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Original Research Article

Burden of Antibiotic-Resistant Urinary Tract Infections in Rural Females: Insights from a Cross-Sectional Study in Bangladesh

Bithi Dutta[1], Tithi Dutta[2], Umme Sale Rima[3], Jahidul Islam[4], Aishwarya Roy[5], Suriya Islam Mim[6], Farhana Ferdaus[7]*

[1] *Lecturer, Community Medicine and Public Health, Khulna City Medical College, Khulna*
[2] *Lecturer, Pharmacology and Therapeutics, Khulna City Medical College, Khulna*
3 Medical Officer, Ad-din Barrister Rafique-ul Huq Hospital, Dhaka
[4] *RMO, School of Infantry & Tactics, Sylhet*
[5] *Lecturer, pathology, Khulna City Medical College*
[6] *Lecturer, Anatomy, Khulna City Medical College*
[7] *Associate Professor and Head, Community Medicine and Public Health, Khulna City Medical College, Khulna, Bangladesh*

ABSTRACT: ***Background:*** Antibiotic-resistant urinary tract infections (UTIs) pose a significant public health challenge, particularly in rural areas where access to healthcare is limited. Understanding the prevalence and factors contributing to antibiotic resistance in this population is crucial for developing effective treatment strategies. ***Objective:*** This study aimed to assess the burden of antibiotic-resistant UTIs among rural females and identify sociodemographic and clinical factors associated with antibiotic resistance. ***Methods:*** A descriptive cross-sectional study was conducted at Satkhira Sadar Hospital from October 2023 to March 2024, involving 290 rural female participants with UTI symptoms. Data were collected through structured interviews and laboratory analysis of urine samples to determine the presence of uropathogens and their antibiotic resistance profiles. Statistical analyses, including Chi-square tests and logistic regression, were performed to explore associations between resistance and various factors. ***Results:*** The predominant uropathogen identified was Escherichia coli (69%). Antibiotic resistance was observed in varying degrees, with moderate resistance to ampicillin (30%), azithromycin (35%), and doxycycline (40%), while lower resistance rates were noted for imipenem (10%) and meropenem (5%). Significant associations were found between antibiotic resistance and factors such as age (p=0.045), education level (p=0.032), history of incomplete treatment (p=0.001), and hospitalization due to UTIs (p=0.038). ***Conclusion:*** The findings highlight a considerable burden of antibiotic-resistant UTIs among rural females in Bangladesh. Factors such as age, education, and treatment history significantly influence resistance patterns. These insights underscore the need for targeted public health interventions, including education on antibiotic use and adherence to treatment protocols, to combat antibiotic resistance effectively.

Keywords: Antibiotic Resistance, Urinary Tract Infections, Rural Females, Bangladesh, Uropathogens.

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***Corresponding Author:**

Dr. Farhana Ferdaus

INTRODUCTION

Urinary tract infections (UTIs) in both community and hospital settings are estimated to affect approximately 405 million people globally, with nearly 0.23 million deaths attributed to UTIs, contributing to 5.2 million disability-adjusted life years (DALYs) in 2019 [1]. Treatment for UTIs often begins empirically, frequently involving various broad-spectrum antibiotics [2]. The occurrence of UTIs caused by multidrug-resistant uropathogens has been rising at an alarming rate globally. These prevalent infections can develop into life-threatening conditions, particularly in developing nations [3, 4]. The frequency, range, and antibiotic resistance of uropathogens vary across different geographic regions and over time, underscoring the

