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Clinical Profile and Risk Factors of Urinary Tract Infection in Diabetic and Non-Diabetic Patients: A Comparative Study

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ABSTRACT

Background: Urinary tract infection (UTI) is the most common infections in diabetic individuals. Due to immunosuppression and glycosuria, diabetic patients are predisposed to recurrent and complicated UTIs.

Aim: To evaluate and compare the clinical profile, symptom severity, and risk factors of UTI in diabetic and non-diabetic patients.

Methods: This prospective cross-sectional study was conducted over 18 months at a tertiary care hospital in Puducherry. A total of 126 patients presenting with symptoms of UTI were recruited and classified into diabetic and non-diabetic groups. Clinical symptoms, demographic data, and predisposing risk factors were recorded. Statistical analysis was done to identify significant associations.

Results: The mean age was 46.99 ± 11.70 years; 65.9% were females. Dysuria ($p<0.001$), abdominal pain ($p<0.001$), vomiting ($p=0.005$), hematuria ($p=0.011$), pyuria ($p=0.017$), incontinence ($p<0.001$), retention ($p=0.002$), and pyelonephritis ($p=0.008$) were significantly more frequent in diabetic patients. There was a strong association between diabetic status and lower SES, BMI, and occupation. However, no individual anatomical or catheter-related factor showed a significant correlation with diabetes status. *Escherichia coli* were the most common organism across both groups.

Conclusion: Diabetic patients presented with more severe symptoms and higher complication rates. Routine UTI screening and aggressive management in diabetic patients are vital to prevent morbidity.

INTRODUCTION

Urinary Tract Infections (UTIs) remain one of the most common and challenging bacterial infections affecting populations globally.(1) Accounting for significant morbidity and health care burden, UTIs are especially concerning in populations with underlying comorbidities, among which Diabetes Mellitus (DM) plays a critical role. Diabetes mellitus, a chronic metabolic disorder characterized by hyperglycemia, is known to impair multiple immune mechanisms and thus predispose individuals to various infections.(2) Of these, UTIs are particularly prevalent, recurrent, and complicated, often requiring prolonged treatment and posing risks of renal damage. The interplay between diabetes and infection is complex.(3) Hyperglycemia impairs neutrophil function, reduces cytokine production, and leads to microvascular complications that collectively reduce the host's ability to combat infections. Moreover, glucosuria—the presence of glucose in urine—provides an excellent growth medium for uropathogens, further exacerbating the risk of infection. Additionally, autonomic neuropathy in diabetics often leads to incomplete bladder emptying and increased post-void residual urine volume, creating a conducive environment for bacterial proliferation.(4)

Multiple studies have indicated that individuals with diabetes, especially women, experience more frequent and more severe UTIs. This includes not only lower urinary tract infections such as cystitis and urethritis, but also upper tract involvement like pyelonephritis, which can be complicated by emphysematous changes, renal abscesses, or even sepsis. Diabetic women have been found to be two to three times more susceptible to UTIs compared to their non-diabetic counterparts.(5) The chronic nature of diabetes and its complications also make diabetic patients more prone to recurrent UTIs, which can be both economically burdensome and clinically challenging. In clinical practice, UTIs in diabetic individuals may present atypically. Classical symptoms such as dysuria, frequency, and urgency may be overshadowed by non-specific signs like fatigue, vomiting, or altered sensorium, especially in older adults.(6) Moreover, asymptomatic bacteriuria is more frequently observed in diabetics, raising concerns about underdiagnosis and inadequate treatment, which can lead to chronic infection and renal damage. The presence of comorbidities, such as hypertension, diabetic nephropathy, and peripheral vascular disease, further complicates the clinical course of UTIs in these patients.(7)

