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ORIGINAL RESEARCH ARTICLE

Prevalence, Phenotypic Characterization and Antibiogram of Uro-pathogenic *Escherichia coli* (UPEC) in Patients attending a Tertiary Hospital in Katsina Metropolis

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ABSTRACT
This study examines the prevalence and antibiotic resistance of uro-pathogenic *Escherichia coli* (UPEC) among 150 patients at General Hospital Katsina (GHK). The urine samples were cultured on CLED and subsequently sub-cultured on EMB using standard protocols to obtain pure colonies. Gram stain, biochemical, and antibiotic susceptibility tests were carried out on the UPEC isolates using standard methods. Of the 150 urine samples analyzed, 69(46%) yielded growth, with 20(13.33%) UPEC prevalence at GHK. Chi-square revealed a higher UTIs prevalence of (48.89%: X^2=24.00) based on age observed in the 31-40 years group. Based on gender, females have a higher UTIs prevalence of (60%: X^2=2.00) than males (40%: X^2=2.00). Business-inclined individuals showed UTIs prevalence (39.13%: X^2= 20.0) higher than other occupations. Remarkable UPEC resistance was observed with AMP, CAZ, CRX, and ERY. UPEC showed high susceptibility to Nitrofurantoin and Imipenem, but 65% of isolates were multidrug resistant. Multiple drug-resistant indices (MARI) ranged from 0.3 to 0.9, indicating the existence of high multidrug resistance UPEC in the study population. Pearson correlation indicated a positive correlation between age (r=0.44) and gender (r= 0.797) in relation to multidrug antibiotic resistance. Routine surveillance is recommended.

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Uropathogenic, Antibiotics, Patients, Urine, Multidrug

INTRODUCTION
Urinary tract infections (UTIs) are one of the most common bacterial infections, with an estimated 150 million cases according to Da Cruz Campos (2020) and 400 million cases with 230,000 deaths worldwide, as reported by Whelan *et al.* (2023). Uro-pathogenic *Escherichia coli* (UPEC) is a major cause of urinary tract infections (UTIs) (Islam *et al.,* 2024). Uro-pathogenic *Escherichia coli* (UPEC) is responsible for 70–90% of urinary tract infections (UTIs), posing a significant healthcare challenge due to rising antibiotic resistance (Larramendy *et al.,* 2020).

In order to lower mortality and morbidity from infections, antibiotics use is crucial (Adenipekun *et al.* 2016). In recent times, there has been a notable rise in antimicrobial resistance in Uropathogenic *Escherichia coli* (UPEC) (Gibreel, 2011).

A report from Nigeria by Onifade and Agunloye (2019) indicates a growing rate of infections caused by multiple drug-resistant bacteria as a serious threat that needs urgent attention. The causal effect of antibiotic resistance is projected to hit around 1 trillion dollars in total economic impact worldwide by 2050 if left unchecked (Schoepp *et al.,* 2017). The effect will especially be felt in countries referred to as MINT (Mexico, Indonesia, Nigeria, and Turkey) and BRIC (Brazil, Russia, India, and China) (Tomy *et al.* 2020). Experts suggested antibiotic stewardship, improvement of patients' outcomes, and rapid evaluation of antimicrobial susceptibility may help deal with the menace (Schoepp *et al.,* 2017).

Numerous recent studies have focused primarily on the emergence of multidrug-resistant bacteria from diverse sources, including humans and animals (Islam *et al.*, 2024). The urinary tract is made up of the kidneys, ureters, bladder, and urethra (Katarzyna, 2017). Urine is transported from the kidney to the bladder by tiny tubules called ureters. The bladder, an organ that resembles a balloon, is situated in the pelvis of women and above the prostate gland in men. The tube that allows urine to leave the bladder is called the urethra (Katarzyna, 2017).

Based on the urinary tract's anatomical classification, UTIs are grouped into two. The first category includes the

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lower urinary tract, which includes the bladder (cystitis) and urethra (urethritis) (Smelov *et al.* 2016).

The second category is the upper urinary tract which includes the kidney (pyelonephritis) and ureter (ureteritis) (Smelov *et al.* 2016). There are differences between lower and upper UTI symptoms. Patients with pyelonephritis present fever, backache, and nausea, while patients with cystitis frequently present dysuria, voiding urgency, nocturia, suprapubic pain, and hematuria (Kumar *et al.,* 2015).

Furthermore, in certain instances of lower UTIs in men, the prostate (prostatitis) or the epididymis (epididymitis) may be impacted (Adolfsson *et al.,* 2018). In humans of all ages, *Escherichia coli*, a typical resident of the intestinal tract of mammals, is frequently responsible for intestinal infections, urinary tract infections (UTIs), and bacteremia (Adenipekun *et al.,* 2016). It has been reported that *E. coli* is resistant to several antimicrobials, such as aminoglycosides, beta-lactams, cephalosporins, fluoroquinolones, sulfonamides, tetracycline, and trimethoprim (Adenipekun *et al.,* 2016). One of the pathogens that are isolated in clinical practice the most frequently is UPEC, and it is thought to be a significant source of genes that encode resistance to antibiotics.

Many studies reported that bacteria can horizontally transfer antibiotic-resistance genes to other bacteria, which calls for an urgent need to further evaluate their prevalence and management (Chinyere *et al.,* 2020). Antibiotic resistance can arise and spread due to a number of factors, such as the quantity of antibiotics used and unsanitary conditions (Gibreel, 2011).

This study focused on the prevalence, phenotypic characterization, and antibiogram of uro-pathogenic *Escherichia coli* (UPEC) among patients attending a Tertiary Hospital in Katsina Metropolis in other to provide valuable information for guiding antimicrobial treatment strategies and addressing antibiotic resistance challenges.

MATERIALS AND METHODS

Ethical Approval

The study was approved ethically prior to its initiation by the research ethics committee of the Katsina State Ministry of Health, using the Health Research Ethical Review Committee (HREC) assigned number MOH/ADM/SUB/1152/1/849. Prior to the collection of samples, informed consent was acquired from each patient (Abdulkadir and Aisha, 2018; Abdu *et al.,* 2018).

Study Area

With a land area of approximately 24,194 Km², Katsina State is situated between longitudes 6°52', 9°20'E and latitudes 11°8', 13°22'N. The NPC (2006) estimates that the State has 5,800,672 inhabitants, of which 2,947,639 are men and 2,853,033 are women. The major occupations in Katsina State are farming, cattle rearing, trading, fishing, hunting, and crafts, among other things. Herbalists, craftspeople, and traditionalists are few. The State has two distinct seasons: wet and dry. According to Dauda *et al.* (2016), the Sahel region experiences 300–400 mm of annual rainfall, the Sudan 600–800 mm, and the Northern Guinea Savannah 900–1100 mm of annual rainfall. The mean daily temperature ranges between 16°C and 40°C (Dauda *et al.,* 2016).

