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Prevalence, antimicrobial sensitivity patterns and associated factors of urinary tract infection among patients attending Nekemte Comprehensive Specialized Hospital, Western Ethiopia, 2024: a cross-sectional study

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Abstract

Background Urinary tract infections (UTIs) are a common health problem worldwide, leading to increased morbidity, mortality, and healthcare costs. Data on the prevalence of urinary tract infections, antimicrobial susceptibility patterns, and the associated factors are scarce in the study area. Therefore, the aim of this study was to determine the prevalence, antimicrobial susceptibility patterns and associated factors among urinary tract infections suspected patients.

Methods A hospital-based cross-sectional study was conducted at Nekemte Comprehensive Specialized Hospital, from June to September 2024 among 270 participants. Midstream urine samples were collected under aseptic techniques. Then samples were cultured on blood and MacConkey agars following standard microbiological techniques. Antimicrobial sensitivity testing was performed using the disc diffusion (Kirby-Bauer) method. The data were checked for completeness and consistency, entered into Epi Data version 4.6, and analyzed by Statistical Package for Social Sciences (SPSS) version 26. Logistic regression analysis was performed to determine the associated factors of urinary tract infections. *P-value* < 0.05 was considered statistically significant.

Result Of the total samples collected, 78/270 (28.9%) had significant bacteriuria. Gram-negative and gram-positive bacteria accounted for 67/78 (85.9%) and 11/78 (14.1%), among which *Escherichia coli* was the most prevalent, 30/78 (38.5%), followed by *Klebsiella* species, 26/78 (33.3%). Gram-positive isolates were highly susceptible to gentamicin (100%) and clindamycin (88.9%). Gram-negative bacteria showed high-level susceptibility to amikacin (100%), cefepime (93.3%), and gentamicin (91.0%). The total multidrug resistance identified was 44/78 (56.4%). Female gender, a having history of UTI, and antibiotic use without a prescription were statistically significant with UTI.

Conclusion and recommendation Most of the isolated uropathogens were multidrug-resistant. A significant association with UTI was observed with being female, having a previous history of UTI, and using antibiotic without a prescription. Treatment of UTI should be supported by culture and antimicrobial susceptibility patterns.

Keywords Bacteria, Urinary tract infection, Multidrug resistance

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Introduction

Urinary tract infection (UTI) refers to infection caused by the growth of microorganisms in the urinary tract [1]. Clinically, it can be regarded as the presence of significant bacteriuria regardless of the location of the infection in the urinary tract system [2]. It is the most prevalent infectious disease, affecting half of the population, at least once in their lifetime and having the potential to cause serious health issues [3]. It is the second most prevalent bacterial infection treated in primary care, resulting in about 8.1 million annual visits to medical professionals [4].

Urinary tract infections affect the urinary tract, primarily the kidneys, bladder, urethra, and prostate. [5]. Based on location, UTI can be lower, affecting the urethra (urethritis), bladder (cystitis), and upper, affecting kidneys (pyelonephritis) [6]. Upper UTIs have a major negative impact on kidney function and can be fatal when bacteria from infected kidneys enter the bloodstream and cause urosepsis. Based on severity, UTI can be uncomplicated, in which the urinary tract is both anatomically and functionally normal, and complicated, which is described as one that has been linked to host risk factors like host immunodeficiency, urinary tract abnormalities, bladder dysfunction in type 2 diabetes, and estrogen deficiency, with growing colonization and declining treatment efficacy [7].

Gram-negative and gram-positive bacteria are the most common causative agents for UTIs [8]. Among gram-negative bacteria, *Proteus* species, *E. coli*, *Klebsiella* species, *Acinetobacter* species, and *Pseudomonas aeruginosa* are the predominant causes of UTI, while *Staphylococcus aureus*, coagulase-negative staphylococci, and *Enterococcus* species are common among gram-positive bacterial causes of UTIs. The pathophysiology of UTIs is linked to important virulence factors that exhibit invasion, colonization, and mediation of different host defense mechanisms directed against the bacterial pathogens [9].

Every year, around 150 million people worldwide receive a UTI diagnosis, costing the world economy more than 6 billion dollars [10]. In addition, it has emerged as the most frequent hospital-acquired infection, accounting for 35% of nosocomial infections. In hospitalized patients, it is the second most frequent cause of bacteremia [11]. Urinary tract infection is a serious public health issue that contributes significantly to morbidity, medical expenses, and treatment failures owing to repeated infections. It is also among the primary causes of misuse of antibiotics in the community, which contributes to the growing prevalence of antimicrobial resistance [12].

The prevalence of UTI varies from region to region and nation to nation. Study findings from China, France, Bangladesh, and Yemen revealed UTI prevalence of 16.6% [13], 19.2% [14], 17.7% [15] and 18.0% [16], respectively. Findings from a systematic review indicated that the magnitude of UTI in Sub-Saharan Africa (SSA) was 32.12% [17]. Moreover, in Gambia, Uganda, and Kenya, the magnitude of UTI accounted for 12.8% [18], 24.9% [19], and 27.6% [20], respectively. Furthermore, study findings from Ethiopia reported UTI prevalence of 23.7% [21], 15.8% [11], 32.1% [22], 16.3% [23], 24.1% [24], and 31.6% [25].