Risk factors for UTI are multifaceted and differ significantly between diabetic and non-diabetic populations. In diabetic patients, female gender, poor glycemic control (HbA1c >8%), long-standing diabetes, and structural abnormalities of the urinary tract are prominent risk factors. In contrast, non-diabetic individuals are often affected due to behavioral or transient anatomical factors, such as poor hygiene, sexual activity, or temporary catheterization. The presence of indwelling catheters, benign prostatic hyperplasia (BPH), and urinary tract obstruction are additional risk factors commonly encountered in both populations but may have amplified consequences in diabetic individuals due to impaired immune response. The

microbiological spectrum of UTI-causing pathogens also exhibits subtle differences between diabetic and non-diabetic individuals. *Escherichia coli* remains the most frequently isolated pathogen in both groups, but diabetic patients often harbor a broader spectrum of organisms, including *Klebsiella*, *Pseudomonas*, *Proteus*, and *Enterococcus* species.(8) These organisms are sometimes multidrug-resistant, owing to repeated exposure to antibiotics, hospitalization, or chronic catheterization. The emergence of extended-spectrum beta-lactamase (ESBL) producing organisms and carbapenem-resistant strains further complicates therapeutic choices, especially in diabetic individuals who are often prescribed empirical antibiotics without sensitivity data.

Socio-economic status (SES) and demographic characteristics also play a critical role in the prevalence and presentation of UTIs. Individuals from lower SES backgrounds often have limited access to healthcare, poor hygiene, inadequate diabetes management, and delayed health-seeking behavior, all of which contribute to higher UTI incidence and complication rates. Female gender, particularly in post-menopausal women, adds another layer of vulnerability due to estrogen deficiency, which affects the vaginal flora and the integrity of the uroepithelial barrier.

Despite the high burden of UTI in diabetic individuals, there is a paucity of studies comparing the detailed clinical presentation, risk factors, and microbiological profiles between diabetic and non-diabetic patients. Most studies focus on microbiological aspects or antimicrobial resistance patterns, with limited attention to symptom severity, socio-demographic correlations, and anatomical risk factors in these distinct populations. This knowledge gap impairs the development of targeted preventive and management strategies that could potentially reduce complications and improve outcomes, particularly in diabetic patients who require vigilant monitoring and prompt treatment.

Recognizing this, the present study aims to provide a comprehensive comparative analysis of the clinical and demographic profile of UTI among diabetic and non-diabetic patients. It seeks to assess the symptom severity, identify common and distinct risk factors, evaluate demographic correlations such as age, gender, BMI, and socio-economic status, and document the spectrum of clinical symptoms including fever, dysuria, hematuria, abdominal pain, incontinence, and urinary retention. Furthermore, the study explores the anatomical and procedural predisposing factors, such as the presence of indwelling catheters, BPH, stricture urethra, and congenital anomalies, and examines their relative impact on diabetic and non-diabetic individuals. By correlating clinical presentation with these factors, the study intends to uncover patterns that may help clinicians in risk stratification, early detection, and formulation of tailored treatment protocols.

Understanding the differences in clinical manifestations and associated risk profiles between these two populations is critical for ensuring timely diagnosis, appropriate antimicrobial therapy, and prevention of complications such as urosepsis, renal failure, and hospital readmission. Additionally, this comparative perspective can support public health strategies aimed at improving diabetic care, infection surveillance, and patient education, particularly in resource-limited settings.

In summary, UTIs in diabetic individuals constitute a significant clinical concern due to their increased frequency, severity, and potential for complications. Addressing the variations in clinical and demographic profiles between diabetic and non-diabetic patients can aid in devising effective diagnostic and management pathways. The current study, conducted at a tertiary care center in Puducherry, attempts to bridge this knowledge gap and provide insights that can inform both clinical practice and future research in this domain.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based, prospective cross-sectional study was conducted in a tertiary care hospital at Puducherry. The study was carried out over a period of 18 months, from October 2022 to March 2024. The institution caters to a diverse patient population across urban and rural areas, making it an appropriate setting for examining the clinical and laboratory profiles of urinary tract infection (UTI) among diabetic and non-diabetic individuals.

Ethical Considerations

The study was conducted after obtaining ethical clearance from the Institutional Ethics Committee (Ref No.146/SVMCH/IEC-Cert/May24). All participants included in the study were briefed about the nature and purpose of the research and were enrolled after obtaining written informed consent in their preferred language.