Study Population

In this investigation, purposive sampling was employed. One hundred and fifty (150) clinical urine samples made up the sample population. Both male and female patient samples are included in the group. The patients' ages ranged from ≥20 to 81 years. Clinical urine samples were obtained from patients at General Hospital Katsina who had been diagnosed with UTIs (Nas *et al.,* 2019).

Sample Size Determination

The sample size of 150 was determined using the formula $n = Z^2\ p\ (1\text{-}p)/d^2$ where Z= Z-score for 95% confidence interval = 1.96, p = previous prevalence in North West Nigeria= 10.8% and d = acceptable error (5%). The prevalence of UTIs among patients attending selected hospitals in Northern Nigeria was used (Chinyere *et al.,* 2020).

$$n = \frac{(1.96)^2 \times (0.108) \times (1\text{-}0.108)}{(0.05)^2} = 148.03$$

The value 148.03 was rounded up to the nearest 100, which gave 150. Therefore, 150 urine samples were assessed in this study (Ali and Abdallah, 2019).

Inclusion and Exclusion Criteria

This study only included patients who were reported to show symptoms related to UTIs attending General Hospital Katsina. Uro-pathogenic *Escherichia coli* isolates were only considered in this study as the etiologic agent of UTI. Age brackets of ≥20 years were only considered (Torres-Sangiao *et al.,* 2022). Patients not attending General Hospital Katsina were not considered in the study. Age brackets <20 years were not considered as well (Torres-Sangiao *et al.,* 2022).

Microbiological Analysis

Sample Collection and Handling

A total of 150 urine samples were obtained from the patients and placed in sterile, labeled universal containers. The patients supplied clean catch midstream urine in the early morning. Within two hours of being collected, the specimens at the GHK microbiology lab were labeled and examined. All patients received instructions on how to collect samples aseptically in order to prevent urethral contamination (Ado *et al.,* 2019; Abdu *et al.,* 2018).

Media

Cystine Lactose Deficient agar (CLED) (L:S-BIOTEC, USA), Eosin Methylene blue (EMB) (TM MEDIA, INDIA), Nutrient agar (NA) (HiMedia, USA), Simmons Citrate Agar (LIFESAFE BIOTECH, USA), Methyl Red Voges Proskaur (MRVP) agar (HKM, CHINA), Triple Sugar Iron Agar (TSI) (HKM, CHINA), peptone (ZAYO SIGMA, GERMANY) were prepared according to the manufacturer's instructions.

Isolation of Bacteria (UPEC) from Urine Sample

A sterile wire loop was dipped into the sediments of a 10-milliliter urine sample from each patient, which was centrifuged (Model-800-1, USA) for five minutes at 2000 rpm. The sediments were then streaked onto a surface that had been prepared with Cysteine-Lactose Deficient Agar (CLED). All of the samples underwent the same process, and the plates were incubated for 24 hours at 37 °C. To obtain pure UPEC colonies, the discrete yellowish colonies on CLED of the bacteria from each plate were further sub-cultured on EMB. The pure isolates of the bacteria were kept on Nutrient Agar slants for future use (Nas *et al.,* 2019).

Gram Staining Technique

Gram Stain

On a clean, labeled glass slide, a 24-hour bacterial culture of the isolates was emulsified to create a thin smear using a sterilized wire loop. The smear was heat-fixed after air drying. The slide was flooded for 60 seconds with a crystal violet primary stain, and it was then cleaned with distilled water. The smear was then flooded with Lugol's iodine for 60 seconds and then rinsed with distilled water. Acetone was used to decolorize the slide for 30 seconds and immediately rinsed with distilled water. Safranin was used as counterstain for 60 seconds then giving it a quick rinse with distilled water. It was examined using a microscope (Carl Zeiss Gmbh: Model-37081, GERMANY) with an oil immersion objective lens (×100) (Nas *et al.,* 2019).

Biochemical Tests

Indole Test

After inoculating the organism into peptone water and incubating for 24 hours at 37°C, Kovac's reagent was added in drops. According to Nas *et al.* (2019), a positive outcome was indicated by the pink ring that forms in the center of the tube.

Citrate Utilization Test

UPEC colonies that were well isolated following overnight incubation were emulsified in citrate media using a sterilized wire-loop and incubated (TT-9052 Techmel and Techmel, USA) at 37°C for 24 hours. No changes in color indicated positive results.

Triple Sugar Iron (TSI) Agar

A discrete colony was taken from a pure overnight culture and stabbed through the middle of the medium to the bottom (butt), then streaked on the slant of the medium. It was then incubated at 37^{O}C for a 24hrs. The procedure was done using a sterile wire loop. When any sugar is fermented, acid is produced, as seen by a color shift in the phenyl red indicator from red to yellow in both the butt and the slant (Gladys, 2019).

Methyl Red-Voges Proskauer Test

A methyl red indicator is used in this test to identify acidity that results from glucose fermentation. Colonies from the overnight culture were picked using a sterile wire loop and inoculated into a labeled tube containing MR broth; an un-inoculated tube was kept as a control. The two tubes were incubated for 24 to 48 hours at 37^{0}C. Both tubes were filled with 3 drops of MR indicator, thoroughly mixed, and the color change was monitored. The red color that surfaced denotes a Positive test.

Voges-Prokauer Test

Using a sterilized wire loop, separate colonies were selected from an overnight culture and injected into the VP broth. The tube and control were incubated for 24 to 48 hours at 37 ^{O}C. Barrett's reagent B was added to both tubes in three (3 ml) doses. The caps were removed, and the tubes were gently shaken for 30 seconds to expose the media to oxygen. Positive outcomes are indicated by the color crimson red when it appears (Gladys, 2019).

Preparation of McFarland Standard

One milliliter (1 mL) of concentrated sulfuric acid (H_2SO_4) was added to 99 mL of distilled water to prepare a 1 percent solution of barium chloride; 1 g of $BaCl_2$ was added to the same amount of water. Then, zero point five (0.5) McFarland standard was made by combining ninety-nine milliliters of H_2SO_4 with zero point five milliliters of the prepared $BaCl_2$ (Ezugwu *et al.,* 2021).

