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Original Article

# Frequency of Uropathogens in Patients Admitted with Urinary Tract Infection and Diabetes Mellitus

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## Abstract

**Objective:** We aimed to identify and classify the specific uropathogens responsible for UTIs in patients with DM who require hospitalization and to determine the prevalence of urinary tract infections (UTIs) in patients admitted to healthcare facilities with coexisting Diabetes Mellitus (DM).

**Methods:** The prospective study conducted at Fatima Memorial Hospital in Lahore, Pakistan (November 2023 to January 2024) involved 116 participants recruited through Non-Probability Sampling. Data analysis utilized IBM SPSS version 26. Descriptive analysis covered variables (age, gender, UTI symptoms and urine culture reports). Categorical variables (e.g., gender, UTI symptoms and organisms in culture reports) were presented as frequencies and percentages using pie and bar charts. Quantitative variable age, was expressed as mean±SD.

**Results:** Involving 116 participants (31% male, 69% female, average age 45.20, SD = 21.16), urine analysis revealed Escherichia coli (48.3%), Enterococcus Faecium (13.8%), Candida Tropicalis (5.2%), and 32.8% with no growth. Common symptoms include fever (49.1%), dysuria (63.8%), urgency (87.9%), and lower abdominal pain (66.4%).

**Conclusion:** Urinary tract infections (UTIs) are highly prevalent in patients with type 1 and type 2 diabetes mellitus. These infections tend to be more severe and are caused by pathogens with higher resistance levels. Our study of 116 participants revealed a significant female predominance in UTI cases for both diabetes types. The most common uropathogen was Escherichia coli, followed by Enterococcus faecium and Candida tropicalis. These findings provide a comprehensive understanding of UTIs in diabetic patients and contribute to more effective clinical outcomes.

**Keywords:** Diabetes Mellitus, Urinary tract infection, Uropathogens frequency, Escherichia Coli, Enterococcus faecium, Candida Tropicalis.

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## Introduction

Urinary tract infections (UTIs) are a widespread global health problem affecting millions of individuals. In the context of diabetes mellitus (DM), UTIs are of particular importance due to various factors such as compromised immunity, altered urinary tract function and glycosuria. This study embarks on an exploratory journey to investigate the frequency and microbiological characteristics of uropathogens in DM patients hospitalized for urinary tract infections and provide crucial insights into the epidemiological and clinical implications of this complex comorbidity.

In uncomplicated UTIs, uropathogens from the gut infect the periurethral area, migrate to the bladder and adhere to superficial cells, leading to cystitis. Some bacteria evade the immune system, multiply, and form biofilms, that damage the host cells and potentially ascend to the kidneys where they produce toxins. In complicated UTIs often associated with catheterization, pathogens follow a similar pattern, but must compromise the bladder, if untreated; UTIs can progress to bloodstream infection and renal damage.[1] Urinary tract infections are a common concern for patients with Type 2 Diabetes Mellitus, owing to factors such as immune system impairments, metabolic control issues, and autonomic neuropathy. UTIs in diabetic patients range from asymptomatic bacteriuria to severe pyelonephritis and

urosepsis, often leading to serious complications. Furthermore, diabetic individuals are at an increased risk of encountering antibiotic-resistant pathogens during UTIs, which may have significant clinical and economic implication.[2] The cross-sectional study conducted in West Bengal, India, from August to October 2020 focused on UTIs in DM patients. Among the 202 DM participants, the research revealed a 24.3% prevalence of culture-confirmed UTIs, with 32.7% experiencing symptomatic UTIs. Notably, female DM patients, particularly housewives, were more susceptible to UTIs. Escherichia coli emerged as the predominant uropathogen, particularly among symptomatic cases. The prevalence of gram-negative bacteria has surpassed gram-positive (65.3% vs. 28.57%) and the percentage of gram-negative isolates that produce Extended-Spectrum Beta-Lactamases (ESBLs) is 34.37%. Gram-negative bacteria have revealed high sensitivity to select antibiotics, such as Piperacillin-tazobactam and Meropenem, while they showed low sensitivity to fluoroquinolones and ampicillin. On the other hand, gram-positive bacteria showed high sensitivity to vancomycin, teicoplanin, and linezolid but low sensitivity to fluoroquinolones and ampicillin.[3]

