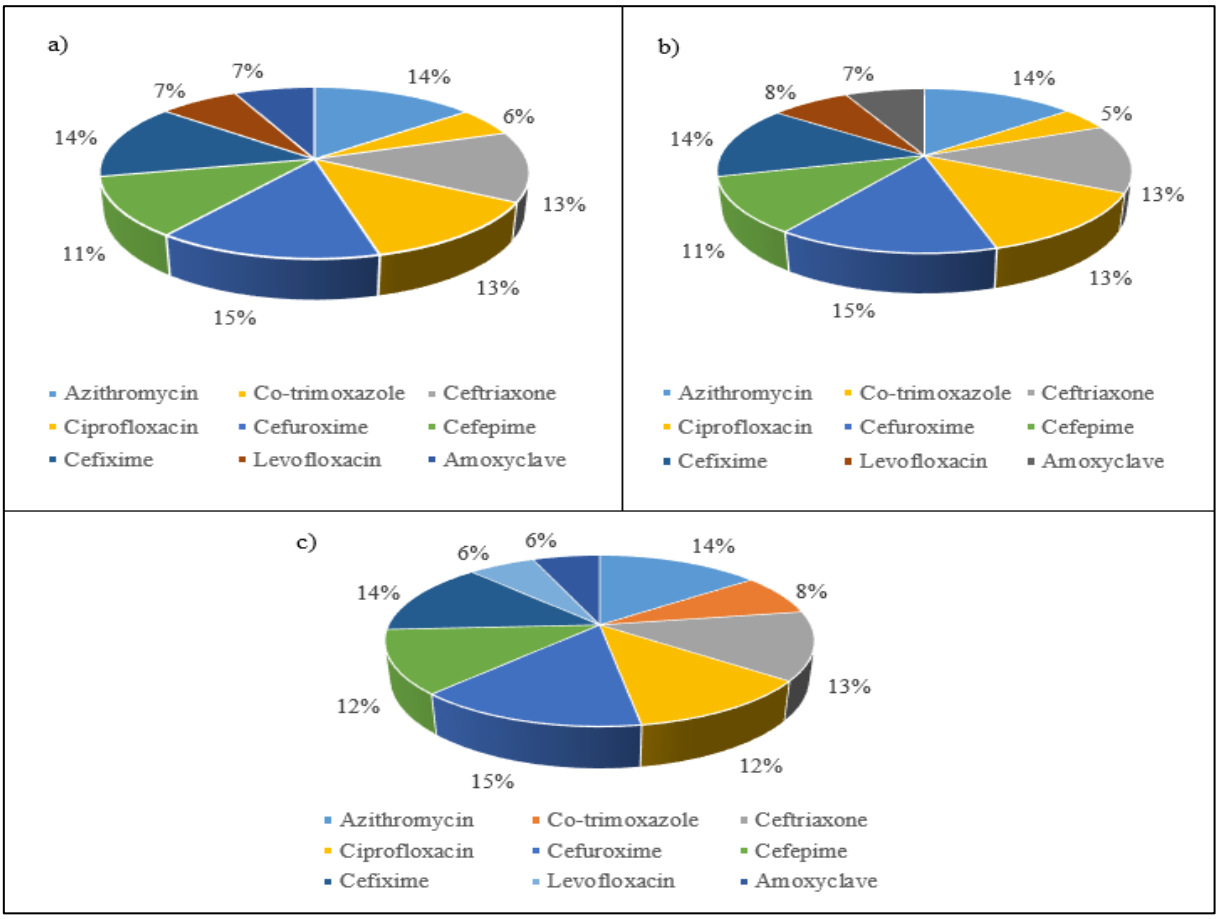

Fig 3 A Visual Representation of some *significant* Antibiotic Resistance a) Most Significant Antibiotic Resistance in Total Population b) Most Significant Antibiotic Resistance in Female c) Most Significant Antibiotic Resistance in Male