Standardization of the Inoculum

The inoculum was standardized by sub-culturing the isolates on fresh NA using sterilized wire followed by incubating at 37°C for 24 hours. Following incubation, discrete colonies were picked using a sterile wire loop and placed into 5 mL sterilized distilled water in a test tube. The size of the inoculums for the corresponding organisms was then compared with the McFarland scale of 0.5 or 1.5×10^{8} cfu/mL (Oyeleke and Manga, 2008).

Antibiotic Susceptibility Testing

The antibiotic susceptibility testing followed the modified single disc diffusion techniques, interpreted in accordance with Clinical and Laboratory Standard Institute (CLSI,

2017) guidelines. Statistical significance was determined using Pearson's Chi-square test with $p<0.05$ was considered significant. Standardized overnight culture of each isolate (containing approximately 10^6 cfu/ml) equivalent to 0.5 McFarland Standard was used to flood the surface of Mueller Hinton agar plates and allowed to dry while the petri dish lid was in place. The following standard antimicrobial discs namely; Ciprofloxacin (CIP, 5µg), Erythromycin (ERY, 15µg), Gentimisin (GEN, 10µg), Imipenem (IMI, 10µg), Amoxicillin (AMP, 20µg), Ceftazidime (CAZ, 30µg), Cefuroxime (CRX, 30µg), Ofloxacin (OFL, 5 µg), Nitrofurantoin (NIT, 50µg), and Amoxicillin-Clavulanate (AUG, 30µg) obtained from MASTDISCS^{R}AST, UK, were aseptically placed at reasonable equidistance. Plates were then incubated at 37^0C for 18-24 hours. The diameter of the zone of inhibition produced by each antibiotic disc was measured with a graduated ruler in millimeters. Breakpoints and interpretative for susceptibility/resistance were based on the CSLI (2023) criteria.

Determination of Multiple Antibiotic Resistance Index

The standard method, as described by Abdu *et al.* (2018), was employed in the determination of the Multiple Antibiotic Resistance Index (MARI). The isolated UPEC that were resistant to three or more antibiotic groups were considered multiple antibiotic resistant (MAR), and the MARI was determined using the formula:

MAR= x/y

Where: x= Number of antibiotics to which the isolate was resistant

y= Total number of antibiotics to which the test isolates have been evaluated for sensitivity.

Data Analysis

Data obtained were analyzed using descriptive statistics, Pearson correlation, and Chi-square test. SPSS statistical software version 20 was used for the analysis (Mutonga *et al.,* 2019).

RESULTS

Table 1: Association of UTIs with Socio-Demographic Information of Patients at General (GHK) (n=150)

Variables	Bacteriological Growth (%)		Pearson Chi-square	p-value
	Positive Growth=69(46%)	Negative Growth=81(54%)		
Age (years)	**GHK**	**GHK**		
20-30	13(18.84)	28(34.57)		
31-40	33(47.83)	28(34.57)	X^2=24.00	0.242
41-50	15(21.74)	14(17.28)		
51-60	2(2.90)	6(7.41)		
61-70	4(5.80)	5(6.17)		
71-80	2(2.90)	0(0)		
Gender				
Male	25(36.23)	31(38.27)	X^2=2.00	0.157
Female	44(63.77)	50(61.73)		
Occupation				
Civil Servants	19(27.54)	20(24.70)		
Students	4(5.80)	11(13.58)		
Farmers	11(15.94)	4(4.94)	X^2=20.00	0.220
House Wife	8(11.60)	23(28.40)		
Business	27(39.13)	23(28.40)		

KEY: GHK= General Hospital Katsina.

Of the 150 suspected cases of UTIs at GHK, Table 1, 69(46%) yielded positive bacterial growth, while 81(54%) yielded no growth. Regarding age, 31-40 years have the highest prevalence rate of 33(47.83%), followed by 41-50 years, 15(21.74%), 20-30 years 13(18.84%), 61-70 years 4(5.80%), 51-60 and 71-80 years 2(2.90%) respectively. Age groups 20-30 and 31-40 years equally have the highest rate of no growth at 28(34.57%), followed by 41-50 years 14(17.28%), 51-60 years 6(7.41%) and 61-70 years 5(6.17%). Chi-square analysis revealed a weak association between UTIs and age (X^2= 24.00, p> 0.05).

Females have higher prevalence of UTIs 44(63.77%) compared to males 25(36.23%). Chi-square results indicated a weak association between gender and UTIs (X^2= 2.00, p>0.05).

Regarding occupation, those engaged in businesses have the highest prevalence of UTIs, 27(39.13%), followed by civil servants 19(27.54%), farmers 11(15.94%), housewives 8(11.6%) and students 4(5.8%). Chi-square analysis showed there is a weak association between occupation and UTIs (X^2= 20.00, p>0.05).

Of the 150 urine samples examined, Figure 1, 81(54%) yielded no bacterial growth, 69(46%) yielded growth with 20(13.33%) confirmed UPEC at GHK. Females have the

highest prevalence rate of UPEC 12(60%) than males 8(40%).

Table 2 shows the biochemical reactions such as Indole (+), MR (+), VP (-), citrate (-), and TSI with yellow slope, butt, and Gas production alongside motility of the UPEC isolates from GHK and their morphological characteristics on CLED and EMB media.

Figure 2 below indicated that CAZ, CRX, AUG, AMP, and ERY showed 100% resistance against UPEC isolates tested from GHK, while IMI, NIT, and GM showed appreciable susceptibility and CIP, and OFL where intermediate against the UPEC isolates. Chi-square results revealed a significant association between UPEC isolates and antibiotic resistance (X^2= 22.5, p=0.05).

Table 3 shows various UPEC that are resistant to CAZ, CRX, GEN, CIP, OFL, AMP, ERY, NIT, and AUG at different levels of MARI as 0.5, 0.6, 0.7, 0.8, and 0.9. It can be deduced that UPEC isolates with 0.9 MARI indicated high resistance followed by 0.8, 0.7, 0.6, and 0.5.

Of the 20 UPEC isolates assessed, as shown in Table 4, a positive correlation of 0.797 with a p-value of 0.000 at 0.01 level of significance suggests that there is a strong positive linear relationship between UPEC multidrug antibiotic-resistant pathogens and gender. Meaning, gender is likely to have a significant influence on the level of multidrug antibiotic resistance observed in the study. Regarding age, a positive correlation of 0.44 and a p-value of 0.05 indicated that there is a moderate positive correlation between age and UPEC multidrug resistance at 0.05 level of significance. Notably, the relationship is not as strong as that observed in gender.

