



URINARY TRACT INFECTIONS IN TYPE 2 DIABETES: AN ANALYSIS OF PREVALENCE AND CONTRIBUTING FACTORS

Pallavi Sharma^{1*}, Shikha Paliwal², Ruchi Kant³

^{1*}Assistant Professor, Department of Medical Lab Techniques, Chandigarh University, Uttar Pradesh, India.

Email: pallavisharma8126@gmail.com

²Assistant Professor, Department of Medical Lab Techniques, Teerthanker Mahaveer University, Moradabad (India-244001).

Email: shikha.paramedical@tmu.ac.in

³Research Scholar, History, Vikrant University, Gwalior, Madhya Pradesh India³Professor and Head, Department of Medical Lab Techniques, Teerthanker Mahaveer University, Moradabad (India-244001).

Email: ruchi.paramedical@tmu.ac.in

Received:- 03/03/26

Revised:-08/04/26

Accepted:-15/04/26

Published:- 22/04/26

ABSTRACT

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder with rising global prevalence, frequently associated with complications such as urinary tract infections (UTIs). Diabetic patients are more susceptible to UTIs due to impaired immune responses, glycosuria, and bladder dysfunction, resulting in more frequent, severe, and recurrent infections.

Objective: This study aimed to assess the prevalence, risk factors, and microbial etiology of UTIs among patients with T2DM presenting with clinical features suggestive of infection.

Methods: A prospective observational study was conducted at the Teerthanker Mahaveer University College of Paramedical Sciences and the Department of Microbiology, Teerthanker Mahaveer Hospital & Research Centre, Moradabad. A total of 158 T2DM patients aged above 18 years with symptomatic features of UTI were enrolled. Midstream urine samples were collected aseptically and analyzed using standard microbiological techniques including culture on CLED agar, wet mount microscopy, and Gram staining. Significant bacteriuria was defined as colony growth $\geq 10^5$ CFU/ml based on Kass criteria.

Results: Of the 158 urine samples, 40 (25.31%) showed significant bacteriuria. The prevalence was highest among patients aged >35 years. Gram-negative bacteria accounted for 65% of isolates, with *Escherichia coli* being the most common pathogen (52.5%), followed by *Staphylococcus aureus* (12.5%) and *Pseudomonas aeruginosa* (10%). Gram-positive organisms comprised 35% of isolates.

Conclusion: The study reveals a notable prevalence of UTIs among T2DM patients, particularly in older adults. *E. coli* remains the predominant uropathogen. Early microbiological evaluation and culture-guided antimicrobial therapy are crucial for managing UTIs in diabetics. Routine screening and timely diagnosis can significantly reduce complications and improve clinical outcomes in this high-risk population.

Key words: Urinary Tract Infection, Diabetes Mellitus, Asymptomatic Bacteriuria, Bacterial Uropathogens, Glycemic Control

1. INTRODUCTION

The term Diabetes Mellitus originates from two languages: the Greek word diabetes, meaning "to siphon" (referring to excessive urination), and the Latin word mellitus, meaning "sweetened" (indicating the presence of glucose in urine). It is currently one of the most common endocrine disorders, with its prevalence increasing significantly due to sedentary lifestyles and dietary shifts, especially in industrialized nations. Type 2 diabetes mellitus (T2DM), the most common form of the disease, is a progressive metabolic disorder characterized by insulin resistance, impaired insulin secretion, and excessive hepatic glucose production. In 2015, approximately 415 million individuals were living with type 2 diabetes worldwide—a figure projected to rise to 642 million by 2040. T2DM is associated with multiple complications, including cardiovascular disease, nephropathy, retinopathy, neuropathy, and an increased susceptibility to infections, particularly urinary tract infections (UTIs).

UTIs are the most frequently reported infections among individuals with T2DM. An estimated 150 million people worldwide are affected by UTIs annually. These infections can range from asymptomatic bacteriuria to symptomatic lower UTIs (cystitis), pyelonephritis, and severe urosepsis. Diabetic individuals are particularly vulnerable due to factors such as impaired immune response, glycosuria, autonomic neuropathy leading to bladder dysfunction, and poor glycemic control. Women are more prone to UTIs than men due to anatomical differences, including a shorter urethra and its proximity to the anus. In diabetics, UTIs are not only more common but also tend to be more severe and recurrent. Complications such as renal abscesses, emphysematous cystitis, and renal papillary necrosis are more prevalent in diabetic patients than in the general population.