need for a comprehensive understanding of the epidemiology of community-acquired UTIs (CA-UTIs) [5]. The primary organism responsible for both complicated and uncomplicated UTI is uropathogenic *Escherichia coli*, followed by *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Proteus mirabilis*, and group B Streptococcus (GBS) [6]. Moreover, multidrug-resistant *E. coli* and *K. pneumoniae* are increasingly recognized as causes of both CA-UTIs and hospital-acquired UTIs [7, 8]. Due to these pathogens, empirical treatment for acute pyelonephritis often involves a third-generation cephalosporin [9]. However, inappropriate antibiotic use is highly prevalent in the management of CA-UTIs. In developing countries, the situation is exacerbated by a significant portion of UTI patients purchasing antibiotics directly from community pharmacies without prescriptions or consultation with experts [10, 11]. Consequently, commonly used antibiotics lose effectiveness. Although UTIs can occur in individuals of any age or sex, female children, women of reproductive age, and elderly women are particularly susceptible to these infections [12]. UTI presents a substantial public health issue in Bangladesh, contributing to considerable morbidity and increasing healthcare costs due to frequent treatment failures and recurrent infections [13, 14]. UTI is also a leading cause of antibiotic misuse within the community, fueling the growing burden of antimicrobial resistance [11]. A study conducted in 2012 among 443 suspected UTI patients in a regional medical college hospital in Bangladesh revealed that 43% of patients had significant bacterial growth of uropathogens in their urine samples [15, 16]. Urinary tract infections (UTIs) are among the most common bacterial infections affecting women, often leading to significant morbidity and healthcare costs. In rural settings, where healthcare access and resources may be limited, the burden of UTIs can be particularly pronounced [13]. The increasing prevalence of antibiotic-resistant strains of uropathogens poses a substantial challenge in managing these infections effectively [6]. Antibiotic resistance is driven by various factors, including overuse and misuse of antibiotics, incomplete treatment courses, and inadequate awareness of appropriate medication use among patients [8, 9]. The global rise in antibiotic resistance is a pressing public health concern, leading to treatment failures, prolonged illness, and increased healthcare expenditures. In developing countries like Bangladesh, where access to healthcare services is often restricted, understanding the prevalence of antibiotic-resistant UTIs is essential for developing appropriate intervention strategies. Rural women, in particular, may face unique challenges, such as limited access to health education, inadequate diagnostic facilities, and a higher likelihood of recurrent infections [5]. Previous studies have indicated a troubling trend of rising antibiotic resistance in uropathogens, especially *Escherichia coli*, which is the most common pathogen associated with UTIs. Understanding the sociodemographic and clinical factors associated with antibiotic resistance in this population is critical for implementing effective treatment guidelines and public health interventions [6-8]. This study aims to explore the burden of antibiotic-resistant UTIs among rural females in Bangladesh and identify key factors contributing to resistance. By conducting a comprehensive analysis of sociodemographic characteristics, clinical history, and treatment patterns, we aim to provide valuable insights that can inform healthcare strategies and improve patient outcomes in rural settings. The findings of this research will not only enhance our understanding of antibiotic resistance in UTIs but also serve as a basis for developing targeted public health initiatives.

METHODOLOGY

The research is conducted at Satkhira Sadar Hospital over nine months from October 2023 to March 2024. The sample size consists of 290 participants, all of whom are rural females presenting with symptoms of UTIs. Participants are selected through a non-probability purposive sampling technique to ensure the inclusion of relevant cases. Data collection is carried out using structured face-to-face interviews with a pre-tested questionnaire designed to gather demographic information, medical history, and antibiotic use patterns. Urine samples are collected for laboratory analysis, identifying the presence of UTIs and their antibiotic resistance profiles. Informed consent is obtained from all participants before data collection, ensuring ethical compliance. Data will be collected and stored confidentially, and participants are assured that their identities will remain anonymous throughout the research process.

RESULT

Table 1: Sociodemographic Distribution of Study Participants (n=290)

Variables	Categories	Frequency (n)	Percentage (%)
Age (years)	21-30	86	29.7
	31-40	94	32.41
	>40	110	37.93
Education Level	No formal education	75	25.9
	Primary	93	32.1
	Secondary	85	29.3
	Higher	37	12.7
Profession	Housewife	168	57.9
	Student	34	11.7
	Small trade	22	7.6
	Teacher	17	5.9
	Day laborer	49	16.9
Socioeconomic Status	Lower	97	33.4
	Lower middle	74	25.5
	Middle	62	21.4
	Upper middle	38	13.1
	Upper	19	6.6

Table 1 presents the sociodemographic characteristics of the 290 study participants. The majority of the women fall >40 years age group (37.93%), while the least represented group is 21-30 years (29.7%). In terms of education, a significant portion of the participants completed primary education (32.1%), whereas only 12.7% had higher education. Regarding profession, the majority were housewives (57.9%), followed by day laborers (16.9%). A smaller proportion of the women were involved in small trade (7.6%), teaching (5.9%), or were students (11.7%). In terms of socioeconomic status, 33.4% of participants belonged to the lower-income group, while 6.6% fell into the high socioeconomic group. The lower-middle-income group represented 25.5%, with 21.4% in the middle class, and 13.1% in the upper-middle class.