The heatmap (Figure 4) illustrates the distribution of age and gender wise antibiotic resistance pattern against some commonly used drugs. The color gradient represents the number of resistant individuals against these drugs, where lighter shade indicates low resistance and darker shade indicates high resistance. The highest levels of resistance were observed in Cefixime, 21 female cases aged 21–40 years and Cefuroxime, 20 female cases aged range 21–40 years. Resistance to Azithromycin was also prominent, particularly among females aged 21–40 years (19 cases). In contrast, Co-trimoxazole and Amoxiclav showed relatively lower resistance frequencies across all age groups. Females (21–40 years age range) consistently exhibited the highest resistance numbers across multiple antibiotics, indicating this age group is more vulnerable to antibiotic resistance. Older females (61–100 years age range) showed moderate resistance levels to most antibiotics, but lower compared to younger groups. Male patients, across all age groups, demonstrated comparatively lower resistance frequencies. The highest male resistance count was seen with Azithromycin (12 cases aged 0–20 years). Azithromycin, Ciprofloxacin, Cefepime, Cefixime, Cefuroxime, and Ceftriaxone exhibited widespread resistance across both genders, particularly in the 21–40 years age group. Levofloxacin resistance was relatively lower, with a maximum of 8 cases recorded among females aged 21–40 years. Co-trimoxazole displayed the least resistance, with no cases in elderly males. Amoxiclav resistance was moderate, with the highest number (8 cases) in females aged 41–60 years.