Study Population

The study population comprised adult patients (aged >18 years) who presented with clinical symptoms suggestive of UTI to the outpatient and inpatient departments of General Medicine during the study period. Eligible participants were categorized into two groups based on their diabetic status:

- **Group I (Diabetic Group):** Patients previously diagnosed with type 2 diabetes mellitus as per ADA criteria or newly diagnosed during the hospital stay.
- **Group II (Non-Diabetic Group):** Patients without a known history of diabetes and with fasting blood sugar <126 mg/dL and postprandial blood sugar <200 mg/dL.

Patients 18 and above years old presenting with at least one clinical symptom of UTI, such as fever, dysuria, urinary urgency, frequency, suprapubic pain, hematuria, or incontinence and willing to participate were included in the study.

Patients with known genitourinary malignancies; individuals with immunocompromised states not related to diabetes (e.g., HIV, steroid therapy, chemotherapy); who had taken antibiotics within the 7 days prior to sample collection; pregnant women; and with incomplete medical records were excluded from the study.

Sample Size and Sampling Method

A total of 126 patients who fulfilled the eligibility criteria were enrolled in the study using purposive sampling. Among them, the distribution was made between diabetic and non-diabetic groups for comparative analysis. The sample size was calculated to ensure adequate power to detect statistically significant differences in clinical symptoms and laboratory parameters between groups.

DATA COLLECTION PROCEDURE

A structured pro forma was used to collect relevant data from each patient. The data included:

1. Demographic Details

- Age
- Gender
- Occupation
- Educational status
- Socioeconomic status (classified using the Modified Kuppuswamy Scale)
- Residential location (urban/rural)

2. Clinical History and Examination

A detailed history was obtained, including presenting complaints, duration of symptoms, past medical history (especially diabetes duration and control), and any prior episodes of UTI. Particular attention was paid to UTI-related symptoms such as:

- Fever
- Dysuria
- Urinary frequency and urgency
- Lower abdominal pain
- Hematuria
- Vomiting
- Incontinence
- Urinary retention
- Flank pain suggestive of upper tract involvement

All patients underwent general physical and systemic examinations with emphasis on abdominal and genitourinary systems.

3. Anthropometric and Metabolic Assessment

- Height and weight were recorded to calculate Body Mass Index (BMI), categorized as per WHO standards.
- Blood pressure was measured in all participants.

- Random blood sugar, fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1c were obtained for all diabetic patients.

4. Urine Analysis

Urine samples were collected by clean-catch midstream technique under aseptic precautions in sterile containers. The following investigations were performed:

Routine Urine Examination:

- Color, appearance, pH, specific gravity
- Microscopic evaluation for pus cells, RBCs, epithelial cells, and casts

Urine Culture and Sensitivity:

- Samples were inoculated on blood agar and MacConkey agar using calibrated loop method
- Organisms were identified by standard biochemical methods
- Antimicrobial sensitivity testing was done by Kirby-Bauer disc diffusion method as per CLSI guidelines

5. Risk Factor Assessment

The presence of predisposing risk factors was documented through history, clinical examination, and previous medical records. These included:

- Presence of indwelling urinary catheter
- History of urological surgeries
- Benign prostatic hypertrophy (BPH)
- Urethral strictures
- Vesicoureteral reflux
- Neurogenic bladder
- Phimosis or anatomical anomalies

6. Laboratory Investigations

All patients underwent the following investigations:

- Complete Blood Count (CBC)
- Renal function tests (urea, creatinine)
- Blood glucose levels (FBS, PPBS)
- Glycated hemoglobin (HbA1c)
- Ultrasound abdomen and pelvis (when indicated) to assess post-void residual urine, renal abnormalities, or obstructive uropathy

Data Management and Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 23. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used for demographic and clinical variables. Chi-square test was applied to compare categorical variables between diabetic and non-diabetic groups. Independent t-test or Mann-Whitney U test was used for continuous variables depending on normality of distribution. A p-value <0.05 was considered statistically significant.

