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ORIGINAL RESEARCH

Identification of Bacterial Uropathogen and Antimicrobial Resistance Patterns Among Patients with Diabetic and Hypertension Attending Dilla University General Hospital, Dilla, Ethiopia

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Background: Having a urinary tract infection (UTI) is a serious health issue which is caused by microbial colonization and proliferation in the urinary system. Patients with diabetes and blood pressure are more vulnerable to bacterial urinary tract infections because their host defense is compromised and their urine has a high glucose content. A proper and quick investigation of uropathogen and their antibiogram is key to patient treatment and infection control.

Objective: Aimed to assess the identification of bacterial uropathogen and antimicrobial resistance patterns among diabetic and hypertension patients attending DUGH, Ethiopia.

Methods: A Facility-based cross-sectional study was conducted from February to December 2022 among 158 diabetic and hypertensive patients using a clean catch mid-stream urine sample. Pretested structured questionnaires were used to collect data from study participants. Urine samples were taken and cultured on Blood agar, MacConkey agar and CLED Agar for the identification of uropathogen. An antimicrobial susceptibility test was done according to CLSI. Binary and multiple logistic regression were used to assess the association. A P-value less than 0.05 was considered statistically significant.

Results: The overall prevalence of bacterial uropathogenic among diabetes mellitus and hypertension patients was 15.2%. *E. coli* (29.2%), coagulase negative Staphylococci (CoNS) (20.8%), *K. pneumoniae* 3 (12.5%) and *S. aureus* 2 (12.5%) were the leading isolated uropathogens. In our study, illiterates (AOR =8.1, 95% CI: (5.1–12.4)), participants with high blood glucose levels (AOR=1.81, 95% CI: (1.01–2.21)) and comorbid patients (AOR = 4.2, 95% CI: (4.1–17.2)) were significantly associated with UTI. Both gram-negative and gram-positive isolated bacteria showed higher resistance to most of the commonly used antibiotics. Multidrug resistance was reported in 62.5% of the total isolates.

Conclusion: This study revealed a high prevalence of bacterial isolate and multidrug resistance. Therefore, continuous monitoring of microbiological and antimicrobial surveillance of UTI among DM patients is crucial for appropriate treatment and infection control.

Keywords: urinary tract infection, diabetes mellitus, hypertensive, uropathogens, prevalence, antimicrobial susceptibility pattern

Introduction

UTI is caused by microbial colonization and proliferation in the urinary system (UT).[1,2] It may occur either because of the pathogenicity of the organism or the susceptibility of the host as bacteria transmit from the intestine to the urethra and start to grow to cause infection. UT is normally resistant to microbial development and colonization, which may be a result of a number of physiological mechanisms.[3–5] Additionally, innate immunity, some antibody, protective secretion from mucous and prostate, barrier development, and over contents of urea protect microbial colonization and proliferation in the urinary system which causes UTI.[4] Nevertheless, anatomical and physiological abnormalities that prevent urine from flowing normally[6] and other factors that pass host immunity and resulted in UTI.[7]

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As many research reports indicated, UT is the most frequent area for bacterial infection in humans.[8] When microorganisms get a chance, UT can be affected by microbes, which develop virulence factors that allow them to overwhelm urinary epithelial cells. UTIs are caused by different microorganisms. *Escherichia coli, Klebsiella pneumoniae*, and *Proteus mirabilis* are the leading etiologic agent of UTIs which accounts for 75% of the isolates. Other Enterobacteriaceae species, enterococcus species and staphylococcus species also cause UTI. Antimicrobial resistance is becoming an important public health problem in patients with UTIs. The problem is challenging in low-income countries because of the high prevalence of infection, irrational uses of antibiotics and poor infection prevention practices.[9,10]

Globally, non-communicable illnesses are becoming a world threat as they cause high morbidity and mortality.[11,12] Diabetes mellitus and hypertension are the most common non-communicable, organ or system disorder that persist for a long time. Numerous studies from throughout the world show that individuals with diabetes and hypertension are more likely to get urinary tract infections and that these infections are more severe and have dangerous consequences[13–17] which may be due to host immune system abnormalities and a large concentration of glucose in the urine of those patients.[3,18,19] These include granulocyte dysfunction and improved microbial adherence to the uroepithelial cells.[20,21] Large glucose contents in urine promote bacterial growth and colonization in the UT[22] and results in complications of renal function and lead to renal failure in these patients.[23]