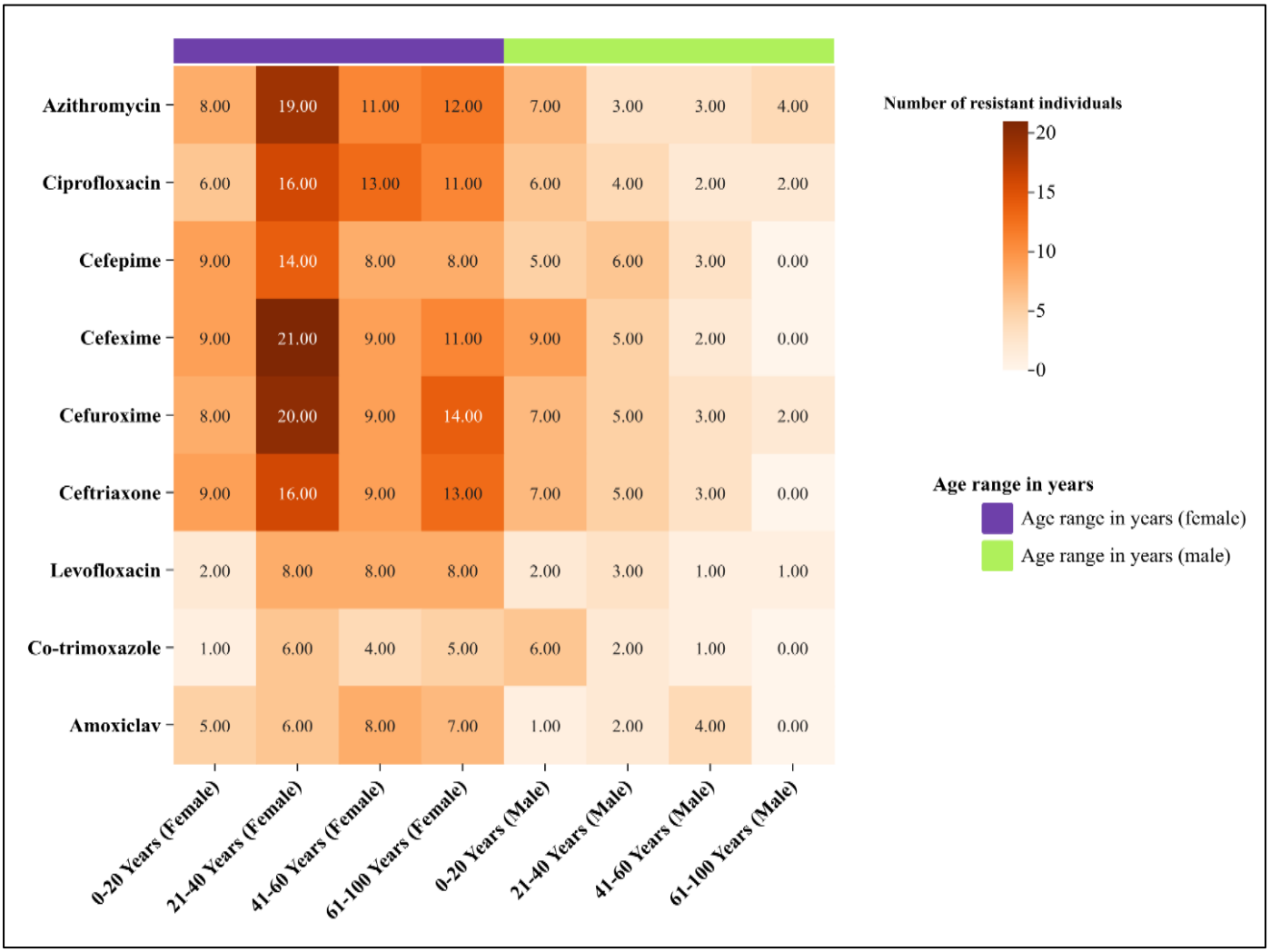

Fig 4 Heatmap of Age and Gender Wise Comparison of Resistance to Some Selective Antibiotics

The mean multiple antibiotic resistance in UTI-positive cases varied across age range and sex (Figure 5). In females, resistance was highest in the 0-20, 41–60 and 61–100 years age groups (On average 6 antibiotics resistance) and lowest in 21–40 years (On average 5 antibiotics resistance). In males, the highest multiple antibiotic resistance was noted in 21–40 and 61–100 years age groups (On average 7 antibiotic resistance), while the lowest was in 0-20 and 41–60 years age groups (On average 6 antibiotic resistance). Overall, males showed higher multiple antibiotic resistance than females.

