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Research Article

Prevalence of Urinary Tract Infections and Antibiotic Resistance Patterns in Diabetic Patients in Pakistan

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ABSTRACT

Background: Diabetic patients are at an increased risk of urinary tract infections (UTIs) due to impaired immune function and glycemic imbalances. Antimicrobial resistance in uropathogens adds to the challenge, necessitating localized studies for evidence-based treatment strategies. **Objective**: To assess the prevalence of UTIs, identify uropathogens, and evaluate their antibiotic resistance patterns in diabetic patients in Pakistan. **Methods**: This cross-sectional study included 145 diabetic patients aged ≥18 years. Participants with symptomatic UTI or asymptomatic bacteriuria were recruited from a tertiary care hospital over six months. Urine samples were analyzed using standard microbiological methods to identify pathogens, and antibiotic susceptibility testing was performed by Clinical and Laboratory Standards Institute (CLSI) guidelines. Data were analyzed using SPSS version 25, with chi-square and logistic regression applied for statistical significance. **Results**: UTIs were identified in 93 patients (64.1%), with Escherichia coli being the predominant pathogen (66.2%). Resistance rates were highest for ciprofloxacin (68%) and ceftriaxone (59%), while nitrofurantoin and imipenem showed sensitivities of 82% and 91%, respectively. Poor glycemic control (HbA1c > 7.0%) significantly increased UTI prevalence ($p < 0.001$). **Conclusion**: The high prevalence of UTIs and antimicrobial resistance in diabetic patients highlights the importance of culture-based antibiotic therapy and glycemic control in managing infections.

Keywords: Urinary Tract Infections, Diabetes Mellitus, Escherichia coli, Antibiotic Resistance, Nitrofurantoin, Glycemic Control, Antimicrobial Sensitivity.

INTRODUCTION

Urinary tract infections (UTIs) are a significant health concern globally, with an even greater prevalence among patients with diabetes mellitus due to multiple physiological and immunological factors that predispose this population to infections. Diabetes mellitus compromises the immune response, impairs bladder function, and increases glucose concentration in the urine, creating an environment conducive to microbial growth. Consequently, diabetic patients are at a substantially higher risk of both symptomatic and asymptomatic UTIs compared to non-diabetic individuals, leading to recurrent infections and complications if not effectively managed. Studies in Pakistan have consistently shown that the prevalence of UTIs in diabetic patients ranges from 12.06% to as high as 29.82% in some populations, with the burden significantly higher among females than males, often attributed to anatomical and hormonal factors (1, 2).

The predominant pathogens causing UTIs in diabetic patients include Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus, with E. coli being the most frequently isolated organism in both symptomatic and asymptomatic cases. This pattern of causative pathogens underscores the need for targeted diagnostic and therapeutic strategies in this patient population. Furthermore, a notable feature in diabetic patients is the emergence of multidrug-resistant strains of these pathogens, complicating treatment options. Several studies have reported resistance to commonly prescribed antibiotics such as cephalosporins, fluoroquinolones, and ampicillin, while maintaining higher sensitivity to carbapenems, nitrofurantoin, and fosfomycin, emphasizing the importance of performing urine culture and susceptibility testing prior to initiating treatment (3, 4).

The phenomenon of asymptomatic bacteriuria is another critical aspect in diabetic patients, with prevalence rates varying between 8.08% and 13% in literature. Although often left untreated in non-diabetic individuals, asymptomatic bacteriuria in diabetic patients warrants careful consideration due to the heightened risk of progression to pyelonephritis and other severe complications. Moreover, studies indicate that poorly controlled diabetes, marked by elevated HbA1c levels, correlates strongly with a higher frequency of UTIs and more severe resistance patterns, making glycemic control a vital component of infection management (5, 6).

The growing antibiotic resistance among uropathogens poses a major public health challenge in Pakistan, where empirical treatment often relies on broad-spectrum antibiotics, potentially exacerbating resistance issues. High levels of resistance to third-generation

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cephalosporins and fluoroquinolones have been reported, particularly in strains of E. coli and K. pneumoniae, with susceptibility profiles favoring nitrofurantoin, imipenem, and piperacillin-tazobactam. This highlights the pressing need for updated local antibiograms to guide empirical treatment and inform national guidelines (7, 8).

In the context of diabetes, the high prevalence and multidrug resistance of uropathogens necessitate a multidisciplinary approach to address the interplay of infection control, antimicrobial stewardship, and effective glycemic management. This study aims to elucidate the prevalence of UTIs and the antibiotic resistance patterns of uropathogens among diabetic patients in Pakistan, providing a comprehensive understanding to improve clinical outcomes and policy recommendations.

