Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 6 No. 3 (2025): March 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i3.1597
Original Article

A CROSS-SECTIONAL PROSPECTIVE STUDY ON ANTIMICROBIAL RESISTANCE PROFILES OF COMMON BACTERIAL PATHOGENS CAUSING URINARY TRACT INFECTIONS AMONG PATIENTS AT MENGO HOSPITAL, KAMPALA DISTRICT.

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Abstract

Introduction

Urinary Tract Infection (UTI) is a common disease affecting all age groups and is increasingly difficult to treat due to antimicrobial resistance.

Methods

This study assessed the prevalence of UTIs and antimicrobial resistance profiles in patients at Mengo Hospital, Kampala. A cross-sectional, prospective study was conducted from March to May 2023. Mid-stream urine samples were analyzed using macroscopic, microscopic, Gram staining, culture, biochemical tests, and antibiotic sensitivity testing. Data was processed and analyzed using SPSS version 25.

Results

The results showed that 70.4% of patients had UTI, with a higher occurrence in females (72.7%) than in males (27.3%). UTI prevalence peaked at 30-39 years (37.5%). Common pathogens were *Escherichia coli* (20.8%), *Staphylococcus aureus* (15.2%), and *Candida albicans* (12%). Antimicrobial resistance was highest against Clindamycin (92%), Erythromycin (89%), and Ciprofloxacin (80%). Imipenem (96%), Meropenem (85%), and Vancomycin (78%) showed better sensitivity.

Conclusions

UTIs and antimicrobial resistance are significant public health concerns at Mengo Hospital. Women and individuals aged 30-39 years are at higher risk. Resistance varies widely, emphasizing the need for targeted antibiotic use.

Recommendations

The current study recommends routine UTI screening for high-risk patients. Antibiotic sensitivity testing should be done before treatment. Empiric therapy should be emphasized with effective antibiotics like Imipenem, Vancomycin, and Meropenem, considering local resistance patterns. Public awareness campaigns on UTI prevention and responsible antibiotic use should be carried out. Further research should be done on UTI epidemiology and resistance patterns to inform healthcare policies.

Keywords: *Urinary Tract Infection (UTI), Prevalence, Antimicrobial Resistance*
Submitted: *2025-03-03* ***Accepted:*** *2025-03-14* ***Published:*** *2025-03-31*

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Introduction

Urinary tract infections (UTIs) are common bacterial infections globally, affecting more than 150 million people worldwide (Abongomera et al., 2021). At least 10% of people experience UTIs during their lifetime (Munyemana et al., 2020). The disease is also one of the leading causes of morbidity and growing healthcare expenditure worldwide (Shakya et al., 2021). Although the introduction of antibiotic therapy has played an important role in the management of UTI, there is a rapid emergence of antibiotic resistance in both hospital and community-acquired UTI cases (Munyemana et al., 2020). This study aimed to assess

the prevalence of urinary tract infection and antimicrobial resistance profile in patients attending Mengo Hospital in the Kampala district.

Materials and methods

Study design and site

The study was cross-sectional and prospective, conducted from March to May 2023 at Mengo Hospital, Uganda's oldest hospital, established in 1897. Located on

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Namirembe Hill in Rubaga division, northwest of Kampala, the hospital has a bed capacity of about 800 and includes various departments such as intensive care, maternity, laboratory, pediatric, eye, dental, HIV counseling, radiology, and training schools. The hospital primarily serves residents of the Rubaga division, the Kampala Metropolitan area, and beyond. The study area was chosen due to the researcher's familiarity with the location.

Inclusion criteria

This study included only patients at Mengo Hospital who exhibited signs and symptoms of urinary tract infection and for whom the attending doctor had requested a urine culture and sensitivity test. All participating patients provided their consent to be part of the study.

Exclusion criteria

Patients who were severely ill were excluded from the study.

Sample size calculations

The sample size was estimated using the formula by Fink and Kosecoff (1965),

n = (Z/e)2 (p) (1-p)

Where, n = sample size

Z = standard score corresponding to a given confidence level, usually a 95% confidence level (Z = 1.96).

e = the proportion of sampling error; an acceptable error level traditionally is up to ±0.5 or ±0.10 (5 or 10% point).

p = estimated proportion or incidence of cases, if not known, is usually taken at 50% (0.5).

n= (1.96/0.1)2*0.5*0.5

n 96.04 approx. 97.

Adjustment for non-response: We expected a non-response rate of 20%. We adjusted the sample size. That is, adjusted sample size = 121.25.

Therefore, a sample size of 125 patients was considered.

Study tool design

The researchers designed a simple laboratory data entry form, which was used to collect data.

Sampling technique

A purposive sampling technique was used, and it targeted only clinically suspected UTI patients on whom the attending doctor had requested urine culture and sensitivity tests to be performed.