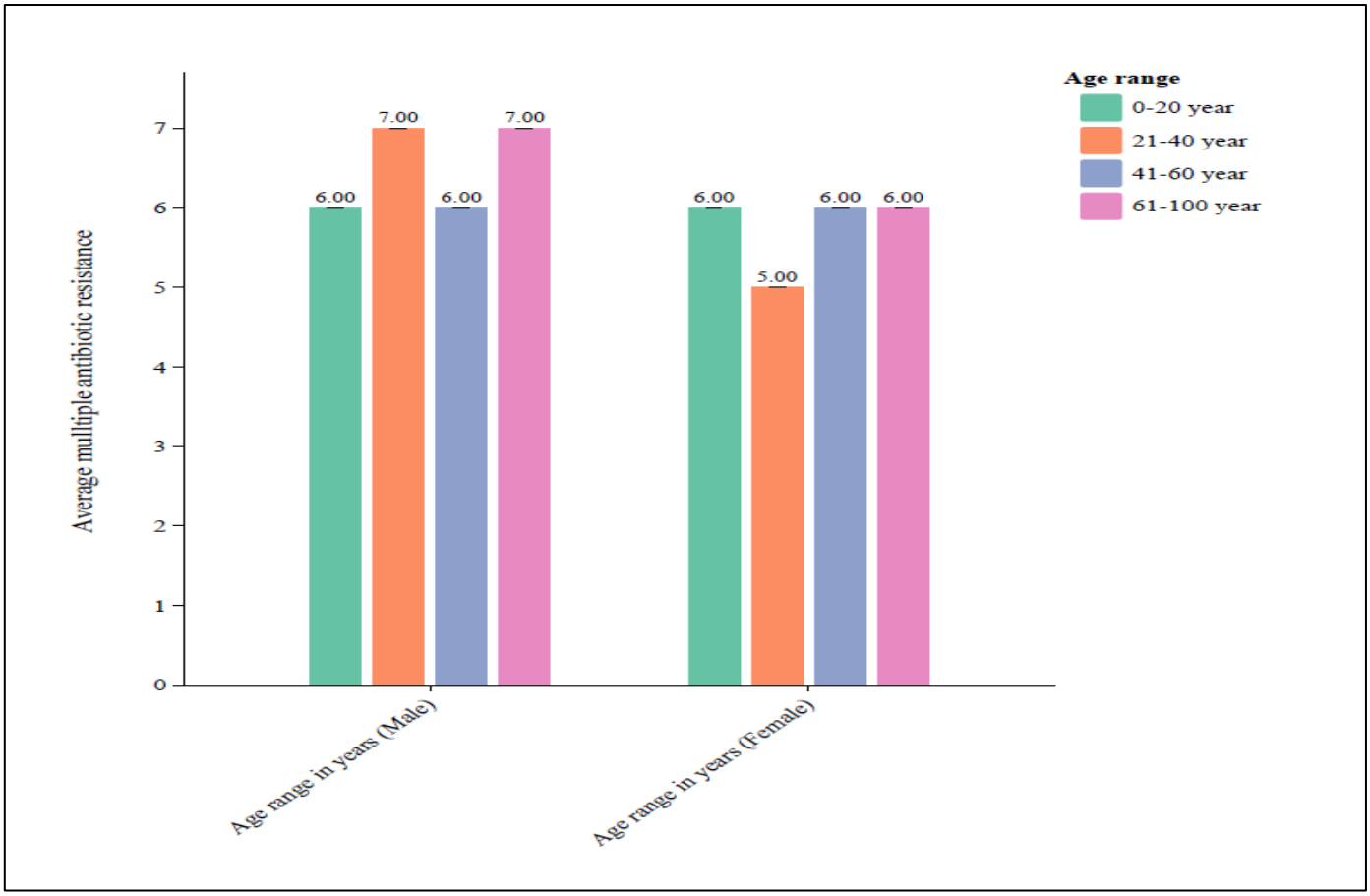

Fig 5 Average of Multiple Antibiotic Resistance in a) Female and b) Male

IV. DISCUSSION

The study analyzed antibiotic resistance patterns in 136 individuals (106 females and 30 males) with urinary tract infections (UTIs) in North-Eastern Bangladesh. Nine antibiotics exhibited the highest resistance rates Azithromycin, Ceftriaxone, Ciprofloxacin, Cefuroxime, Cefepime, Cefixime, Amoxiclav, Co-trimoxazole, and Levofloxacin, as shown in Figure 2. In the South Asian region, high resistance to these antibiotics in *Escherichia coli*, *Klebsiella spp.* the most common pathogens causing UTIs, is very worrying. It's concerning not only for people but also for the environment, food, and poultry industries (Hassan, 2020). Livestock, particularly poultry and their living environments, act as a significant reservoir for *E. coli*. Which represents a possible source of infection in humans by it's pathogenic strain (Stromberg et al., 2017). *E. coli* that is resistant to antimicrobials can be passed from poultry to people either directly or through food consumption. These resistant strains have the potential to colonize in the human digestive system and might also transfer resistance genes to the natural microflora of human body. Multiple studies indicate the transfer of antimicrobial-resistant *E. coli* from poultry to people across different nations (Amir et al., 2019). Females showed more antibiotic resistance than male according to our study (Figure 2). That's might be because they are more UTI sensitive than males. Women are more prone to UTIs because their urethra (the tube from the bladder to where the urine releases of the body) is shorter than men's and the opening of the urethra is close to the vagina and anus, making it easier for bacteria (main source of germs such as *E. coli*) to enter the bladder and cause UTIs (Najar et al., 2009). *E. coli* combinedly with other microbes can move from the perineum areas contaminated with fecal micro-organisms to the warm and moist environment of the female genital area can also be a reason causing UTI (Andabati & Byamugisha, 2009). Research suggests that sexually active women, especially those using contraceptives like foams, gels, diaphragms, and spermicides, are more likely to get UTIs due to increased colonization of bacteria at vaginal area (Nwanze et al., 2007). A reason for which men get UTIs less often could be the presence of antibacterial substances in prostatic fluid (Mclaughlin & Carson, 2004).