Several factors are responsible for the incidence of UTI. Analysis of risk factors revealed that gender (mostly being female) and age were associated with UTIs. In females, the length of the urethra is shorter than that of males. On the other hand, frequency of sexual intercourse, use of contraceptive methods such as spermicides, shorter distance between anus and urethra, and poor perianal hygiene are risk factors for UTI in females [26, 27]. In addition, the inability to complete bladder emptying leads to the accumulation of residual urine, predisposing individuals with advanced age to UTI [28]. The presence of underlying anatomical urinary tract abnormalities, kidney failure, or use of medical devices such as catheters is believed to predispose to UTIs [29].

In the study area, there were no data on the current prevalence of UTI and antimicrobial susceptibility patterns. Besides, antimicrobial resistance is very dynamic, so periodic regular screening is important. Therefore, this study aimed to determine the magnitude of UTI, the antimicrobial susceptibility patterns of bacterial causes of UTI, and assess associated factors at Nekemte Comprehensive Specialized Hospital.

Methods and materials

Study area, period, and design

The study was conducted at Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, which is located in Nekemte Town, East Wallaga, West Oromia, at a distance of 328 km from Addis Ababa. The hospital has different departments and wards like the outpatient department, medical ward, and surgical ward. It is diversified by health services such as emergency, outpatient, inpatient, maternal and child health (MCH), delivery, imaging, laboratory, physiotherapy, pharmacy, psychiatry, and follow-up of chronic diseases. A hospital-based cross-sectional study was conducted from June to September 2024.

Population and eligibility criteria

All patients who were attending Nekemte Comprehensive Specialized Hospital were used as the source population, while patients who were suspected to have UTI (having pain during urination, pain in the flank, pain in the abdomen, pain in pelvic area, fever, etc.) were the

study population. All patients who were clinically suspected of having UTIs and willing to participate were included. On the other hand, patients who had been on antibiotics within the last 14 days of the data collection period and unconscious patients were excluded.

Sample size determination and sampling technique

The sample size was determined by using a single population proportion formula.

$$n = \left(z_{1-\frac{\alpha}{2}}\right)^2 \frac{P[1-P]}{d^2}$$

n = Number of study participants.

Z = standard normal distribution at 95% CI which is 1.96.

P = Prevalence of UTI which was 22.7% from study conducted in Addis Ababa [30].

D = Margin of error which is 5%

Therefore, by taking p = 22.7, Z = 1.96, d = 0.05.

$$\mathrm{N} = \frac{(1.96)^2 \times 0.227(1-0.227)}{(0.05)^2} = \frac{3.8416 \text{ X } 0.227 \text{ X } 0.773}{0.0025} = 270$$

The final sample size was 270. A convenience sampling method was used to select study participants.

Data collection and laboratory testing

Data collection

The data collection tool was a structured questionnaire obtained and modified from different literature [22, 24, 28–31]. Data collectors were trained and briefed on how to gather data using a questionnaire. The data collection tool was validated by pre-testing 5% [14] of the sample size. Data regarding socio-demographic characteristics and associated factors were collected by using an interviewer-administered structured questionnaire from each study participant by two trained nurses.

Sample collection

After conducting the interview, study participants were oriented on how to collect urine samples. Midstream urine samples (10–20 ml) were collected aseptically. Two medical laboratory professionals collected, labeled, and immediately transported at ambient temperature to the Nekemte Public Health Research and Referral Laboratory Center for culture and antimicrobial susceptibility tests. The samples were transported to culture laboratory within two hours of collection. At the testing laboratory the samples were processed immediately.

Bacterial isolation and identification

Each urine sample was inoculated onto blood agar (Liofilchem, Italy) and MacConkey agar ((Liofilchem, Italy) using a sterile, standard calibrated wire loop (0.001 ml). Calibrated wire loop enables accurate determination of CFU/ml in the urine sample. In freshly voided urine, the culture of ≥ 100 colonies of one type (number of bacteria ≥ 10^5 CFU/ml) has usually been regarded as cutoff for UTI. Following 24–48 h of aerobic incubation at 37 °C, the plates were macroscopically assessed for morphological characteristics on the media to make presumptive identifications. Gram staining reactions and biochemical profiles, including tests for indole production, sugar fermentation, H_2S production, gas production, citrate utilization, motility, urease activity, and oxidase tests, were performed to identify gram-negative isolates. For gram-positive bacteria, catalase and coagulase tests were done. A catalase test was done to differentiate staphylococci (catalase producers) and streptococci (not catalase producers) while coagulase. On the other hand, we performed coagulase test to differentiate *S. aureus* (coagulase- producer) from coagulase negative staphylococcus species.

Antimicrobial susceptibility testing

Antimicrobial sensitivity testing (AST) was done using the Kirby-Bauer disc diffusion method on Mueller–Hinton Agar (MHA) (HIMEDIA, India) according to Clinical and Laboratory Standards Institute (CLSI) 2024 guidelines [34]. Pure culture colonies of 24-h-old were suspended in a tube with 5 mL of physiological saline to get bacterial inoculums equivalent to 0.5 McFarland turbidity standards. A sterile cotton swab was dipped and rotated across the wall of the tube to avoid excess fluid, evenly inoculated on MHA, and then the antibiotic disks were placed on the plates. The plates were then incubated at 35 °C to 37 °C for 18–24 h. Diameters of the zone of inhibition were measured using a ruler. Antimicrobial sensitivity test results were interpreted based on the standardized table supplied by the CLSI criteria as sensitive, intermediate, and resistant. The antibiotic disks (OXOID, UK) were selected for both gram-positive and gram-negative based on the CLSI guideline and frequently prescribed antibiotics for the treatment of UTIs in the study area. Accordingly, ciprofloxacin (CIP, 5 µg), nitrofurantoin (NIT, 300 µg), trimethoprim-sulfamethoxazole (SXT, 1.25/23.75 µg), penicillin G (PG, 10 units), amoxicillin-clavulanate (AMC, 20/10 µg), ampicillin (AMP, 10 µg), gentamicin (GEN, 10 µg), ceftazidime (CAZ, 30 µg), ceftriaxone (CRO, 30 µg), cefoxitin (FOX, 30 µg), clindamycin (2 µg), azithromycin (ATH, 15 µg), piperacillin-tazobactam (PTZ, 100/10 µg), amikacin (AK,

30 µg), cefazolin (CZ, 30 µg), cefepime (FEB, 30 µg), and meropenem (MEM, 10 µg) were tested.