Currently, the high prevalence of diabetes and hypertension throughout the world has become a major risk factor for UTI and is becoming a major economic burden on healthcare.[17] Additionally, misuse of antibiotics for the treatment of UTIs contributes to the emergence of antibiotic-resistant uropathogens.[24] There are no guidelines that separate treatment options among patients suffering from UTI who were with and without those NCDs.[25] Moreover, the inappropriate use of antibiotics often results in the increased resistance of UT pathogens to the most commonly used antimicrobial drugs.[26] Information about the etiologies of UTI and antimicrobial resistance among patients with diabetes and blood pressure is limited in the study area. Therefore, this study was undertaken to analyze the prevalence of bacterial etiologic agents, antimicrobial susceptibility patterns, and risk factors among patients with diabetes and hypertension in Dilla University Referral Hospital.

Methods

Study Design and Study Area

Facility-based cross-sectional study was applied between January 2022 and December 2022 by using Laboratory-based experimental tests for the isolation of etiologic agents and testing antimicrobial resistance patterns. The study was done in Gedeo Zone which is situated in Southern region of Ethiopia on patients with diabetics and hypertension. It is located at 365 kilometers from Addis Ababa (the capital city of the country). It is located in the Kola agro-ecological zone, 1400 kilometers above sea level, with an average annual temperature of 22 to 29 degree Celsius. According to the central statistical agency of Ethiopia's 2007 census, Dilla had a total population of 61114 people, of which 31,329 were males and 29,785 were Females.

Study Population and Sampling Technique

The study population were patients with diabetic mellitus and hypertension cases visiting Dilla University General Hospital. All patients with confirmed diabetes mellitus and hypertension cases and those who signed informed consent were included in this study while patients without diabetic mellitus and hypertension cases and those patients with diabetics and hypertension cases who have been taking antibacterial drugs for the last two weeks were excluded from this study. Ethical approval was obtained from the institutional review board of Dilla University Medical and Health Science College with Unique protocol number duirb/012/22-01.

The sample size was calculated based on a single sample size estimation using the prevalence of 10.5% indicated in the study done in Ethiopia,[27] with an expected margin of error taken at 5% and a confidence interval of 95% and 10% contingency for the non-respondent. The calculated sample size was 158. From a total of 502 diabetic and hypertension patients registered in the study area, 158 samples were drawn using a systematic random sampling technique.

Collection, Management, and Transportation of Specimens

Patients with diabetics and blood pressure were advised on how to collect the sample, a fresh midstream urine sample (5–10 mL) was collected in a sterile urine cup. Each specimen checked for its quality. Inappropriate samples contaminated with other materials like stool and soil were rejected. The urine sample was transported to Dill University Referral Hospital Microbiology Laboratory for organism identification and further analysis.

Isolation and Identification of Bacterial Uropathogen

Urine samples collected from patients were inoculated on Cysteine Lactose Electrolyte Deficient agar, MacConkey, and Blood agar plates (Oxoid, Ltd., Hampshire, England) using a sterile calibrated wire loop measuring 1 microliter. The inoculated plates were incubated aerobically for 24 hours at 35–37°C, and the results were classified as significant or non–significant. Significant bacteriuria was defined as culture plates containing 10^5 colony-forming units (CFU)/mL of a single bacterial species. Bacterial identification was done presumptively based on the appearance of bacteria on culture media, microscopic examination, and the gram-reaction. Gram-negative bacteria were further identified using indole production, citrate utilization, H2S formation, gas formation, urea hydrolysis, lysine decarboxylation, lactose fermentation, and motility. The mannitol fermentation test, catalase, and coagulase tests were utilized to identify gram-positive bacteria.

