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**Research Article** **Open Access**

# Bacteriological and Antibiotic Resistance Patterns of Uropathogens: A Laboratory-Based Study for outpatients clinic in Ajdabiya City Libya [2025]

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## Abstract

This study aimed to assess the prevalence of bacteria causing urinary tract infections (UTIs) and to identify common patterns of bacterial isolates along with their relationship to urine pH in patients visiting the Elite Clinic laboratory in Ajdabiya. A total of 60 urine samples were collected under sterile conditions from individuals suspected of having UTIs. Bacterial cultures were conducted using standard media, and the bacterial species were identified based on their growth characteristics and biochemical tests. Additionally, urine pH was measured during the analysis. The findings revealed that 48 samples (80%) showed positive bacterial growth, indicating a high incidence of UTIs. Gram-negative bacteria accounted for most isolates (70–75%), while Gram-positive bacteria represented a smaller proportion (25–30%). Among the identified pathogens, *Escherichia coli* was the most prevalent (40–45%), followed by Klebsiella spp. (15–20%) and other species at lower frequencies. Furthermore, most positive samples were associated with acidic urine conditions, with 60–65% of elevated bacterial growth observed at pH levels below 7, compared to 35–40% in alkaline urine. The study highlights a significant prevalence of UTIs in the area under investigation, with a predominance of Gram-negative bacteria, particularly *E. coli*. It underscores the influence of urine pH on bacterial growth and distribution, offering valuable insights into the dynamics of urinary pathogens.

**Keywords:** Urinary Tract Infections, Urine Culture, Escherichia Coli, Bacterial Resistance, Antibiotics.

## INTRODUCTION

Urinary tract infections (UTIs) rank among the most prevalent bacterial illnesses encountered in clinical practice, affecting individuals across various age groups (Kundu et al., 2025; He et al., 2025; Baimakhanova et al., 2025). However, the incidence of these infections is notably higher in females than in males, primarily due to distinct anatomical and physiological differences. The widespread occurrence poses a considerable public health concern, underscoring their significance within medical care (Li et al., 2022; Yang et al., 2022; Aleinein et al., 2024). They may develop into serious complications if not diagnosed and treated properly, such as kidney inflammation or kidney failure (Scherberich et al., 2021; Kaur et al., 2021; Mancuso et al., 2023). Bacteria are the primary cause of urinary tract infections, with *E. coli* being the most common pathogen. Other types, including Klebsiella, Proteus, and Staphylococcus, are also

significant contributors (Ahmed et al., 2014; Jalil et al., 2022; Zhou et al., 2023). Understanding these causes has become increasingly critical in recent years, largely due to the steady rise in antibiotic resistance. This issue is widely recognized as one of the most urgent challenges in global health, especially given the widespread problem of indiscriminate or unregulated use of medications (Sabtu et al., 2015; Larsson and Flach, 2022; Salam et al., 2023).

This study is essential as it concentrates on local bacterial patterns responsible for urinary tract infections and evaluates their reactions to commonly prescribed antibiotics. Its goal is to support evidence-based treatment decisions, ultimately reducing treatment failures and curbing the spread of antibiotic resistance. Furthermore, the findings offer a credible scientific foundation for enhancing treatment and prevention strategies within healthcare institutions.

## MATERIALS AND METHODS

This study was carried out at the Elite Clinic laboratory in Ajdabiya between September and December 2025 to investigate urinary tract infections among the city's residents. Employing a descriptive analytical approach, the research focused on bacteriological and statistical analysis of urine samples to determine the primary causes of infections, examine antibiotic resistance patterns, and identify the demographics most vulnerable to these infections. A total of 60 urine samples were collected from patients presenting to the clinic with clinical symptoms suggestive of a potential urinary tract infection. Participants included both genders and various age groups. Samples were obtained using the midstream collection method in sterile containers, following clear instructions given to patients on how to properly collect their samples to minimize contamination risks. They were transported to the laboratory within a 30-minute window after collection to maintain testing accuracy. Samples that arrived late or showed signs of contamination were excluded from the analysis.