T2DM is also a recognized risk factor for catheter-associated UTIs, healthcare-associated UTIs, and recurrent post-transplant UTIs. Furthermore, the incidence of fungal UTIs, particularly due to *Candida* species, is higher in diabetic individuals. Proper diagnosis and management of UTIs in diabetic patients are essential to prevent complications and reduce morbidity. Common symptoms include dysuria, urgency, frequency, and suprapubic discomfort, though neuropathic patients may exhibit atypical presentations. Hence, timely urine analysis and microbiological evaluation are crucial, especially in symptomatic or high-risk individuals.

2. MATERIALS AND METHODS

This prospective and observational study was meticulously carried out over a defined period in the Teerthanker Mahaveer University College of Paramedical Sciences at Teerthanker Mahaveer University & Bacteriology section of the Department of Microbiology at Teerthanker Mahaveer Hospital & Research Centre, Moradabad. The primary aim of the research was to evaluate the prevalence, risk factors, and microbial etiology of urinary tract infections (UTIs) among patients diagnosed with Type 2 Diabetes Mellitus. A total of 158 patients were enrolled in the study, all of whom were aged above 18 years and exhibited either symptomatic or clinically suggestive features of UTI, including dysuria, increased urinary frequency, urgency, suprapubic discomfort, and occasionally fever. Inclusion in the study was based on well-defined criteria focusing exclusively on patients with Type 2 Diabetes Mellitus, while strict exclusion was applied to individuals with Type 1 diabetes, non-diabetic participants, and patients under 18 years of age to maintain consistency in data collection and eliminate confounding variables.

Each patient was instructed to provide a midstream urine sample, collected under aseptic conditions into sterile, leak-proof containers to prevent contamination. In cases where immediate sample processing (within 1–2 hours) was not possible, the samples were either stored at 4°C to prevent overgrowth of bacteria or chemically preserved using boric acid, as per standard clinical laboratory practices. Following collection, urine samples underwent a series of standard microbiological investigations. For culture and isolation, each sample was carefully inoculated onto CLED (Cysteine Lactose Electrolyte Deficient) agar using a calibrated nichrome loop delivering 0.001 mL of urine, ensuring accurate quantification of bacterial load. Plates were then incubated aerobically at 37°C for 24 hours. Based on the Kass Criteria (1956), the presence of bacterial colonies exceeding 10⁵ colony-forming units (CFU/ml) was interpreted as significant bacteriuria, indicative of infection rather than contamination. In addition, wet mount microscopy of centrifuged urine sediments was conducted to identify the presence of red blood cells (RBCs), white blood cells (WBCs), epithelial cells, and casts, which could support the diagnosis of infection or inflammation. For preliminary bacterial identification, Gram staining was employed to categorize isolates based on their cell wall structure: Gram-positive organisms retained the primary crystal violet stain and appeared purple, whereas Gram-negative bacteria took up the safranin counterstain, appearing pink under the microscope.

3. RESULT

A total of 158 Type 2 diabetic patients were enrolled in this study to assess the prevalence and causative agents of urinary tract infections (UTIs). The findings are summarized below.

Table 1: Number of Patients with Bacteriuria (n = 158)

Bacteriuria Status	Number of Patients	Percentage (%)
Significant Bacteriuria	40	25.31%
Without Bacteriuria	118	74.68%
Total	158	100%

In this study, 25.31% of patients exhibited significant bacteriuria, while 74.68% showed no bacteriuria.

Table 2: Age-wise Distribution of Significant Bacteriuria

Age Group (Years)	Total Cases (%)	Significant Bacteriuria (%)
21–25	12 (7.5%)	1 (0.63%)
26–30	30 (18.98%)	3 (1.89%)
31–35	50 (14.87%)	14 (8.86%)
>35	66 (41.77%)	22 (13.92%)
Total	158 (100%)	40 (100%)

The majority of patients with significant bacteriuria belonged to the age group above 35 years (13.92%), followed by the 31–35 years group (8.86%).