Antibiotic Susceptibility Testing (AST)

AST was performed for each identified bacterium using the standard Kirby-Bauer disk diffusion method on Muller Hinton agar (MHA) (Biomark Laboratories India) based on CLSI guidelines.[28] The suspension was made by taking 3–5 colonies out of pure culture with an inoculation loop and was emulsified in nutrient broth and mixed gently. Until the suspension's turbidity was corrected to 0.5 McFarland standards, it was incubated at 37°C. The organisms were evenly distributed across the surface of the MHA. The following drugs and concentrations were used to determine the antibiogram of the strains: Fourteen antibiotic disks were used and impregnated on the surface of the plate from the top antibiotics used in the study area. The drugs for disc diffusion testing were in the following concentrations: nitrofurantoin (30 µg), ciprofloxacin (15 µg), doxycycline (30µg), ampicillin (10µg), vancomycin (30µg), Trymethoprim-sulfamethoxazole (1.25/1.75 µg), gentamycin (10µg), penicillin (10 units), meropenem (10µg), ceftazidime (30µg), ceftriaxone (30µg) and amoxicillin-clavulanate (30µg). The antimicrobial selection was based on the recommendation of CLSI guidelines. The predefined antimicrobial disks were put on the MHA plate's surface and incubated at 37°C for 18–24 hours and the clear region around the disc was measured to the nearest millimeter using a graduated caliper in millimeters, and the isolates were categorized as sensitive, intermediate, and resistant according to CLSI, 2016.[29]

Data Processing and Analysis

The laboratory request form was used to acquire demographic information and patient history. Data were entered and analyzed using Epi-Data 3.1 and the statistical package for social science version 23.0 software. Descriptive analysis such as frequency and mean was used. A P-value less than 0.05 was taken as statistically significant.

Result

Socio Demography of the Study Participants

A total of 158 diabetic and hypertension patients diagnosed with urinary tract infections were included in this study. Most of the study subjects were male 93 (58.9%), while female accounted 65 (41.1%) with male-to-female ratio of 1.43:1. The age of study participants ranged from 18 to 83 years with a mean age of 46.0+13.7 years. A 81.2% of study subjects were from urban areas. Most of the study participants have learned college and above. In the current study, more than half of the study participants were married (Table 1).

Table 1 Percentage of Socio-Demographic Data of Diabetic and Hypertensive Patients Diagnosed for UTIs in DUGH, South Ethiopia, 2022

Socio Demographic Information		Frequency	Percentage
Age	18–39	56	35.4
	40–59	75	47.5
	≥60	27	17.1
Sex	Male	93	58.9
	Female	65	41.1
Residence	Urban	128	81.2
	Rural	30	18.8
Educational background	Illiterate	34	21.9
	Primary school	24	14.6
	Secondary school	42	26.4
	College and above	57	37.1
Marital status	Married	97	61.5
	Unmarried	61	39.5

Clinical Feature of the Study Participants

Among 158 study participants, 89 (56.4%) study participants were without symptoms of urinary tract infection while patients with urinary tract infection symptom accounted 69 (43.6%). The majority of participants were type II DM 132 (82.7%). Prior history of urinary tract infection and catheterization were found in 51 (32.3%) and 3 (1.8%) of study participants, respectively. Around 49 (30.1%) of the study participants were comorbid patients. Cardiovascular disease, rheumatoid arthritis, cancer, asthma and pyelonephritis are some of the comorbid diseases seen in study participants (Table 2).

Table 2 Frequency of Clinical Feature of Diabetic Patients Diagnosed for UTIs in DUGH, South Ethiopia

Clinical Feature		Frequency	Percentage
Types of DM	Type I DM	26	17.3
	Type II DM	132	82.7
Fasting	< 126	46	29
	≥ 126	112	71
Previous UTI	Yes	51	32.3
	No	107	67.7
Presence of comorbidities	Yes	49	30.1
	No	109	69.9
History of catheterization	Yes	3	1.8
	No	155	98.2

(*Continued*)

Table 2 (Continued).

Clinical Feature		Frequency	Percentage
Medication for DM	Tablet	74	46.8
	Insulin	62	39.2
	Both	22	14
Medication for hypertensive	Yes	20	12.7
	No	6	3.8

Prevalence of Bacterial Uropathogens

In the current study, the overall prevalence of uropathogens among DM and hypertension study participants was 24 (15.2%). From the total 24 uropathogens isolated, the female and male study participants accounted 16 (66.7%) and 8 (5.1%), respectively. From the total 24 uropathogens isolated, gram-negative and positive bacteria accounted 15 (62.5%) and 9 (37.5%) respectively. The isolated bacterial species were categorized into nine groups. *E. coli* 7 (29.2%) was found to be the leading bacterial isolates among gram-negative followed by *K. pneumoniae* 3 (12.5%) and Enterobacter species 2 (8.3%), while Coagulase negative staphylococcus (CoNS) 5 (20.8%) was the leading isolates followed by *S. aureus* 2 (12.5%) and Enterococcus species from gram-positive (4.2%) (Table 3).

Antimicrobial Resistance Pattern Among Gram Negative and Positive Uropathogens

Gram-negative bacterial isolates which categorized into six groups were assessed for antimicrobial resistance patterns. Among the *E. coli* isolates, higher susceptibility was reported to nitrofurantoin, ceftriaxone, and meropenem each accounts 6 (85.7%) followed by ceftazidime and gentamicin each accounts for 5 (71.4%). It was highly resistant to ampicillin (100%) and doxycycline (85.7%). Likewise, a higher susceptibility to nitrofurantoin and meropenem each

Table 3 Prevalence of Bacterial Isolates Among Different Age and Sex Groups in DURH, South Ethiopia, 2022

Name of Bacterial Isolate	Gender		Age Groups			Total
	Male (N=93)	**Female (N=65)**	**18–39 (N=56)**	**40–59 (N=75)**	**>60 (N=27)**	
Gram negative bacteria (N= 15)						
E. coli	3 (12.5)	4 (16.7)	2 (8.3)	2 (8.3)	3 (12.5)	7 29.2)
K. pneumoniae	1(4.2)	2 (8.3)	1 (4.2)	1 (4.2)	1 (4.2)	3(12.5)
Enterobacter species	1 (4.2)	1 (4.2)	1 (4.2)	0	1 4.2)	2(8.3)
K. oxytoca	0 (0.0)	1 (4.2)	1 (4.2)	0 (0.0)	0 (0.0)	1(4.2)
P. mirabilis	0 0.0)	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)	1(4.2)
Citrobacter species	0 (0.0)	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)	1(4.2)
Gram positive bacteria N= 9)						
CoNS	2 (8.3)	3 (12.5)	2 (8.3)	1 (4.2)	2 (8.3)	5(20.8)
S. aureus	1 (4.2)	2 (8.3)	1 (4.2)	0 (0.0)	1 (4.2)	3(12.5)
Enterococcus species	0 (0.0)	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)	1(4.2)
Total	**8 (33.3)**	**16 (66.7)**	**8 (33.3)**	**4 (16.7)**	**12 (50)**	**24 (100)**

Abbreviation: CoNS, Coagulase negative.

accounts 2 (66.7%) was reported to *K. pneumoniae* while it was highly resistant to ampicillin, ciprofloxacin, ceftazidime and doxycycline (100%). *Enterobacter species, K. oxytoca, P. mirabilis* and *Citrobacter species* showed high susceptibility to nitrofurantoin and ciprofloxacin (100%), but it was highly resistant to ampicillin (100%). Among gram-positive bacterial isolates, *CoNS* showed high susceptibility to vancomycin and nitrofurantoin ranging from 80% to 100% while it was high resistance to ampicillin (100%). On the other hand, among *S. aureus* isolated, high resistance was reported in ampicillin, Penicillin, Amoxicillin-clavulanic acid and ceftazidime ranged from 60% to 100%, but it was highly susceptible to vancomycin and nitrofurantoin ranging from 80% to 100%. Enterococcus species were highly resistant to ceftazidime and penicillin (100%), while it was highly susceptible to ciprofloxacin, nitrofurantoin, and ciprofloxacin (100%) (Table 4).

Multidrug Resistance (MDR) Patterns of the Isolates

From the total 24 bacterial isolates, MDR (bacteria that are resistance to at least one in three or more categories of antibiotics) was reported in 16 (66.7%). Out of 15 gram-negative bacteria, 11 (73.3%) were MDR while 4 (44.4%) were MDR among 9 gram-negative bacteria. In this study, *K. pneumoniae* 3 (100%) followed by *E. coli* 4 (57.1%) and Enterobacter species 1 (50%) were reported as gram-negative bacteria with higher level of MDR, while *S. aureus* 2 (66.7%) followed by *CoNS* 2 (40%) were gram-positive bacteria with higher level of MDR (Table 5).