In a study, without *E. coli* and *Klebsiella spp.* some other common organisms causing UTI include *Staphylococcus aureus, Enterobacter spp., Serratia spp., Staphylococcus saprophyticus, Citrobacter spp., and Streptococcus spp.*, while *Pseudomonas, Enterococcus, Proteus, and Acinetobacter* were less common where in our study, *Staphylococcus aureus*, *Serratia spp. Streptococcus spp.* were less common and few in number to consider than *E.coli* and *Klebsiella spp*. In the same study, the most affected age groups for both men and women were 21-30 and 61-70 years respectively (Asaduzzaman et al., 2018). Whereas in our study, for female cases of 21–40-year and 61-100-year age group we saw the same scenario except for some differences. In the North-Eastern region of Bangladesh, women typically get married around 20-29 years old (Zahangir & Nahar, 2021), which could lead to a high frequency of "honeymoon cystitis" in this group (Mural et al., 2022). Reproductive

age group of Bangladesh is 15–49 years in majority cases (*Family Planning in South-East Asia: Factsheets*, 2016). The position of the female urethra near the vagina makes it vulnerable to trauma during sex and bacteria can be pushed into the bladder during pregnancy and childbirth (Kolawole et al., 2009; Parveen et al., 2011). Asymptomatic bacteriuria (ABU) is often harmless and does not usually need antibiotic treatment in nonpregnant and otherwise healthy women (Nicolle, 2006). These women are more likely to develop pyelonephritis, which is common due to the anatomical and physiological changes in the urinary tract during pregnancy. Pyelonephritis is more common in the second half of pregnancy because the growing uterus puts pressure on the bladder, reducing the complete emptying of urine from the bladder. The presence of leftover urine in the bladder, along with hormonal changes during pregnancy, can facilitate microbes to cause infection (Vr et al., 2019). These issues can result in severe infections for both the mother and the fetus (Foxman & Brown, 2003). During pregnancy, the body undergoes many changes, such as increased urination frequency. In later stages of pregnancy, night-time urination and lower abdominal pain might be mistaken with UTI (like those of cystitis). It leads to antibiotic misuse, which causes the first-line treatments less effective (Sekikubo et al., 2017). Therefore, confirming the infection through bacteriological testing is especially important during pregnancy because using antibiotics while pregnancy can harm the developing baby (Kenyon et al., 2008). A study identified factors of older women getting UTIs more frequently. Factors include gender, marriage, menopause, diabetes, problems with the genital area and urinary tract, hospital admission, use and frequent use of catheters (Mahmood et al., 2024). The same study also showed that male patients were more commonly affected compared to female patients under ten years of age, which aligns with our findings. In our study, we noticed a higher number of antibiotic-resistant cases among males aged 0-20 years compared to other age groups, and sometimes more resistant cases in males than females within the same age group. The reason behind UTI in male infants is, more bacteria grows under the foreskin of penis and around the urethra, which leads to ascending infections (Kose et al., 2013). When the foreskin of the penis can't be shrunk easily (phimosis), it is linked to a higher chance of UTIs in male infants (Shim et al., 2009). In female children (0-15 years age group), UTIs are often related to anatomical or functional abnormalities in the urinary system, congenital abnormalities, and vesico-ureteral reflux (Pulipati et al., 2017). Poor personal hygiene, improper sanitation, lower socioeconomic status, and malnourishment can also contribute to UTIs in children (M. A. Khan & Shakeel, 2024). The main goals in treating childhood UTIs are quick recovery from symptoms and preventing complications such as urosepsis, kidney stones, and renal abscesses, as well as avoiding permanent damage to the renal parenchyma (Beetz & Westenfelder, 2018). In about half of all pediatric UTI cases, commonly used antibiotics show susceptibility (Prabhu et al., 2013; Saperston et al., 2014). Another study noted that, 50% of outpatient prescriptions in three cities of Bangladesh included antimicrobials, with 25% of these prescriptions containing multiple antibiotics (Hoque et al., 2020). A study of 2020 revealed that, 60% of low-income urban parents did not complete the full course of antibiotics for their children, which may contribute to antibiotic misuse and the spread of AMR (Harun et al., 2020). The number of cases involving multi-drug resistant (MDR) bacteria, which are resistant to at least one antibiotic from one group, total three or more groups, has increased from 71% to 82% between 2017 and 2023 in Bangladesh (*National Antimicrobial Resistance (AMR) Surveillance Report , Bangladesh*, 2023). The same report mentioned that bacteria found in Intensive Care Units (ICU) are least responsive to antibiotics, followed by those derived from indoors. "Superbugs" refer to bacteria that have developed resistance to antibiotics. This resistance leads to economic loss due to prolonged infection duration, higher treatment costs, and reduced success in surgeries because of hospital-acquired infections (Kumarasamy et al., 2010). The world is facing a growing risk from multidrug-resistant (MDR) gram-negative "superbugs" (Jones, 2001). The adaptation mechanisms of the bacteria have caused serious global concern about the current and traditional medicines used to treat various bacterial infections, such as urinary tract infections (UTIs). A bacterial strain of *E. coli* (Shafiq et al., 2022), named ECCL209 taken from a hospitalized patient, a 94-year-old man, who had a UTI at Shantou Hospital in Guangdong, China, carries multiple plasmids that can spread antibiotic resistance genes between bacteria. These plasmids make the bacterial cells highly dangerous because they can easily pass on resistance genes to other bacteria through horizontal gene transfer (Algammal et al., 2023). Many harmful microbes are resistant to multiple antibiotics, and this resistance can be either plasmid borne or chromosomal or both (Wang et al., 2004; N. Woodford & Ellington, 2006). In another study, it was found that the proportion of MDR *E. coli* in males was higher than in females, both in communities and hospitals, which supports our findings (Khanal et al., 2024). This could be because male urinary tract infections (UTIs) are more often linked to structural issues like kidney stones, cancer, or long-term stents, which make it harder to treat infections causing increased antibiotic use, and lead to the development of resistance (Wagenlehner et al., 2014).