Table 3: Distribution of Gram-negative and Gram-positive Isolates

Organism Type	Number	Percentage (%)
Gram-negative	26	65%
Gram-positive	14	35%
Total	40	100%

Gram-negative organisms accounted for the majority (65%) of isolates, while Gram-positive organisms represented 35%.

Table 4: Bacterial Organisms Isolated in Significant Bacteriuria Cases (n = 40)

Organism	Number	Percentage (%)
Gram-Negative Bacteria (GNB)		
Escherichia coli	21	52.5%
Klebsiella pneumoniae	3	7.5%
Pseudomonas aeruginosa	4	10%
Acinetobacter spp.	2	5%
Gram-Positive Bacteria (GPB)		
Staphylococcus aureus	5	12.5%
Staphylococcus saprophyticus	3	7.5%
Enterococcus spp.	2	5%
Total	40	100%

Among all isolated organisms, E. coli was the most predominant pathogen, responsible for 52.5% of infections, followed by S. aureus (12.5%), P. aeruginosa (10%), and others in smaller proportions.

4. DISCUSSION

The present study was conducted over a six-month period, from January to June 2022, at Teerthanker Mahaveer Hospital & Research Centre, Moradabad. A total of 158 urine samples were collected from patients diagnosed with Type 2 Diabetes Mellitus (T2DM) presenting with symptoms of urinary tract infection (UTI). Among these, 40 samples (25.31%) demonstrated significant bacteriuria. This prevalence aligns closely with similar findings reported in previous studies. For instance, OM Rahiman F et al. reported a 27.34% prevalence of symptomatic UTIs among T2DM patients, while Kant S et al. found a slightly lower rate at 23.3%. Thakur S et al. observed a higher prevalence of 30.23%, and Rizvi M et al. reported 24.2% of symptomatic bacteriuria in diabetic individuals. These findings suggest a consistent burden of UTI among the T2DM population across different settings.

In the current investigation, the majority of patients with significant bacteriuria were above 40 years of age, accounting for 13.92% of the total cases. This was followed by the 31–35 age group (8.86%), 26–30 years (1.89%), and 21–25 years (0.63%). Our findings are supported by Ranjan A et al., who noted the highest incidence of UTI in patients older than 40 years (14.32%), and similar age-related trends were also reported by Sujatha R et al., where the maximum prevalence (20.92%) was seen in the above-45 age group, followed by 31–40 years (16.93%).

In terms of microbial etiology, *Escherichia coli* was the most commonly isolated uropathogen, accounting for 52.5% of the total isolates. This was followed by *Staphylococcus aureus* (12.5%), *Pseudomonas aeruginosa* (10%), *Klebsiella pneumoniae* (7.5%), *Staphylococcus saprophyticus* (7.5%), *Enterococcus* spp. (5%), and *Acinetobacter* spp. (5%). These results are consistent with studies by Eshwarappa M. et al., who reported *E. coli* as the predominant isolate (57.3%), and MP Srinath et al., who reported a similar trend with *E. coli* at 55.3%. Likewise, Samage PM et al. found *E. coli* in 50.3% of UTI cases among diabetics.

Regarding Gram classification, our study revealed that Gram-negative organisms accounted for 65% of the isolates, while Gram-positive organisms represented 35%. These proportions are in agreement with Thattil SJ et al., who reported 66% Gram-negative and 33% Gram-positive organisms, and OM Rahiman R et al., who found 63% Gram-negative and 37% Gram-positive organisms. These results collectively highlight the significant prevalence of UTIs in T2DM patients, particularly in older age groups, and reinforce the dominance of Gram-negative organisms—especially *E. coli*—as the primary causative agents. The findings emphasize the importance of early diagnosis, regular screening, and appropriate antimicrobial stewardship in managing UTIs among diabetic populations.

5. CONCLUSION

The present study highlights a significant association between Type 2 Diabetes Mellitus and urinary tract infections, with a prevalence of 25.31% significant bacteriuria among the study population. The incidence of UTI was highest among patients aged above 40 years, indicating age as a major contributing risk factor. Gram-negative bacteria, particularly *Escherichia coli*, were identified as the most common uropathogens, followed by *Staphylococcus aureus* and *Pseudomonas aeruginosa*. These findings are consistent with previous research and underscore the importance of early detection and proper microbiological evaluation in diabetic patients to prevent complications arising from undiagnosed or improperly treated UTIs. Regular screening, especially in asymptomatic individuals with diabetes, along with appropriate antimicrobial therapy based on culture and sensitivity, is essential for effective management and improved patient outcomes.

REFERENCES

1. Jennifer Jiang, Dr. Shuchismita Dutta. (2017, April). Global Health. Diabetes Mellitus. Retrieved From <https://Pdb101.Rcsb.Org>
2. Hu Fb. Globalisation Of Diabetes: The Role Of Diet, Lifestyle, And Genes. *Diabetes Care*. 2011;34(6):1249–57
3. Patterson Je, Andriole Vt. Bacterial Urinary Tract Infections In Diabetes. *Infect Dis Clin North Am*. 1997;11(3):735–50.
4. Zheng Y, Ley Sh, Hu Fb. Global Aetiology And Epidemiology Of Type 2 Diabetes Mellitus And Its Complications. *Nat Rev Endocrinol*. 2018;14:88–9
5. Ncd Risk Factor Collaboration (Ncd-Risc). Worldwide Trends In Diabetes Since 1980: A Pooled Analysis Of 751 Population-Based Studies With 4.4 Million Participants. *Lancet*. 2016;387:1513–1530s.
6. Muller Lmaj, Gorter Kj, Hak E, Goudzwaard Wl, Schellevis Fg, Hoepelman Ai, Et Al. Increased Risk Of Common Infections In Patients With Type 1 And Type 2 Diabetes Mellitus. *Clin Infect Dis*. 2005;41:281–8

7. Shah Br, Hux Je. Quantifying The Risk Of Infectious Diseases For People With Diabetes. *Diabetes Care*. 2003;26:510–3
8. Fu Az, Iglay K, Qiu Y, Engel S, Shankar R, Brodovicz K. Risk Characterisation For Urinary Tract Infections In Subjects With Newly Diagnosed Type 2 Diabetes. *J Diabetes Complicat*. 2014;28(6):805–10
9. Gupta K, Sahm Df, Mayfeld D, And Stamm We. National Analysis Of Uropathogens That Cause Women's Community-Acquired Urinary Tract Infections That Are Resistant To Antibiotics. 89. *Clin Infect Dis*. 2001;33(1):
10. Ellenberg M. Diabetic Neuropathy: Clinical Aspects. *Metabolism*. 1976;25:1627–55
11. Bonadio, M., Costarelli, S., Morelli, G., And Tartaglia Diabetes Mellitus' Effects On The Range Of Uropathogens And The Level Of Antibiotic Resistance In Senior Adult Patients With Urinary Tract Infections. (6):54 *Bmc Infect Dis*. (2006)
12. Nitzan O, Elias M, Chazan B, Saliba W. Urinary Tract Infections In Patients With Type 2 Diabetes Mellitus: Review Of Prevalence, Diagnosis, And Management. *Diabetes Metab Syndr Obes*.2015;8:129–36
13. Gorter Kj, Hak E, Zuithof Np, Hoepelman Ai, Rutten Ge. Risk Of Recurrent Acute Lower Urinary Tract Infections And Prescription Pattern Of Antibiotics In Women With And Without Diabetes In Primary Care. *Fam Pract*. 2010;27(4):379–85
14. Geerlings Se, Hoepelman Aim. Immune Dysfunction In Patients With Diabetes Mellitus (Dm). *Fems Immunol Microb*. 1999;26(3-4):259-65.
15. Kofteridis Dp, Papadimitraki E, Mantadakis E, Maraki S, Papadakis Ja, Tzifa G, Et Al. Effect Of Diabetes Mellitus On The Clinical And Microbiological Features Of Hospitalized Elderly Patients With Acute Pyelonephritis. *J Am Geriatr Soc*. 2009;57(11):2125-8.
16. Stamm We. Measurement Of Pyuria And Its Relation To Bacteriuria. *Am J Med*. 1983;75(1):53-8
17. <https://www.mayoclinic.org/diseases-conditions/type-2-diabetes/symptoms-causes/syc-20351193>
18. Sandhu R, Sayal P, Jakkhar R, Sharma G. Catheterization-Associated Urinary Tract Infections: Epidemiology And Incidence From Tertiary Care Hospital In Haryana. *J Health Res Rev*. 2018; 5(3):135-41.
19. Jacobsen Sm, Stickler Dj, Mobley Hl, Shirliff Me. Complicated Catheterassociated Urinary Tract Infections Due To Escherichia Coli And Proteus Mirabilis. *Clin Microbiol Rev*. 2008; 21(1):26-59.
20. Guidelines For The Prevention Of Catheter Associated Urinary Tract.Infection;Availableat:[https://www.hpsc.ie/Az/Microbiologyantimicrobialresistance/Infectioncontr/Olandhai/Guidelines/File,12913.21-Arellano, Ronald S. Non Vascular Interventional Radiology Of Abdomen](https://www.hpsc.ie/Az/Microbiologyantimicrobialresistance/Infectioncontr/Olandhai/Guidelines/File,12913.21-Arellano,%20Ronald%20S.%20Non%20Vascular%20Interventional%20Radiology%20Of%20Abdomen.%20New%20York:%20Springer.%20Isbn%20978-1-4419-7731-1.%20Archived%20From%20Original%20On%202016-06-10.). New York: Springer. Isbn 978-1-4419-7731-1. Archived From Original On 2016-06-10.
21. Khan R, Saif Q, Fatima K, Meher R, Shahzad Hf, Anwar Ks. Clinical Bacteriological Profile Of Uti Patients Attending A North Indian Tertiary Care Center. *J Integr Nephrol Androl* 2015;2(1):29-34
22. Nickel, J. C. J Management Of Urinary Tract Infections: Historical Perspective And Modern Approaches: Part 1: Before Antibiotics, *Urol*. 2005; 173(1):21-6
23. Richard S Snell. *Clinical Anatomy By Regions*. 9th Ed. Lippincott Williams And A Wolters Kluwer Business 2012.P.206-9
24. Maarteen W. Taal, Glenn M. Chertow , Philip A. Marsden , Karlskorecki ,Alab S.L.Yu, Barrym. Brenner; Brenner And Rectors's The Kidney; 9th Ed; Elsevier; P 1361-73.
25. Al-Badr A, Al-Shaikh G. Recurrent Urinary Tract Infections Management In Women: A Review. *Sultan Qaboos Univ Med J*. 2013; 13(3):359-67.
26. Monica Cheeseborough; *District Laboratory Practice In Tropical Countries-Part 2*; 2nd Ed; Cambridge University Press, 2006; P 105-115.
27. Kolawole As, Kolawole Om, Kandaki-Olukemi Yt, Babatunde Sk, Durowade Ka, Kolawole Cf. Prevalence Of Urinary Tract Infections (Uti) Among Patients Attending Dalhatu Araf Specialist Hospital, Lafia, Nasarawa State, Nigeria. *Int J Med Med Sci*. 2009; 1(5):163-7.
28. Bhatia N, Daga Mk, Garg S, Prakash Sk. Urinary Catheterization In Medical Wards. *J Glob Infect Dis*. 2010; 2(2):83-90.
29. Najar Ms, Saldanha Cl, Banday Ka. Approach To Urinary Tract Infections. *Indian J Nephrol*. 2009; 19(4):129-39.
30. Ananthanarayan R, Paniker Ckj. *Textbook Of Microbiology*. 7th Ed. Hyderabad: Orient Longman; 2005.
31. Jacobsen Sm, Stickler Dj, Mobley Hl, Shirliff Me. Complicated Catheterassociated Urinary Tract