**Laboratory tests:** Laboratory tests were conducted following standard approved methods and included the following procedures:

- Microscopic analysis of urine to identify white blood cells, red blood cells, and bacteria.
- Culturing of urine samples on blood agar medium, with plates incubated at 37°C for 24 to 48 hours.
- Identification of isolated bacteria based on colony morphology, Gram staining, and specific biochemical tests tailored to each bacterial species.

**Antibiotic Sensitivity Testing:** The susceptibility of bacterial isolates to frequently used antibiotics was evaluated through the Kirby-Bauer disk diffusion method. Based on the diameters of the inhibition zones, the results were categorized as sensitive, intermediate, or resistant.

**Statistical analysis:** The collected data were entered into organized tables and analyzed using descriptive statistical methods. The main objective was to determine percentages and frequencies, with the aim of clarifying the distribution of bacterial types and studying their patterns of resistance to antibiotics, in addition to analyzing the relationships between the variables studied. All statistical analyses were performed using Microsoft Excel 2021 and Python 3.11.

## RESULTS

**General distribution of bacterial isolates:** Urine culture results showed positive bacterial growth in 48 samples, representing 80% of the total samples studied, indicating a high prevalence of urinary tract infections among patients attending the Elite Clinic in Ajdabiya. Bacterial isolates varied between Gram-negative and Gram-positive bacteria, with a clear predominance of Gram-

negative bacteria. The results showed that E. coli was the most common among the isolates, accounting for 31.3% (15 cases out of 48), followed by Streptococcus at 20.8% (10 cases), then Candida at 14.6% (7 cases). Pseudomonas and Staphylococcus were equally prevalent at 12.5% (6 cases each), while Proteus mirabilis was the least prevalent at 8.3% (4 cases) as shown in Figure 1. These results demonstrate the key role of E. coli as the main cause of urinary tract infections, due to its virulence factors that enable it to adhere to urinary epithelial cells and colonize the urinary tract.

The results also showed a difference in infection rates among different groups, with the highest infection rate recorded among males at 50%, followed by females at 43.3%, while the infection rate among children was the lowest, reaching 6.7% of the cases studied as shown in Figure 2. The higher incidence rate among females compared to adult males can be explained by anatomical and physiological factors such as the shortness of the urethra and its proximity to the anus, which facilitates the transmission of bacteria and increases the likelihood of infection.

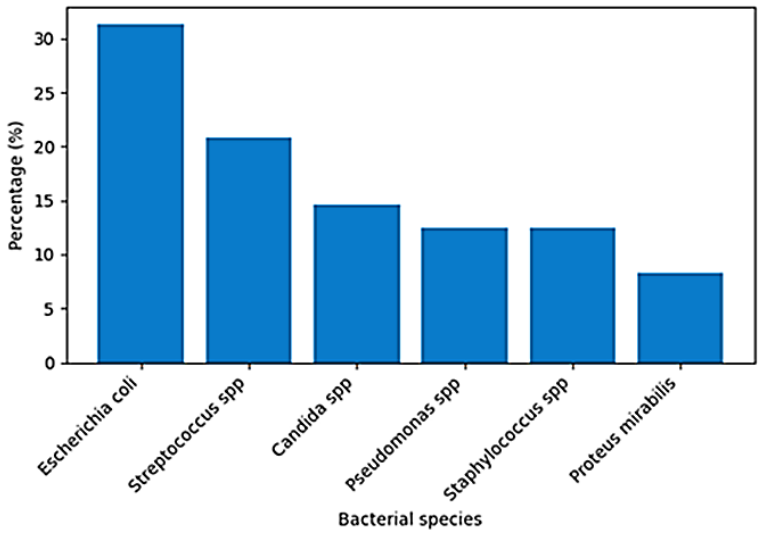


**Figure (1).** Distribution of Bacterial Isolates in Positive Urine Cultures

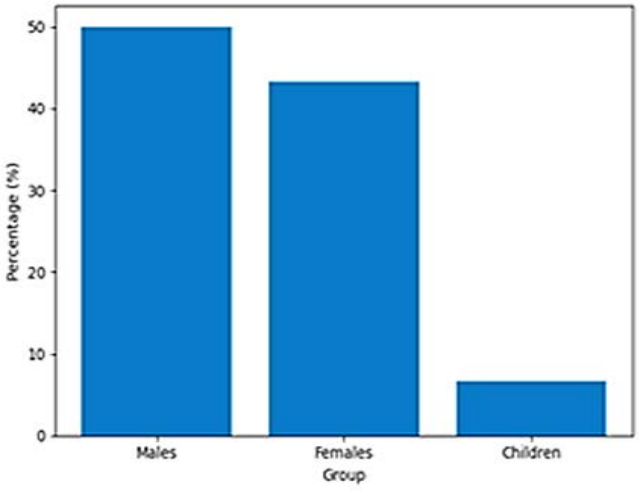


**Figure (2).** Distribution of Urinary Tract Infection Cases by Gender

The prevalence of bacterial species found in urine samples was categorized by urine pH, as shown in Figure 3. A noticeable variation in the occurrence of several bacterial species was seen between acidic and alkaline urine, suggesting that urine pH might influence bacterial proliferation and infection severity.

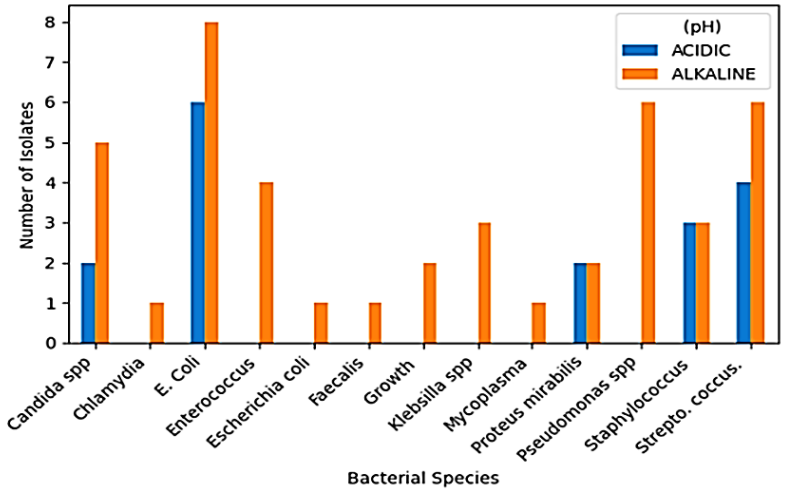


**Figure (3).** Distribution of Urinary Tract Infection Cases by Gender

**Antibiotic sensitivity test results:** The sensitivity test results revealed significant variations in how bacterial isolates responded to the antibiotics tested, with differing resistance levels observed across the drugs. Augmentin and Amikacin showed the highest resistance rates at 17.9% each, suggesting a decline in their therapeutic effectiveness against certain bacterial strains. Moderate resistance was identified for ceftriaxone, azithromycin, cefuroxime, and amoxicillin, each with a resistance rate of 7.1%. In contrast, nalidixic acid exhibited a lower resistance rate of 5.4%, while gentamicin demonstrated the least resistance at 1.8%, highlighting its comparatively high efficacy against the isolates as shown in Figure 4. These findings point to the prevalence of multidrug resistance, particularly among Gram-negative bacteria, which poses an increasing challenge for treatment. They emphasize the importance of relying on urine culture results and antibiotic susceptibility testing to guide the selection of appropriate therapies.

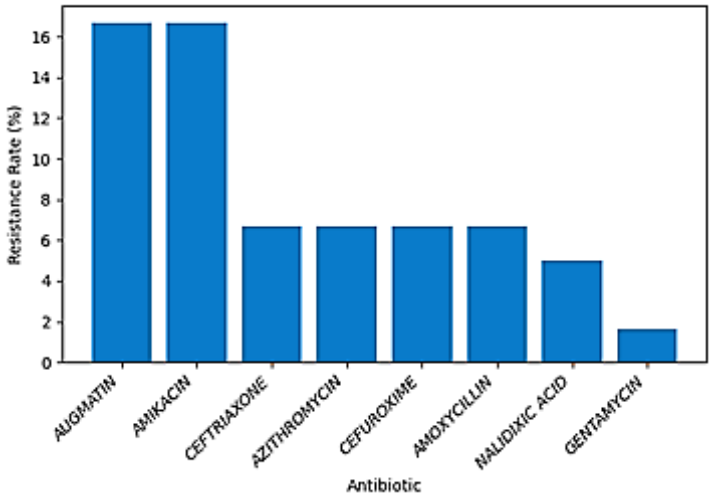


**Figure (4).** Antibiotic resistance rates among isolated bacteria

## DISCUSSION

The present study demonstrated a high prevalence of urinary tract infections (UTIs), as evidenced by the high rate of positive urine cultures (80%). This finding indicates that UTIs represent a significant health concern among patients attending Al-Nokhba Clinic in Ajdabiya and is comparable to rates reported in similar regional and international studies (Khan et al., 2023; Sror et al., 2025).

Gram-negative bacteria predominate among the isolated pathogens, with *E. coli* being the most frequently identified organism. This result is consistent with numerous previous studies that identify E. coli as the primary etiological agent of UTIs worldwide (Alhazmi et al., 2023; Farag et al., 2024; El-Arifi et al., 2024; Wireko et al., 2025).

The predominance of E. coli is largely attributed to its virulence factors, including adhesins and fimbriae, which enhance attachment to uroepithelial cells and promote colonization of the urinary tract (Sung et al., 2024). Other bacterial and fungal isolates such as Streptococcus spp., Candida spp., Pseudomonas spp., and Staphylococcus spp. were detected at variable frequencies, suggesting possible roles of host immunity and the production of toxins, prior antibiotic exposure, and healthcare-associated factors (Bunduki et al., 2021; Wang et al., 2025; Gao et al., 2026).

Differences in infection rates were observed among gender groups, with males showing a slightly higher prevalence than females, while children accounted for the lowest proportion of cases. Although UTIs are typically more common in females due to anatomical and physiological factors, the higher rate among males in this study may be related to age distribution, urological abnormalities, or underlying conditions such as prostatic disorders (Brandstrom and Hansson, 2022; Gonzalez et al., 2024; Moghnia et al., 2025).

Variation in bacterial distribution according to urine pH was also observed, indicating that urinary acidity or alkalinity may influence bacterial growth and infection severity, as previously reported (Herrera-Espejo et al., 2024; Erinmez and Ozturk, 2024).

Antimicrobial susceptibility testing revealed variable resistance patterns, with the highest resistance observed against Augmentin and Amikacin, while Gentamicin showed the lowest resistance rate. These findings indicate the presence of multidrug-resistant organisms, particularly among Gram-negative bacteria, emphasizing the necessity of routine urine culture and antibiotic susceptibility testing prior to treatment (Adjei and Adjei, 2025).

## CONCLUSION

This research determined that urinary tract infections constitute a notable health issue among attendees of the Elite Clinic in Ajdabiya, where urine culture outcomes showed a substantial rise in the proportion of affirmative samples, mirroring the broad presence of this affliction in the studied populace. The findings demonstrated that Gram-negative microbes were the primary driver of contagion, with *E. coli* being the most frequently found among bacterial separations, which aligns with observations from numerous prior investigations. The study additionally uncovered an interesting variety in bacterial isolates and pointed to variations in contagion frequency based on sex and age bracket, affirming the impact of anatomical and physiological aspects and existing medical ailments on infection initiation. Moreover, the evaluation emphasized that urine acidity can influence the proliferation and spread of certain microbial types, which is directly linked to the infection's intensity and the nature of the germ.

Concerning antimicrobial susceptibility assessment, the data exhibited variability in how bacterial isolates reacted to the medications employed, with differing resistance profiles noted, particularly among Gram-negative bacteria, while certain antimicrobials displayed comparatively greater effectiveness. These outcomes suggest a worsening trend in microbial resistance to drugs, underscoring the need to utilize urine culture findings and sensitivity assays as the foundation for selecting suitable therapy.

The study suggests enhancing health awareness initiatives and encouraging the prudent use of antibiotics, alongside ensuring precise laboratory diagnoses. These strategies are intended to curb the spread of urinary tract infections and mitigate bacterial resistance, ultimately contributing to more effective treatments and safeguarding public health.

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## ETHICS

The author declares that this study was conducted in compliance with ethical standards.

**Duality of interest:** The author declares that they have/have no duality of interest associated with this manuscript.

**Author contributions:** Husam Dakheel contributed to all aspects of the research and manuscript preparation.

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