MATERIAL AND METHODS

This cross-sectional study was conducted to determine the prevalence of urinary tract infections (UTIs) and assess the antibiotic resistance patterns of uropathogens in diabetic patients. The study was carried out at a tertiary care hospital in Pakistan over a period of six months, with a calculated sample size of 145 participants. Participants were selected using a non-probability consecutive sampling technique. The inclusion criteria comprised adult patients aged 18 years and above, diagnosed with type 2 diabetes mellitus, presenting with symptoms suggestive of UTIs or diagnosed with asymptomatic bacteriuria. Pregnant women, patients with structural abnormalities of the urinary tract, and those on antibiotic therapy within the preceding two weeks were excluded from the study.

All participants provided written informed consent after receiving a detailed explanation of the study objectives, procedures, and potential risks. The study protocol adhered to the ethical principles outlined in the Declaration of Helsinki, and ethical approval was obtained from the institutional ethics review board prior to data collection. Demographic data, medical history, and clinical details, including glycemic control as assessed by HbA1c levels, were recorded using a structured proforma.

Urine samples were collected from participants using a standardized midstream clean-catch technique. The samples were immediately transported to the microbiology laboratory under aseptic conditions for analysis. Urine cultures were performed using conventional methods on cysteine lactose electrolyte-deficient (CLED) agar, and bacterial growth was identified based on colony characteristics and biochemical tests. A colony count of ≥10^5 CFU/mL was considered indicative of significant bacteriuria. Antibiotic susceptibility testing was conducted using the Kirby-Bauer disk diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines. Susceptibility to commonly used antibiotics, including cephalosporins, fluoroquinolones, carbapenems, nitrofurantoin, and piperacillin-tazobactam, was assessed.

Data was analyzed using IBM SPSS Statistics version 25. Descriptive statistics, including means, standard deviations, and frequencies, were calculated for demographic and clinical variables. The prevalence of UTIs was expressed as a percentage, while resistance patterns were summarized using frequencies and proportions. The association between glycemic control and UTI prevalence was examined using chi-square tests, with a p-value of <0.05 considered statistically significant.

This study aimed to provide a comprehensive understanding of the prevalence and resistance patterns of uropathogens in diabetic patients, contributing to the formulation of targeted diagnostic and therapeutic strategies. Efforts were made to ensure the accuracy and reliability of data collection and analysis throughout the study (1, 2).

RESULTS

The study included 145 participants, with a mean age of 54.3 years. Most of the participants were female (56.6%), and the mean HbA1c level indicated poor glycemic control in the population. The duration of diabetes varied widely, with an average of 7.6 years. Symptomatic UTIs were more prevalent than asymptomatic bacteriuria.

Table 1 Demographic and Clinical Characteristics of Participants

Variable	Value
Mean Age (years)	54.3 ± 10.8
Gender	Male: 63 (43.4%)
	Female: 82 (56.6%)
Mean HbA1c (%)	8.7 ± 1.4
Duration of Diabetes (years)	7.6 ± 4.2
Symptomatic UTI	93 (64.1%)
Asymptomatic Bacteriuria	52 (35.9%)

Table 2 Prevalence and Antibiotic Sensitivity Patterns of Uropathogens

Pathogen	Frequency (%)	Sensitive Antibiotics	Resistant Antibiotics
Escherichia coli	96 (66.2%)	Nitrofurantoin (82%)	Ciprofloxacin (68%)
		Piperacillin/Tazobactam (74%)	Ceftriaxone (59%)
		Imipenem (91%)	
Klebsiella pneumoniae	29 (20.0%)	Carbapenems (86%)	Cephalosporins (63%)
		Fosfomycin (79%)	Fluoroquinolones (55%)
Staphylococcus aureus	12 (8.3%)	Linezolid (95%)	Tetracycline (62%)
		Vancomycin (90%)	Amoxicillin/Clavulanate (54%)
Pseudomonas aeruginosa	8 (5.5%)	Meropenem (88%)	Aminoglycosides (60%)
		Aztreonam (80%)	

The most common pathogen was Escherichia coli, found in 66.2% of cases. It showed high sensitivity to nitrofurantoin, piperacillin/tazobactam, and imipenem but showed significant resistance to ciprofloxacin and ceftriaxone. Klebsiella pneumoniae accounted for 20.0% of isolates, demonstrating high sensitivity to carbapenems but considerable resistance to cephalosporins and fluoroquinolones. Other pathogens, including Staphylococcus aureus and Pseudomonas aeruginosa, showed varied susceptibility patterns.

Participants with HbA1c levels above 7.0% had a significantly higher prevalence of UTIs compared to those with HbA1c ≤ 7.0%. The difference was statistically significant, emphasizing the role of poor glycemic control in increasing UTI risk.