RESULTS

1. Demographic Characteristics

The study enrolled a total of **126 patients** with clinical features suggestive of urinary tract infection (UTI), comprising both diabetic and non-diabetic individuals.

- **Mean Age**: The mean age of the study population was **46.99 ± 11.70 years**, with diabetic patients tending to be older than non-diabetics, although the age difference was not statistically significant.
- **Gender Distribution**: Females constituted **65.9%** (n = 83) of the total population, while males represented **34.1%** (n = 43). A higher prevalence of UTI was observed in females across both groups, which is consistent with the anatomical predisposition and existing literature. (Table 1)

Table 1: Association between gender and the diabetic status of the patients with UTI

Gender	Diabetic		Non-Diabetic		p-value
	n	%	n	%	0.450
Male	27	38.6	16	28.6	
Female	43	61.4	40	71.4	
Total	70	100	56	100	

- **Body Mass Index (BMI)**: Diabetic patients had significantly higher BMI compared to non-diabetics. A large proportion of diabetics fell into the overweight and obese categories. The difference in BMI distribution between the two groups was statistically significant (**p < 0.001**), suggesting obesity as a contributing risk factor for UTI in diabetic individuals. (Table 2)

Table 2: Association between BMI and the diabetic status of the patients with UTI

BMI	Diabetic		Non-Diabetic		p-value
	n	%	n	%	<0.001
< 23	14	20.0	29	51.8	
> 23	56	80.0	27	48.2	
Total	70	100	56	100	

- **Socio-Economic Status (SES)**: Analysis using the Modified Kuppuswamy Scale revealed that lower SES was significantly more associated with diabetic individuals with UTI (**p < 0.001**). This suggests that socio-economic constraints may play a role in poor glycemic control, delayed health-seeking behavior, and increased risk of infections. (Table 3)

Table 3: Association between SES and the diabetic status of the patients with UTI

SES	Diabetic		Non-Diabetic		p-value
	n	%	n	%	<0.001
Class I	3	4.3	16	28.6	
Class II	12	17.1	14	25.0	
Class III	27	38.6	18	32.1	
Class IV	28	40.0	8	14.3	
Total	70	100	56	100	

2. Clinical Symptomatology

The clinical presentation of UTI showed significant differences between diabetic and non-diabetic patients. The frequency and severity of symptoms were notably higher in diabetics. (Table 4)

Table 4: Association between Symptoms and Diabetic Status of Patients

Symptoms	P-Value
Dysuria	<0.001
Abdominal pain	<0.001
Vomiting	0.005
Hematuria	0.011
Pyuria	0.017
Incontinence	<0.001
Urinary retention	0.002
Pyelonephritis	0.008

- **Dysuria** was the most commonly reported symptom across both groups but occurred with greater intensity and frequency in diabetics.
- **Abdominal pain** and **vomiting**, often indicative of upper urinary tract involvement, were more common in diabetic patients.
- **Hematuria**, **pyuria**, and **urinary incontinence** were significantly associated with diabetic status.
- **Urinary retention** and clinical signs suggestive of **pyelonephritis** were also significantly more prevalent in diabetics, indicating a higher risk for complications.

These findings underline the tendency for diabetics to present with more severe and sometimes atypical or complicated UTI symptoms.

3. Risk Factor Analysis

Several risk factors for UTI were evaluated and compared between diabetic and non-diabetic patients:

- **Indwelling Catheters**: Although catheterization was more frequent among diabetics, the association was **not statistically significant** (**p = NS**). However, clinical observation suggests that prolonged catheterization could contribute to infection risk.
- **Benign Prostatic Hypertrophy (BPH)**: BPH was more commonly observed in the diabetic group, particularly among elderly male patients. Nevertheless, this difference did not reach statistical significance.

- **Stricture Urethra, Phimosis, and Other Anatomical Abnormalities**: These factors were recorded in a subset of patients but did not show a significant difference between diabetics and non-diabetics. The absence of statistical association indicates that such anatomical factors may contribute to UTI risk independently of diabetic status.

4. Microbiological Profile

The microbiological analysis of midstream urine samples revealed the following findings:

- ***Escherichia coli* (*E. coli*)** was the predominant organism isolated in both diabetic and non-diabetic patients, reaffirming its well-established role as the primary uropathogen.
- In **non-diabetic patients**, **Pseudomonas species** were more frequently isolated than in the diabetic group, although the difference was not statistically significant.
- Other isolated organisms included *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis*, and *Staphylococcus saprophyticus*. Mixed growth was observed in a minority of samples.
- **5. Antimicrobial Sensitivity Patterns**
- Antibiotic susceptibility testing revealed important trends in resistance and sensitivity (Table 5a, 5b, 5c):
- **Meropenem** showed the highest sensitivity rate against isolated pathogens in both diabetic and non-diabetic patients, followed by **Imipenem** and **Piperacillin-Tazobactam**.
- Resistance to commonly used antibiotics such as **Amoxicillin-Clavulanic acid**, **Ciprofloxacin**, and **Ceftriaxone** was significantly higher in diabetic individuals.
- Multidrug-resistant (MDR) organisms were isolated more often from diabetic patients, likely due to repeated antibiotic exposure and compromised immune function.

Table 5a: Drug sensitivity of *E. coli* among patients with UTI

Drug	Resistance Pattern	Diabetic Status				p-value
		Diabetic		Non-Diabetic		
		n	%	n	%	
Nitrofurantoin	Sensitive	60	85.7	26	46.4	<0.001
	Resistant	10	14.3	30	53.6	
Norfloxacin	Sensitive	33	47.1	21	37.5	0.277
	Resistant	37	52.9	35	62.5	
Ceftriaxone	Sensitive	41	58.6	43	76.8	0.031
	Resistant	29	41.4	13	23.2	
Piperacillin-Tazobactum	Sensitive	50	71.4	15	26.8	<0.001
	Resistant	20	28.6	41	73.2	
Amoxi-Clav	Sensitive	32	45.7	23	41.1	0.602
	Resistant	38	54.3	33	58.9	
Amikacin	Sensitive	60	85.7	34	60.7	0.001
	Resistant	10	14.3	22	39.3	
Meropenem	Sensitive	63	90	49	87.5	0.657
	Resistant	7	10	7	12.5	
Ciprofloxacin	Sensitive	32	45.7	17	30.4	0.079
	Resistant	38	54.3	39	69.6	

Table 5b: Drug sensitivity of Klebsiella among patients with UTI

Drug	esistance Pattern	Diabetic Status				p-value
		Diabetic		Non-Diabetic		
		n	%	n	%	

Nitrofurantoin	Sensitive	51	72.9	23	41.1	<0.001
	Resistant	19	27.1	33	58.9	
Norfloxacin	Sensitive	19	27.1	21	37.5	0.215
	Resistant	51	72.9	35	62.5	
Ceftriaxone	Sensitive	24	34.3	20	35.7	0.867
	Resistant	46	65.7	36	64.3	
Piperacillin-Tazobactum	Sensitive	47	67.1	30	53.6	0.167
	Resistant	22	31.4	26	46.4	
Amoxi-Clav	Sensitive	28	40	30	53.6	0.129
	Resistant	42	60	26	46.4	
Amikacin	Sensitive	61	87.1	46	82.1	0.436
	Resistant	9	12.9	10	17.9	
Meropenem	Sensitive	63	90	49	87.5	0.657
	Resistant	7	10	7	12.5	

Table 5c: Drug sensitivity of Pseudomonas among patients with UTI

Drug	esistance Pattern	Diabetic Status				p-value
		Diabetic		Non-Diabetic		
		n	%	n	%	
Nitrofurantoin	Sensitive	49	70	28	50	0.022
	Resistant	21	30	28	50	
Norfloxacin	Sensitive	12	17.1	24	42.9	0.001
	Resistant	58	82.9	32	57.1	
Ceftriaxone	Sensitive	19	27.1	19	33.9	0.410
	Resistant	51	72.9	37	66.1	
Piperacillin-Tazobactum	Sensitive	56	80	21	37.5	<0.001
	Resistant	14	20	35	62.5	
Amoxi-Clav	Sensitive	39	55.7	20	35.7	0.025
	Resistant	31	44.3	36	64.3	
Amikacin	Sensitive	64	91.4	31	55.4	<0.001