Minimizing bias

Patients were purposefully selected as they reported to the laboratory for urine testing. A standardized data collection tool was developed to ensure consistency. Well-defined standard operating procedures (SOPs) were followed for diagnosing UTIs and performing antimicrobial resistance testing, ensuring uniform data collection across all participants. Since all patients were those seeking standard healthcare services, laboratory staff were blinded to individual patient details to minimize bias. Clear inclusion and exclusion criteria were established and strictly adhered to. For quality control, the expiry dates of antibiotic discs were routinely checked, and strict adherence to SOPs was maintained. Appropriate statistical methods, such as the chi-square test, were applied to determine associations among variables.

Study procedure

Urine sample collection

Male patients were provided with a sterile container and instructed to clean the penis, retract the foreskin if necessary, and collect mid-stream urine. The female patients were provided with a sterile container and instructed to clean the urethral area, hold the labia apart, and collect mid-stream urine.

Urine analysis

Macroscopically, the urine samples were examined for color and turbidity. Microscopically, the urine samples were examined for bacteria, white blood cells, red blood cells, pus cells, and yeast cells. Urine culture was performed on various agar plates (Blood, Chocolate, MacConkey, CLED, and Sabouraud) and incubated at 35-37°C for 24-48 hours. Gram Staining was performed on discrete colonies to differentiate Gram-positive and Gram-negative bacteria and yeast cells. Biochemical tests were conducted to identify bacterial isolates using tests like catalase, coagulase, urease, indole, citrate utilization, oxidase, and triple sugar iron tests. An antimicrobial susceptibility test was performed on isolated uropathogens to determine their resistance profiles.

Analysis of data

Data was analyzed using statistical packages for social sciences (SPSS version 20). The analyzed data was presented as charts, tables, and graphs followed by narratives.

Ethics

Ethical approval of the study was granted by the Mengo Hospital Research Ethics Committee (MHREC). Approval was granted on 10th March 2023 under the ethical clearance number MH/REC/24/02-2023. An introductory letter from the principal tutor of Mengo Hospital Medical Laboratory Training School was obtained and submitted to the Medical Director and Laboratory Manager, who provided permission for the study. Written consent was obtained from participants, ensuring confidentiality and privacy by not including personal identification details. Participants' information was securely stored.

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Results

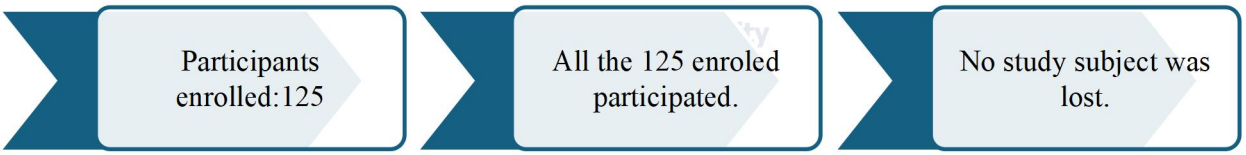

Table 1: The distribution of the patients by gender and age group in the study sample

Variables		Frequency	Percent
Gender	Female	83	66.4
	Male	42	33.6
	Total	**125**	**100.0**
Age group (years)	0-9	4	3.2
	10-19	3	2.4
	20-29	25	20.0
	30-39	48	38.4
	40-49	20	16.0
	50-59	6	4.8
	60-69	7	5.6
	70-79	6	4.8
	80-89	4	3.2
	90-99	2	1.6
	Total	**125**	**100.0**

Table 1 shows the distribution of the patients by gender and age group in the study sample. Findings revealed that most of the patients were females, accounting for 66.4% (n = 125). Additionally, the majority were aged between 20 - 49 years, accounting for 20.0%, peaking at 30-39 years (38.4%). The average age was 40 years (standard deviation of 18.2).

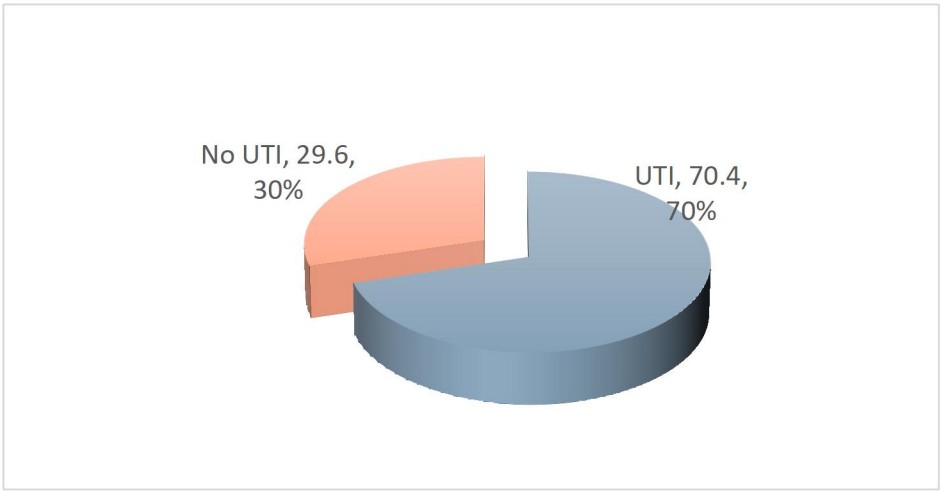

Figure 1: The general prevalence of UTI among patients at Mengo Hospital

Figure 1 above shows the general prevalence of UTIs among patients at Mengo Hospital. Findings revealed that 70.4% (n = 125) of the study respondents had UTIs.