Associated Risk Factors of Urinary Tract Infection

In our study, risk factors for urinary tract infections were assessed among twelve variables using bivariate analysis. In multivariate analysis, individuals who had no educational background (AOR =8.1, 95% CI: (5.1–12.4), p = 0.001), study subjects with high blood glucose level (AOR=1.81, 95% CI: (1.01–2.21), p = 0.01) and study subjects with additional disease (AOR = 4.2, 95% CI: (4.1–17.2), p = 0.001) were significantly associated with urinary tract infection (Table 6).

Discussion

In the current study, the overall prevalence of uropathogens among DM and hypertension patients was 15.2%. It is in line with prior studies done in Harar[30] (15.4%), Addis Ababa[26] (14.9%), Gondar[10] (17.8%), Metu, Ethiopia[31] (16.7%) and Nekemte, Ethiopia[32] (16.5%). However, our findings were disparately higher than studies done in London[33] (5.7%), Iran[34] (8.06%), Hawassa[35] (13.8%), Romania[36] (12.0%) and Debre Tabor[14] (10.9%). However, this study was lower than studies done in Nepal[19] (54.76%), Kuwait[37] (35%), India[38] (49.15%), and Uganda[39] (22.0%). The variations might be explained by variation in location, lifestyle, personal hygiene practice, difference in sample size, study period variation and health education practices.

In our study, gram-negative uropathogens were commonly identified which account for around 62.5%. It includes *E. coli, Klebsiella species*, Enterobacter species, Proteus species, and *Citrobacter species*.[31,40] Different studies conducted in Ethiopia and different parts of the world[10,30,41–43] reported as they were the leading causative agents of UTI. In the current investigation, *E. coli* and *Klebsiella pneumoniae* were the two most prevalent bacterial isolates. This is in line with studies conducted in different areas of the world.[19,30,32,35,41,42] The predominance of *E. coli* might be due to the existence of the bacteria as normal flora in fecal, which can easily rise through genitalia and results in UTI.[35] *E. coli* has a number of virulent factors that assist the bacteria to easily colonize and invade the urinary epithelium and mediate the attachment of the bacteria to uroepithelial cells that contribute to UTI.[44]

In the present study, gram-positive staphylococcus species like CoNSs and *S. aureus*, and Enterococcus species, which play a lesser role in resulting UTI were also identified.[45] Coagulase-negative staphylococcus and S aureus were the leading bacterial isolate with prevalence of 20.8% and 12.5%, respectively, followed by *Enterococcus species* (4.2%). Our finding was comparable with previous studies done in different parts of the country.[26,35,37,46]

In the current study, a large number of gram-negative enteric pathogens were extremely resistant to ampicillin and amoxicillin-clavulanic acid. Likewise, similar findings were reported high bacterial resistance to the medication in different parts of the country.[26,32,35] Overuse/underuse or misuse of the drug, easy availability and cheap price of antibiotics, lack of current guidelines on the selection of medications, and a lack of diagnostic laboratory services for susceptibility tests are some of the factors that contribute to this. On the other hand, nitrofurantoin, meropenem,

Table 4 Antimicrobial Susceptibility Patterns of Gram Positive and Gram Negative Bacterial Isolate from Urine Sample at Dilla University Referral Hospital, from January 2022 to December 2022