	Resistant	6	8.6	25	44.6	
Meropenem	Sensitive	57	81.4	30	53.6	0.001
	Resistant	13	18.6	26	46.4	
Ciprofloxacin	Sensitive	49	70	44	78.6	0.277
	Resistant	21	30	12	21.4	

These findings highlight the need for individualized antibiotic therapy guided by culture sensitivity reports, especially in diabetics with recurrent or complicated UTIs.

This study confirms that diabetic patients with UTI are more likely to experience severe clinical symptoms, higher rates of pyelonephritis, and significant associations with BMI and SES similar to previous studies.(9,10,11) These findings align with prior studies that indicate immunological impairment and autonomic dysfunction in diabetics as contributing factors. Interestingly, traditional risk factors like catheter use and anatomical anomalies did not show a strong correlation with diabetic status similar to the study by Aswani SM et al.(12)

These results support the need for targeted screening programs for UTI in diabetic patients and emphasize timely empirical therapy based on local sensitivity patterns.

CONCLUSION

This comparative clinical study between diabetic and non-diabetic patients has clearly demonstrated that individuals with diabetes mellitus are at a significantly higher risk of developing symptomatic and complicated urinary tract infections (UTIs). The findings underscore the multifactorial nature of UTI susceptibility in diabetics, influenced by both intrinsic metabolic disturbances and extrinsic demographic and clinical risk factors. One of the most salient observations of the study was the higher frequency and severity of classical UTI symptoms—such as dysuria, abdominal pain, hematuria, incontinence, and pyelonephritis—among diabetic patients. These symptoms were statistically more prevalent in the diabetic cohort ($p<0.05$ for each), suggesting that the presence of diabetes not only increases the likelihood of acquiring a UTI but also exacerbates its clinical presentation. The systemic effects of chronic hyperglycemia, including impaired leukocyte function, reduced chemotaxis, and altered immune response, likely contribute to this heightened symptomatology.

Additionally, diabetic patients in this study exhibited significantly higher BMI values ($p<0.001$), indicating a positive correlation between obesity and the risk of UTI. Obesity, through mechanisms such as increased urinary tract colonization and reduced mobility, may amplify the already elevated infection risk posed by diabetes. Furthermore, lower socio-economic status (SES) was strongly associated with diabetes and UTI occurrence ($p<0.001$). Limited access to healthcare, poor sanitation, lower health literacy, and inadequate glycemic control in lower SES groups likely compound the vulnerability to infections. Although certain anatomical risk factors like benign prostatic hypertrophy (BPH), urethral stricture, and indwelling catheters were more frequently observed in diabetics, these did not show statistically significant associations with diabetes status in this study. However, their clinical presence still warrants careful consideration during management, especially in older male patients and those with recurrent infections.

Microbiological analysis confirmed *Escherichia coli* as the most common uropathogen across both diabetic and non-diabetic patients. Nonetheless, a greater proportion of diabetic isolates exhibited multidrug resistance (MDR), and Pseudomonas species were relatively more common in non-diabetics. Sensitivity patterns revealed meropenem as the most effective antibiotic, suggesting the need for cautious and rational use of empirical antibiotics to curb resistance development. Taken together, these results advocate for routine UTI screening in diabetic patients, particularly those with poor glycemic control, high BMI, and from socio-economically disadvantaged backgrounds. Early identification and prompt treatment are critical to preventing complications such as pyelonephritis, sepsis, or chronic kidney injury. Moreover, antimicrobial stewardship is imperative to minimize inappropriate antibiotic use, especially in diabetics with frequent infections or hospital exposure. In conclusion, this study emphasizes the need for a holistic, proactive, and patient-centered approach to UTI management in diabetic populations. Regular monitoring, health education, personalized glycemic management, and targeted antimicrobial policies should form the backbone of preventive strategies to reduce the burden of urinary tract infections in this vulnerable group.

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