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Table 2: The distribution of microorganisms causing UTI by gram reaction

Variables		Frequency	Percent
Gram reaction of the microorganisms isolated	Gram-positive	49	39.2
	Gram-negative	39	31.2
	No growth	37	29.6
	Total	**125**	**100.0**

Table 2 shows the distribution of microorganisms causing UTI by gram reaction. Findings revealed that the majority of UTIs were caused by Gram-positive organisms (39.2%) rather than Gram-negative organisms (31.2%, n = 125).

Table 3: The common microorganisms causing UTI among patients at Mengo Hospital

Variables		Total	%
Isolated micro-organism	*Aeromonas salmonicida*	1	0.8
	Candida albicans	15	12
	Candida species	3	2.4
	Candida tropicalis	1	0.8
	Enterobacter cloacae	2	1.6
	Enterobacter species	3	2.4
	Enterococcus fecalis	1	0.8
	Escherichia coli	26	20.8
	Klebsiella oxytoca	1	0.8
	Klebsiella pneumonia	2	1.6
	Klebsiella species	1	0.8
	Kocuria kristinae	2	1.6
	Providencia rettgeri	1	0.8
	Sphingomonas paucimobilis	1	0.8
	Staphylococcus aureus	19	15.2
	Staphylococcus hemolyticus	2	1.6
	Staphylococcus species	1	0.8
	Streptococcus agalactiae	3	2.4
	Streptococcus species	3	2.4
	Total UTI cases	**88**	**70.4**
	No growth after 48 hours	37	29.6

Table 3 above illustrates the common microorganisms causing UTIs among patients at Mengo Hospital. Findings demonstrated that *Escherichia coli* was the commonest cause of UTI, accounting for 20.8% (26/125), followed by *Staphylococcus aureus* (15.2%, 19/125) and *Candida albicans* (15/125, 12%). Other organisms that caused UTI were *Aeromonas salmonicida* (1/125, 0.8%), Other *Candida* species (3/125, 2.4%), *Candida tropicalis* (1/125, 0.8%), *Enterobacter cloacae* (2/125, 1.6%), *Enterobacter* species (3/125, 2.4%), *Enterococcus fecal* (1/125, 0.8%), *Klebsiella oxytoca* (1/125, 0.8%), *Klebsiella pneumoniae* (2/125, 1.6%), *Klebsiella* species (1/125, 0.8%), *Kocuria kristinae* (2/125, 1.6%), *Providencia rettgeri* (1/125, 0.8%), *Sphingomonas paucimobilis* (1/125, 0.8%), *Staphylococcus hemolyticus* (2/125, 1.6%), *Staphylococcus* species (1/125,

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0.8%), *Streptococcus agalactiae* (3/125, 2.4%) and *Streptococcus* species (3/125, 2.4%).

Table 4a: The antimicrobial resistance profile of the most common bacteria causing urinary tract infection in patients attending Mengo Hospital in the Kampala district

Variables		Isolated organisms																			Total	%
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
Nitrofurantoin	Sensitive	1	0	0	0	1	18	1	1	0	1	0	0	14	2	0	0	3	0	1	43	72
	Resistant	0	0	0	0	0	5	0	0	1	1	1	0	3	0	0	0	0	0	0	11	18
	Intermediate	0	0	0	2	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	6	10
Total		1	0	0	2	1	26	1	1	1	2	1	0	18	2	0	0	3	0	1	60	
Levofloxacin	Sensitive	1	0	0	0	1	0	0	0	1	0	0	0	3	0	1	3	1	0	0	11	29
	Resistant	0	0	0	0	0	6	0	0	0	0	0	0	8	2	0	0	0	0	1	17	45
	Intermediate	0	0	0	0	0	0	0	0	0	1	0	0	6	0	0	0	1	0	2	10	26
Total		1	0	0	0	1	6	0	0	1	1	0	0	17	2	1	3	2	0	3	38	
Ciprofloxacin	Sensitive	0	0	0	0	0	4	1	1	1	0	1	0	0	0	0	0	0	0	0	8	18
	Resistant	0	0	0	1	0	19	0	1	0	2	0	0	10	0	1	0	1	0	1	36	80
	Intermediate	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
Total		0	0	0	1	0	23	1	2	1	2	1	1	10	0	1	0	1	0	1	45	
Imipenem	Sensitive	0	0	0	1	0	6	0	0	0	1	1	0	7	1	0	0	2	0	3	22	96
	Intermediate	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Total		0	0	0	1	0	7	0	0	0	1	1	0	7	1	0	0	2	0	3	23	
Ceftriaxone	Sensitive	0	0	0	1	0	7	1	1	0	1	1	0	3	0	0	0	1	0	1	17	38
	Resistant	0	0	0	1	0	15	0	1	0	1	0	1	5	0	1	0	1	0	2	28	62
Total		0	0	0	2	0	22	1	2	0	2	1	1	8	0	1	0	2	0	3	45	
Ceftazidime	Sensitive	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	7	23
	Resistant	0	0	0	1	0	13	0	1	1	1	0	0	3	0	0	0	1	0	1	22	73
	Intermediate	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3
Total		0	0	0	2	0	17	0	1	1	1	0	1	3	0	0	0	1	0	3	30	
Gentamycin	Sensitive	0	0	0	1	0	7	1	1	1	0	1	0	7	0	1	0	0	0	0	20	38
	Resistant	0	0	0	1	0	14	0	1	0	1	0	0	8	2	0	0	2	0	1	30	58
	Intermediate	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	4

