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Original article

The Ciprofloxacin Sensitivity Pattern of Urine Isolated Bacteria That Collected from Different Clinics in Sirt City

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A B S T R A C T

Urinary tract infection (UTI) is a significant worldwide health concern, mainly caused by pathogenic bacteria and affecting over 100 million people annually. Delay in treatment can lead to severe complications; therefore, physicians administer Ciprofloxacin (CIP) as the first antibiotic choice once UTI is suspected, which has led to the emergence of CIP resistance, especially within developing countries. This study aimed to evaluate CIP resistance among UTI patients in Sirt, Libya. A total of 124 mid-stream urine samples were collected from UTI patients attending various clinics within Sirt city from February to August 2025. Samples were cultured on different media, and isolates with significant growth (≥10^5 CFU/mL) were identified based on colony morphology, Gram stain, and biochemical tests. whereas susceptibility to Ciprofloxacin was evaluated using the disk diffusion method according to CLSI guidelines. The results showed a predominance of female participants, accounting for 83.9% of the study population. The young adult group (15 – 34 years) was the most represented (45.2%). The most prevalent pathogen was *Escherichia coli* at 54.8%, followed by *Pseudomonas spp.* at 16.1%, resistance to CIP was observed in 51.6% of isolates. A strong correlation was found between patient gender and resistance pattern, with resistance overwhelmingly concentrated in females (93.8% of all resistant cases). Furthermore, a highly significant correlation (*p*-value = 0.000) was observed between age and susceptibility, with young adults exhibiting the highest sensitivity rate (61.5%). Conversely, resistance was notably distributed among children and young adults, while a critical trend emerged among the elderly (≥ 60 years), who recorded zero sensitive cases (0.0%). These findings underscore the urgent need for regular antimicrobial surveillance and the need for more stringent antibiotic management programs in Libya.

Introduction

A urinary tract infection (UTI) is a health condition in which urothelial cells become invaded by pathogenic microorganisms, either bacteria or fungi. This triggers an inflammatory response within the urethra and bladder, leading to symptoms that range from localized burning sensations and frequent urination to systemic symptoms like chills, fever, and vomiting [1]. UTIs are primarily caused by pathogenic bacterial infections and are a major global health concern because they globally affect more than 100 million people annually. Additionally, UTIs, according to Lee GH and his colleagues, are mostly caused by *Escherichia coli*, which represents ~70% of UTIs bacterial isolates, and it and other bacterial species develop resistance to Ciprofloxacin in both developing and developed countries [1-3].

Ciprofloxacin (CIP) is a member of the second generation within the quinolone group. It has been used as empirical treatment for UTI infection since 1987; it is still used until now because it has a broad antibacterial spectrum that targets both Gram-positive and Gram-negative bacteria, in addition, it has a high bioavailability and tissue permeability. Nevertheless, the widespread use of CIP globally to treat UTI infections has led to bacteria acquiring resistance, as reported all over the world [1,4,5]. In Libya, a developing country where CIP is widely used to treat UTI patients, monitoring resistance is critical. This study was conducted to evaluate CIP resistance among UTI patients in Sirt, Libya.

Methods

Ethical Considerations

Informed consent was obtained from all participants before urine collection. Furthermore, the study strictly adhered to the ethical guidelines established by local Libyan research standards.

Study Design and Setting

This cross-sectional study was conducted from February to August 2025. It included 124 urine samples collected from patients attending many clinics in Sirt city, who were seeking medical diagnosis and treatment for suspected UTI.

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Sample Collection
The 124 patients were instructed to collect the first-morning, midstream urine (MSU) samples in sterile containers after overnight retention, and then the samples were transported to the microbiology laboratory of the clinics and processed within 30 min.

Culturing and Identification of Bacterial Isolates
The collected samples were cultured on CLED, Blood, and MacConkey agars using sterile disposable loops. Following the streaking method, the media were incubated aerobically at 36-38 °C for 24-48 h.
After the incubation period, cultures with significant growth (≥10^5 CFU/mL) were identified based on colony morphology, Gram stain, and biochemical tests. These included Catalase and Coagulase tests, Methicillin resistance tests for Gram-positive bacteria, while Oxidase, Citrate, *TSI*, *SIM*, Urease, and Indole tests were used for Gram-negative bacteria.

Antibiotic Susceptibility Test
The isolated bacteria that were already identified, their susceptibility to Ciprofloxacin (CIP, 30 mg) was evaluated by using the disk diffusion method according to CLSI guidelines, and each isolate was classified as sensitive, intermediate, or resistant based on the diameter of the inhibition zone around Ciprofloxacin discs.