			Antimicrobial Agents Tested (Gram Negative)											
Bacterial Isolate	**Total**	**Pattern**	**AMP No (%)**	**AMC No (%)**	**CIP No (%)**	**CEF No (%)**	**MER No (%)**	**CRO No (%)**	**DOX No (%)**	**NIT No (%)**	**CN No (%)**	**SXT**	**V No (%)**	**PE No (%)**
E. coli	7	S	0 (0.0)	1 (14.3)	4 (57.1)	5 (71.4)	7 (100)	6 (85.7)	1 (14.3)	6 (85.7)	5 (71.4)	5 (71.4)	NA	NA
		I	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
		R	7 (100)	6 (85.7)	2 (27.6)	2 (27.6)	0 (0.0)	1 (14.3)	6 (85.7)	1 (14.3)	2 (27.6)	2 (27.6)		
K. pneumoniae	3	S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (66.7)	1 (33.3)	0 (0.0)	7 (100)	2 (66.7)	2 (66.7)	NA	NA
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
		R	3 (100)	3 (100)	3 (100)	3 (100)	1 (33.3)	2 (66.7)	7 (100)	0 (0.0)	1 (33.3)	1 (33.3)		
Enterobacter species	2	S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	1 (100)	1 (50.0)	1 (50.0)	NA	NA
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
		R	2 (100)	2 (100)	2 (100)	2 (100)	1 (50.0)	1 (50.0)	2 (100)	0 (0.0)	1 (50.0)	1 (50.0)		
K. oxytoca	1	S	0 (0.0)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	NA	NA
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
		R	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
P. mirabilis	1	S	0 (0.0)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	0 (0.0)	0 (0.0)	NA	NA
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
		R	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	1 (100)		
Citrobacter species	1	S	0 (0.0)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	NA	NA
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
		R	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
Antimicrobial Agents Tested (Gram Positive)														
CoNS	5	S	0 (0.0)	1 (20.0)	4 (80.0)	2 (40.0)	NT	NT	NT	4 (80.0)	3 (60.0)	4 (60.0)	1 (100)	2 (40.0)
		I	0 (0.0)	2 (40.0)	0 (40.0)	0 (0.0)				0 (0.0)	1 (20.0)	1 (20.0)	0 (0.0)	0 (0.0)
		R	5 (100)	2 (40.0)	1 (20.0)	3 (60.0)				1 (20.0)	1 (20.0)	0 (0.0)	0 (0.0)	3 (60.0)
S. aureus	3	S	0 (0.0)	1 (33.3)	2 (66.7)	1 (33.3)	NT	NT	NT	2 (66.7)	1 (33.3)	2 (66.7)	1 (100)	1 (33.3)
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)				0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
		R	5 (100)	2 (66.7)	1 (33.3)	2 (66.7)				1 (33.3)	2 (66.7)	1 (33.3)	0 (0.0)	2 (66.7)
Enterococcus species	1	S	1 (100)	0 (0.0)	1 (100)	0 (0.0)	NT	NT	NT	1 (100)	NT	NT	NT	0 (0.0)
		I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)				0 (0.0)				0 (0.0)
		R	0 (0.0)	1 (100)	0 (0.0)	1 (100)				0 (0.0)				1 (100)

Abbreviations: CoNS, Coagulase negative Staphylococci; S, Sensitive; I, Intermediate; R, Resistance; AMC, Amoxicillin-clavulanic acid; AMP, Ampicillin; CEF, Ceftazidime; CRO, Ceftriaxone; CIP, Ciprofloxacin; DOX, Doxycycline; MER, Meropenem; NIT, Nitrofurantion; CN, Gentamicin; P, Penicillin; SXT, Trymethoprim-Sulfamethoxazole; V, Vancomycine; No, Number; NT, Not tested.

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Table 5 MDR Pattern of Gram Positive and Gram Negative Bacterial Isolate from Urine Sample at Dilla University Referral Hospital, from January 2022 to December 2022

Bacterial Isolates	Total	Antibiotics Resistance Pattern					
		Ro	R1	R2	R3	R4	≥ R5
Gram negative antibiotics resistance pattern							
E. coli	7	0(0.0)	1(14.3)	2(28.6)	2(28.6)	1(14.3)	1(14.3)
K. pneumoniae	3	0(0.0)	0(0.0)	0(0.0)	1(33.3)	1(33.3)	1(33.3)
Enterobacter species	2	0(0.0)	1(50)	0(0.0)	1(50)	0(0.0)	0(0.0)
K. oxytoca	1	0(0.0)	0(0.0)	0(0.0)	1(100)	0(0.0)	0(0.0)
P. mirabilis	1	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(100)	0(0.0)
Citrobacter species	1	0(0.0)	0(0.0)	0(0.0)	1(100)	0(0.0)	0(0.0)
Gram positive antibiotics resistance pattern							
CoNS	5	0(0.0)	1(20)	2(40)	1(20)	0(0.0)	1(50)
S. aureus	3	0(0.0)	1(33.3)	0(0.0)	1(33.3)	0(0.0)	1(33.3)
Enterococcus species	1	0(0.0)	0(0.0)	1(50)	0(0.0)	1(50)	0(0.0)
Total	**24**	**0(0.0)**	**4(16.7)**	**5(25)**	**7(29.2)**	**4(16.7)**	**4(16.7)**

Abbreviation: CoNS, Coagulase negative Staphylococci.