Student's Journal of Health Research Africa
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Total		0	0	0	2	0	21	1	2	1	1	1	1	15	2	1	1	2	0	1	52	
Clindamycin	Sensitive	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	8
	Resistant	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	3	1	0	0	12	92
Total		0	0	0	0	0	0	0	0	0	0	0	0	8	1	0	3	1	0	0	13	

Table 4b: The antimicrobial resistance profile of the most common bacteria causing urinary tract infection in patients attending Mengo Hospital in the Kampala district

Variables		**Isolated organisms**																			**Total**	**%**
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
Erythromycin	Sensitive	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	11
	Resistant	0	0	0	0	1	2	0	0	1	0	0	0	11	1	0	0	1	0	0	17	89
Total		0	0	0	0	1	2	0	0	1	0	0	0	13	1	0	0	1	0	0	19	
Vancomycin	Sensitive	0	0	0	0	1	0	0	0	0	1	0	0	14	2	0	3	0	0	0	21	78
	Resistant	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	4	15
	Intermediate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	7
Total		0	0	0	0	1	1	0	0	0	1	0	0	15	2	1	3	1	0	2	27	
Trimethoprim and Sulphonamide	Sensitive	0	0	0	1	0	1	1	0	0	0	0	1	3	0	1	0	0	0	0	8	31
	Resistant	0	0	0	1	0	11	0	0	0	0	1	0	3	1	0	0	1	0	0	18	69
Total		0	0	0	2	0	12	1	0	0	0	1	1	6	1	1	0	1	0	0	26	
Amoxicillin and Clavulanic acid	Sensitive	0	0	0	0	0	5	1	0	0	0	0	0	2	0	0	0	0	0	2	10	56
	Resistant	0	0	0	2	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	7	39
	Intermediate	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Total		0	0	0	2	0	10	1	0	1	0	0	0	2	0	0	0	0	0	2	18	
Amikacin	Sensitive	1	0	0	2	0	16	1	1	0	0	1	1	2	0	1	1	0	0	0	27	82
	Resistant	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	2	0	0	6	18
Total		1	0	0	2	0	17	1	2	0	0	1	1	3	0	1	2	2	0	0	33	
Meropenem	Sensitive	1	0	0	1	0	14	1	1	0	0	0	1	3	1	1	1	2	0	1	28	85
	Resistant	0	0	0	0	0	2	0	1	0	0	0	0	2	0	0	0	0	0	0	5	15
Total		1	0	0	1	0	16	1	2	0	0	0	1	5	1	1	1	2	0	1	33	
Fluconazole	Sensitive	0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	82
	Resistant	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	18
Total		0	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	17	
Voriconazo	Sensitive	0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	15	88

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le	Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	12
Total		0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	17	
Casponfungin	Sensitive	0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	93
	Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7
Total		0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	15	
Micafungin	Sensitive	0	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	93
	Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7
Total		0	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	14	
Flucytosine	Sensitive	0	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	87
	Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7
	Intermediate	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7
Total		0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	15	
Itraconazole	Sensitive	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20
	Resistant	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	4	80
Total		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	
Miconazole	Sensitive	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20
	Resistant	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	4	80
Total		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	
Ketoconazole	Sensitive	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	4	100

Key for Table 4a and 4b (isolated microorganisms)

1	*Aeromonas salmonicida*	8	*Klebsiella pneumonia*	15	*Staphylococcus species*
2	*Candida albicans*	9	*Klebsiella species*	16	*Streptococcus agalactiae*
3	*Candida tropicalis*	10	*Kocuria kristinae*	16	*Streptococcus agalactiae*
4	*Enterobacter cloacae*	11	*Providencia rettgeri*	17	*Streptococcus species*
5	*Enterococcus fecalis*	12	*Sphingomonas paucimobilis*	18	*Candida species*
6	*Escherichia coli*	13	*Staphylococcus aureus*	20	*Enterobacter species*
7	*Klebsiella oxytoca*	14	*Staphylococcus hemolyticus*		

Tables 4a and 4b above show the antimicrobial resistance profile of the most common bacteria causing urinary infections in patients attending Mengo Hospital in the Kampala district. The antimicrobial resistance profile of common uropathogens at Mengo Hospital revealed widespread resistance, except for Ketoconazole, which showed 100% sensitivity. Resistance rates ranged from 7% to 92%, with the highest resistance observed against Clindamycin (92%), Erythromycin (89%), Ciprofloxacin (80%), Itraconazole (80%), Miconazole (80%), Ceftazidime (73%), Ceftriaxone (62%), Trimethoprim & Sulphonamide (60%), and Gentamycin (58%).