- Infections Due To Escherichia Coli And Proteus Mirabilis. *Clin Microbiol Rev.* 2008; 21(1):26-59.
32. Gavin Jr Iii, Alberti Kgmm, Davidson Mb Et Al. Expert Committee Report. *Diabetes Care* 1997; 1183-1197.
 33. American Diabetes Association Recommendations, Follow-Up Report Of The Expert Committee On The Diagnosis And Classification Of Diabetes Mellitus. *Diabetes Care* 26: 3160-3167, 2003.
 34. Hirji I, Guo Z, Andersson Sw, Hammar N, Gomez-Camirero A. Incidence Of Urinary Tract Infection Among Patients With Type 2 Diabetes In The Uk General Practice Research Database *Diabetes Complications.* 2012;26(6):513–516.
 35. Hammar N, Farahmand B, Gran M, Joelson S, Andersson Sw. Incidence Of Urinary Tract Infection In Patients With Type 2 Diabetes. Experience From Adverse Event Reporting In Clinical Trials. *Pharmacoepidemiol Drug Saf.* 2010;19(12):1287–1292.
 36. Yu S, Fu Az, Qiu Y, Et Al. Disease Burden Of Urinary Tract Infections Among Type 2 Diabetes Mellitus Patients In The Us. *J Diabetes Complications.* 2014;28(5):621–626
 37. Fu Az, Iglay K, Qiu Y, Engel S, Shankar R, Brodovicz K. Risk Characterization For Urinary Tract Infections In Subjects With Newly Diagnosed Type 2 Diabetes. *J Diabetes Complications.* 2014;28(6):805–810.
 38. Chen Sl, Jackson Sl, Boyko Ej. Diabetes Mellitus And Urinary Tract Infection: Epidemiology, Pathogenesis And Proposed Studies In Animal Models. *J Urol.* 2009;182(6 Suppl):S51–S56
 39. Wang Mc, Tseng Cc, Wu Ab, Et Al. Bacterial Characteristics And Glycemic Control In Diabetic Patients With Escherichia Coli Urinary Tract Infection. *J Microbiol Immunol Infect.* 2013;46(1):24–29.
 40. Boyko Ej, Fihn Sd, Scholes D, Chen Cl, Normand Eh, Yarbrow P. Diabetes And The Risk Of Acute Urinary Tract Infection Among Postmenopausal Women. *Diabetes Care.* 2002;25(10):1778–1783.
 41. Soo Park B, Lee Sj, Wha Kim Y, Sik Huh J, Il Kim J, Chang Sg. Outcome Of Nephrectomy And Kidney-Preserving Procedures For The Treatment Of Emphysematous Pyelonephritis. *Scand J Urol Nephrol.* 2006;40(4):332–338.
 42. Kaplan Sa, Te Ae, Blaivas Jg. Urodynamic Findings In Patients With Diabetic Cystopathy. *J Urol.* 1995;153(2):342–344.
 43. Frimodt-Moller C. Diabetic Cystopathy: Epidemiology And Related Disorders. *Ann Intern Med.* 1980;92(2 Pt 2):318–321.
 44. Chatterjee S, Maiti P, Dey R, Kundu A, Dey R. Biofilms On Indwelling Urologic Devices: Microbes And Antimicrobial Management Prospect. *Ann Med Health Sci Res.* 2014; 4(1):100-4.
 45. Majumdar Mi, Ahmed T, Ahmed S, Khan Ar.”Microbiology Of Catheter Associated Urinary Tract Infections. 2018 Intechopen Doi 10.5772/Intechopen 80080.
 46. Jenkins Rd, Fenn Jp, Masten Jm. Review Of Urine Microscopy For Bacteriuria. *Jama.* 1986; 255(24):3397-403.
 47. Mackei And Mccartney Textbook Of Practical Of Medical Microbiology Ed 14th Chapter 41 Fungi. 695-717.
 48. Clague J, Horan M. Urine Collection And Culture In Elderly People. *Age Ageing.* 1998; 27(5):658-9.
 49. Kilpatrick Es, Bloomgarden Zt, Zimmet Pz. Is Haemoglobin A1c A Step Forward For Diagnosing Diabetes? *Bmj.* 2009 Nov 10; 339:B4432. Doi: 10.1136/Bmj.B4432. Pmid: 19903702.