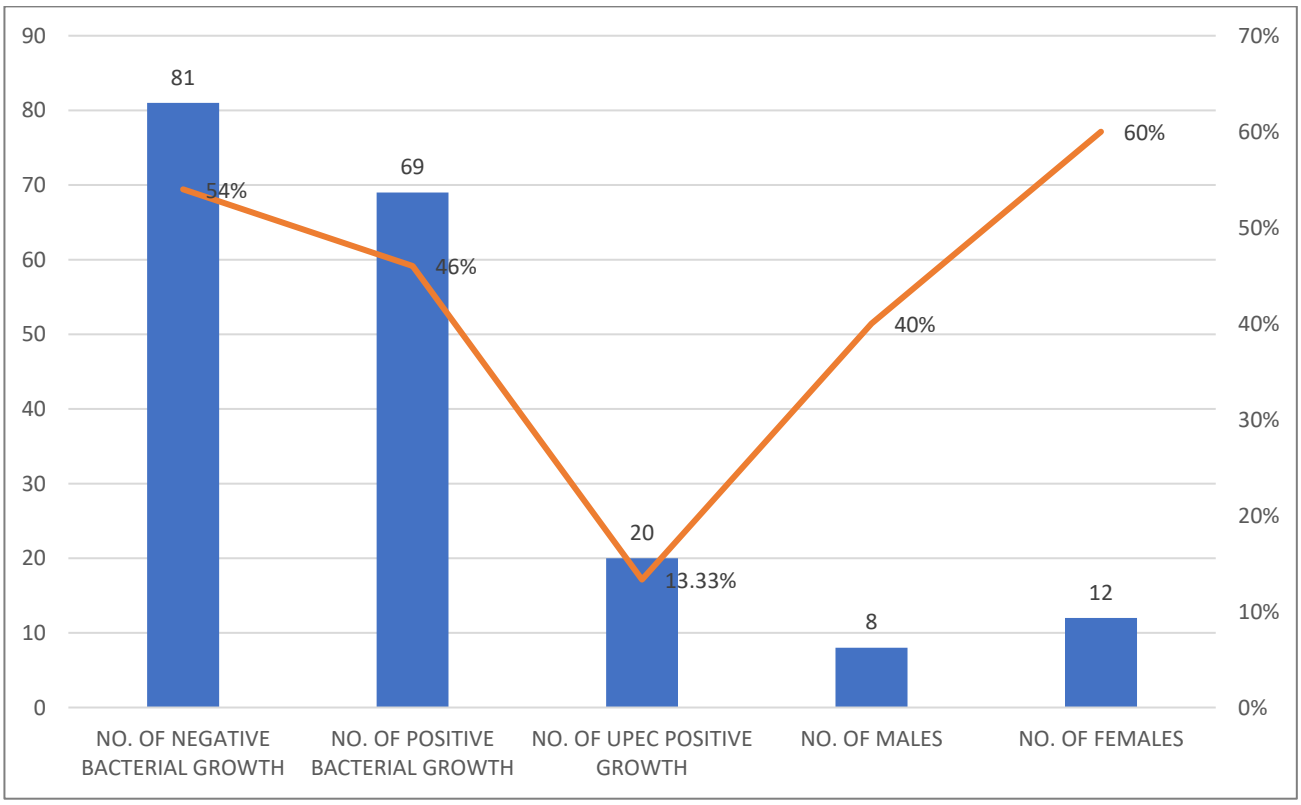


Figure 1: Prevalence of UPEC Isolates at GHK
KEY: GHK= General Hospital Katsina

Table 2: Results of Biochemical Test for GHK UPEC Isolates

Isolates ID	Indole	MR	VP	Citrate	TSI				Morphology	GR
					Slope	Butt	Gas	Motility		-
G1-G20	+	+	-	-	+	+	+	+	Opaque Yellow Colony on CLED and Green Metallic Sheen on EMB	-

KEY: GHK= General Hospital Katsina, MR= Methyl Red, VP= Vouges Proskaur, TSI= Triple Sugar Iron Agar, CLED= Cystein Lactose Deficient Agar, EMB= Eosin Methylene Blue Agar, GR= Gram's Reaction.

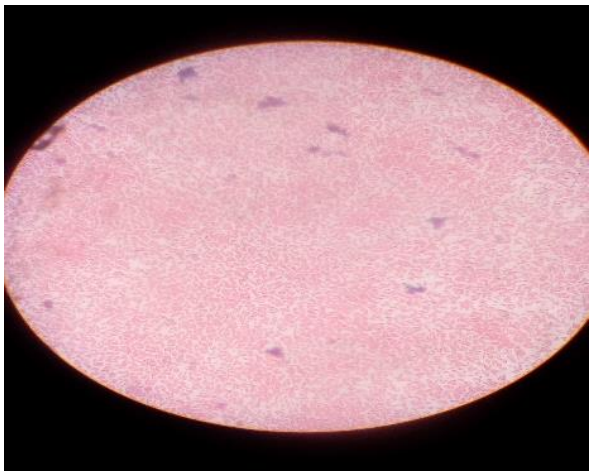


Plate 1: Gram Negative (UPEC) under ×100 Objective Lens (Oil immersion)