Data Analysis
The distribution of bacterial isolates among the study sample and their Ciprofloxacin susceptibility patterns were statistically analyzed by using IBM SPSS Statistics (V28). For all tests, a *p*-value< 0.05 was considered statistically significant.

Results
The results regarding the distribution of 124 patients from whom urine samples were collected in Sirt city reveal a significant female predominance in the sample, with women accounting for the majority at 83.9% (104 cases), compared to males who represented only 16.1% (20 cases). This statistically notable disparity is primarily attributed to the anatomical and physiological characteristics of females that render them more susceptible to urinary tract infections (UTIs) (Table 1). While the age distribution data of patients indicated that the young adult group (15 – 34 years) was the most represented group in the study, accounting for 45.2%, followed by children (under 15) and middle-aged adults (35 – 59 years) at equal rates of 22.6% each, while the elderly (60 years and older) recorded the lowest percentage at 9.7%. This concentration within the young and adult categories reflects a higher frequency of screenings or a greater prevalence of infection triggers during these active life stages (Figure 1).

Table 1. Distribution of the study sample by gender.

Sex	N	%
Male	20	16.1%
Female	104	83.9%

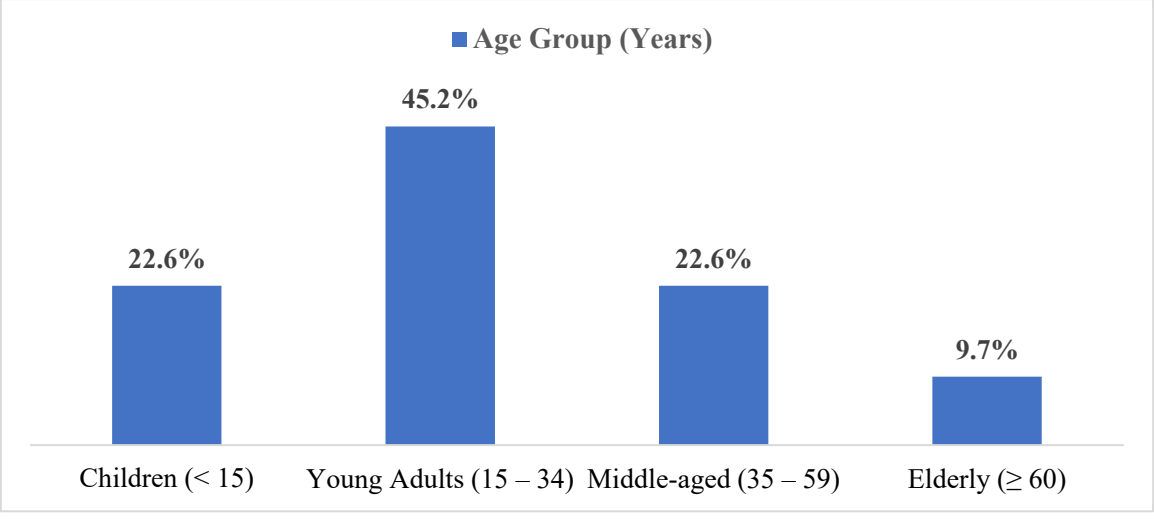

Figure 1. Distribution of the study sample by age group.

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The microbiological analysis of the samples collected revealed significant bacterial diversity, with *E. coli* emerging as the most prevalent pathogen at 54.8%, followed by *Pseudomonas spp.* at 16.1%, confirming the typical dominance of Gram-negative bacteria in urinary tract infections. Conversely, Methicillin-resistant *Staphylococcus aureus* (MRSA) and Methicillin-resistant Coagulase-negative *Staphylococci* (MR-CONS) were recorded at equal rates of 9.7% each, while sensitive strains of CONS and *Staphylococcus aureus* were the least frequent; these findings highlight the necessity of closely monitoring the susceptibility patterns of these isolates to Ciprofloxacin, especially given the presence of resistant (MR) strains within the study population (Figure 2).