Operational definitions

Urinary tract infection (UTI) – is significant bacteriuria a culture that grew $\geq 10^5$ colony-forming units (CFU/mL) in single voided 10–20 ml midstream urine.

Symptomatic UTI- is a patient whose urine is yielding positive referable to the urinary tract cultures ($\geq 10^5$ CFU/ml) and who has symptoms.

Asymptomatic bacteriuria- is significant growth of the pathogenic bacteria ($\geq 10^5$ bacteria/ml) in the absence of clinical manifestation.

Midstream urine- is a sample obtained from the middle part of urine flow: clean catch urine sample.

History of UTI –is any history of infection of the urinary tract diagnosed by a physician. [3]

Multiple drug resistance-refers to resistances to three or more antimicrobial agents belonging to different structural classes [44].

Quality assurance

Pre-analytical phase

Before data collection, data collectors had undergone training, and study participants were informed and asked for their consent/assent. After a face-to-face interview about sociodemographic and clinical data related to UTI, the patients were sent to the laboratory request form. Then, all the study participants were asked to bring 10–20 ml clean-catch midstream urine specimens after urine sample collection techniques were explained by medical laboratory professionals. Sample containers were appropriately labeled with the patient's identifier code, collection date, and time. The collected samples were immediately transported to the Nekemte Public Health Research and Referral Laboratory Center within one hour of collection for culture and AST. Then, they were immediately inoculated on appropriate media. Patient information was regularly reviewed for clarity and completeness. All media and relevant reagents were meticulously inspected and checked for expiration dates before use.

Analytical phase

Culture was performed by microbiologists. Culture media were tested for sterility by incubating 5% of the batch. Only specimens that produced $\geq 10^5$ CFU/mL were considered significant for the study. Standard reference bacterial strains, *E. coli* (ATCC 25922) and *S. aureus* (ATCC 25923) were used as negative and positive controls during the testing process.

Post analytical

Results were reviewed by an assigned person in microbiology. Then test results were documented. Isolated bacteria stored at < −70℃ for future reference.

Data processing and analysis

The collected data was coded, cleaned, and entered into Epi-data version 4.6.0.6 and then exported to SPSS version 26 for analysis. Binary logistic regression analysis was used to select candidate variables for multivariable logistic regression analysis. Variables with p-value < 0.25 were candidates for multivariate analysis. The adjusted odds ratio (AOR) at 95% CI and p-value < 0.05 were used to determine the strength and significance of the association, respectively. Results were presented in words, figures, and tables.

Ethical consideration

An ethical approval letter was obtained from the Salale University Institutional Research Ethics Review Committee (SIU–IRERC-260/2016). Permission was obtained from Nekemte Comprehensive Specialized Hospital and Nekemte Public Health Research and Referral Laboratory Center. Before enrolling in the study, participants, guardians, or caretakers of children receive detailed explanations about the study's goals, potential benefits and risks, and their rights. They were then asked to provide written consent or assent. Written informed consent was obtained from all the participants and the legal guardians of those who were below 16 years of age or did not have formal education. Participation in the study was voluntary, and all information collected was kept confidential and used solely for research purposes. Laboratory findings were shared with their healthcare providers for standard patient care.

Results

Sociodemographic characteristics

Of the total study participants, males and females accounted for 127/270 (47.0%) and 143 (53.0%) were females, respectively. The age of the participants ranged from 2 to 97 years, with a mean age of 33.5 years. The majority of them, 65/270 (24.1%) were in the age range of 25 – 34. About 86 (31.9%) were from urban areas while 71/270 (26.3%) of them had attended secondary education (Table 1).

Clinical characteristics of the study participants

The majority of the participants 209 (77.4%) were from the outpatient department. Forty-two (52.9%) of the participants were found to have a history of antibiotic use without a prescription and a previous history of

Table 1 Sociodemographic characteristics of urinary tract infection suspected patients attending Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, 2024

Variables	Category	Frequency (%)
Sex	Male	127 (47.0%)
	Female	143 (53.0%)
Age in years	≤5	17(6.3%)
	5–14	13(4.8%)
	15–24	57(21.1%)
	25–34	65 (24.1%)
	35–44	38(14.1%)
	45–54`	34(12.6%)
	≥55	46(17%)
Marital status	Single	80(29.6%)
	Married	169(62.6%)
	Divorce	16(5.9%)
	Widowed	5(1.9%)
Residence	Rural	184(68.1%)
	Urban	86(31.9%)
Occupation	Student	69(25.6%)
	Privet employer	11(4.1%)
	Merchant	32(11.9%)
	Government employer	34(12.6%)
	Housewife	26(9.6%)
	Daily labor	16(5.6%)
	Farmer	82(30.4%)
Monthly income	<1500 ETB	76(28.1%)
	1500–3500 ETB	90(33.3%)
	>3500 ETB	104(38.4%)
Educational status	No formal education	50(18.5%)
	Read and write	20(7.4%)
	Primary school	61(22.6%)
	Secondary school	71(26.3%)
	College and above	68(25.2%)

admission for UTI. Six (2.2%) and 108 (40.0%) of them had renal failure and dysuria, respectively (Table 2).