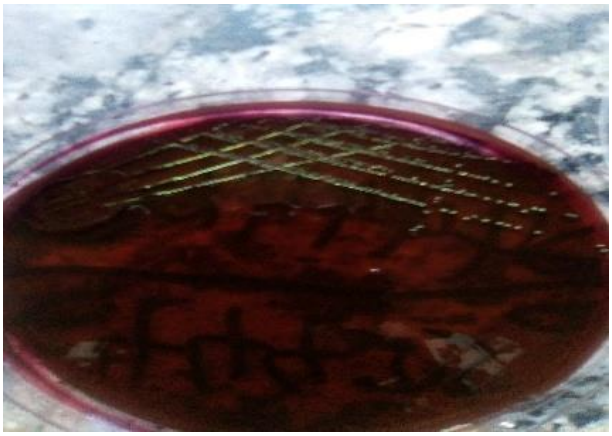
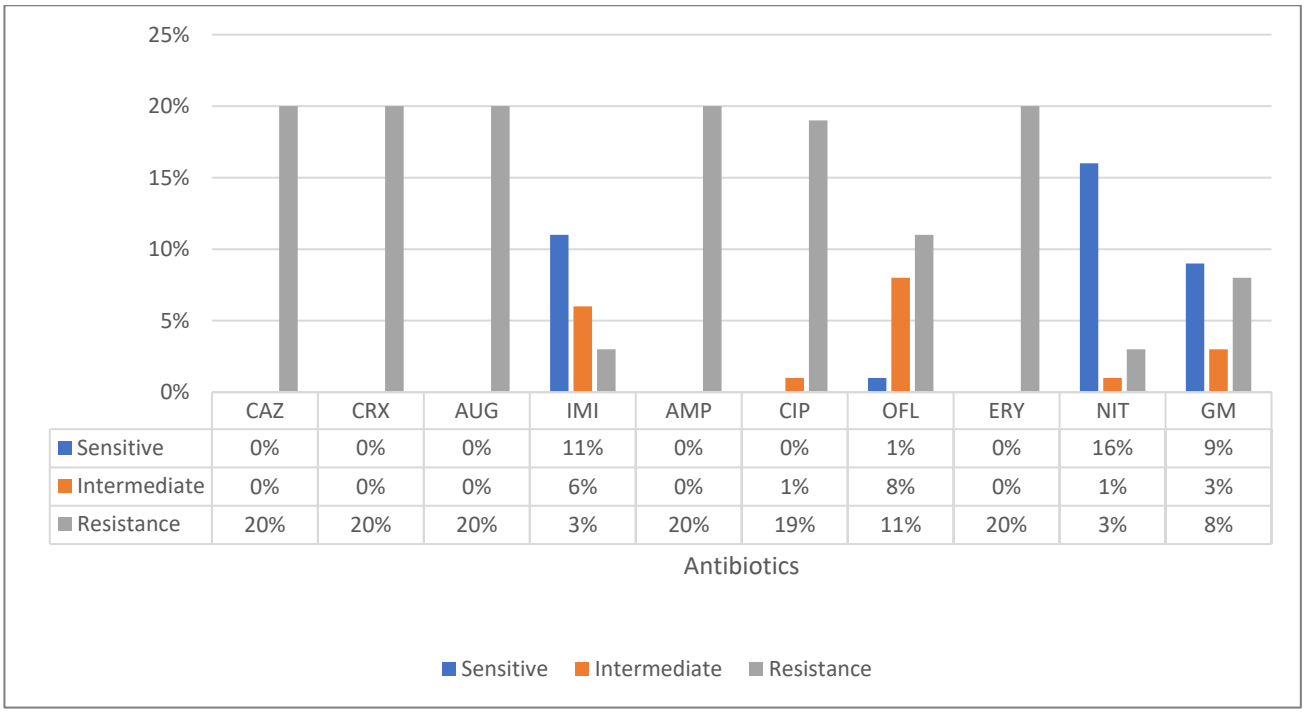


Plate 2: UPEC Colonies on EMB

Plate 3: UPEC Colonies on CLED



	CAZ	CRX	AUG	IMI	AMP	CIP	OFL	ERY	NIT	GM
Sensitive	0%	0%	0%	11%	0%	0%	1%	0%	16%	9%
Intermediate	0%	0%	0%	6%	0%	1%	8%	0%	1%	3%
Resistance	20%	20%	20%	3%	20%	19%	11%	20%	3%	8%

Figure 2: Antibiotic Susceptibility of UPEC Isolates among Patients attending GHK

KEY: CAZ= Ceftazidime, CRX= Cefuroxime, AUG= Amoxicillin-Clavulanate, IMI= Imipenem, AMP= Ampicillin, CIP= Ciprofloxacin, OFL= Ofloxacin, ERY= Erythromycin, NIT= Nitrofurantoin, GM= Gentimicin.

Table 3: Antibiotics Resistance Pattern of UPEC Isolates among Patients attending GHK

No. of Antibiotics Combination	No. of Isolates	Antibiotics									MARI
5	6	AMP	AUG	CAZ	CRX	NIT					0.5
6	4	AMP	AUG	CAZ	CRX	ERY	OFL				0.6
6	1	AMP	AUG	CAZ	CRX	ERY	GEN				0.6
6	1	AMP	AUG	CAZ	CIP	CRX	GEN				0.6
7	2	AMP	AUG	CAZ	CIP	CRX	ERY	OFL			0.7
7	2	AMP	AUG	CAZ	CIP	CRX	ERY	GEN			0.7
7	1	AMP	AUG	CAZ	CRX	ERY	GEN	OFL			0.7
7	1	AMP	AUG	CAZ	CIP	CRX	ERY	GEN			0.7
8	1	AMP	AUG	CAZ	CIP	CRX	ERY	GEN	OFL		0.8
9	1	AMP	AUG	CAZ	CIP	CRX	ERY	GEN	NIT	OFL	0.9

KEY: CAZ= Ceftazidime, CRX= Cefuroxime, AUG= Amoxicillin-Clavulanate, IMI= Imipenem, AMP= Ampicillin, CIP= Ciprofloxacin, OFL= Ofloxacin, ERY= Erythromycin, NIT= Nitrofurantoin, GM= Gentamicin, MARI= Multiple Antibiotics Resistance Index.

