African Journal of Urology

ORIGINAL RESEARCH

Open Access

Evaluating the pattern of antibiotic resistance of urinary tract infection (UTI)-causing bacteria in the urine culture samples of patients in the infectious ward of Imam Khomeini Hospital, Kermanshah, in Iran from 2016–2018

Maria Shirvani[1], Ali Keramati[2] and Mojtaba Esmaeli[3*]

Abstract

Background Increasing resistance of bacteria to antimicrobial agents is a significant problem worldwide. This study aimed to assess the pattern of antibiotic resistance among bacteria that cause urinary tract infections (UTIs) in patients admitted to the infectious ward of Imam Khomeini Hospital in Kermanshah between 2016 and 2018, based on urine culture samples.

Methods The present study was a cross-sectional and descriptive study. The study's statistical population included all patients referred to the infectious disease ward of Imam Khomeini Hospital due to urinary tract infections during the project period. Urine samples were collected in sterile containers, and by using a calibrated loop, the urine sample was cultured on EMB and blood agar media under sterile conditions. Microbial sensitivity was performed by standard disk diffusion method, and the results were analyzed using SPSS-V 16 software.

Results The antibiotic resistance assays showed that the highest resistance included nalidixic acid (73.5%), ciprofloxacin (72.1%), cotrimoxazole (70.6%), and ceftazidime (61.8%), cefixime (57.4%), ceftriaxone (48.5%), gentamicin (32.4%), cephalothin (16.6%), nitrofurantoin (10.3%), norfloxacin (5.9%), cefotaxime (4.4%), imipenem (2.9%), cefepime (2.9%), ampicillin (2.9%), ceftizoxime (1.5%), vancomycin (1.5%), cefazolin (1.5%), and chloramphenicol (1.5%), respectively. In addition, investigating the antibiotic resistance of UTI-causing bacteria according to the gender and age of the patients in the present study showed no significant statistical difference ($P > 0.05$).

Conclusion The bacteria causing urinary infections in the study area mainly belonged to the *E. coli* and *Klebsiella* families. Considering the determination of antibiotic sensitivity patterns in common organisms in the studied area, its report to doctors can be considered in experimental treatments.

Keywords Antibiotic resistance, Urinary tract infection, Urine culture

*Correspondence:
Mojtaba Esmaeli
dr.esmaeli1987@gmail.com
Full list of author information is available at the end of the article

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1 Background

Urinary tract infections (UTIs) are humans' most common bacterial infections, occurring in all age groups [1]. Lack of proper diagnosis and timely treatment can cause severe complications, such as urinary tract disorders, scars remaining in the kidney parenchyma, blood pressure, and uremia, and in pregnant women, they cause premature birth and even miscarriage [2]. Urinary tract infections, including cystitis and pyelonephritis, are common in the hospital. Among the pathogens that cause urinary infections, *E. coli* is the dominant pathogen that causes nearly 80% of infections and infects 8–10 million people in the USA annually [3, 4].

Based on the statistics of international organizations, 17–29 billion dollars are spent annually on the treating hospital infections, of which 39% are related to the costs caused by urinary infections [4]. Gram-negative bacilli are the most common etiological factor of UTI; among them, *E. coli* accounts for more than 80% of acute urinary tract infections [5]. *Staphylococcus saprophyticus* is the cause of 5–10% of urinary infections; other bacterial causes include *Klebsiella*, *Proteus*, *Pseudomonas*, and *Enterobacter*. These cases are not very common and are usually related to urinary system abnormalities or urinary catheters [5, 6].

Infectious diseases are always considered a serious threat to health. With the discovery of antibiotics, the death caused by infectious diseases has decreased significantly. However, these diseases are returning due to the uncontrolled use of antibiotics and resistance to them. Owing to the increase in resistance to antibiotics, the world urgently needs to change the pattern of consumption and prescription of this valuable medicinal source [7, 8]. If the consumption of medicines remains with the same pattern, even the production and development of new medicines cannot prevent the increase of resistance to antibiotics. In addition to the lack of uncontrolled use of antibiotics, measures to reduce the spread of infection through regular vaccination, regular hand washing, and paying attention to food hygiene are necessary [9]. It should be noted that antibiotics can only treat bacterial infections and are ineffective against viral infections such as colds, sore throats, and influenza.

In other words, it can be stated that antibiotics become resistant to these medicines through gene mutation and new generations arise that cannot be combated [10]. One of the most important factors of this type of medicine resistance is the uncontrolled and excessive use of antibiotics. This phenomenon endangers human society, so its danger has been likened to terrorism. These bacteria's resistance to antibiotics is one of the biggest challenges that threaten the health of humans in the modern era [11, 12].