Prevalence of urinary tract infection and bacterial uropathogens isolates

Of the total 270 urine samples cultured, 78 (28.9%) had shown significant bacteriuria. Nine different bacterial species were isolated from the urine samples. The majority of the isolates, 67 (85.9%) were gram-negative while the remaining 11 (14.1%) were found to be gram-positive. The predominant bacterial isolates were *E. coli, Klebsiella* spp., and *Staphylococcus aureus*, accounting for 30 (38.5%), 23 (29.5%), and 9 (11.5%), respectively (Fig. 1).

Antimicrobial sensitivity patterns of bacterial isolates

Gram-negative bacterial isolates

Fifty percent of *E. coli* was resistant to ciprofloxacin and ceftriaxone while 43.3% of the isolates were resistant to ceftazidime, amoxicillin-clavulanate, and ampicillin. On the other hand, 100%, 96.2%, 92.3%, and 88.5% of *Klebsiella* spp. were found to be susceptible to amikacin, gentamicin, meropenem, and cefepime, respectively (Table 3).

Gram-positive bacterial isolates

Gentamicin and clindamycin were the most effective drugs against gram-positive bacteria. All *S. aureus* and coagulase-negative staphylococci were sensitive to gentamicin. In addition, 8(88.9%) *S. aureus* and all coagulase-negative staphylococci were susceptible to gentamicin. About 8 (88.9%) of *S. aureus* isolates were found to be resistant to all ciprofloxacin, azithromycin, and tetracycline. This study finding showed that two out of three (66.7%) *S. aureus* isolates were methicillin-resistant (MRSA), as tested by cefoxitin (Table 4).

Multidrug resistance patterns of isolated bacteria

As revealed by this study, the multidrug resistance (MDR) rate was 44/78(56.4%). Of the isolates, the predominant MDR bacterial species were *E. coli* 17/78 (21.8%) followed by *Klebsiella* spp. 12/78 (15.4%) and *S. aureus* 8/78 (10.3%). Furthermore, the rate of MDR among gram-negative and gram-positive bacterial isolates accounted for 34/67 (50.7%) and 10/11 (90.9%), respectively (Table 5).

Factors associated with UTI

In the bivariate logistic analysis variables including age, sex, educational status, occupation, history of antibiotic use without a prescription, previous treatment of UTI, dysuria, nephropathy, and hypertension were significantly associated with UTI at a *p-value* < 0.25. In multivariate logistic regression analysis variables including sex, history of antibiotic use without prescription, and previous treatment for UTI were significantly associated with UTI at a *p-value* less than 0.05. This study found that females were about 1.951 times more likely to develop UTI than males (AOR 1.951, CI: 1.061–3.583). Participants using antibiotics without prescription were about 5.051 times at risk of developing UTI (AOR 5.051, CI: 2.574–9.911). Furthermore, study participants with a previous history of UTI were 3.476 times more likely to develop UTI than those without this history (AOR 3.476, CI: 1.896–6.371). (Table 6).

Table 2 Clinical characteristics of urinary tract infection suspected patients attending Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, 2024

Variables	Category	Frequency (%)
Patient location	Inpatient	61(22.6%)
	Outpatient	209(77.4%)
History of antibiotic use without prescription	Yes	142(52.9%)
	No	128(47.4%)
Previous history of UTI	Yes	97(35.9%)
	No	173(64.1%)
History of admission for UTI	Yes	42(15.6%)
	No	228(84.4%)
If admitted length admitted in Hospital	For 1–7 days	25(59.52%)
	For two weeks	11(26.19%)
	For three weeks	3(7.14%)
	For one month and above	3(7.14%)
Renal failure	Yes	6(2.2%)
	No	264(97.8%)
Dysuria	Yes	108(40%)
	No	162(60%)
Nephropathy	Yes	110(40.7%)
	No	160(59.3%)
History of Hypertension	Yes	38(14.1%)
	No	232(85.9%)
History of DM	Yes	28(10.4%)
	No	242(89.6%)

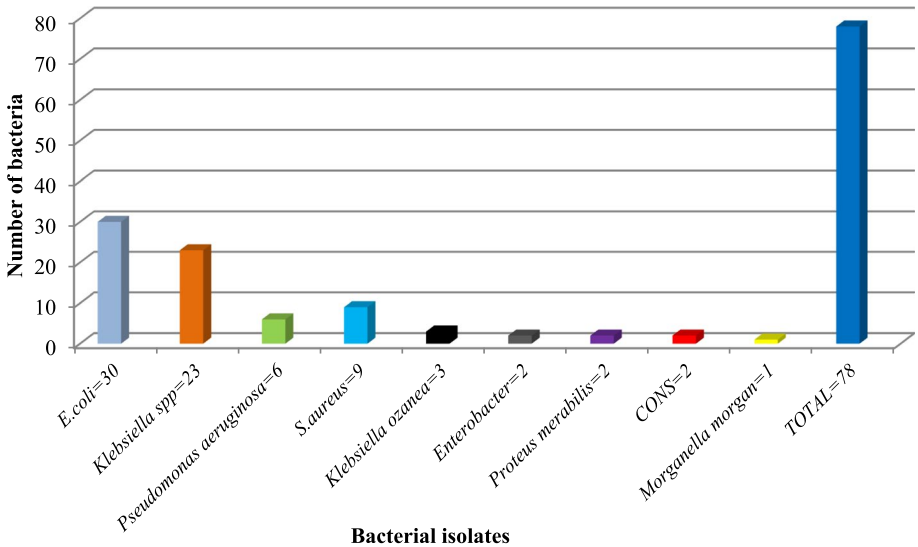


Fig. 1 Frequency of bacterial species among patients with UTI attending Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, 2024

Discussion

Urinary tract infections are prevalent and represent a major healthcare challenge worldwide. Managing these infections is difficult due to the resistance of uropathogens to antibiotics. This research aimed to determine the prevalence of these bacteria, their resistance rates, and the associated factors among patients suspected to have UTI in the study area.