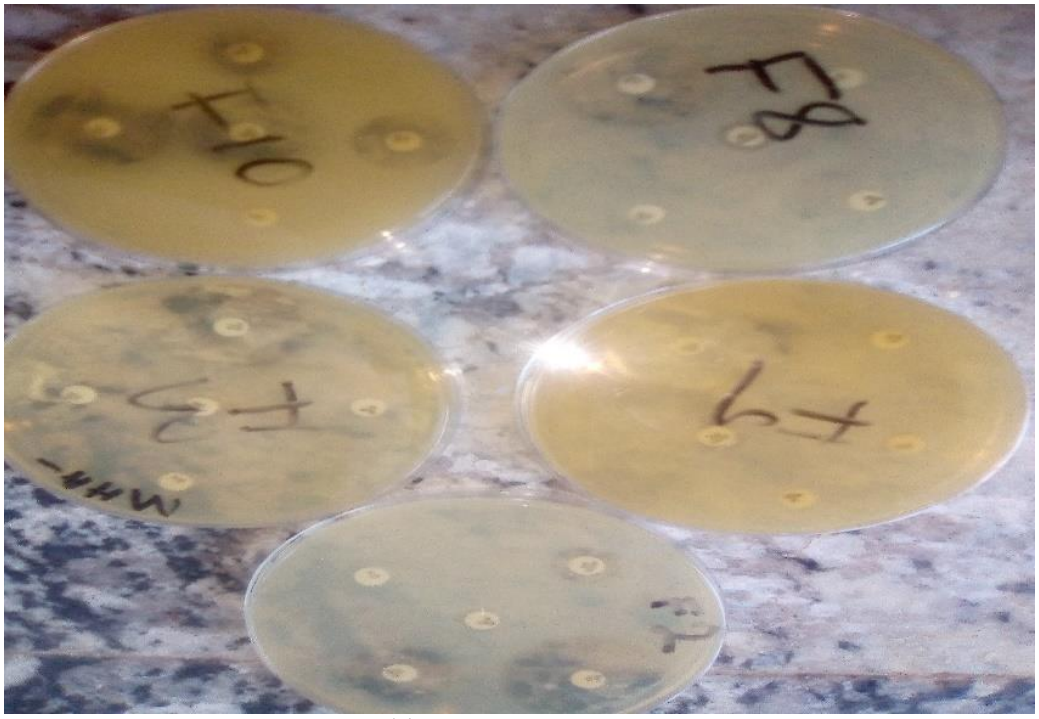


Plate 4: Antibiotic Susceptibility Test for UPEC Isolates

Table 4:Pearson Correlation Coefficients for UPEC Multidrug Antibiotic Resistance in Relation to Gender and Age of Patients at GHK

	Correlations	Gender	Age	Antibiotics
Gender	Pearson Correlation	1	.499*	.797**
	Sig. (2-tailed)		.025	.000
	N	20	20	20
Age	Pearson Correlation	.499*	1	.440
	Sig. (2-tailed)	.025		.052
	N	20	20	20
Antibiotics	Pearson Correlation	.797**	.440	1
	Sig. (2-tailed)	.000	.052	
	N	20	20	20

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Our findings of 13.33% prevalence in UTIs caused by UPEC are closely related to 13% and 23.5% UPEC prevalence reported by Iregbu and Nwajiobi-Princewill (2013) and Iseghohi *et al.* (2020) in Abuja and Minna metropolis respectively, Nigeria. In the same vain, the prevalence agrees with the report of Ali and Abdallah (2019), who also showed a 15.8% prevalence of UPEC in patients attending Murtala Mohammed Specialist Hospital, Kano, while lower (35%) than the report of Chinyere *et al.* (2020), (71.21%) Islam *et al.* (2024) and (35%) Ahmed *et al.* (2019). Shahzad *et al.* (2016) reported 60.7% UPEC prevalence in a study from Pakistan. This could be due to varying sanitary conditions among the patients and also personal hygiene.

Higher UTIs observed in middle age group in this study coincide with the report of Abdu *et al.* (2018). Similarly, the older age group has the least UTIs, and this agrees with the work of Nas *et al.* (2019), who reported age group <18 years 1(2%) and 71> years 5(10%) have the least rate of UTIs. Observed UTIs ranging from younger to older age in this study corresponds with a study reported by Hassan *et al.* (2018), who showed highest UTI in the 21-40 year age group (42.3%) followed by 41-60 years (27.6%), 61-80 years (8.5%) and above 80 years (5.6%). Age was found to be positively related to multidrug resistance in this study, which aligns with the work of Lin *et al.* (2021), who indicated that UPEC strains isolated were significantly resistant to host age increases. The age brackets observed consist of teenagers, adolescents, young people, and the elderly. Increased sexual activity and use of spermicide, which predisposes to UTIs, might be the cause of antibiotic resistance.

UPEC observed in females was higher than males in this study, which is in agreement with the report of Bhargava *et al.* (2022), who indicated a higher prevalence of UTIs in females (60.7%) than males (39.3%). Gender was found to be positively related to multidrug resistance in this study, contrary to the report of Arafa *et al.* (2022). Lin *et al.* (2021) reported that males did not significantly differ (Pearson Chi-square (X^2) = 0.084, p>0.05) from females, contrary to our findings. The high prevalence of UPEC observed in the female gender in this study might be due to the short anatomical urethra nature in females, the use of contraceptives, and spermicides, which promote greater colonization of the vagina as this increases the incidence of developing UTIs. Regarding the occupation of the patients in both hospitals, those involved in businesses and housewives have the highest UTIs, and the outcome corresponds directly with the report of Kolo and David (2021), who showed the highest level of UTIs among housewives 80(79.2%) and business individuals 13(12.9%). Okafor and Nweze (2020) also showed the highest rate of UTIs among civil servants 88(33%), followed by students 67(25%), traders 56(21%), unemployed 29(11%), farmers 19(7%) and artisans 7(3%) which are closely related to the findings in this study.

The findings of this study's biochemical tests align with those of Hassan *et al.* (2018), who reported that *Escherichia coli* was identified biochemically as gram-negative, raised, circular, motile, lactose, glucose-fermenting, Indole positive, methyl red positive, Voges praskauer negative, and citrate negative bacilli. In patients visiting GHK, the UPEC isolates demonstrated a high degree of variable susceptibility to Beta-lactams, nitrofuran, aminoglycosides and fluoroquinolones classes of antibiotics. This aligns with the research conducted by Kubone *et al.* (2020), who found that patients undergoing treatment at certain South African hospitals had 100% UPEC susceptibility to Imipenem. Further consistent with the research of Hassan *et al.* (2018), who demonstrated sensitivity to Augmentin, Ciprofloxacin, and Imipenem and further demonstrated the value of prescribing those antibiotics for complex UTI in Osogbo. The results of this study are further supported by the findings of Abdu *et al.* (2018), who found that Nitrofurantoin was the most sensitive 117 (78%) against UPEC isolated from patients visiting a tertiary care hospital in Maiduguri, North Eastern Nigeria. Iseghohi *et al.* (2020) also documented UPEC susceptibility to Ofloxacin and Gentamicin, which is consistent with our results. Abdu *et al.* (2018) found that the antibiotic compounds most susceptible to UPEC were Gentimisin (64%) and Nitrofurantoin (70%). This finding is directly supported by Iregbu and Princewill's (2013), who demonstrated that Imipenem 45(89%) was generally the most sensitive medication against UPEC isolates. The study's Multiple Antibiotics Resistance Index (MARI) was >0.3, which is consistent with the findings of Iseghohi *et al.* (2020), who revealed that 70% of UPEC have a MARI of ≥0.3. Sixty-five percent (65%) of the isolates from GHK exhibited resistance to multiple drugs. Most notable resistance patterns include resistance to Beta-lactams, fluoroquinolones, and macrolide classes, which are frequently found in UPEC of female origin (Arafa *et al.,* 2022). This is consistent with the findings of Alshaikh *et al.* (2024), who found that 90% of UPEC bacterial isolates are either multidrug-resistant or extensively drug-resistant. Additionally, Adenipekun *et al.* (2016) revealed 53 resistant patterns in *E. coli* isolates, accounting for 70% of the isolates (172/247).