Urinary tract infections (UTIs) are a frequently recurring health issue for women belonging in to all age groups. Women face a higher susceptibility to UTIs due to their distinctive lower urinary tract anatomy and its close proximity to reproductive organs. Various life stages and medical conditions, including pregnancy, postmenopause, diabetes, epilepsy, urinary catheterization, and surgical procedures, increase the risk of UTIs in women. Recurrent UTIs, characterized by multiple infections within a specific time period, present a significant concern as they affect 25-50% of UTI cases in women.[4] Individuals with diabetes mellitus (DM) are more prone to urinary tract infections (UTIs), including pyelonephritis and severe urosepsis (abscesses or emphysematous). UTIs in DM patients share similar bacterial patterns to those in non-DM patients, predominantly caused by E. coli. Preventive measures include adequate fluid intake, complete bladder emptying and avoiding the use of catheters. Some studies suggest potential benefits of cranberry juice and lactobacillus for preventing UTI and its recurrence in female patients. Renal papillary necrosis should be considered in cases of pyelonephritis unresponsive to antibiotic therapy. It may require interventions to relieve obstruction5. This systematic review and meta-analysis of 86 randomized controlled trials (RCTs) on SGLT-2 inhibitors (including canagliflozin, dapagliflozin, and empagliflozin), used in diabetes management, reveals a significant threefold increased risk of genitourinary infections[6]. The study conducted in Tanzania investigated community-acquired urinary tract infections (UTIs) in 1327 patients, enlightening a 27.4% prevalence rate, with E. coli being the most commonly isolated gram-negative uropathogen and S. aureus and S. haemolyticus as the most frequent gram-positive uropathogens. This study also determined the antibiotic resistance patterns and found varying resistance levels across different antibiotics. Carbapenems, third-generation cephalosporins, and nitrofurantoin showed lower resistance. Multidrug-resistant (MDR) bacteria were prevalent with specific MDR patterns identified among gram-negative and gram-positive uropathogens. Methicillin-resistant Staphylococcus aureus (MRSA) and methicillin-resistant CoNS (MR-CoNS) were also very common, and extended-spectrum β-lactamase (ESBL) production was observed in Enterobacteriaceaes.[7]

The primary goals of this study are to find out and categorize the particular uropathogens accountable for urinary tract infections (UTIs) and to establish the prevalence of UTIs in hospitalized patients with Diabetes Mellitus (DM). It offers important insights for improving treatment and preventive methods, eventually enhancing the wellbeing of this susceptible group, by investigating the frequency of uropathogens in UTI patients with DM.

## Methods

This research was conducted at Fatima Memorial Hospital in Shadman, Lahore, Pakistan, employing a prospective study design. The study focused on 116 Urinary Tract Infection (UTI) patients, consisting of 80 females and 36 males, who were admitted to the hospital from November 2023 to January 2024. Participants were selected through a Non-Probability Sampling technique. Inclusion criteria specified that participants must have a documented diagnosis of Diabetes Mellitus (Type 1 or Type 2), confirmed through medical records, physician diagnosis, or elevated blood glucose levels indicated by laboratory tests (HbA1C > 7%). "Diabetes Mellitus (DM): A medical condition characterized by elevated blood glucose levels (fasting blood sugar level > 130 mg/dl and random blood sugar level > 200 mg/dl and HbA1C >7 % either through a physician's diagnosis of Type 1 or Type 2 diabetes or the use of antidiabetic medications such as insulin or oral hypoglycemic agents." The participants, spanning both genders and within a specified age range (adults aged 18 years and older), were required to exhibit a confirmed diagnosis of Urinary Tract Infection (UTI) based on clinical symptoms and laboratory evidence, including positive leukocyte esterase and urine culture results. "Urinary Tract Infection (UTI): The presence of clinical symptoms and laboratory-confirmed evidence of bacterial infection in the urinary tract. Clinical symptoms may include dysuria, increased urinary frequency, urgency, and supra-