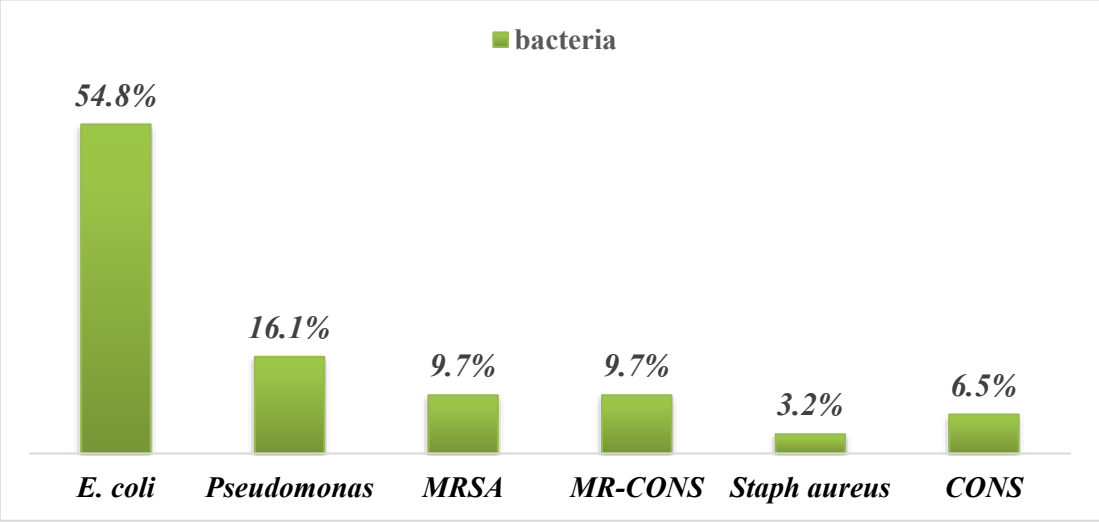

Figure 2. Type of bacterial isolates.

The antibiotic susceptibility test results indicated that more than half of the bacterial isolates in Sirt (at 51.6%) showed resistance to Ciprofloxacin, a concerning clinical indicator reflecting the growing challenges in treating urinary tract infections with this drug, while the sensitive isolates accounted for 41.9%. Meanwhile, a small percentage of 6.5% showed intermediate sensitivity, highlighting the urgent need to re-evaluate empirical treatment protocols and rely more heavily on laboratory culture results to avoid therapeutic failure caused by the increasing resistance to this class of quinolones (Figure 3). As seen, the results reveal a fundamental variation in susceptibility patterns directly dependent on the bacterial species (p-value = 0.000), with *E. coli* emerging as the most responsive pathogen, accounting for 84.6% of all sensitive cases, despite also having the highest numerical count of resistant isolates. Conversely, *MR-CONS* and *MRSA*, along with *Pseudomonas*, exhibited alarmingly high resistance levels; notably, sensitivity was absent (0.0%) in *MR-CONS*, *S. aureus*, and *CONS* isolates. This confirms that the clinical efficacy of Ciprofloxacin in Sirt is primarily limited to *E. coli*, while it has almost entirely lost its therapeutic value against *Staphylococci* and *Pseudomonas*, imposing strict limitations on its use as a first-line empirical treatment without prior susceptibility testing (Table 2).

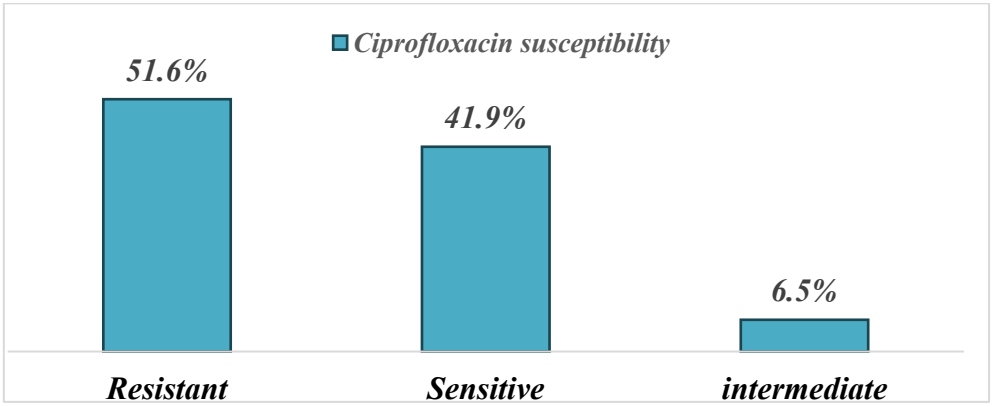

Figure 3. Susceptibility of bacterial isolates to Ciprofloxacin.

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Table 2. Relationship between bacterial species and Ciprofloxacin susceptibility.