Table 6 Bivariate and Multivariate Logistic Regression Analysis of Factors Associated with UTI Among Diabetic Patients (n=158) Attending in DUGH, Southern Ethiopia, 2022

Variables	Significant Bacteriuria		COR (95% CI)	P-value	AOR (95% CI)	P-value
	No N (%)	Yes N (%)				
Gender						
Male	93 (58.9)	8 (33.3)	1	1		
Female	65 (41.1)	16 (66.7)	1.3 (0.3–6.4)	0.762		
Age in year						
18–39	56 (35.4)	8 (33.3)	1.5 (0.4–3.9)	0.532		
40–59	75 (47.5)	4 (16.7)	1.1 (0.3–3.4)	0.434		
≥60	27 (17.1)	12 (50)	1	1		
Residence						
Rural	106 (79.1)	22 (91.7)	1	1		
Urban	28 (20.9)	2(8.3)	1.4 (0.04–2.78)	0.309		
Educational background						
Illiterate	14 (10.4)	11 (45.8)	1.5 (0.4–3.9)	0.002*	8.1 (5.1–12.4)	0.001*
Primary school	26 (19.4)	4(16.7)	1.1 (0.3–3.4)	0.234	1.2 (0.32–3.4)	0.270
Secondary school	53 (39.6)	1 (4.2)	0.9 (0.2–5.3)	0.235	2.2 (0.21–3.5)	0.201
College and above	41 (30.6)	8 (33.3)	1	1	1	1

(*Continued*)

Table 6 (Continued).

Variables	Significant Bacteriuria		COR (95% CI)	P-value	AOR (95% CI)	P-value
	No N (%)	Yes N (%)				
Marital status						
Married	50 (37.3)	11 (45.8)	1	1		
Unmarried	84 (62.7)	13 (54.2)	0.5 (0.2–2.3)	0.455		
Types of DM						
Type I DM	22 (16.4)	4(16.7)	1	1		
Type II DM	112 (83.6)	20 (83.3)	0.6 (0.1–3.4)	0.576		
Fasting						
< 126	37 (27.6)	9 (37.5)	1	1	1	1
≥ 126	97 (72.4)	15 (62.5)	1.1 (1.3–3.2)	0.034*	1.81 (1.01–2.21)	0.01*
Previous UTI						
Yes	62 (46.3)	14 (58.3)	1	1	1	1
No	72 (53.7)	10 (41.7)	2.5 (0.3–5.1)	0.131	7.7 (0.67–8.9)	0.104
Presence of comorbidities						
Yes	22 (16.4)	16 (66.7)	3.5 (3.1–10.5)	0.001*	4.2 (4.1–17.2)	0.001*
No	112 (83.6)	8 (33.7)	1	1	1	1
History of catheterization						
Yes	7 (5.2)	3 (12.5)	3.1 (0.3–15.6)	0.361		
No	127 (94.8)	21 (87.5)	1	1		
Medication for DM						
Tablet	49 (36.6)	5 (20.8)	6.5 (0.6–7.4)	0.174	0.2 (0.04–1.75)	0.119
Insulin	83 (61.9)	17 (70.8)	4.2 (0.55–6.2)	0.474	4.4 (0.04–1.75)	0.319
Both	2(1.5)	2(1.3)	1	1	1	1
Medication for hypertensive						
Yes	4 (3.0)	2 (8.3)	2.1 (0.5–8.1)	0.575		
No	130 (97)	22 (91.7)	1			

Note: *Indicates significantly associated variable.

ceftriaxone and ceftazidime showed higher rates of sensitivity. This increased antibiotic resistance including multidrug resistance gram-negative bacterial isolates may be due to the habit of empirical use of drugs and lack of antimicrobial susceptibility testing. This leads to the onset of chronic renal disorder.[47]

Higher penicillin (56%), ceftazidime (75.6%), and ampicillin (100%) resistance was observed in gram-positive bacteria. This can be due to the accessibility and indiscriminate use of widely prescribed medications, which could result in a rise in resistance. On the other hand, greater than 80% of the examined gram-positive isolates exhibited nitrofurantoin, trymethoprim-sulfamethoxazole and vancomycin sensitivity. Likewise, similar studies reported the same finding in different parts of the country.[26,35,40] According to our findings, trymethoprim-sulfamethoxazole, vancomycin, and nitrofurantoin are the most effective drugs for the empiric therapy of UTI, especially in study subjects with diabetic patients in the study area.