Pathogen-specific resistance was observed. *Staphylococcus aureus* exhibited high resistance to Ciprofloxacin (100%), Ceftazidime (100%), Clindamycin (87.5%), and Erythromycin (84.6%). *Escherichia coli* showed complete resistance to Erythromycin (100%) and high resistance to Trimethoprim & Sulphonamide (91.7%), Ciprofloxacin (83%), and Ceftazidime (76.5%).

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Vol. 6 No. 3 (2025): March 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i3.1597
Original Article

The antibiotics with better sensitivity were Imipenem (96%), Meropenem (85%), Amikacin (82%), Vancomycin (78%), Nitrofurantoin (72%), and Amoxicillin & Clavulanic acid (56%). These findings highlight the urgent need for antibiotic susceptibility testing before treatment and the careful selection of effective antibiotics to combat UTIs.

Table 5a: The distribution of urinary tract infections by gender and age group

Sex			Age group (years)										Total
			0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	
Male	Isolated organisms	*Candida albicans*	0	0	0	0	0	0	0	0	1	1	2
		Candida tropicalis	1	0	0	0	0	0	0	0	0	0	1
		Enterobacter species	0	0	0	1	1	0	0	0	0	0	2
		Escherichia coli	0	0	0	2	2	2	0	0	1	0	7
		Klebsiella pneumoniae	0	0	0	0	0	0	0	1	0	0	1
		Providencia rettgeri	0	0	0	0	0	1	0	0	0	0	1
		Staphylococcus aureus	0	0	2	2	1	0	2	0	0	0	7
		Staphylococcus species	0	0	0	0	1	0	0	0	0	0	1
		Streptococcus species	0	0	0	1	0	0	0	0	0	1	2
	Total		**1**	**0**	**0**	**6**	**5**	**3**	**2**	**1**	**2**	**2**	**24**
Female	Isolated organisms	*Aeromonas salmonicida*	0	0	1	0	0	0	0	0	0	0	1
		Candida albicans	0	0	7	3	2	0	0	0	1	0	13
		Candida species	0	1	0	2	0	0	0	0	0	0	3
		Enterobacter cloacae	0	0	0	1	0	0	0	1	0	0	2
		Enterobacter species	0	0	0	0	0	0	1	0	0	0	1
		Enterococcus faecalis	0	0	0	1	0	0	0	0	0	0	1
		Escherichia coli	1	1	4	6	3	2	0	2	0	0	19
		Klebsiella oxytoca	0	0	0	1	0	0	0	0	0	0	1
		Klebsiella pneumoniae	0	0	0	0	0	0	1	0	0	0	1
		Klebsiella species	0	0	0	0	0	0	0	0	1	0	1
		Kocuria kristinae	0	0	0	1	0	1	0	0	0	0	2
		Sphingomonas paucimobilis	1	0	0	0	0	0	0	0	0	0	1
		Staphylococcus	1	0	2	7	2	0	0	0	0	0	12

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 6 No. 3 (2025): March 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i3.1597
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		aureus											
		Staphylococcus hemolyticus	0	0	0	1	1	0	0	0	0	0	2
		Streptococcus agalactiae	0	0	0	3	0	0	0	0	0	0	3
		Streptococcus species	0	0	0	1	0	0	0	0	0	0	1
	Total		**3**	**2**	**14**	**27**	**8**	**3**	**2**	**3**	**2**	**0**	**64**

Table 5a shows the distribution of urinary tract infections by gender and age group. In both genders, *Candida albicans, Escherichia coli,* and *Staphylococcus aureus* were the most common organisms causing UTIs. Findings also revealed that in both genders, *Escherichia coli* occurrence was highest in the age group 30-39 years (2 in males, 6 in females). *Staphylococcus aureus* infections among males were highest in the age group 30-39 years (7/64). In the females, *Staphylococcus aureus* infection was highest in the age group 30-39 years (7/64). In males, *Candida albicans* infections occurred only in the age group 80-89 years (1/64) and 90-99 years (1/64). However, among the females, *Candida albicans* infections were highest in the age group 20-29 years (7/64).

Table 5b: The distribution of urinary tract infections by gender

Variables		**Sex**	
		Female	Male
Isolated	*Aeromonas salmonicida*	1	0
micro-organism	*Candida albicans*	13	2
	Candida species	3	0
	Candida tropicalis	0	1
	Enterobacter cloacae	2	0
	Enterobacter species	1	2
	Enterococcus fecalis	1	0
	Escherichia coli	19	7
	Klebsiella oxytoca	1	0
	Klebsiella pneumonia	1	1
	Klebsiella species	1	0
	Kocuria kristinae	2	0
	Providencia rettgeri	0	1
	Sphingomonas paucimobilis	1	0
	Staphylococcus aureus	12	7
	Staphylococcus hemolyticus	2	0
	Staphylococcus species	0	1
	Streptococcus agalactiae	3	0
	Streptococcus species	1	2
	Total UTI cases	**64**	**24**
	% UTI	**72.7**	**27.3**

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 6 No. 3 (2025): March 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i3.1597
Original Article

Table 5b shows the distribution of urinary tract infections by gender. Findings revealed that among the infected patients, more females (72.7%) than males (27.3%) had UTI (n=88). Findings also showed that UTI was more associated with the female gender than the male gender. The distribution of the most common organisms isolated by gender showed that *Candida albicans*, *Escherichia coli,* and *Staphylococcus aureus* affected more females than males.