Table 2: Clinical Characteristics of Study Participants (n=290)

Variables	Categories	Frequency (n)	Percentage (%)
Frequency of UTIs	1 time	74	25.5
	2-3 times	108	37.2
	4-5 times	67	23.1
	>5 times	41	14.1
Antibiotic Use for UTIs	Never	76	26.2
	1-2 times	88	30.3
	3-5 times	81	27.9
	>5 times	45	15.5
History of Incomplete Treatment	Yes	134	46.2
	No	156	53.8
Hospitalization Due to UTI	Yes	59	20.3
	No	231	79.7
Type of UTI (Complicated/Simple)	Complicated	83	28.6
	Simple	207	71.4

Current UTI Symptoms	Painful urination	199	68.6
	Increased frequency of urination	178	61.4
	Blood in urine	56	19.3
	Fever	91	31.4
	Back pain	122	42.1

Table 2 summarizes the clinical history and current condition of the 290 study participants regarding UTIs. The majority (37.2%) had experienced 2-3 UTIs in their lifetime, while 14.1% reported having more than 5 UTI episodes. In terms of antibiotic usage, 30.3% had taken antibiotics 1-2 times for UTI treatment, and 27.9% had used antibiotics 3-5 times. A significant proportion (46.2%) had a history of incomplete antibiotic treatment. Regarding hospitalization, 20.3% of the participants reported being hospitalized due to severe UTI episodes. Additionally, 28.6% of the participants had experienced complicated UTIs, while the rest (71.4%) had simple UTIs. For current symptoms, painful urination (68.6%) and increased frequency of urination (61.4%) were the most common complaints. Other notable symptoms included back pain (42.1%) and fever (31.4%), while 19.3% reported blood in their urine.

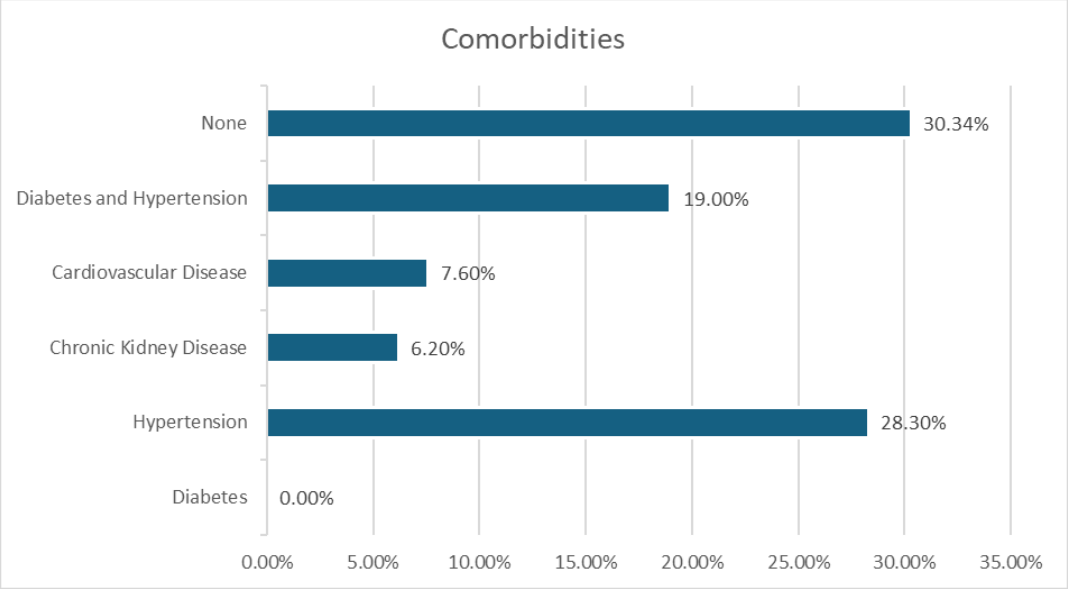

Figure 1: Comorbidities History of Study Participants (n=290)

Figure 1 displays the distribution of comorbidities among the 290 rural female participants. Hypertension is the most prevalent comorbidity, affecting 28.30% of the study population. Diabetes follows with a prevalence of 22.4%. Notably, 19.00% of participants suffer from both diabetes and hypertension, indicating a substantial overlap between these conditions. Chronic kidney disease and cardiovascular disease are less common, with prevalence rates of 6.20% and 7.60%, respectively. Interestingly, a significant proportion of the participants (30.34%) reported having no comorbidities, representing the largest single category.