In our study, multiple drug resistance was reported in 16 (66.7%) bacterial isolates. This is comparable with the study conducted in Debre Tabor[14] (56.7%), Gondar[10] (59.8%) and Addis Ababa[48] (71.7%). However, prior studies done in Harar[30] (92.5%) and Hawassa[35] (93.9%) reported higher prevalence of MDR. The discrepancy may result from differences in the time of study the kind and generation of antibiotics we used for susceptibility testing or differences in type and quantity of antibiotics used to define bacterial isolate as MDR or not or any combination of these factors. Multiple antibiotic resistant bacteria are increasing at high rate from time to time. Numerous factors have been identified as major contributors to the emergence of multidrug resistant strains, including the indiscriminate and prolonged use of a wide variety of antibiotics, a lack of infection control, an increase in the frequency and speed of travel, a lack of antibiotic susceptibility testing site, and the absence of updated guidelines on the selection of drugs.

In our study, most of the independent variables like age, sex, residence, educational status, marital status, previous UTL, history of catheterization, medication for diabetes, and hypertension had no significant association with identified uropathogens bacteria (P>0.05). This is comparable with studies conducted in different parts of the country.[27,35,49] The current study showed that high blood glucose was positively correlated with urinary tract infections. Likewise, similar findings were reported in previous study conducted in Gondar.[10] In contrast to our finding, studies conducted in Nigeria reported that there are no associations between urinary tract infection and blood glucose level.[50] This may be due to the possibility that a single blood glucose reading does not accurately reflect glycemic management, which facilitates diabetic people to be more susceptible to UTIs. The increased prevalence of uropathogens in individuals with high blood sugar levels may be primarily attributable to a defective bladder's inadequate contraction, which results in static urine pools and, in combination with glycosuria, produces an ideal habitat for bacterial growth.

In our study, illiterate study participants and patients with additional diseases had a significant association with uropathogens (higher odds of getting urinary tract infections compared with other study participants). This is the same as other studies conducted elsewhere which reported illiteracy as a risk factor for urinary tract infections. This might be due to a lower level of knowledge on how to protect their health, particularly their personal hygiene, and protect themselves from bacterial infection and the immune suppression of HIV in infected patients and also the effects of hypertension with kidney disease.[32,51–54]

Conclusion

The prevalence rate of bacterial isolates among uropathogens was high with predominance of isolates of *E. coli*, CoNS, and *K. pneumoniae*. Both gram-negative and positive were highly resistant to the commonly used antimicrobial agents. Moreover, high multidrug resistances were identified in both gram-negative and positive bacterial isolates. We identified a significant association between comorbid patients, illiterate patients, and patients with higher blood glucose levels and the presence of UTI among diabetic patients. For diabetes mellitus patients, health information should be disseminated regarding UTI, glycemic management, and drug usage habits. Patients with additional diseases and diabetics with blood glucose levels below 126 mg/dL should have their urinary tracts screened for infections. The therapy of urinary tract infections in diabetes mellitus patients should be supported by AST and urine culture test results. Additional research employing molecular techniques, such as genotypic characterization in ESBL-producing bacteria infecting diabetic patients' urinary tracts in a larger sample size.

Data Sharing Statement

The corresponding author will provide the data set upon reasonable request, which was used for the analysis in the current work. All data relevant to the study are included in the article.

Ethical and Consent Statements

The Dilla University Health Research Ethics Review Committee authorized a protocol for patient recruitment and participation in the study that adhered to the Declaration of Helsinki and had the unique number duirb/012/2022-01. Each participant in the study received information about its purpose during the data collection process. Before beginning the data collection, each patient provided written consent. The clinical samples were gathered only for this study purpose. In order for patients to receive therapy based on the isolates' drug susceptibility data, samples with positive culture results were shared with doctors. The Dilla University Medical and Health Science College's Ethical Review Committee granted approval for the study. During the interview procedure, strict confidentiality was upheld, and anonymity was upheld during data processing and report writing. Participants in the study who had high levels of uropathogens were directed to their local medical center for the necessary therapies.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no conflicts of interest in this work.

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