Nowadays, the treating these types of infections has faced severe problems due to the increasing use of antibiotics and the subsequent increase in antibiotic resistance. The basis for treating urinary infections is selecting a highly efficient and effective antibiotic [13]. Antibiotics that were once effective now have minimal effect on bacteria that cause urinary tract infections, primarily due to the emergence and spread of bacteria-resistant strains, population growth, travel, and uncontrolled and excessive use of antibiotics [11, 12, 14]. Different studies suggest that regardless of the pattern of antibiotic consumption, antibiotic-resistance genes can be transferred among bacterial populations [14]. Urinary tract infections are more common in females than males. Around half of all females experience at least one infection during their lifetime, and recurrences are common [15–17].

Changing the sensitivity pattern of bacteria to different antibiotics over time and in different geographical areas has become a serious problem. Hence, antibiotic treatment of infections should be based on the information obtained from the antibiotic sensitivity and resistance pattern. Due to the increasing use of antibiotics and the subsequent increase in antibiotic resistance, as well as the differences in antibiotic sensitivity in dealing with different bacteria, recognizing the sensitivity pattern of this organism to antibiotics can be helpful in the treatment of most patients suffering from a urinary tract infection [18–20]. The present study aims to evaluate the antibiotic resistance pattern of UTI-causing bacteria in urine culture samples of infectious ward patients of Imam Khomeini Hospital in Kermanshah between 2016 and 2018.

2 Methods

2.1 Study locations and ethical approval

The present study was a cross-sectional and descriptive study. After obtaining the consent form from all patients, the study's statistical population included all patients referred to the infectious disease ward of Imam Khomeini Hospital due to urinary tract infections during the project period. Based on the study by Mahmoudi et al. [21], *E. coli* isolates in urinary infection samples have the highest resistance to co-trimoxazole antibiotics (74%). Based on 74% resistance, the minimum sample volume formula and 95% confidence, and the error of 0.1, the minimum sample size is 74 people. The code of ethics (IR.KUMS.REC.1398.191) was received from the Kermanshah University of Medical Sciences after obtaining permission from the research assistant. Inclusion criteria were catheterized patients with a final diagnosis of urinary tract infection, no history of hospitalization and catheterization, and no antibiotic use for two weeks before sending their samples to the laboratory. In addition, patients who consumed antibiotics during sampling or one month after hospitalization were excluded from this research.

2.2 Sample collections and culture procedure

For the final diagnosis of urinary tract infection, midstream urine samples were collected in sterile containers and using a calibrated loop (0.01 ml). The midstream urine sample was cultured on EMB and blood agar media under sterile conditions incubated at 37 °C. After 18–24 h, the samples in which the number of grown colonies was equal to or more than 100,000 CUF/ml were considered positive regarding urinary infection. To identify the bacteria, biochemical tests and differential culture media such as indole production and motility (sulfide indole motility: SIM), triple sugar iron agar (TSI), urease, methyl red (methyl red), Voges–Proskauer, lysine decarboxylase (LD) were used.

2.3 Antibiotic susceptibility test

Antibiotic resistance tests were performed using 11 antibiotic disks, including ceftazidime (30 μg), cefotaxime (30 μg), imipenem (10 μg), cefixime (5 μg), nitrofurantoin (300 μg), cotrimoxazole (25 μg), nalidixic acid (30 μg), ciprofloxacin (5 μg), gentamicin (10 μg), ampicillin (25 μg), and cefoxitin (30 μg) [16]. The sample was placed on a plate and incubated at 37 °C. After 24 h, the inhibition zone diameter was measured and used to determine antibiotic susceptibility (i.e., susceptible or resistant) for each microorganism, according to CLSI guidelines [15]. A checklist was completed based on demographic and laboratory information to identify the bacteria that cause urinary tract infections and their antibiotic resistance, which is available in the laboratory of Imam Khomeini Hospital, by the project executor.

2.4 Statistical analysis

Data were performed using Microsoft Office Excel 2013, SPSS version 16 (Statistical Package for Social Sciences). The Chi-square or Fisher's exact test was performed to investigate the significance of the differences. A *p*-value of less than 0.05 was considered statistically significant.

3 Results

Seventy-four patients with urinary tract infections referred to the infectious ward of Imam Khomeini Hospital were studied. The following sections deliberately describe each phase using the data from these patients.

3.1 Identifying the frequency of bacteria causing urinary infection

After carrying out bacterial cultures, eight different bacteria species were identified from the urine sample with significant growth. The most common bacterium causing urinary tract infections in patients was *E. coli* (58.82%), followed by *Klebsiella* (19.12%), *Acinetobacter* (11.76%), *Staphylococcus aureus* (2.95%), and *Pseudomonas* (2.94%). *Staphylococcus epidermidis* (1.47%), *Pseudomonas aeruginosa* (1.47%), and *Staphylococcus auricularis* (1.47%) which were the least frequent isolates in this population, as shown in Fig. 1.

3.2 Identifying the frequency of used antibiotics

Based on the results of this study, the most common antibiotics used in the studied patients were nalidixic acid (73.53%), ciprofloxacin (72.06%), cefixime (72.05%), and cotrimoxazole (70.59%), ceftazidime (61.76%), ceftriaxone (61.76%), amikacin (33.82%), imipenem (27.94%), gentamicin (32.35%), cephalothin (16.18%), and vancomycin (14.7%), respectively, as shown in Table 1.

3.3 Identifying the frequency of UTI-causing bacteria based on age

Patients were divided into six age groups: ≤ 30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, and ≥ 71 years (Table 2). Accordingly, in Table 2, the urinary infection with the bacterial agent *E. coli* was more (40%) in the ≥ 71 age group and the lowest in the 41–50 age group (2.5%). *Klebsiella* bacterial agent was seen in all age groups except ≤ 30. The bacterial agent *Acinetobacter* was seen in age groups ≥ 41. The bacterial agent *Staphylococcus aureus* was seen only in two age groups ≥ 71 and ≤ 30. Bacterial agents *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Staphylococcus auricularis* were seen in the age groups 61–70, 51–60, and ≤ 30, respectively. In contrast, the bacterial agent *Pseudomonas* was seen only in groups 51–60 and those ≥ 71.

3.4 Identifying the frequency of UTI-causing bacteria based on gender

Table 3 shows the frequency of UTI-causing bacteria according to gender. *E. coli* showed a higher percentage of urinary tract infections in females (55%) than in males (45%). Meanwhile, UTIs caused by *Klebsiella* bacteria were 64.5% and 35.5% in women and men, respectively. In addition, UTIs caused by the bacterial agent *Acinetobacter* were 62.5 and 37.5% in women and men, respectively. The prevalence of UTI caused by *Staphylococcus aureus* and *Pseudomonas* bacteria was the same (50%) in both sexes. In contrast, the prevalence of UTI caused by *Staphylococcus epidermidis* and *Staphylococcus auricularis* bacteria was seen only in the female population, and *Pseudomonas aeruginosa* bacteria were seen only in the male population.

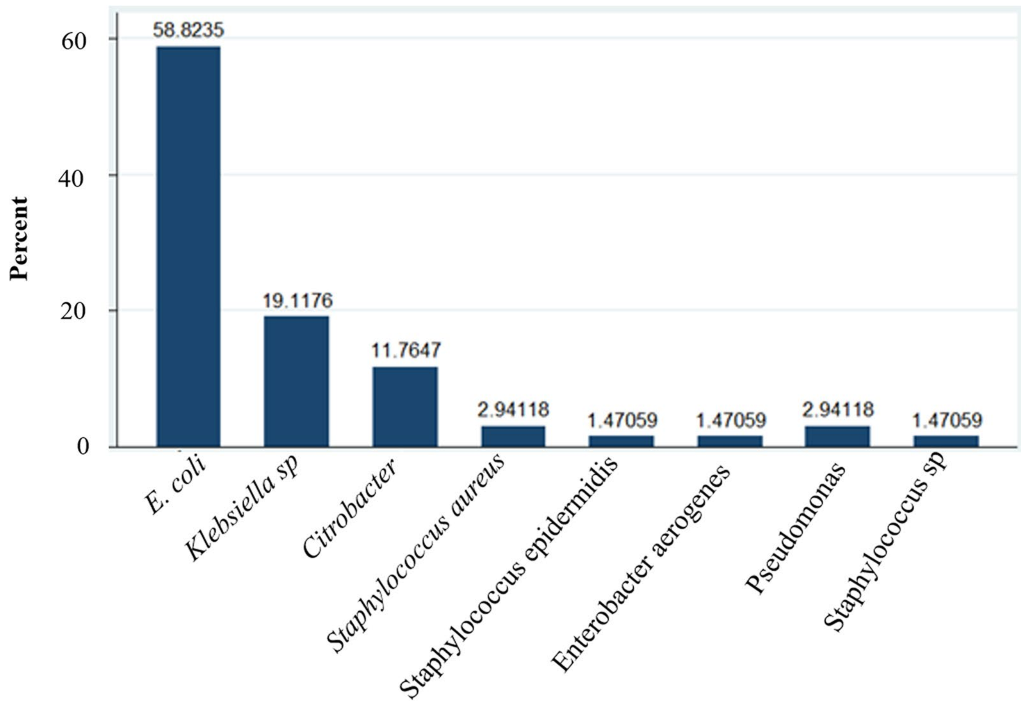

Fig. 1 Frequency of bacteria causing blood infection in the studied patients

3.5 Antibiotic resistance of UTI-causing bacteria

Antibiotic resistance test of bacteria causing urinary tract infections showed that the highest resistance was related to ciprofloxacin (72.1%), nalidixic acid (73.5%), and cotrimoxazole (70.6%). On the other hand, the lowest antibiotic resistance of the bacteria responsible for urinary tract infections was related to vancomycin (1.5%), ceftizoxime (1.5%), cefazolin (1.5%), and chloramphenicol (1.5%) as mentioned in Table 4.

3.6 Identifying the frequency of antibiotic resistance of UTI-causing bacteria based on the age

As seen in Table 5, ciprofloxacin showed the highest resistance among all antibiotics in the age group of 61–70. While rifampin, metronidazole, tazocin, clindamycin, and isoniazid antibiotics did not cause resistance in any age group. Based on the results of the present study, no statistically significant difference was observed in terms of antibiotic resistance of UTI-causing bacteria based on the age of the patients ($P > 0.05$).

3.7 Identifying the frequency of antibiotic resistance of UTI-causing bacteria based on gender

Table 6 shows that men's antibiotic resistance was related to nalidixic acid (73.14%) and ceftazidime (67.74%). Cotrimoxazole (78.39%) and nalidixic acid (72.97%) antibiotics had the highest resistance in women. Based on the results of the present study, no statistically significant difference was observed in terms of antibiotic resistance of UTI-causing bacteria found on the gender of the patients ($P > 0.05$). Only more antibiotic resistance to gentamicin was reported as significant in males than in females ($P = 0.039$).

4 Discussion

The incidence of antibiotic resistance is increasing dramatically worldwide. UTI, which affects numerous individuals yearly, is an infectious illness generated by bacteria with various antibiotic resistance patterns [22]. On the other hand, the increasing spread of antibiotic resistance causes additional treatment costs, hospitalizations, and more deaths [23]. Considering that many studies have not been conducted to evaluate the results of antibiotic resistance treatment in pathogens in the western region of Iran, the present study was conducted to investigate the effects and clinical consequences of antibiotic resistance in urinary pathogens in patients with UTI. This study was conducted on 74 patients diagnosed with urinary tract infection (UTI)-causing bacteria in the urine culture samples admitted to Imam Khomeini Hospital in Kermanshah between 2016 and 2018.

The results of the present study also showed that *E. coli* and *Klebsiella*, in general, were the most common causes of urinary tract infections, consistent with other studies [24]. These findings were in line with the studies of other researchers in this field [25, 26]. In addition, consistent

Table 1 Number and frequency percentage of antibiotics used in the studied patients

Consumed antibiotics	Number	f (%)
Norfloxacin		
Consumed	4	88.5
Not consumed	64	12.94
Imipenem		
Consumed	19	27.94
Not consumed	49	72.06
Vancomycin		
Consumed	10	14.71
Not consumed	58	58.29
Rifampin		
Consumed	2	2.94
Not consumed	66	97.06
Metronidazole		
Consumed	4	5.88
Not consumed	64	94.12
Tazocin		
Consumed	3	4.41
Not consumed	65	95.59
Clindamycin		
Consumed	3	4.41
Not consumed	65	95.59
Amikacin		
Consumed	23	33.82
Not consumed	45	66.18
Nitrofurantoin		
Consumed	0	0
Not consumed	68	100
Co-trimoxazole		
Consumed	48	70.59
Not consumed	20	29.41
Norfloxacin		
Consumed	4	5.88
Not consumed	5.88	94.12
Cefotaxime		
Consumed	3	4.41
Not consumed	65	95.59
Streptomycin		
Consumed	1	1.47
Not consumed	67	98.53
Ampibactam		
Consumed	3	4.41
Not consumed	65	65.59
Azithromycin		
Consumed	4	5.88
Not consumed	64	94.12
Isoniazid		
Consumed	1	1.47
Not consumed	67	98.53
Chloramphenicol		
Consumed	1	1.47
Not consumed	67	98.53
Tetracycline		
Consumed	0	0
Not consumed	68	100
Ofloxacin		
Consumed	0	0
Not consumed	68	100
Cefazolin		
Consumed	1	1.47
Not consumed	67	98.53
Nalidixic acid		
Consumed	50	73.53
Not consumed	18	26.47
Cephalothin		
Consumed	11	16.18
Not consumed	57	83.82
Cefepime		
Consumed	2	2.94
Not consumed	66	97.06
Tobramycin		
Consumed	0	0
Not consumed	68	68(100)
Amoxicillin		
Consumed	0	0
Not consumed	68	100
Ceftriaxone		
Consumed	42	61.76
Not consumed	26	38.24
Cefixime		
Consumed	49	72.05
Not consumed	19	27.95
Ceftazidime		
Consumed	42	61.76
Not consumed	26	38.24
Ceftizoxime		
Consumed	1	1.49
Not consumed	67	98.53
Nitrofurantoin		
Consumed	7	10.29
Not consumed	61	89.71
Ciprofloxacin		
Consumed	49	72.06
Not consumed	19	27.94
Gentamicin		
Consumed	22	32.35
Not consumed	46	67.65
Ampicillin		
Consumed	2	2.94
Not consumed	66	97.06

Table 2 Number and percentage of frequency of bacteria causing urinary infection based on the age of the studied patients

Bacteria	Less than 30		31–40		41–50		51–60		61–70		More than 71	
	n	**(%) *f***	***n***	**(%)*f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***
E. coli	5	12.5	5	2	1	2.5	8	20	8	20	16	40
Klebsiella	0	0	1	7.7	1	7.7	4	30.8	3	23.1	4	30.8
Acinetobacter	0	0	0	0	2	25	2	25	2	25	2	25
Staphylococcus aureus	1	50	0	0	0	0	0	0	0	0	1	50
Staphylococcus epidermidis	0	0	0	0	0	0	0	0	1	100	0	0
Pseudomonas aeruginosa	0	0	0	0	0	0	1	100	0	0	0	0
Pseudomonas	0	0	0	0	0	0	1	50	0	0	1	50
Staphylococcus auricularis	1	100	0	0	0	0	0	0	0	0	0	0

Table 3 Number and frequency percentage of UTI-causing bacteria based on gender in the studied patients

Bacteria	Female		Male	
	n	**(%) *f***	***n***	**(%) *f***
E. coli	22	55	18	45
Klebsiella	6	64.5	3	35.5
Acinetobacter	5	62.5	3	37.5
Staphylococcus aureus	1	50	1	50
Staphylococcus epidermidis	1	100	0	0
Pseudomonas aeruginosa	0	0	1	100
Pseudomonas	1	50	1	50
Staphylococcus auricularis	1	100	0	0

Table 4 Number and frequency percentage of antibiotic resistance of UTI-causing bacteria in the studied patients

Antibiotic	Antibiotic resistance	
	n	**(%) *f***
Amikacin	2	13
Cefixime	4	57
Ceftazidime	8	61
Ceftizoxime	5	1
Nitrofurantoin	3	10
Ciprofloxacin	1	72
Gentamicin	4	32
Cotrimoxazole	6	70
Nalidixic acid	5	73
Norfloxacin	9	5
Cefotaxime	4	4
Cephalothin	6	16
Imipenem	9	2
Vancomycin	5	1
Cefazolin	5	1
Cefepime	9	2
Ampicillin	9	2
Chloramphenicol	5	1
Ceftriaxone	2	48

with our results, Motamedifar et al. [27] reported that *E. coli* was the most common cause of UTI, followed by *Klebsiella* species. Farajnia et al. [28] showed that *E. coli*, *P. aeruginosa*, and *Staphylococcus saprophyticus* bacteria are the most common causes of UTI in patients under 9 nine years and older. Meanwhile, in our study, *E. coli* bacteria caused the most common causes of UTI in people over 71 years of age, and it did not match our results. According to the reports of other researchers, such as Raya et al. [29], Vazuras et al. [30], and Duicu et al. [31], in this field, *E. coli* was the leading cause of UTI in our study. Therefore, the role of *E. coli* in causing UTIs has been presented in many researchers' reports [32]. These changes depend on various factors such as geographic region, people's race, type of pollution, etc. [33].

In our study, *E. coli* bacteria were the leading cause of UTI in 16 people (40%) in the age group ≥ 71. However, in reporting the results of our data, the patterns of UTIs caused by other bacterial agents other than *E. coli* were not the same in different age groups. On the other hand, apart from the type of bacteria causing UTI, no statistically significant difference was seen among people in different age groups. The report of the study by Shasharkinia et al. indicated that statistically, there was a significant relationship between the type of bacteria that causes UTI and the age of people, in which the main cause of UTI in all ages is *E. coli* (75%) followed by *Proteus* (11%) which was not consistent with the results of our study [34].

Complete treatment of UTI in patients occurs when the infection's bacterial cause and the antibiotic sensitivity patterns are diagnosed in time [35]. By comparing the reports of several studies on the resistance of different antibiotics in Iran and other countries, it was observed that the resistance of different antibiotics to urinary pathogens in Iran and other countries is a cause of great

Table 5 Number and frequency percentage of antibiotic resistance of UTI-causing bacteria based on age

Antibiotic	Less than 30		31–40		41–50		51–60		61–70		More than 71		*P*-Value
	n	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	
Amikacin													
Resistant	0	0	0	0	0	0	2	12.5	3	21.43	4	16.67	0.018
Not-resistant	7	100	3	100	4	100	14	87.5	11	87.57	20	83.33	
Cefixime													
Resistant	5	71.43	2	66.67	2	50	10	62.5	8	57.14	12	50	0.654
Not-resistant	2	28.57	1	33.33	2	50	6	37.5	6	42.86	12	50	
Ceftazidime													
Resistant	2	28.57	2	66.67	3	75	11	68.75	11	87.75	13	54.17	0.654
Not-resistant	5	71.43	1	33.33	1	25	5	31.25	3	21.43	11	45.73	
Ceftizoxime													
Resistant	1	14.29	0	0	0	0	0	0	0	0	0	0	–
Not-resistant	6	85.71	3	100	4	100	16	100	14	100	24	100	
Nitrofurantoin													
Resistant	0	0	1	33.33	0	0	2	12.5	1	7.14	3	12.5	–
Not-resistant	7	100	2	66.67	4	100	14	87.5	13	92.86	21	87.5	
Ciprofloxacin													
Resistant	3	42.86	1	33.33	0	0	10	62.5	13	92.86	18	75	
Not-resistant	4	57.14	2	66.67	4	100	6	37.5	1	7.14	6	25	0.069
Gentamicin													
Resistant	1	14.29	0	0	1	25	6	37.5	7	50	7	29.17	
Not-resistant	6	85.71	3	100	3	75	10	62.5	7	50	17	70.83	0.577
Cotrimoxazole													
Resistant	5	71.43	0	0	1	25	13	81.25	9	64.29	17	70.83	0.115
Not-resistant	2	28.27	3	100	3	75	3	18.75	5	35.71	7	29.17	
Nalidixic acid													
Resistant	4	57.14	0	0	3	75	13	81.25	11	78.57	16	66.67	
Not-resistant	3	42.86	3	100	1	25	3	18.75	3	21.43	8	33.33	–
Norfloxacin													–
Resistant	2	28.27	0	0	0	0	1	6.25	1	7.14	0	0	
Not-resistant	5	71.43	3	100	4	100	15	93.75	13	92.86	24	100	
Cefotaxime													
Resistant	1	14.29	0	0	0	0	1	6.25	1	7.14	0	0	–
Not-resistant	6	85.71	3	100	4	100	15	93.75	13	92.86	24	100	
Cephalothin													–
Resistant	2	28.57	0	0	0	0	3	18.75	3	21.45	3	12.5	
Not-resistant	5	71.43	3	100	4	100	13	81.25	11	87.57	21	87.5	
Imipenem													
Resistant	0	0	0	0	0	0	0	0	0	0	2	8.33	0.143
Not-resistant	7	100	3	100	4	100	16	100	14	100	22	91.67	
Vancomycin													
Resistant	1	14.29	0	0	0	0	0	0	0	0	0	0	0.932
Not-resistant	6	85.71	3	100	4	100	16	100	14	100	24	100	
Rifampin													
Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0.903
Not-resistant	7	100	3	100	4	100	16	100	14	100	24	100	
Metronidazole													
Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0.781
Not-resistant	7	100	3	100	4	100	16	100	14	100	24	100	

Table 5 (continued)

Antibiotic	Less than 30		31–40		41–50		51–60		61–70		More than 71		*P*-Value
	n	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	***n***	**(%) *f***	
Tazocin													
Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0.219
Not-resistant	7	100	3	100	4	100	16	100	14	100	24	100	
Clindamycin													
Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0.482
Not-resistant	7	100	3	100	4	100	16	100	14	100	24	100	
Cefazolin													
Resistant	0	0	0	0	0	0	0	0	1	7.14	0	0	–
Not-resistant	7	100	3	100	4	100	16	100	13	92.86	24	100	
Cefepime													
Resistant	0	0	0	0	0	0	0	0	1	7.14	1	4.17	0.562
Not-resistant	7	100	3	100	4	100	16	100	13	92.86	23	95.83	
Isoniazid													
Resistant	0	0	0	0	0	0	0	0	0	0	0	0	0.654
Not-resistant	7	100	3	100	4	100	16	100	14	100	24	100	
Ampicillin													
Resistant	0	0	0	0	0	0	0	0	2	14.29	0	0	0.868
Not-resistant	7	100	3	100	4	100	16	100	12	85.71	24	100	
Chloramphenicol													
Resistant	0	0	0	0	0	0	0	0	0	0	1	4.17	–
Not-resistant	7	100	3	100	4	100	16	100	14	100	23	95.83	
Ceftriaxone													
Resistant	3	42.86	2	66.67	2	50	8	50	8	57.14	10	41.67	0.083
Not-resistant	4	57.14	1	33.33	2	50	8	50	6	42.86	14	58.33	

concern for treating UTI patients [36]. In the present study, the antibiotic resistance of different bacteria differed; each was resistant to some antibiotics and sensitive to others. Molazade et al. [37] reported that the most common organisms were *E. coli* at 64.3%, *Klebsiella* at 14.5%, and *Staphylococcus* at 6.4%. Bacteria had the highest sensitivity to ciprofloxacin and nitrofurantoin and had the highest resistance to co-trimoxazole and cephalothin antibiotics. In this regard, in our study, the highest resistance belonged to nalidixic acid (73.5%), ciprofloxacin (72.1%), and cotrimoxazole (70.6%), ceftazidime (61.8%), cefixime (57.4%), and ceftriaxone (48.5%), respectively. In the study conducted by Molazade et al., it was recommended to use ciprofloxacin and nitrofurantoin in cases where it is necessary to treat urinary tract infections in an outpatient way. The selection of antibiotics for treating urinary tract infections should be based on the prevalence of bacteria in each region and their sensitivity to the desired antibiotic.

In line with the results of the present study, which shows that women are more likely to suffer from urinary tract infections than men, in the study of Haqgoo et al. [38], 72.3% of patients with positive urine culture were women and 27.7% were men. In the study of Jarsiah et al. [39], it was also observed that the number of positive cultures is more in women than in men. In the study of Ramezanzadeh et al. [40], most of the bacteria were also isolated from women's samples. It was also reported in Laupland et al. [41] study that the rate of urinary infection was higher in women. The present study's findings are supported by all of the mentioned results, which suggest that women may be more susceptible to this condition because of their shorter urethra and the proximity of its outlet to the vagina and anus.

Majumder et al. reported that the main cause of UTI in their study population was *E.coli* bacteria (75%), followed by *Klebsiella* (10.7%) and *Enterococcus* (6%). Most (73.3%) of antibiotic resistance in this study were female, and this gender difference was statistically significant. The most potent antibiotics in this study were imipenem, meropenem, amikacin, and nitrofurantoin. The effectiveness of these drugs was 91–100%. Over 60% antibiotic resistance against amoxicillin, nalidixic acid, cefixime, ciprofloxacin, co-trimoxazole, and cephalosporins was reported [42], which is consistent with the findings of our study to some extent.

Table 6 Number and frequency percentage of antibiotic resistance of UTI-causing bacteria based on the gender

Antibiotic	Female		Male		*P*-Value
	n	(%) *f*	*n*	(%) *f*	
Amikacin					
Resistant	3	8.11	6	19.35	0.173
Not-resistant	34	94.89	25	80.65	
Cefixime					
Resistant	21	56.76	18	58.06	0.914
Not-resistant	16	43.24	13	41.94	
Ceftazidime					0.353
Resistant	21	56.76	21	67.74	
Not-resistant	16	43.24	10	32.26	
Ceftizoxime					
Resistant	1	2.7	0	0	0.364
Not-resistant	36	97.30	31	100	
Nitrofurantoin					
Resistant	4	10.18	3	9.68	0.876
Not-resistant	33	89.19	28	90.32	
Ciprofloxacin					
Resistant	23	62.16	3	9.68	0.878
Not-resistant	14	37.84	28	90.32	
Gentamicin					
Resistant	8	21.62	14	45.16	0.039
Not-resistant	29	78.38	17	54.74	
Cotrimoxazole					
Resistant	29	78.39	19	61.29	0.123
Not-resistant	8	21.62	12	38.71	
Nalidixic acid					
Resistant	27	72.97	23	73.14	0.910
Not-resistant	10	10.03	8	25.81	
Norfloxacin					
Resistant	2	5.14	2	6.45	0.855
Not-resistant	35	94.59	29	93.55	
Cefotaxime					
Resistant	2	5.14	1	3.25	0.663
Not-resistant	35	94.59	30	96.77	
Cephalothin					
Resistant	4	10.81	7	22.58	0.189
Not-resistant	33	83.19	24	77.42	
Imipenem					
Resistant	1	2.70	1	3.23	0.899
Not-resistant	36	96.30	30	96.77	
Vancomycin					
Resistant	1	2.70	0	0	0.356
Not-resistant	36	96.30	31	100	
Rifampin					
Resistant	0	0	0	0	–
Not-resistant	37	100	31	100	
Metronidazole					
Resistant	0	0	0	0	–
Not-resistant	37	100	31	100	
Tazocin					
Resistant	0	0	0	0	-
Not-resistant	37	100	31	100	
Clindamycin					
Resistant	0	0	0	0	–
Not-resistant	37	100	31	100	
Cefazolin					
Resistant	1	2.70	0	0	0.356
Not-resistant	36	96.30	31	100	
Cefepime					
Resistant	2	5.14	0	0	0.189
Not-resistant	35	94.59	31	100	
Isoniazid					
Resistant	0	0	0	0	–
Not-resistant	37	100	31	100	
Ampicillin					
Resistant	2	5.14	0	0	0.189
Not-resistant	35	94.59	31	100	
Chloramphenicol					
Resistant	0	0	1	3.23	0.271
Not-resistant	37	100	30	96.77	
Ceftriaxone					
Resistant	18	48.65	15	48.39	0.983
Not-resistant	19	51.35	15	51.61	

In the present study, most bacterial resistance to antibiotics was seen in the age groups of 31–40 and 41–50. The reason for this can be that these ages are more sexually active. These results are more or less consistent with other studies [43]. Including, in the study of Haqgou et al., the average age of patients with positive urine culture was 61.0 ± 18.6 years, which is not consistent with the results of the present study [38].

In a study carried out by Asadpour et al. [13] to identify the pattern of antibiotic resistance of *E. coli* in the urine samples of patients, 980 urine samples were examined. Of the 195 *E. coli* isolates, 93.76% were from females, while the remaining were from males. The highest sensitivity was obtained for imipenem. The highest level of resistance in the penicillin family belonged to oxacillin and ampicillin, and in the cephalosporins family, the highest level belonged to cephalothin. Also, the lowest resistance to cefoxitin was obtained. Among the quinolones, the highest resistance was reported for nalidixic acid. Also, the lowest resistance was reported for gentamicin, nitrofurantoin, and cefoxitin, with 8.2%, 8.71%, and 11.79%, respectively. Also, 36.92% of the strains produced ESBL [13]. In another study by Razak et al. [44], 573 urine samples were examined with the diagnosis of urinary tract infection. *E. coli* was the most common pathogen (37.95%), followed by Klebsiella (21.41%) and Acinetobacter (10.94%), respectively. *E. coli* was very sensitive to antibiotics nitrofurantoin (81.92%) and amikacin (69.88%) and was very resistant to ampicillin. Klebsiella was very sensitive to imipenem and was reportedly to be very resistant to ampicillin [44], which was consistent with the results of our study.

Overall, the present study's general results are consistent with previous studies' results. Despite this, the amount of drug resistance to all kinds of antibiotics in other regions of the world due to genetic changes in the strains that cause resistance, differences in the amount of antibiotic consumption, arbitrary use of antibiotics, differences in the availability of antibiotics, the extent and the new, temporal, spatial, cultural, and health conditions of the studied communities have been different [40]. In addition, the reasons for the observed differences have been previously mentioned. Other factors that may contribute to discrepancies in study results include variations in patient population characteristics, differences in hospitalization conditions and ward types, and variations in the method of drug administration (e.g., oral versus injection).

5 Conclusions

Based on the results of the present study, the most common bacteria causing urinary tract infections were *E. coli* and *Klebsiella*. The probability of a positive urine culture result was higher in women than in men. The incidence of urinary tract infections (UTIs) is positively correlated with age, as older individuals are more susceptible to developing these infections. Given the considerable antibiotic resistance demonstrated by bacteria responsible for urinary tract infections in both the present study and recent research, it is recommended that clinicians take this issue into account when devising treatment strategies for affected patients. Moreover, considering the increasing prevalence of antibiotic resistance globally and in Iran, planning and training for correctly using antibiotics in necessary cases and in the correct manner are recommended. In order to better and more accurately investigate the pattern of antibiotic resistance in the province of Kermanshah in Iran, it is suggested to conduct more comprehensive studies with a larger number of samples in different cities of the province and different hospitals.

Abbreviations

UTI	Urinary tract infection
E. coli	Escherichia coli

Acknowledgements
All the authors are grateful to all the Imam Khomeini Kermanshah Hospital staff for their help and cooperation.

Author contributions
Author contributions are as follows: MS, AK, and ME were involved in the conceptualization. ME contributed to the data curation. AK and ME contributed to the formal analysis. MS acquired the funding. MS, AK, and ME contributed to the investigation. MS and AK assisted in the methodology. MS contributed to the project administration. MS and AK contributed to the resources. AK and ME contributed to the software. MS, AK, and ME were involved in the supervision. MS, AK, and ME contributed to the validation. AK and ME were involved in the visualization and writing—original draft. ME contributed to the writing—review & editing.

Funding
This work was supported by Kermanshah University of Medical Sciences (Grant number: 98022), Kermanshah, Iran.

Availability of data and materials
Not applicable.

Declarations

Ethics approval and consent to participate
All precipitants signed a written consent form. Also, the study protocol was approved by the local ethics committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1398.191).

Consent for publication
Not applicable.

Competing interests
So far, no conflicts of interest have been reported between the authors.

Author details
[1]Infection Diseases Research Center, Kermanshah University of Medical Sciences, Kermanshah, Iran. [2]Department of Pediatrics, Medical School, Kermanshah University of Medical Sciences, Kermanshah, Iran. [3]Department of Anatomical Sciences, Medical School, Gerash University of Medical Sciences, Gerash, Shiraz, Iran.

Received: 24 January 2023 Accepted: 16 June 2023
Published online: 26 June 2023

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