Table 3 Antibiotic sensitivity patterns of gram-negative bacteria isolated from urinary tract infection suspected patients attending Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, 2024

Types of Bacteria tested		Susceptibility patterns of bacteria N (%)													
		AK	GEN	PTZ	CRO	CAZ	CIP	MEM	AMC	AP	TS	TTC	FEB	NIT	CZ
E. coli (30)	S	29 (96.6)	25 (83.3)	21 (70)	15 (50)	18 (60)	21 (70)	26 (86.7)	5 (16.7)	7 (23.3)	16 (53.3)	17 (56.7)	28 (93.3)	27 (90)	16 (53.3)
	I	0 (0.0)	0 (0.0)	3 (10)	0 (0.0)	0 (0.0)	0 (0.0)	3 (10)	4 (13.3)	1 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	2 (6.7)	2 (6.7)
	R	1 (3.3)	5 (16.7)	6 (20)	15 (50)	12 (40)	9 (30)	1 (3.3)	21 (70)	22 (73.3	14 (46.7)	13 (43.3)	2 (6.7)	1 (3.3)	12 (40)
Klebsiella spp. (26)	S	26 (100)	25 (96.2)	14 (53.8)	17 (65.4)	16 (61.5)	14 (53.8)	24 (92.3)	17 (65.4)	NT	16 (61.5)	NT	23 (88.5)	20 (76.9)	13 (50)
	I	0 (0.0)	1 (3.8)	8 (30.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (11.5)	NT	0 (0.0)	NT	0 (0.0)	2 (7.7)	0 (0.0)
	R	0 (0.0)	0 (0.0)	4 (15.4)	9 (34.6)	10 (38.5)	12 (48.2)	2 (7.7)	6 (23.1)	NT	10 (38.5)	NT	3 (11.5)	4 (15.4)	13 (50)
P. mirabilis (2)	S	2 (100)	2 (100)	2 (100)	0 (0.0)	0 (0.0)	2 (100)	2 (100)	2 (100)	2 (100)	2 (100)	NT	2 (100)	0 (0.0)	NT
	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)	NT	0 (0.0)	0 (0.0)	NT
	R	0 (0.0)	0 (0.0)	0 (0.0)	2 (100)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	NT	0 (0.0)	2 (100)	NT
P. aeruginosa (6)	S	5 (83.3)	6 (100)	1 (16.7)	NT	1 (16.7)	6 (100)	4 (66.7)	NT	NT	NT	NT	3 (50)	6 (100)	NT
	I	0 (0.0)	0 (0.0)	2 (33.3)	NT	0 (0.0)	0 (0.0)	0 (0.0)	NT	NT	NT	NT	0 (0.0)	0 (0.0)	NT
	R	1 (16.7)	0 (0.0)	3 (50)	NT	5 (83.3)	0 (0.0)	2 (33.3)	NT	NT	NT	NT	3 (50)	0 (0.0)	NT
M. morganii (1)	S	1 (100)	1 (100)	1 (100)	0 (0.0)	1 (100)	1 (100)	1 (100)	NT	NT	1 (100)	0 (0.0)	1 (100)	NT	0 (0.0)
	I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	NT	NT	0 (0.0)	0 (0.0)	0 (0.0)	NT	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	NT	NT	0 (0.0)	1 (100)	0 (0.0)	NT	1 (100)
Enterobacter spp. (2)	S	2 (100)	2 (100)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100)	NT	NT	0 (0.0)	0 (0.0)	1 (50)	2 (100)	1 (50)
	I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)	NT	NT	0 (0.0)	0 (0.0)	1 (50)	0 (0.0)	1 (50)
	R	0 (0.0)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	2 (100)	0 (0.0)	NT	NT	2 (100)	2 (00)	0 (0.0)	0 (0.0)	0 (0.0)
Total	S	65 (97)	61 (91)	41 (61.2)	32 (47.8)	36 (53.7)	44 (65.7)	59 (88)	24 (41.4)	9 (28.1)	35 (57.4)	18 (52.9)	57 (86.4)	55 (83.3)	30 (50.8)
	I	0 (0.0)	1 (1.5)	13 (19.4)	0 (0.0)	2 (3)	0 (0.0)	3 (4.5)	7 (12)	1 (3.1)	0 (0.0)	0 (0.0)	1 (1.5)	4 (6.1)	3 (5.1)
	R	2 (3)	5 (7.5)	13 (19.4)	29 (58.8)	29 (43.3)	23 (34.3)	5 (7.5)	27 (46.6)	22 (68.8)	26 (42.6)	16 (47.1)	8 (12.1)	7 (10.6)	26 (44.1)