Bacteria	Ciprofloxacin susceptibility					
	Resistant		Sensitive		Intermediate	
	N	%	N	%	N	%
E. coli	20	31.3%	44	84.6%	4	50.0%
Pseudomonas	12	18.8%	4	7.7%	4	50.0%
MRSA	8	12.5%	4	7.7%	0	0.0%
MR-CONS	12	18.8%	0	0.0%	0	0.0%
Staph aureus	4	6.3%	0	0.0%	0	0.0%
CONS	8	12.5%	0	0.0%	0	0.0%

Pearson Chi-Square=47.206, df=10, p-value=0.000

The results demonstrate a strong correlation between patient gender and the susceptibility pattern to Ciprofloxacin, with bacterial resistance being overwhelmingly concentrated in females, who accounted for 93.8% of all resistant cases (60 cases), compared to only 6.3% in males. Furthermore, females accounted for 100% of all intermediate susceptibility cases; the Chi-Square test (p-value < 0.01) confirms a highly significant statistical difference, suggesting that frequent infections or prior antibiotic exposure among women in Sirt may have driven increased bacterial virulence and resistance, whereas males maintained a relatively higher proportion of sensitivity (30.8% of all sensitive cases) despite their smaller representation in the sample (Table 3). Whereas statistical analysis reveals a highly significant correlation between age group and antibiotic susceptibility patterns (p-value = 0.000), with young adults (15–34 years) exhibiting the highest sensitivity rate (61.5% of all sensitive cases), suggesting a favorable treatment response in this group.

Conversely, resistance was notably distributed among children and young adults at 31.3% each; clinically, a critical trend emerges among the elderly (≥ 60 years), who recorded zero sensitive cases (0.0%), with their results divided strictly between resistance and intermediate susceptibility. This reflects an accumulation of bacterial resistance in the elderly population of Sirt, likely due to repeated antibiotic exposure over time or diminished immunity, necessitating extreme caution when prescribing Ciprofloxacin to this specific age demographic (Table 4).

Table 3. Relationship between gender and Ciprofloxacin susceptibility.

Sex	Ciprofloxacin susceptibility					
	Resistant		Sensitive		Intermediate	
	N	%	N	%	N	%
Male	4	6.3%	16	30.8%	0	0.0%
Female	60	93.8%	36	69.2%	8	100.0%
Total	64	100.0%	52	100.0%	8	100.0%

Pearson Chi-Square=14.395, df=2, p-value=0.000

Table 4. Relationship between age group and Ciprofloxacin susceptibility.

Age Group (Years)	Ciprofloxacin susceptibility					
	Resistant		Sensitive		Intermediate	
	N	%	N	%	N	%
Children (< 15)	20	31.3%	8	15.4%	0	0.0%
Young Adults (15 – 34)	20	31.3%	32	61.5%	4	50.0%
Middle-aged (35 – 59)	16	25.0%	12	23.1%	0	0.0%
Elderly (≥ 60)	8	12.5%	0	0.0%	4	50.0%

Pearson Chi-Square=31.979, df=6, p-value=0.000

Discussion

The result of this study demonstrated a predominance of female participants (83.9%), with the young adult group (15 – 34 years) being the most represented age group (45.2%). These findings align with a study by Bono et al., which indicated that women, particularly those aged 16 to 35 years, were more prone to acquiring UTI [6]. Our results are also aligned with a study conducted in China, where 409 of 550 UTI patients were females, and 91% of the study bacterial isolates were *E. coli* [2]. In the current study, E. coli was the most prevalent pathogen at 54.8%. However, our results differ regarding the second most frequent isolate, which we identified as *Pseudomonas spp.* (16.1%), whereas the Chinese study indicated *Klebsiella spp.* (8%) [2]. The antibiotic susceptibility testing revealed that more than half of the bacterial isolates in Sirt (51.6%) were resistant to CIP. These findings contrast with two previous studies: one of them, conducted in

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China (2023), reported that 46% of the indicated uropathogens were resistant to CIP, while the other study, conducted in Ethiopia (2018), indicated that ~57% of the bacterial isolates were sensitive to CIP [2,7]. Even so, *E. coli* showed the highest susceptibility to CIP (84.6% of all sensitive cases), and it also accounted for the highest number of resistant isolates due to its high prevalence.
Conversely, *MR-CONS* and *MRSA*, along with *Pseudomonas*, exhibited alarmingly high resistance levels; these results align with a study conducted in Iraq (2023), which showed *E. coli* had a high susceptibility to CIP ~75% [8]. Finally, this study indicated a highly significant correlation between patient gender, age, and the susceptibility pattern to CIP, with women and elderly patients found to be the most resistant to CIP. These results align with a study indicating a strong relationship between women's gender and the elderly with CIP resistance [7].

Conclusion

This study indicates a significantly high level of CIP resistance among the study population in Sirt city. *E.coli* was the most prevalent uropathogen and showed the highest relative sensitivity; however, it also exhibited the highest resistance rates, followed by *Pseudomonas spp.,* which was later considered a major clinical concern. Furthermore, the results showed high resistance within females and among elderly patients, suggesting CIP may no longer be an effective empirical choice for the population within Sirt.

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Conflicts of Interest
The author declares no conflicts of interest.

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