Table 5c: The distribution of UTI by age group

Sex		Age group (years)										Total
		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	
Isolated organism	*Aeromonas salmonicida*	0	0	1	0	0	0	0	0	0	0	1
	Candida albicans	0	0	7	3	2	0	0	0	2	1	15
	Candida species	0	1	0	2	0	0	0	0	0	0	3
	Candida tropicalis	1	0	0	0	0	0	0	0	0	0	1
	Enterobacter cloacae	0	0	0	1	0	0	0	1	0	0	2
	Enterobacter species	0	0	0	1	1	0	1	0	0	0	3
	Enterococcus fecalis	0	0	0	1	0	0	0	0	0	0	1
	Escherichia coli	1	1	4	8	5	4	0	2	1	0	26
	Klebsiella oxytoca	0	0	0	1	0	0	0	0	0	0	1
	Klebsiella pneumoniae	0	0	0	0	0	0	1	1	0	0	2
	Klebsiella species	0	0	0	0	0	0	0	0	1	0	1
	Kocuria kristinae	0	0	0	1	0	1	0	0	0	0	2
	Providencia rettgeri	0	0	0	0	0	1	0	0	0	0	1
	Sphingomonas paucimobilis	1	0	0	0	0	0	0	0	0	0	1
	Staphylococcus aureus	1	0	4	9	3	0	2	0	0	0	19
	Staphylococcus hemolyticus	0	0	0	1	1	0	0	0	0	0	2
	Staphylococcus species	0	0	0	0	1	0	0	0	0	0	1
	Streptococcus agalactiae	0	0	0	3	0	0	0	0	0	0	3
	Streptococcus species	0	0	0	2	0	0	0	0	0	1	3
Total		4	2	16	33	13	6	4	4	4	2	88

Table 5c shows the distribution of UTIs by age group. Findings revealed that cases of UTI increased with increasing age, peaking at 30-39 years (37.5%, n=88) and thereby dropping from age 40-49 years (16.0%, n=20), until age 90-99 years (1.6%, n=2). These findings also revealed that UTI was associated with age groups 30-39 years (37.5%, n=88).

Discussion

The overall prevalence of UTI among patients at Mengo Hospital was 70.4% (n = 125, 88/125) of the study respondents. This occurrence aligns with a previous report from St. Joseph's Kitgum Hospital-Uganda. (Félix et al., 2022), Which documented a UTI prevalence with bacterial growth of 64.0% (n = 89). Although the UTI prevalence in this study is comparable to findings from other regions worldwide, it highlights a significantly high burden of UTI at the study site. Notably, the current study prevalence rate surpasses most reported cases across sub-Saharan Africa. For instance, an earlier study in Uganda found a UTI prevalence of 13.3% at Mulago Hospital. (Odoki et al., 2019). Similarly, UTI prevalence rates reported in other African countries were significantly lower: Ghana Police Hospital (15.9%), Algeria (4.5%), Senegal (0.7%), and

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 6 No. 3 (2025): March 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i3.1597
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Nigeria, where community-acquired and nosocomial UTIs were 12.3% and 9.3%, respectively. (Odoki et al., 2019). Even on a global scale, lower prevalence rates have been documented, such as in a pediatric hospital in Nepal, where 12.3% of samples exhibited significant bacterial growth. (Ganesh et al.., 2019).

These findings support prior reports that UTIs remain among the most common bacterial infections globally. (George et al., 2021).

Furthermore, this study revealed antimicrobial resistance against all tested antibiotics except Ketoconazole, which demonstrated 100% sensitivity. Resistance rates ranged from 7% to 92%. This study's findings indicate that some antibiotics are still effective against urinary tract infection (UTI)- causing bacteria, while others have significantly reduced efficacy. Although Ketoconazole was the only antimicrobial agent that demonstrated 100% sensitivity against all tested isolates, its primary use is as an antifungal rather than a standard treatment for bacterial infections. The high resistance rates observed for some antibiotics (up to 92%) highlight a concerning trend of antimicrobial resistance (AMR), which could limit treatment options and necessitate more stringent antimicrobial stewardship measures. Further investigation into prescribing patterns, resistance mechanisms, and alternative therapeutic strategies is recommended.

These findings are comparable to a previous Ugandan study in 2019, which reported drug resistance rates between 20% and 60% among antenatal mothers at Mulago Hospital. (Odoki et al., 2019). These findings also align with another related study indicating that nearly all test organisms exhibited multiple antibiotic resistance (Sanjida et al., 2015). Likewise, our results support the WHO (2021) reports that antimicrobial resistance (AMR) is a global health and development threat. In Uganda, a major contributor to antibiotic resistance may be the widespread availability of pharmacies and drug shops, which facilitate easy over-the-counter drug purchases. Self-medication, including underdosing, further exacerbates resistance. (Desie et al., 2022).