S Susceptible, *I* Intermediate, *R* Resistant, *NT* Not tested, *AK* Amikacin, *AMC* Amoxicillin-clavulanate, *AP* Ampicillin, *GEN* Gentamicin, *PTZ* Piperacillin-Tazobactam, *CRO* Ceftriaxone, *NIT* Nitrofurantoin, *TTC* Tetracycline, *CAZ* Ceftazidime, *MEM* Meropenem, *CIR* Ciprofloxacin, *TS* Trimethoprim-sulfamethoxazole, *FEB* Cefepime *CZ* Cefazolin

Table 4 Antibiotic susceptibility pattern of gram-positive bacteria isolated from urinary tract infection suspected patients attending Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, 2024

Types of Bacteria tested		Susceptibility patterns of bacteria N (%)								
		GEN	CIP	FOX	ATH	CD	TTC	TS	PG	NIT
S. aureus (9)	S	9 (100)	1 (11.1)	3 (33.4)	1 (11.1)	8 (88.9)	1 (11.1)	6 (66.6)	0 (0.0)	2 (22.2)
	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	0 (0.0)	8 (88.9)	6 (66.6)	8 (88.9)	1 (11.1)	8 (88.9)	3 (33.3)	9 (100)	7 (77.8)
CONS(2)	S	2 (100)	0 (0.0)	2 (100)	2 (100)	2 (100)	2 (100)	1 (50)	0 (0.0)	0 (0.0)
	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	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50)	2 (100)	2 (100)
Total (11)	**S**	**11 (100)**	**1 (9.1)**	**5 (45.5)**	**3 (27.3)**	**10 (90.9)**	**3 (27.3)**	**7 (63.6)**	**0 (0.0)**	**2 (18.2)**
	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	**0 (0.0)**	**10 (90.9)**	**6 (54.5)**	**8 (72.7)**	**1 (9.1)**	**8 (72.7)**	**4 (36.4)**	**11 (100)**	**9 (81.8)**

NT Not Tested, *GEN* Gentamicin, *NIT* Nitrofurantoin, *CRO* Ceftriaxone, *CIR* Ciprofloxacin, *TS* Trimethoprim-sulfamethoxazole, *CD* Clindamycin, *PG* Penicillin G, *TTC* Tetracycline, *ATH* Azithromycin, *FOX* Cefoxitin

Table 5 Multidrug resistance patterns of gram-negative and gram-positive bacteria isolated from urinary tract infection suspected patients attending Nekemte Comprehensive Specialized Hospital, Nekemte, 2024

Isolates (number)	Degree of Resistance								
	R0 (%)	R1 (%)	R2 (%)	R3 (%)	R4 (%)	R5 (%)	R6 (%)	≥ R7 (%)	Total MDR
Gram-negative									
E. coli (30)	7 (23.3)	1 (3.3)	5 (16.7)	2 (6.7)	3 (10)	2 (6.7)	4 (13.3)	6 (20)	17/30 (56.7)
Klebsiella spp. (26)	8 (30.4)	4 (17.4)	2 (8.7)	0 (0.0)	5 (13)	0 (0.0)	4 (17.4)	3 (13)	12/26 (46.2)
P. aeruginosa (6)	1 (16.7)	0 (0.0)	3 (50)	1 (16.7)	1 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	2/6 (33.3)
P. mirabilis (2)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
M. morganii (1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1/1(100)
Enterobacter spp. (2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	2/2(100)
Total (67)	**16 (53.3)**	**5 (16.7)**	**12 (40)**	**3 (10)**	**12 (40)**	**2 (6.7)**	**8 (13.3)**	**9 (30)**	**34/67 (50.7)**
Gram Positive									
S. aureus (9)	1 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (11.1)	5 (55.6)	2 (22.2)	0 (0.0)	8/9 (88.9)
CONS (2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50)	1 (50)	0 (0.0)	0 (0.0)	2/2 (100)
Total (11)	**1/11 (9.1)**	**0/11 (0.0)**	**0/11 (0.0)**	**0/11 (0.0)**	**2/11 (18.2)**	**6/11 (54.5)**	**2/11 (18.2)**	**0/11 (0.0)**	**10/11 (90.9)**
Grand total (67 + 11 = 78)	**17/78 (21.8)**	**5/78 (6.4)**	**12/78 (15.4)**	**3/78 (3.8)**	**14/78 (17.9)**	**8/78 (10.3)**	**10/78 (12.8)**	**9/78 (11.5)**	**44/78 (56.4)**

R0 Sensitive to antibiotics, *R1-7* Resistance to 1, 2, 3, 4, 5, 6, and 7 antibiotics; R3 – R7: resistance to 3 or more antibiotics from different classes (MDR)

In this study, the overall prevalence of UTI observed among suspected patients was 28.9% (95% CI: 23.7–34.5%). A comparable result was reported in the studies conducted in Addis Ababa 32.1% [22], Hawassa 32.8% [35], Eastern Ethiopia was 28.4% [36] and study conducted in Tanzania 27.4% [37], and a study conducted in Kenya 27.6% [20]. But Lower than the study conducted in Ethiopia 90.1% [38], 39.8% [39], Uganda 64.0% [40], and India 77.9% [41]. However, the current study finding was higher than the study conducted in Northwest Ethiopia 20.6% [32], and Gambia 12.8% [18].This difference might be due to population variation and differences in the sample sizes.

In this study, 85.9% (95% CI: 76.9–92.3) and 14.1% (95% CI: 7.7–23.1) gram-negative and gram-positive bacteria were identified, respectively, yielding a total bacterial isolate of 78. A study from Felege Hiwot Hospital reported a lower prevalence of gram-negative bacteria (73.2%) but a higher prevalence of gram-positive bacterial isolates (26.8%) [11]. Another study finding from Tanzania reported lower rates of gram-negative bacterial isolates (57.8%) and higher rates of gram-positive bacteria (42.2%)

Table 6 Bivariate and multivariate analyses of factors associated with the culture-confirmed urinary tract infection suspected patients attending Nekemte Comprehensive Specialized Hospital, Nekemte, Ethiopia, 2024

Variables		Culture results				Bivariate analysis		Multivariate analysis	
		Positive		Negative		COR (95% CI)	*P-value*	AOR (95% CI)	*P-value*
		No	%	No	%				
Age category	<5	6	35.3	11	64.7	1.075(0.357–3.432)	0.903	0.410(0.100–1.6880	0.217
	5–14	2	15.4	11	84.6	3.227(0.637–16.312)	0.157*	1.663(0.279–9.9050	0.577
	15–24	10	17.5	47	82.5	2.755(1.111–6.830)	0.029*	2.047(0.722–5.801)	0.178
	25–34	20	30.8	45	69.2	1.319(0.594–2.928)	0.496	1.143(0.451–2.899)	0.778
	35–44	15	39.5	23	60.5	0.879(0.371–2.176)	0.813	0.771(0.277–2.145)	0.618
	45–54	8	23.5	26	76.5	1.905(0.706–5.143)	0.203*	2.609(0.847–8.0360	0.095
	>55	17	37	29	63	1		1	
Sex	Female	49	34.4	94	65.7	1.762(1.027–3.021)	0.040*	1.951(1.061–3.583)	0.031**
	Male	29	22.8	98	77.2	1		1	
Educational status	No formal education	14	28	36	72	1.314	0.501	2.114(0.712–6.278)	0.178
	Can write and read	4	20	16	80	2.044	0.245*	2.840(0.645–12.493)	0.167
	1º education	1	24.6	6	75.4	1.567	0.252	2.055(0.745–5.672)	0.164
	2º education	22	30.9	49	69.1	1.138	0.721	1.624(0.663–3.980)	0.289
	College and above	23	33.8	45	66.2	1		1	
Occupation	Student	15	21.73	54	78.27	1.579(0.753–3.311)	0.227*	0.795(0.225–2.809)	0.721
	Governmental employer	11	32.4	23	67.6	0.917(0.389–2.164)	0.843	1.322(0.355–4.926)	0.677
	Privet employer	3	27.3	8	72.7	1.170(286-4.780)	0.827	1.385(0.238–8.066)	0.717
	Daily labor	4	25	12	75	1.316(0.386–4.481)	0.661	1.304(0.269–6.322)	0.742
	Merchant	8	25	24	75	1.316(0.520–3.328)	0562	2.453(0.726–8.288)	0.148
	Housewife	12	46.1	14	53.9	0.512(0.207–1.262)	0.146*	0.769(0.226–2.6619)	0.769
	Farmer	25	30.5	57	69.5	1			
History of antibiotic use without prescription	No	64	45.1	78	54.9	1			
	Yes	14	10.9	114	89.1	6.681(3.502–12.748)	0.0001*	5.051(2.574–9.911)	0.001**
Previous history of UTI	No	30	17.3	143	82.7	1			
	Yes	48	49.5	49	50.5	4.669(2.668–8.173)	0.0001*	3.476(1.896–6.371)	0.001**
Dysuria	No	40	24.7	122	75.3	1			
	Yes	38	35.2	70	64.8	0.604(0.355–1.029)	0.063*	0.764(0.322–1.811)	0.541
Nephropathy	No	40	24.7	122	75.3	1			
	Yes	3	35.2	70	64.8	0.632(0.371–1.075)	0.090*	1.511(0.735–3.103)	0.261
Hypertension	No	62	26.7	170	73.3	1			
	Yes	16	37.2	27	64.3	0.501(0.247–1.017)	0.056*	0.581(0.239–1.416)	0.232

*Candidate variable for multivariate analysis, *p-value* <0.25. ** Associated factor, *p-value* <0.05

[37] but study findings from Iraq reported gram-negative and gram-positive bacterial isolates accounting for 80.6% and 19.4%, respectively, which is consistent with the current study [10]. Variations in study participants, climate, and geographical locations are possible reasons for the differences in the distribution of bacterial isolates.

The predominant bacterial isolate in this study was *E. coli*, which accounted for 38.5%. Other study findings also reported *E. coli* as the predominant bacteria, like in Northwest Ethiopia 42.6% [32], Northeast Ethiopia 42.7% [21], and China 39.2% [13]. The frequent isolate for *E. coli* might be attributed to its unique structure, which promotes both bacterial attachment to and invasion of host tissues within the urinary tract. *E. coli* is the most common cause of UTI due to certain virulence factors like hemolysin production and the presence of fimbriae [42]. *E. coli* showed the highest resistance rates to ampicillin, amoxicillin-clavulanate, tetracycline, ceftriaxone, and trimethoprim-sulfamethoxazole consecutively, which was in line with a study conducted in Northwest Ethiopia

[32]. *P. aeruginosa* was 100% sensitive to nitrofurantoin, the result which was in line with a study conducted in India (41).

All *S. aureus* isolates and 88.9% were found to be susceptible to gentamicin and clindamycin, respectively. On the other hand, the highest resistance to penicillin 100%, ciprofloxacin 88.9%, azithromycin 88.9% and tetracycline 88.9% was demonstrated by *S. aureus*. In a study conducted at Bahir Dar all *S. aureus* isolates were resistant to penicillin [11]. In Bangladesh, it was found that all (100%) *S. aureus* isolates were susceptible to gentamicin which is consistent with current study findings, but on the contrary, none of the isolates were resistant to ciprofloxacin [15].