The chi-square test showed a statistically significant variation (p<0.05) between the resistant and sensitive UPEC isolates (X^2=50.0; X^2=22.5, p<0.05). These variations in susceptibility may be due to the prescription habits in different localities, as inappropriate exposure to

antibiotics drives the development of resistance. Iregbu and Nwajiobi-Princewill (2013) also reinforce the need for mandatory urine culture for all suspected UTIs to properly guide therapy.

CONCLUSION

The overall prevalence of UTI caused by UPEC in the study population was found to be 13.33%. Females were found to be more affected than males in terms of UTI caused by UPEC. The age group 31-40 years was observed to have a high rate of UPEC infection, followed by >41 years. The results also showed high rates of UPEC antibiotic sensitivity to Nitrofurantoin and Imipenem, followed by Gentimisin, Ofloxacin, and Ciprofloxacin in GHK isolates. However, alarming rates of multidrug resistance were observed from CAZ, CRX, AMP, ERY, and OFL antibiotics, posing a significant public health concern and limiting treatment options. These findings emphasize the widespread issue of antibiotic resistance in the study population.

RECOMMENDATIONS

Reducing the incidence of UPEC and continually monitoring the susceptibility of the commonly used antibacterial drugs is crucial at the local level. Health organizations are urged to regularly assess and monitor emerging patterns and trends of UPEC multidrug resistance to prioritize and implement effective antimicrobial stewardship policies and recommendations at health facilities.

REFERENCES

Abdu, A., Kachalla, M., and Bulus, D. Y. (2018). Antibiotic Susceptibility Patterns of Uropathogenic *Escherichia coli* among Patients with Urinary Tract Infections in a Tertiary Care Hospital in Maiduguri, North Eastern Nigeria, *Journal of Biosciences and Biotechnology Discovery,* 3:14-24 ISSN: 2536-7064. **[Crossref]**

Abdulkadir, B. and Aisha, A. S. (2018). Analysis of Bacterial Urinary Tract Infection among Pregnant Women In Tertiary Hospital in Katsina Metropolis, *Bayero Journal of Pure and Applied Sciences,* 11(1): 68-72 ISSN 2006 – 6996. **[Crossref]**

Arafa, S. H., Alshehri, W. A., Organji, S. R., Elbanna, K., Obaid, N. A., Aldosari, M. S., Asiri, F. H., Ahmad, I., and Abulreesh, H. H. (2022). Antimicrobial Resistance, Virulence Factors-Encoding Genes and Biofilm forming ability of Community associated UPEC in Western Saudi Arabia, *Pol. J. Microbiol.,* **71**(3): 325-339. **[Crossref]**

Adenipekun, E. O., Jackson, C. R., Ramadan, H., Iwalokun, A. B., Oyedeji, K. S., Frye, J. G., Barrett, B. J., Hiott, L. M., Woodley, A. T., and Oluwadun, A. (2016). Prevalence and multidrug resistance of *Escherichia coli* from community acquired infections in Lagos, Nigeria, *The Journal of Infection in Developing Countries,* 10(9): 920-931. **[Crossref]**

Ado, A., Chonoko, U., G., and Badaru, M. (2019). Antibacterial Activity of *Eucalyptus globulus* on Urinary Tract Clinical Bacterial Isolates, *FUDMA Journal of Sciences (FJS),* 3(1): 100 -103 ISSN online: 2616-1370

Adolfsson, J., Russell, B., Garmo, H., Beckmann, K., and Van Hemelrijck, M. (2018). "A case-control study of lower urinary-tract infections, associated antibiotics and the risk of developing prostate cancer using PCBaSe," *PlosOne,* 1–10.

Ahmed, H. I., Fagwalawa, L. D., Ahmad, I., Yushau, M. and Ali, M. (2019). Determination of Antibiotic Sensitivity Pattern of Bacteria Associated with UTI among Adult Males in Kano, Nigeria, *EAS Journal of Parasitology and Infectious Diseases,* 1(5): 127-132 ISSN 2663-0982 and 2663-6727

Ali and Abdallah, (2019). Prevalence of UTI among Pregnant Women in Kano, Northern Nigeria, *Archives of |Reproductive Medicine and Sexual Health,* 2(1): 23-29. **[Crossref]**

Alshaikh, S. A., Elbanna, T., and Sonbol, F. (2024). Correlation between Antimicrobial Resistance, Biofilm formation, and Virulence Determinants in Uro-pathogenic *Escherichia coli* fron Egyptian Hospital, *Annals of Clinical Microbiology and Antimicrobials,* **23**(20): 1-10. **[Crossref]**

Bhargava, K., Nath, G., Bhargava, A., Kumari, R., Aseri, G. K., and Jain, N. (2022). Bacterial Profile and Antibiotic Susceptibility Pattern of Uropathogens causing Urinary Tract Infection in the Eastern Part of Northern India, *Front. Microbiology,* 01-010. **[Crossref]**

Chinyere, E. L., Nura, S. M., Ahmad, G. M., Kemi, A. F., and Sani, M. N. (2020). Prevalence and Molecular Analysis of Extended Spectrum Bete Lactamase producing Uropathogens among Pregnant Women, Jigawa State, Nigeria. *Journal of Clinical Microbiology and Biochemistry Technology,* 6(1): 33-38. **[Crossref]**

Clinical and Laboratory Standards Institute (CLSI) (2017). Performance Standards for Antimicrobial Susceptibility Testing. Twenty-seventh Information Supplement, 37(1), M100-S26:1-249

Clinical and Laboratory Standards Institute (CLSI) (2023). Performance Standard for Antimicrobial Susceptibility Testing, 33rd ed. Supplement M100 (ISBN 978-1-68440-170-3[print] ISBN 978-1-68440-171-0 [electronic])

Dauda, G., Bashir, B. H., Sidahmed, M. and Bella, B. A. (2016). Socio-economic Factors Influencing the Participation of the Marginalized and Vulnerable Farmers in the Ifad-Community Based Agriculture and Rural Development Programme in Katsina State, Nigeria, *Journal of Resource Development and Management,* 24: 50-57 ISSN 2422-8397

Ezugwu, I. A., Afunwa, R. A., Onyia, F. C., Unachukwunwejim, M. N., Offe, I. M., Onyia, C.