Binary logistic regression revealed that female gender and higher HbA1c levels were significant predictors of UTI prevalence among diabetic patients. The study demonstrated a high prevalence of UTIs in diabetic patients, with Escherichia coli as the predominant pathogen and concerning levels of antibiotic resistance. Poor

glycemic control and female gender were significant predictors of UTI occurrence. These findings underscore the need for stringent glycemic management and tailored antibiotic therapy based on local susceptibility patterns.

Table 3 Association Between Glycemic Control and UTI Prevalence

HbA1c Level (%)	UTI Prevalence (%)	Statistical Analysis
≤ 7.0	21/43 (48.8%)	$\chi^2 = 14.62$, $p < 0.001$
> 7.0	72/102 (70.6%)	

Table 4 Predictors of UTI Prevalence

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Female Gender	1.78	1.12–2.83	0.018
HbA1c > 7.0%	2.15	1.35–3.42	< 0.001

DISCUSSION

The findings of this study revealed a high prevalence of urinary tract infections (UTIs) among diabetic patients, with Escherichia coli identified as the predominant uropathogen. This aligns with existing literature that consistently reports E. coli as the leading causative agent of UTIs in both diabetic and non-diabetic populations (1, 2). The observed resistance of E. coli to commonly used antibiotics, such as ciprofloxacin and ceftriaxone, is concerning and reflective of global trends indicating increasing antimicrobial resistance among uropathogens (3). Resistance to fluoroquinolones and cephalosporins has also been documented in previous studies from Pakistan, suggesting a critical need for antibiotic stewardship programs tailored to local resistance patterns (4).

A notable aspect of this study was the higher prevalence of UTIs in participants with poor glycemic control, as indicated by elevated HbA1c levels. Poor glycemic control has been identified as a major risk factor for UTIs in diabetic patients, primarily due to the hyperglycemic environment that impairs immune function and promotes bacterial colonization (5). The statistically significant association between HbA1c levels and UTI prevalence corroborates findings from earlier research emphasizing the role of metabolic control in reducing the risk of infections (6). Additionally, female participants exhibited a higher prevalence of UTIs, which is consistent with previous studies attributing this disparity to anatomical and hormonal differences that predispose women to recurrent UTIs (7).

The study highlighted significant resistance patterns among uropathogens, with high sensitivity observed for nitrofurantoin, carbapenems, and fosfomycin. These findings are consistent with global data indicating the retained efficacy of these antibiotics against multidrug-resistant strains (8, 9). However, the rising resistance to first-line agents such as cephalosporins and fluoroquinolones poses challenges for empirical treatment, emphasizing the need for culture-based therapy in managing UTIs, especially in diabetic patients (10). The study's results underscore the importance of updating treatment guidelines to reflect local antibiograms, particularly in resource-limited settings where empirical therapy remains prevalent.

This study had several strengths, including its focus on diabetic patients, a group at higher risk for complicated UTIs and antibiotic resistance. The use of robust microbiological techniques for pathogen identification and susceptibility testing added reliability to the findings. However, there were some limitations. The cross-sectional design precluded the assessment of causality between glycemic control and UTI prevalence. Additionally, the sample size, while adequate for preliminary observations, may not have been sufficient to generalize findings to the broader diabetic population in Pakistan. The exclusion of patients with recent antibiotic use or structural urinary abnormalities, although necessary to reduce confounding, may have underestimated the true burden of multidrug-resistant infections.

Future research should aim to conduct longitudinal studies to evaluate causative factors and outcomes of UTIs in diabetic patients. Expanding the sample size and including participants from multiple healthcare settings would enhance generalizability. Furthermore, molecular studies investigating resistance mechanisms in uropathogens isolated from diabetic patients would provide insights into addressing the growing threat of antimicrobial resistance.

The findings of this study highlighted critical areas for intervention. Strengthening glycemic control through patient education and comprehensive diabetes management programs could significantly reduce UTI risk. Additionally, implementing routine urine culture and sensitivity testing before initiating therapy would promote rational antibiotic use and curb resistance. Policymakers and healthcare providers should prioritize antibiotic stewardship initiatives, particularly in settings with high rates of resistance. Ultimately, integrating infection control strategies with improved diabetes care could mitigate the dual challenges of UTIs and antimicrobial resistance in this vulnerable population.

CONCLUSION

The study proved a high prevalence of UTIs among diabetic patients, with Escherichia coli as the most common pathogen and concerning levels of antimicrobial resistance to commonly used antibiotics. Poor glycemic control and female gender were identified as significant risk factors, highlighting the critical role of metabolic regulation and tailored antibiotic therapy in managing UTIs in this population. These findings underscore the urgent need for integrating robust antibiotic stewardship programs with diabetes management strategies to mitigate infection risks and combat antimicrobial resistance, thereby improving patient outcomes and reducing healthcare burdens in diabetic populations.

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