pubic pain. Laboratory confirmation includes positive findings in urine analysis and urine cultures showing the growth of pathogenic bacteria in significant quantities." Informed consent was obtained from participants or their legal representatives, ensuring a comprehensive understanding of the research objectives and procedures. Exclusion criteria were applied to patients with immunocompromised conditions (chronic kidney disease, HIV/AIDS, cancer, transplant recipients, autoimmune disorders RA, SLE, chronic steroid use), a history of cerebrovascular accidents, hemolytic disorders (Hereditary Spherocytosis, Sickle Cell Disease, Thalassemia, Autoimmune Hemolytic Anemia, G6PD Deficiency), significant organ compromise or multiple organ dysfunction (congenital abnormalities, end-stage heart failure, severe chronic obstructive pulmonary disease (COPD), and chronic liver cirrhosis and those with a history of psychiatric illness or cognitive impairment). Data analysis was performed using SPSS version 26, incorporating descriptive analysis of all variables including age, gender, symptoms of UTI, urine culture and sensitivity reports. Categorical variables (qualitative variables) such as gender, symptoms of UTI, organisms on urine culture and sensitivity report were presented as frequencies and percentages in the form of pie and bar charts. Quantitative variable like age was taken as mean±SD. The study synopsis was reviewed by the Institutional Review Board (IRB) at Fatima Memorial Hospital, Shadman, Lahore, in compliance with ethical guidelines. Comprehensive informed consent was acquired prior to participation, guaranteeing that participants were fully informed about the goals, methods, potential risks, and benefits of the study. To ensure participant anonymity, strict protocols, such as data encryption and secure storage, were put in place, adhering to the highest standards of confidentiality and privacy. Participant welfare was given top priority, and precautions were taken to reduce any possible harm. The application for IRB approval was made in order to make sure that ethical standards were followed, encouraging impartial reporting of findings and fair participant selection in order to preserve scientific integrity and protect the rights of participants. Participants' anonymity and confidentiality were strictly protected throughout the research process, and strong security measures were used to protect the privacy of the data. "Frequency of Uropathogens: The prevalence and distribution of specific microorganisms, such as Escherichia coli, Klebsiella pneumoniae, Enterococcus faecalis, etc. identified through urine culture and sensitivity testing in patients with UTI and DM who are admitted to healthcare facilities during the study period."

## Results

In this study involving 116 participants, the gender distribution showed that 36 individuals (31.0%) were men, while 80 participants (69.0%) were women (Figure 1). The calculated mean age of the study participants was 45.20 years, with a standard deviation of 21.16 years. Analysis of urine culture and sensitivity revealed distinct patterns among uropathogens. Escherichia Coli (E. coli) was the most prevalent, accounting for 48.3% (56 cases), followed by Enterococcus Faecium at 13.8% (16 cases), Candida Tropicalis at 5.2% (6 cases), and 32.8% (38 cases) showing no growth (Figure 2). The survey results revealed that nearly half of the participants experienced fever (49.1%), while the remaining 50.9% reported no fever. Pain or discomfort during urination was prevalent among 63.8% of respondents, with 36.2% indicating no such symptoms. Urgency to urinate was a common complaint, with 87.9% affirming this symptom, while 12.1% reported no urgency. Lower abdominal pain was reported by 66.4% of participants; whereas 33.6% did not experience this discomfort (Figure 3). These detailed results offer a comprehensive understanding of the gender distribution, prevalent uropathogens, and reported symptoms within the studied population.

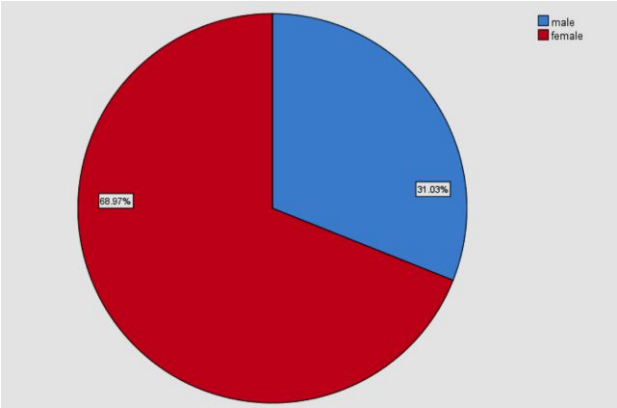


**Figure 1:** *Gender –based distribution of UTI patients*

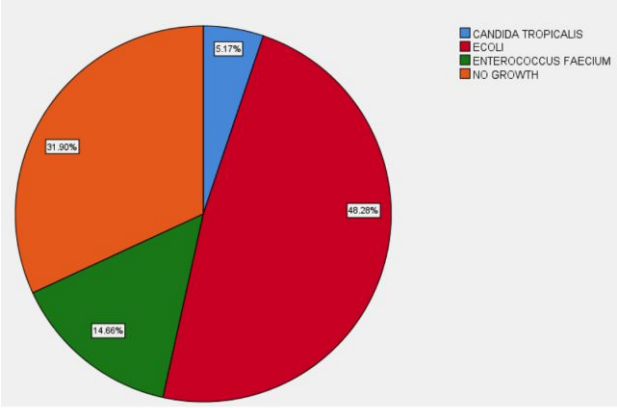


**Figure 2:** *Pie chart representing organisms on urine culture and sensitivity*

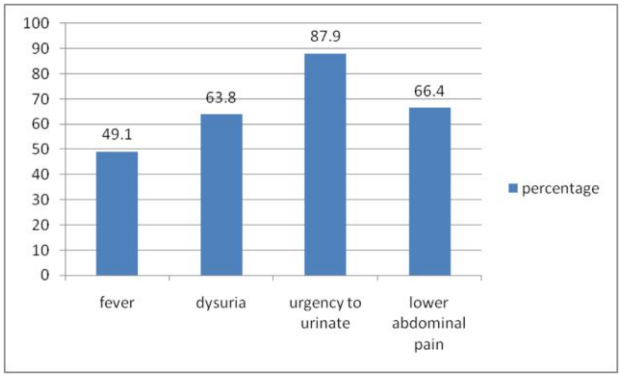


**Figure 3:** *Symptoms of UTI*

## Discussion

In general, patients with diabetes are more susceptible to infections, especially UTIs. Significant morbidity and mortality can result from severe urinary tract infections and the complications they cause such as sepsis and septic shock. Nephropathy is a condition that diabetic kidney disease patients experience. It increases the risk of infection and can cause neurogenic bladder and urinary stasis. Furthermore, decreased leukocyte concentrations, neutrophil activity, and urinary cytokines in diabetic patients may encourage the adhesion of microorganisms to uroepithelial cell. Moreover, hyperglycemia itself promotes the colonization and growth of a wide range of organisms. We tried to find out how common UTIs were affecting the patients in DM and look into the range of uropathogens without comparing the data with non-diabetic people. As a result, it's critical to routinely screen all diabetic patients for urinary tract infections (UTIs). Our research and a Sudanese study both found a correlation between an increased risk of UTIs and poorly controlled diabetes, defined as HbA1c levels above 7%. This highlights how important glycemic control is for managing diabetes and how it affects the risk of UTIs.[3]

The observed gender distribution in our study, with a higher prevalence of females in UTI cases (69.0%), aligns with existing literature highlighting the increased susceptibility of women to UTIs due to anatomical factors, such as shorter urethral length and peri- and post-menopausal women include hormonal changes (oestrogen insufficiency) and connective tissue aging (urinary incontinence, pelvic organ prolapse). In our study, the estimated mean age was 45.20, with a standard deviation of 21.16 years and this age group is consistent with findings from previous studies.[1,4,8]