According to international guidelines, fluoroquinolones, second-generation cephalosporins, third-generation cephalosporins, and co-trimoxazole are usually the first-choice treatments for UTIs (Grabe et al., 2015; Gupta et al., 2011). Even though fluoroquinolones are among the most effective drugs for treating UTIs (Kurutepe et al., 2005), their effectiveness has decreased due to their frequent use. The prevalence of fluoroquinolone resistance is closely linked to how often antibiotics are used (Čižman et al., 2001; Landry et al., 2014). This is supported by a report showing that fluoroquinolone resistance has increased over time, especially in older patients and among those hospitalized (Boyd et al., 2008). This is likely because hospitalized patients having weaker immune systems, are more likely to get hospital-acquired infection. Which leads to use of fluoroquinolones more frequently, especially for

complicated infections. Fluoroquinolone resistance is more common in developing countries than in developed ones (Gururaju et al., 2015). The lack of good diagnostic tools trained medical staff, proper drug control, and strong infection control practices makes UTIs more common in developing countries (Samuel et al., 2010). Resistant strains of bacteria are not confined to one area; they can spread easily from regions with high resistance rates to other parts of the world through humans, animals, agricultural products, water, etc (Okeke & Edelman, 2001). The causes of antibiotic resistance are complex and involve many factors, such as inadequate healthcare services, inappropriate use of antibiotics in humans and animals, poor water and sanitation systems, gaps in both access, research for essential health technologies and development where necessary, environmental pollution (Velazquez-meza & Galarde-lópez, 2022). The careless use of antibiotics in agriculture and farming across the country is a major cause of antibiotic resistance (ABR) in Bangladesh (Biswas, Roy, Tajmim, et al., 2014). Some research shows that low-income countries like Bangladesh are more impacted by AMR due to factors such as the misuse of antibiotics, use of antibiotics in non-human areas, poor quality of medicines, lack of proper surveillance, and issues related to poverty such as weak healthcare systems, malnutrition, repeated infections, and the inability to afford better and more expensive drugs (Shibl et al., 2016). A study found that 75.17% of shopkeepers involved in a survey had no certified pharmacy training or diploma, and if they had any training, it was just a short course. In rural areas, there are very few diagnostic facilities. So uncertified healthcare providers who are not qualified doctors rely on their experience and judgment to diagnose patients and give antibiotics to these poor, uneducated villagers. Since many people seek care for common illnesses like fever, cough, cold, and gastrointestinal problems, these conditions are often wrongly thought to be caused by bacteria. It leads to incorrect diagnosis and improper antibiotic use. Only registered doctors should be allowed to prescribe antibiotics, and pharmacies should not give antibiotics without a prescription, whether in rural or urban areas. Unqualified village doctors and pharmacy shopkeepers in Bangladesh often prescribe antibiotics for viral infections (Kumar et al., 2023), where antibiotics are not effective for viral infections (Kenealy & Arroll, 2013). There are laws against these practices (*Bangladesh Medical and Dental Council Act*, 2010). Applying these laws strictly might help people to quit these practices.