O., and Eze, E. A. (2021). Prevalence of UTIs and Associated Risk Factors among Pregnant Women in Enugu Metropolis, Nigeria, *Journal of Biosciences and Medicines,* 9: 156-171. **[Crossref]**

Gibreel, T. M. (2011). Molecular Epidemiology of Uropathogenic *Escherichia coli* in North West England and characterisation of the ST131 clone in the region, A Thesis submitted to the University of Manchester for the degree of Doctor of Philosophy in the Faculty of Medical and Human Science, 1-180.

Gladys, C. M. (2019). Profiling of Antibiotic Resistance among Uropathogens Isolated from Patients attending Kericho County Referral Hospital, A M. Sc. Thesis, 1-76.

Hassan, A. O.,Adebimpe, W. O., Fadeju, O. J., Ojo, T. Omisakin, A.O. (2018). Causative agents of Urinary Tract Infection and their antibiotic susceptibility pattern in a tertiary health institution, *International Journal of Medicine and Biomedical Research,* 7(1): 41-51

Iregbu, K. C. and Nwajiobi-Princewill, P. I. (2013). Urinary Tract Infections in A Tertiary Hospital in Abuja, Nigeria, *African Journal of Clinical and Experimental Microbiology,* 169-177 ISBN 1595-689X. **[Crossref]**

Islam, M. F., Das, D. K., Islam, B., Rashid, M. B., Sarker, S., and Haque, M. H. (2024). Risk Factors and Antibiogram of Human Uropathogens in the Northern Part of Bangladesh: Across-sectional Study, *Journal of Applied Biology and Biotechnology,* 12(2)212-224. **[Crossref]**

Katarzyna, S. (2017). Evaluation of new diagnostic technologies for rapid detection of urinary pathogens and their antibiotic resistances, A Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy, University of East Anglia, 1-365

Kolo, R. L., and David, I. J. (2021). Prevalence of UTI among Pregnant Women in Gashua, Nigeria, *International Journal of Multidisplinary Research and Growth Evaluation,* 2(3): 505-508 ISSN: 2582-7138. **[Crossref]**

Kubone, P. Z., Mlisana, K. P., Govinden, U., and Abia, A. L. K. (2020). Antibiotic Susceptibity and Molecular Characterization of Uropathogenic *Escherichia coli* Associated with Community-Acquired Urinary Tract Infections in Urban and Rural Settings in South Africa, *Journal of Tropical Medicine and Infectious Disease,* 5(176):1-13

Larramendy S, Deglaire V, Dusollier P et al (2020) Risk factors of extended-spectrum beta-lactamases-producing escherichia coli community acquired urinary tract infections: a systematic review. Infect Drug Resist 13:3945–3955. **[Crossref]**

Lin, W., Wang, M., Liu, P., Chen, P., Wen, L., Teng, C. and Kao, C. (2021). *Escherichia coli* Urinary Tract Infections: Host Age-related differences in Bacterial Virulence factors and Antimicrobial Susceptibility, *Journal of Microbiology, Immunology* and *Infection,* **55**(2): 249-256. **[Crossref]**

Nas, F., S., Ali, M., Abdallah, M., S., and Zage, A., U. (2019). Prevalence and Antibiotic Susceptibility Pattern of Escherichia Coli Isolated from Urine Samples of Urinary Tract Infection Patients, *ARC Journal of Urology,* **4**(1): 14-20 ISSN No. (Online):2456-060X. **[Crossref]**

National Polation Commision (2006). National Population Commission Report, Available online at: nationalpopulation.gov.ng, Accessed: 15/09/2024

Nzalie, R. N., Gonsu, K. H., and Koulla-Shiro, S. (2016). Bacterial Etiology and Antibiotic Profile of Community-Acquired Urinary Tract Infections in a Cameroonian City, *International Journal of Microbiology,* 1-10 Article ID 3240268. **[Crossref]**

Okafor, J. U.and Nweze, E. I. (2020). Antibiotic Susceptibility of *Escherichia coli* Isolated in Cases of Urinary Tract Infection in Nsukka, Nigeria, *Journal of Preclinical and Clinical Research* 14(1): 1-7. **[Crossref]**

Onifade, A. K. and Agunloye, O. O. (2019). Antibacterial assessment of Crude and Fractionated Extracts of *Vernonia amygdalina* Leaf against Multi Drug Resistant Bacteria of Wound Infection, *Asian Journal of Research in Medical and Pharmaceutical Sciences,* **7**(1): 1-12 ISSN: 2457-0745. **[Crossref]**

Oyeleke S. B.,and Manga S. B. (2008). Essentials of Laboratory Practicals in Microbiology. Niger, TOBEST PUBLISHER, 93-99

Smelov, V., Naber, K., and Bjerklund, T. E. (2016). "Improved Classification of Urinary Tract Infection: Future Considerations," *European Urology, Supplements*, **15** (4): 71–80. **[Crossref]**

Schoepp, N. G., Schlappi, T. S., Curtis, M. S., Butkovich, S. S., Miller, S., Humpheries, R. M., and Ismagilov, R. F. (2019). Rapid Pathogen Specific Phenotypic Antibiotic Susceptibility testing using Digital LAMP Quantification in Clinical samples, *Sci. Transl. Med.* **9**(410): 1-10. **[Crossref]**

Shahzad, N., Aslam, B., Hussain, I., Ijaz, M., Rasood, F. T., Hamid, T., Tayyeb, A. and Tanveer, H. (2016). Distribution and Phylogenetic Analysis of Bacterial Isolates from Urinary Tract Infection Patients of Pakistan, *Pakistan Journal of Zoology,* 48(6): 1925-1930

Torres-Sangiao, E., Lamas-Rodriguez, B., Cea-Pajaro, M., Carracedo-Montero, R., Parajo-Pazos, N., and Garcia-Riestra, C. (2022). Direct Urine Resistance Detection using VITEK2, *Journal of Antibiotics,* **11**: 1-10. **[Crossref]**

Tomy, A., Aravind, H., David, E., Ravi, R., Ramachandran, L., and Thomas, A. (2020). Antimicrobial Susceptibility of Uropathogens and Prescribing Patterns in Hospital and Community Acquired UTIs in a Tertiary Care Hospital, *J. Appli. Pharm. Sci.,* **10**(11): 50-58. **[Crossref]**

Whelan, S., Lucey, B., and Finn, K. (2023). UPEC-associated UTIs: The Molecular Basis for Challenges to Effective Treatment, *Journal of Microorganisms,* **11**: 1-10. **[Crossref]**