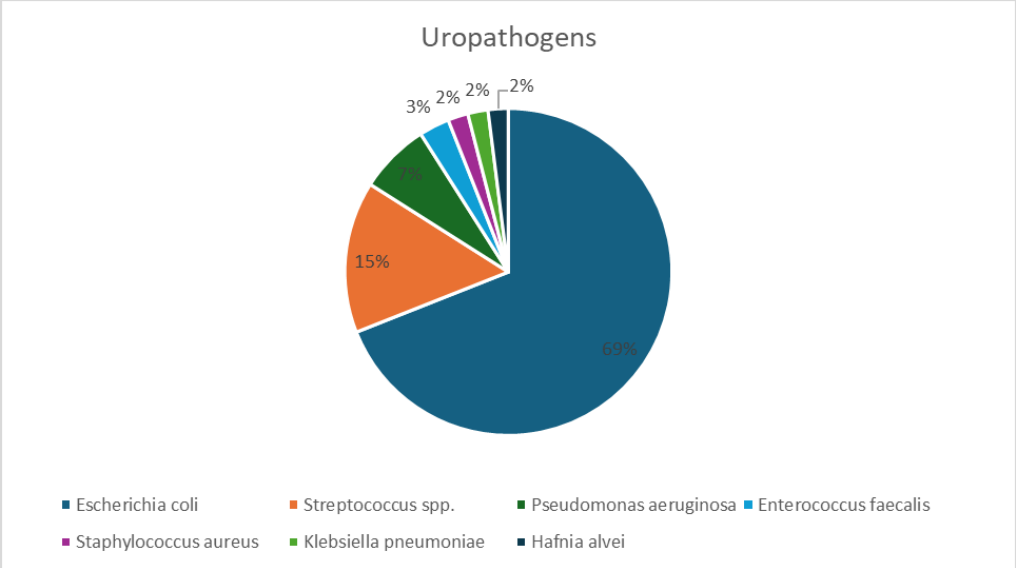

Figure 2: Distribution of Uropathogens (n=290)

Figure 2 illustrates the distribution of uropathogens identified in urine samples from the 290 study participants. **Escherichia coli** is the predominant pathogen, accounting for 69% of the cases. This is followed by **Streptococcus spp.**, which represents 15% of the infections. **Pseudomonas aeruginosa** is found in 7% of cases. The less frequent pathogens include **Enterococcus faecalis** (3%), **Staphylococcus aureus** (2%), **Klebsiella pneumoniae** (2%), and **Hafnia alvei** (2%).

Table 3: Antibiotic Resistance/Sensitivity Pattern of *Escherichia coli* Isolates (n=200)

Antibiotic	Resistance (%)	Sensitivity (%)
Ampicillin	30	70
Azithromycin	35	65
Doxycycline	40	60
Nalidixic Acid	30	70
Amoxicillin	35	65
Levofloxacin	25	75
Ciprofloxacin	30	70
Tetracycline	40	60
Cephalexin	35	65
Imipenem	10	90
Meropenem	5	95
Amikacin	8	92
Nitrofurantoin	5	95
Netilmicin	0	100
Gentamicin	0	100
Ceftriaxone	0	100

Table 3 summarizes the antibiotic resistance and sensitivity patterns of *Escherichia coli* isolates obtained from urine samples of rural female participants in the study. High Resistance Levels: The isolates demonstrated moderate resistance levels, particularly to ampicillin (30%), azithromycin (35%), and doxycycline (40%). This suggests that these antibiotics may be less effective for treating UTIs caused by these isolates in the studied population. Moderate Resistance:

Resistance rates for nalidixic acid, amoxicillin, and tetracycline ranged between 30% and 40%, indicating a significant portion of the isolates exhibit resistance, which could complicate treatment options. Lower Resistance Rates: The isolates showed low resistance to more potent antibiotics such as imipenem (10%), meropenem (5%), amikacin (8%), and nitrofurantoin (5%), suggesting these could be effective treatment options. Complete Sensitivity: Notably, the isolates exhibited complete sensitivity (100%) to netilmicin, gentamicin, and ceftriaxone, which are strong candidates for empirical therapy in the presence of resistant strains.

Table 4: Statistical Analysis of Factors Associated with Antibiotic-Resistant UTIs in Rural Females

Variable	Comparison Group	p-value	Significance Level
Age Group (21-30 vs. >40 years)	<40 years	0.045	Significant
Education Level (Higher vs. No formal education)	Higher vs. No formal	0.032	Significant
Profession (Housewives vs. Others)	Housewife vs. Non-Housewife	0.022	Significant
Socioeconomic Status (Lower vs. Upper)	Lower vs. Upper	0.057	Not Significant
Frequency of UTIs (1-2 times vs. >3 times)	1-2 times vs. >3 times	0.013	Significant
History of Incomplete Treatment	Yes vs. No	0.001	Highly Significant
Hospitalization due to UTI	Yes vs. No	0.038	Significant
Comorbidities (Presence vs. Absence)	With comorbidities vs. None	0.028	Significant
Type of UTI (Complicated vs. Simple)	Complicated vs. Simple	0.015	Significant

Table 4 provides an overview of the relationships between various demographic, clinical, and treatment-related factors and the prevalence of antibiotic-resistant urinary tract infections (UTIs). The analysis reveals significant associations with several variables. Specifically, age shows a significant relationship (p=0.045), indicating that older women are more likely to experience antibiotic resistance. Education level also demonstrates significance (p=0.032), suggesting that higher education correlates with lower resistance rates. Furthermore, being a housewife is linked to higher resistance (p=0.022), while socioeconomic status approaches significance (p=0.057), indicating potential implications for treatment access and awareness. A history of 1-2 UTIs compared to more than three episodes reveals a significant relationship (p=0.013), highlighting the impact of recurrent infections on resistance patterns. Notably, incomplete treatment history is significantly associated with resistance (p=0.001), underscoring the critical role of adherence to antibiotic courses. Additionally, hospitalization due to UTI is significantly linked (p=0.038), suggesting that severe cases may be tied to resistance issues. Comorbidities also show a significant association (p=0.028), while the type of UTI (complicated vs. simple) indicates significance (p=0.015), further emphasizing the complexity of treatment outcomes. Overall, Table 4 illustrates the multifaceted nature of antibiotic resistance in UTIs among rural women and highlights key factors that warrant attention for effective management and prevention strategies.

DISCUSSION

The findings of this study reveal a significant burden of antibiotic-resistant urinary tract infections (UTIs) among rural females in Bangladesh, underscoring the urgent need for targeted public health interventions. The prevalence of *Escherichia coli* as the predominant uropathogen (69%) aligns with other studies, such as those conducted in Pakistan and India, where *E. coli* was similarly identified as the primary pathogen responsible for UTIs in women [2, 3]. The high rate of *E. coli* infections in our population reflects broader epidemiological trends in South Asia, where this organism is a leading cause of UTI. Our study identified moderate resistance levels to several antibiotics, including ampicillin (30%), azithromycin (35%), and doxycycline (40%). These findings are consistent with research from neighboring countries, where similar resistance patterns have been documented[5]. For instance, a

study conducted in India reported *E. coli* resistance rates of 32% for ampicillin and 38% for azithromycin, highlighting the regional challenges posed by antibiotic resistance [5,6]. The resistance rates observed in our study suggest that these antibiotics may no longer be effective first-line treatments for UTIs in this population, necessitating a review of local treatment guidelines. Interestingly, lower resistance rates were observed for more potent antibiotics such as imipenem (10%), meropenem (5%), amikacin (8%), and nitrofurantoin (5%). These findings suggest that while there is a growing concern regarding antibiotic resistance, some effective treatment options remain available. This is corroborated by other studies indicating that carbapenems and nitrofurantoin continue to retain their efficacy against resistant *E. coli* strains [5-7]. Furthermore, the complete sensitivity (100%) of the isolates to netilmicin, gentamicin, and ceftriaxone offers promising alternatives for empirical therapy in the face of rising resistance [8-11]. A noteworthy aspect of our results is the significant association between antibiotic resistance and several sociodemographic factors. Specifically, resistance was linked to age (p=0.045), education level (p=0.032), history of incomplete treatment (p=0.001), and hospitalization due to UTIs (p=0.038). This is consistent with findings from a study in rural India, which highlighted that lower education levels and incomplete treatment history were significant predictors of antibiotic resistance [14-17]. These associations underscore the importance of health education and awareness programs aimed at promoting appropriate antibiotic use, especially among vulnerable populations like rural women. The high prevalence of comorbidities, including hypertension (28.3%) and diabetes (22.4%), observed in our participants also indicates a complex interplay between chronic health conditions and UTI susceptibility. Similar findings have been reported in other studies, emphasizing the need for integrated healthcare approaches that address both chronic diseases and infectious conditions [16-23].

CONCLUSION

The findings from this study highlight the pressing issue of antibiotic resistance in UTIs among rural females in Bangladesh. The moderate resistance rates to commonly prescribed antibiotics and the significant associations with sociodemographic factors underscore the need for targeted interventions to improve antibiotic stewardship and enhance patient education. As antibiotic resistance continues to evolve, continuous surveillance and updated treatment protocols will be essential to combat this growing public health challenge.

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