Early diagnosis of a urinary tract infection (UTI) is important (Schmiemann et al., 2010). Urine samples should be cultured and doctors should consider suggesting antibiotics to high-risk groups, like certain age or sex groups, based on the best available options (Sup et al., 2016). With few new antibiotics available, it is crucial to use the existing ones carefully. Studies show that using antibiotics in a controlled and limited way can reduce antibiotic resistance (Barbosa & Levy, 1998). This can be done by setting stricter rules on antibiotic use and by educating healthcare professionals and the public. Since misuse of antibiotics is common in Bangladesh both in prescribed and self-medicated cases, easy availability of over-the-counter medicines has led to a high rate of self-medication (Biswas, Roy, Manik, et al., 2014). Since these antibiotic susceptibility test results might vary over time, doctors should stay updated about it while choosing the right antibiotic, keeping costs in mind (M. Rahman et al., 2022). Antibiotic stewardship programs should also be started to ensure antibiotics are used properly in healthcare. Regional monitoring should also be carried out to find out how microorganisms respond to antibiotics in different areas (S. S. Ahmed et al., 2019). Regular monitoring to track resistance patterns of the pathogens should be a concern for the whole country (I. Ahmed et al., 2019). Resistance data, studies and the number of studies should be available for most regions of the country. For some pathogens, where resistance data is limited due to few cases, might not be ignored and knowing risk factors might help to find ways for preventing the infection. While approximately about 97.9% of households of Bangladesh are now owning a mobile phone (*Survey on ICT Use and Access by Individuals and Households*, 2023), the government should send messages or alerts to all phone users through online or offline methods to raise awareness about antibiotic resistance among people of Bangladesh. This will help everyone to follow guidelines (*Standard Treatment Guidelines (STG) on Antibiotic Use in Common Infectious Diseases of Bangladesh*, 2021), and stop using drugs without a prescription. Regardless of whether an antimicrobial or non-antimicrobial approach is used, counseling patients on ways to avoid risk factors and change behaviors can be an important first step in preventing recurrent urinary tract infections (rUTIs). It's also important to consider non-antimicrobial strategies that can help reduce the occurrence of rUTIs. Several strategies are available to decrease the need for antimicrobial use in uncomplicated UTIs, such as Methenamine Hippurate, cranberry extract, d-mannose, probiotics, intra-vesical GAG therapy, and prophylactic vaccination. More well-designed studies are needed to improve the evidence supporting these non-antimicrobial options and to clearly define their role in standard medical practice. It's also important to identify which patients may benefit most from non-antimicrobial treatments for acute UTIs or non-antimicrobial prevention for rUTIs (Pothoven, 2023).

V. CONCLUSIONS

No age and gender-wise clinical data survey on antimicrobial resistance pattern was done among UTI patients of that specific region of Bangladesh. This study has limitations like lack of epidemiological data, absence of molecular characterization, small sample size and study location. Study conducted above revealed several issues that might be the reasons behind age and gender wise abundance of single and multiple antibiotic resistance in a specific region. Resistance was higher in females, particularly in reproductive age groups, while males showed greater multiple antibiotic resistance overall. Treatment might be the solution for a disease, but misuse of the treatment can be vital. Overcoming these limitations

and possible solutions might help people worldwide to fight the challenge of Antibiotic Resistance.

➢ *Conflicts of Interest*

The authors declare no conflicts of interest.

ACKNOWLEDGEMENTS

The authors would like to thank all individuals who contributed to this study. No external funding was received for this research.

➢ *Author Contributions*

MGRM managed collecting samples and conducting laboratory experiments. MR analyzed data and wrote draft of the manuscript. SA wrote Abstract and Conclusion. MGRM, MTHA reviewed and edited the whole manuscript. All authors have read and agreed to the published version of the manuscript.

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