The prevalence of Escherichia coli (48.3%) as the predominant uropathogen in our study aligns with the findings of numerous previous studies, reinforcing its established significance in urinary tract infections (UTIs). The observation from one research in Tanzania, where 27.4% of 1327 analyzed urine samples showed notable microbial growth, underscores the persistent impact of E. coli in community-acquired UTIs[7,10-11]. This pilot study simulating the harsh conditions of urinary tract infections (UTIs) through sequential passaging of E. coli, we identified some proteins i.e., ATPB_ECOBW, ASPA ECOLI, DPS ECOL6, and DCEB ECOLI — that exhibited significant upregulation. These proteins play crucial roles in cellular adaptation, energy production, DNA protection and acid resistance, suggesting their involvement in E. coli's response to stressful environments. The consistency in E. coli prevalence across various studies may be attributed to its unique adaptive features, as indicated by the upregulation of these proteins[9]. The prevalence of Enterococcus Faecium is 13.8%. A study conducted between February 2012 and February 2013 in Iran, collected a total of 186 Enterococcus isolates from a teaching hospital. These isolates were characterized by type, species, and antibiotic resistance. Identification revealed 57% as E. faecalis and 43% as E. faecium. The study highlights an increase in vancomycin-resistant Enterococci and a rise in Gentamicin-resistant isolates, emphasizing the need for effective treatment strategies[15]. Fungal urinary tract infections (UTIs) remain debated, with our extensive study focusing on risk factors and outcomes in adults. The elderly, primarily women with prevalent diseases like diabetes, displayed funguria. Over half of the patients went untreated or received varied regimens, such as oral fluconazole or amphotericin B irrigation, yielding comparable outcomes. Funguria resolved without antifungal therapy in many cases, underscoring the nuanced clinical approach required.[12-13]

The prevalence of Candida Tropicalis (5.2%) adds valuable insights into the spectrum of uropathogens, facilitating a more comprehensive understanding of UTI etiology. C.tropicalis is notably prevalent in Candida bloodstream isolates within tropical regions, particularly affecting cancer patients. The associated mortality can be high, partly due to the severity of illness in the at-risk patient group. Initial susceptibility of naïve C.tropicalis to various antifungal agents is observed, with rare intrinsic resistance. However, fluconazole resistance may lead to cross-resistance within the triazole drug class[14]. The notable proportion (32.8%) exhibiting no growth in urine cultures raises considerations. This phenomenon may be associated with faulty culture techniques or antibiotic use before sample collection, emphasizing the importance of standardized procedures and clinical history assessment in obtaining accurate results. Recognizing such statistical nuances is critical to inform diagnostic and management strategies tailored to the unique challenges posed by urinary tract infections in individuals with diabetes 16-18. Symptom analysis indicates a considerable impact of UTIs on participants, with fever (49.1%), pain or discomfort during urination

(63.8%), urgency to urinate (87.9%), and lower abdominal pain (66.4%) reported. These findings are consistent with established literature on common UTI symptoms.[19,20]

High prevalence of Urinary tract infections (UTIs) is common in patients with type 1 and type 2 diabetes mellitus. It is noteworthy that these urinary tract infections have an increased severity and are characterized by pathogens with increased levels of resistance, leading to less favorable outcomes as compared to non-diabetics. Treatment recommendations focus on treating symptomatic cases, taking into account the common occurrence of asymptomatic bacteriuria and the possibility that antibiotic treatment contributes to bacterial resistance. In our study of 116 participants, there was a significant female predominance in urinary tract infection cases (both in type 1 and type 2 diabetes). The predominant uropathogen was Escherichia coli followed by Enterococcus faecium and Candida tropicalis. These detailed findings contribute to a comprehensive understanding of UTI in both type 1 and type 2 diabetes and lead to more effective clinical outcomes.

**Study Limitations:** Our study faced limitations in comparing data with non-diabetic patients. An additional constraint was observed with the phenomenon of no growth in around 32.8% of cases. This phenomenon potentially linked to faulty techniques and prior antibiotic use, underscores the necessity for careful interpretation and implies opportunities for improving diagnostic methods in urinary tract infections among individuals with diabetes. Collecting data from a single hospital setting using a non-probability sampling technique may result in findings that lack generalizability to the larger population. This method does not allow for the calculation of traditional sampling error.

**Ethical Approval:** The IRB/EC approved this study via letter no.FMH-04/10/2023-IRB-1322 dated 16-11-2023.

**Conflict of Interest:** *None*

**Funding Source:** *None*

## Authors' Contribution

**SA:** Conception
**JB:** Design of the work
**MKR:** Data acquisition, analysis, or interpretation
**JB, MKR:** Draft the work
**SK:** Review critically for important intellectual content
**SA, JB, MKR:** Approve the version to be published
**SA, JB, MKR:** Agree to be accountable for all aspects of the work

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