The overall prevalence of MDR observed among UTI-suspected patients was 56.4% (95% CI: 45.3–67.0%). This finding is consistent with study findings from Addis Ababa (59.5%) [22], Arba Minch General Hospital 50.4% [43] and Saudi Arabia 46.2% [44]. However, the MDR rate of the current study is lower than studies done at Hawassa 80.3% [35], Mekelle 73% [45] and Gambia 88.9% [18]. This variation of MDR might be due to widespread misuse of antibiotics, inappropriate prescription of drugs, and lack of knowledge about drug resistance. Once a patient acquires resistant strain bacteria, then it transfers antibiotic resistance genes to other bacteria. [31]. As revealed by this study, the predominant bacterial species with MDR were *E. coli*, *Klebsiella* spp., and *S. aureus*, accounting for 21.8%, 15.4%, and 10.3%, respectively. A study from Gondar University Comprehensive Specialized Hospital supports this finding, where *E. coli* and *Klebsiella* spp. were predominant MDR bacteria [23].

In this study, being female was found to be statistically significant with UTI. It was observed that females were about 1.951 times more likely to develop UTI than males. This association was also reported by studies from Hawassa [35], Bahir Dar [33] and Gambia [18]. Physiological and anatomical differences are accounted for by the differences between males and females. Females are more susceptible to infection than males, a phenomenon explained by their short urethra and its anatomical proximity to the anal orifice [26, 27, 41].

Another risk factor identified by the current study was a history of antibiotic consumption without a prescription. It was found that patients with a history are about 5.051 times more likely to develop UTI than those who use antibiotics with a prescription. Other studies also reported the statistical significance of antibiotic consumption without prescription [18, 21, 23, 24]. Using antibiotics without medical prescription greatly contributes to the emergence of resistant bacterial species as repeated exposures enhance drug resistance mechanisms. Establishing antibiotic stewardship and limiting prescribed antibiotics reduces the probability of resistance [24, 43, 46].

This study also identified that having a previous history of UTI is a significant risk factor for developing UTI. The likelihood of patients with previous admission for UTI was about 3.476 times greater than those who had no such history. This finding was also supported by other study findings that reported an association between previous UTIs and the probability of developing a UTI [18, 31]. This association can be explained by the fact that the infection can be caused by the persistence of previous uropathogens or the recurrence of those infections [18, 24].

Strength and limitations

The strength of the study was that all the laboratory procedures were performed with strict adherence to standard operating procedures. In addition, more detailed studies that include molecular testing can be done based on these findings. Regarding limitations, due to the cross-sectional nature of the study design, it was not possible to determine the temporal relationship between the exposure and outcome variable. This study was not representative of patients with UTI in Ethiopia due to its small sample size and convenience sampling design. The antibiotic susceptibility pattern was assessed using disc diffusion methods, which may not completely reflect effectiveness. Moreover, differentiation of some bacteria such as coagulase-negative staphylococci, *Klebsiella* spp., *Proteus* spp., and *Enterobacter* spp. was not possible due to resource constraints.

Conclusion

Up-to-date information on the bacterial profile and antimicrobial susceptibility pattern of pathogenic bacteria is essential in the therapeutic management of UTIs. Higher rates of resistance to the commonly used antimicrobial agents were noticed for both Gram-negative and Gram-positive bacterial isolates. Moreover, MDR in more than half of the bacterial isolates has been indicated. Understanding the prevalence of infections caused by these organisms, as well as their resistance rates, is crucial. Females were more affected than males. Further research is necessary to develop a stratified antibiogram that will assist healthcare providers in making decisions regarding antibiotic prescriptions and dispensing.

Recommendations

Based on current study findings, the following recommendations should be noted:

- Health information dissemination should be given about the magnitude of UTI.

- Facilitate periodic surveillance to control and prevent the emergence of MDR strain.
- Routine UTI screening for suspected patients.
- Managing antimicrobial prescriptions making decisions based on Laboratory results to minimize inappropriate use of antimicrobials.
- Special attention should be given to females and patients with a previous history of UTI, since these groups are easily susceptible to acquiring infections.
- Further studies should be conducted using relatively standard methods, a large study population, and isolation of strains of each specific bacterium.

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Authors' contributions
AD and ET worked on designing the study, training and supervising the data collectors, analyzing, and interpreting the result, and preparing the manuscript. ET, MC, and AD performed laboratory analysis. GJ, SG, FA and KT played their role in revising the analysis and manuscript. All authors were involved in reading and approving the final manuscript.

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Data availability
All data are available within the manuscript. Additional data can be obtained from the corresponding author on a reasonable request.

Declarations

Ethics and consent to participate
Ethical approval was obtained from the Salale University Institutional Research Ethics Review Committee (SIU–IRERC-260/2016). This study was conducted in agreement with the Declaration of Helsinki, the Ethical principle for medical research involving human subjects http://www.wma.net/en/30publications/10policies/b3/index.html). Then permission was taken from Nekemte Comprehensive Specialized Hospital and Nekemte Public Health Research and Referral Laboratory Center to conduct this study. Written informed consent was obtained from all the study participants and from the legal guardians of the participants who were below 16 years of age and also who did not have formal education. The inclusion of study participants was voluntary. Information obtained from them was kept confidential and used only for research purposes.

Consent to publication
Not applicable.

Competing interests
The authors declare no competing interests.

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