In this study, the highest resistance rates were observed for Clindamycin (92%), followed by Erythromycin (89%), Ciprofloxacin (80%), Itraconazole (80%), Miconazole (80%), Ceftazidime (73%), Ceftriaxone (62%), Trimethoprim and Sulphonamide (60%), and Gentamycin (58%). These findings indicate a multi-drug resistance pattern. Similar observations were made in a study from Nepal, which reported a 61.9% multi-drug resistance rate among isolates in a hospital setting (Ganesh et al., 2019). While Félix et al. (2022) found the highest resistance rates against Amoxicillin (66.2%) and Ciprofloxacin (44.6%), their findings remain comparable to ours, as Ciprofloxacin resistance was also recorded in our study.

This study identified several antibiotics with relatively high sensitivity against the bacterial isolates, indicating their potential effectiveness in treating urinary tract infections (UTIs) in the study population. These antibiotics, in order of their efficacy, included Imipenem (96%), Meropenem (85%), Amikacin (82%), Vancomycin (78%), Nitrofurantoin (72%), and Amoxicillin and Clavulanic acid (56%). This finding indicates that Imipenem (96%) was the most effective antibiotic, followed by Meropenem (85%), both exhibiting strong activity against resistant bacteria. Amikacin (82%) and Vancomycin (78%) also showed high efficacy, making them viable options for multidrug-resistant UTIs. Nitrofurantoin (72%) demonstrated moderate sensitivity, supporting its use for uncomplicated UTIs, while Amoxicillin-Clavulanic Acid (56%) had lower sensitivity, indicating limited effectiveness. These results differ from those of Félix et al. (2022) at St. Joseph's Kitgum Hospital-Uganda, where Nitrofurantoin was the most effective antibiotic (81.7% for Gram-positive and 87.3% for Gram-negative bacteria), followed by Imipenem (94.2% and 74.5%, respectively).

The study findings further demonstrated that *Escherichia coli* was the most common cause of UTI, accounting for 20.8% (26/125) of cases, followed by *Staphylococcus aureus* (15.2%, 19/125) and *Candida albicans* (12%, 15/125), among other organisms. The finding of *Escherichia coli* as the leading cause of urinary tract infections (UTIs) aligns with global trends, as *E. coli* is the most common uropathogen due to its ability to colonize the urinary tract. For example, a study in Romania identified *Escherichia coli* as the most frequently reported cause of UTI (42.9%) (Răzvan-Cosmin et al., 2019). Similarly, a study at Mulago National Referral Hospital, Kampala, Uganda, revealed that *Escherichia coli* was the most commonly isolated UTI pathogen (10%). In Bangladesh, a hospital-based study reported *Escherichia coli* as the most prevalent Gram-negative uropathogen (63.93%), followed by *Klebsiella pneumoniae* (17.09%) (Sanjida et al., 2015). A related study in Somalia found that *Escherichia coli* was isolated in 34 (41%) out of 83 samples, followed by *Staphylococcus aureus* (26.5%) (Malyun et al., 2020). The finding of *Staphylococcus aureus* in our study as the second most frequently isolated pathogen suggests that both Gram-negative and Gram-positive bacteria play a role in UTIs in this setting. Interestingly, in our study, *Candida albicans* was also a notable cause of UTIs, indicating the presence of fungal urinary infections, which are often associated with immunocompromised patients, prolonged antibiotic use, or catheterization.

In this study, *Escherichia coli* exhibited high resistance rates to multiple antibiotics commonly used, including Erythromycin (100%), Trimethoprim and Sulphonamide (91.7%), Ciprofloxacin (83%), Ceftazidime (76.5%), Ceftriaxone (68%), and Gentamycin (66.7%). The findings raise concerns about the effectiveness of standard treatments for urinary tract infections (UTIs). These findings further emphasize the need for antimicrobial

stewardship and culture-based prescribing to improve treatment outcomes and prevent further resistance development. These findings in the current study contrast with those of Răzvan-Cosmin et al. (2019), who reported increased resistance of *Escherichia coli* to Levofloxacin, similar to *Klebsiella* and *Enterococcus*. Additionally, our results differed from those of a related study in Somalia, where *Escherichia coli* showed the highest resistance rate to Ceftriaxone (97.1%) (Malyun et al., 2020).

Similarly, *Staphylococcus aureus* exhibited resistance to a broad range of antibiotics in our study, including Clindamycin (87.5%), Erythromycin (84.6%), Ciprofloxacin (100%), Ceftriaxone (62.5%), Ceftazidime (100%), Gentamycin (53.3%), and Trimethoprim and Sulphonamide (50%). These findings pose a significant challenge for UTI treatment. It highlights the need for alternative treatment strategies and the importance of monitoring antibiotic resistance patterns. These findings align with a study in Nepal, which reported a high prevalence of multidrug resistance (61.9%) among *Staphylococcus aureus* isolates. (Ganesh et al.., 2019).

The study findings revealed that among the infected patients, more females (72.7%) than males (27.3%) had UTIs (n=88). The higher prevalence of UTIs among females observed in our study is consistent with reports from various regions worldwide. For instance, a study in South Brazil similarly reported that UTIs were more frequent in women (12.6%) (Zuleica et al., 2022). A report from Kitwe Central Hospital, Zambia, also indicated that UTIs were most common in females (43.9%) (Chisanga et al., 2017). Additionally, Adane et al. (2017) found that significant bacteriuria was more prevalent in females (81.25%) compared to males (18.75%). The higher UTI prevalence among females is likely attributed to anatomical factors, such as a shorter urethra and its proximity to the anus, which facilitates contamination of the urinary tract with fecal microbes - primarily *Escherichia coli*. Other contributing factors include hormonal changes and pregnancy, which increase susceptibility to infection. (Legese et al., 2022).

Furthermore, this study's findings indicated that UTI cases increased with age, peaking in the 30–39 years age group (37.5%, n=88) before gradually declining from 40–49 years onward, up to 90–99 years. This suggests a strong association between UTI prevalence and age groups. Our findings align with those of Adane et al. (2017), who reported that individuals aged 25–44 were the most affected by UTIs. However, our results differ from those reported at Kitwe Central Hospital, Zambia, where the highest frequency of UTIs was observed in the 15–29 years age group (Chisanga et al., 2017). This variation may be due to differences in reproductive health factors, as younger women in their reproductive years are more exposed to UTIs, particularly due to sexual activity and the physiological changes associated with pregnancy, which can lower immunity and increase susceptibility to infections.

Conclusions

UTI (70.4%) and antimicrobial resistance among patients at this study site were high and a serious public health problem. *Escherichia coli* was the most common cause of UTI in this study setting. UTIs were more associated with the female gender (72.7%) than the male gender (27.3%). UTI increased with increasing age, peaking at 30-39 years (37.5%) and therefore, UTI was associated with age groups. Antimicrobial Resistance was recorded for every antibiotic except Ketoconazole, which showed 100% sensitivity. Imipenem (96%) was the most effective antibiotic, followed by Meropenem (85%), both exhibiting strong activity against resistant bacteria.

Generalizability

While these findings at Mengo Hospital provide valuable insights, local variations in patient demographics, pathogen prevalence, and resistance patterns should be considered. Factors such as local healthcare practices, antibiotic usage, and patient population characteristics can influence these patterns. It is essential to consider local variations and conduct further research.

Limitations of the study

Manual mid-stream urine culture and sensitivity tests were occasionally performed due to the malfunction of the automated Vitek 2 compact system at some point.

Recommendations

Increase awareness about UTI causes, symptoms, preventive measures, and the importance of appropriate antibiotic use to combat antimicrobial resistance. Implement UTI screening for high-risk groups, such as females and individuals aged 30-39 years, for early detection and treatment. Develop and implement programs to promote appropriate antibiotic use and prevent resistance. Clinicians should consider antibiotics like Imipenem, Vancomycin, Nitrofurantoin, Amoxicillin and Clavulanic acid, Amikacin, and Meropenem for empiric therapy while also considering laboratory susceptibility patterns. Conduct more research on UTI epidemiology and antimicrobial resistance to inform policy and develop effective interventions.

Acknowledgments

This study was made possible with the support and contributions of many individuals. First and foremost, we extend our deepest gratitude to the Almighty God for His unwavering love and grace, which enabled us to begin and complete this work. We are immensely grateful to all whose guidance and dedication were instrumental

throughout the study. Special thanks to Mr. Abunyang Stephen for his invaluable support and commitment during data collection. We owe profound gratitude to Mrs. Ojera Milly and Mr. Unen Coothembu Fred for their unwavering love and financial support for this study. We also thank Giramia Mercy Immaculate and Opakrwoth Maxwell for their encouragement and assistance. Lastly, we appreciate our friends for their moral, psychological, and material support during this journey.

List of abbreviations:

AMR - Antimicrobial resistance
CLED - Cystine-Lactose-Electrolyte-Deficient agar
GLP - Good Laboratory Practices
HIV - Human Immunodeficiency Virus
MHREC - Mengo Hospital Research Ethics Committee
SOP - Standard operating procedures
SPSS - Statistical Package for Social Scientists
UTI - Urinary Tract Infection
WHO - World Health Organization

Source of funding

This study did not receive any external funding.

Conflict of interest

There was no conflict of interest declared.

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1. Aramalo, Savior Yoacel – Conceptualization, Investigation, Methodology, Writing - original draft
2. Akullo, Mirriam – Investigation, Supervision
3. Oromcan, Benjamin Wathum – Investigation, Formal analysis, Writing - review & editing, Investigation.

Data availability

Data was readily available and accessible, as Mengo Hospital receives an average of over 2,000 suspected cases of urinary tract infections each month.

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PUBLISHER DETAILS:

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa