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The Role of Bacteria in the Inflammation of Urinary Tract

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ABSTRACT: The present study aimed to determine the role of bacteria in causing urinary tract infections (UTIs) in Maysan province. A total of 20 urine samples were collected from UTI patients attending Al-Hakeem Teaching Hospital during the period from October 2025 to December 2026. In addition, 10 control samples were collected from healthy individuals.

The samples were cultured on routine media including MacConkey agar, Chocolate agar, and Blood agar.

Four bacterial species were isolated from the 20 samples and distributed as follows:

E. coli accounted for 40% (8 cases), followed by Klebsiella pneumonia (6 cases) at 30%, then Staphylococcus aureus at 20% (4 cases), and finally Proteus mirabilis (2 cases) at 10%. These species were identified using the VITEK 2 system.

The patients were categorized according to age groups. The highest infection rate was observed in the 30–39 age group (9 cases, 45%), followed by the 20–29 group (5 cases, 25%), then the 40–49 group (4 cases, 20%), and finally the last age group with 2 cases (10%).

The study also classified infections based on gender. Females accounted for 12 cases (60%), indicating a higher prevalence compared to males, who represented 40% (8 cases).

Additionally, diabetes mellitus was associated with 7 cases (35%), followed by neurogenic bladder inflammation in 5 cases (25%).

As for the control samples, no bacterial growth was detected.

INTRODUCTION :

Urinary tract infections (UTIs) are among the most prevalent bacterial infections affecting women worldwide. Their incidence is significantly influenced by various physiological and hormonal factors that alter the normal function of the urinary system (Delzell Jr & Lefevre, 2000). These changes can modify the composition of urine and promote relaxation of the smooth muscles in the ureters, thereby facilitating the ascent of microorganisms from the lower to the upper urinary tract (Cunningham & Nelson, 2015).

Among the causative agents, *Escherichia coli (E. coli)* remains the predominant pathogen responsible for the majority of UTI cases (Cheng et al., 2022). However, other bacterial species, including *Klebsiella pneumoniae* and *Staphylococcus aureus*, are also frequently implicated (Hu et al., 2025). Accurate diagnosis of UTIs typically relies on a combination of clinical evaluation and

laboratory investigations, particularly urinalysis and urine culture, which are essential for identifying the causative organism and determining its antimicrobial susceptibility profile (Stephenson & Cathcart, 2025).

Despite the availability of effective diagnostic methods and treatment options, UTIs continue to represent a significant public health concern, particularly due to their high recurrence rates and the growing issue of antimicrobial misuse. Several factors contribute to the recurrence of UTIs, including previous medical history, genetic predisposition, and inappropriate behavioral practices such as incomplete adherence to prescribed treatments and the unsupervised use of antibiotics.

Therefore, this study aims to analyze the prevalence of urinary tract infections among women within the local community and to identify the main etiological and contributing factors. It further seeks to evaluate current diagnostic and therapeutic practices by assessing the accuracy of commonly used laboratory tests, including urinalysis and urine culture, as well as by analyzing treatment patterns involving both antibiotic and herbal therapies(Stephenson & Cathcart, 2025).

In addition, this research intends to examine the impact of these factors on disease severity and the risk of developing complications, particularly upper urinary tract infections such as pyelonephritis. The study also aims to identify gaps in health awareness, evaluate patient adherence to treatment protocols, and propose evidence-based recommendations to improve clinical outcomes, enhance medical follow-up, and reduce the burden of UTI-related complications(Cheng et al., 2022)

MATERIALS AND METHODS:

The current study included the collection of 20 samples over a period from October 2025 to December 2026 from patients at Al-Hakeem Hospital in Maysan Governorate who were diagnosed with urinary tract infections (UTIs). Their ages ranged from 20 to 50 years. In addition, 10 control samples were collected from healthy individuals who visited private laboratories.

Patient samples were collected in sterile plastic containers and then cultured on routine culture media, namely Chocolate agar and MacConkey agar. Data were also recorded by asking the participants questions as shown in Appendix No. (1).

Sample Collection and Inoculation

Urine samples were collected in special containers, then transported and cultured on laboratory media. The samples were incubated aerobically at 37°C for 24 to 72 hours.

RESULT

Isolation and diagnosis of bacteria

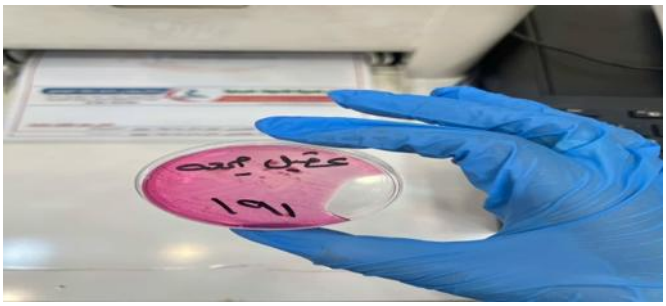
Staphylococcus, E. coli, Klebsiella, and Proteus mirabilis bacteria were isolated and identified from urinary tract infection samples.

This study demonstrated the possibility of isolating Staphylococcus, E. coli, Klebsiella, and Proteus mirabilis bacteria from urine samples of individuals exhibiting symptoms of urinary tract infections (UTIs) at Al-Hakim Hospital in Maysan Governorate. Twenty samples were collected and cultured on chocolate agar and mac Conkey agar to determine the role of these bacteria in causing UTIs. The samples were identified using a Vitec 2 Compact analyzer, achieving a 100% detection rate. Additionally, control samples were collected from healthy individuals and cultured in private laboratories; no bacterial species were identified in these samples.

Description of the colonies

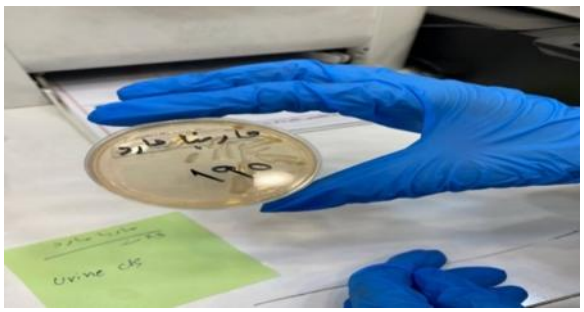
E. coli bacteria colonies appeared spherical in shape as shown in

8Spherical colonies of Klebsiella bacteria also appeared, as shown in the figure 2-3



Staphylococcus aureus colonies also appeared in a spherical shape, as shown in the figure 3-3

9Proteus mirabilis colonies also appeared in a spherical shape, as shown in the figure 4-3



10Gram stain was used to stain the bacteria, and the cells appeared spherical as shown in Figure 5-3

11Gram staining was used to stain Klebsiella bacteria, and the result was positive as shown in the figure 6-3

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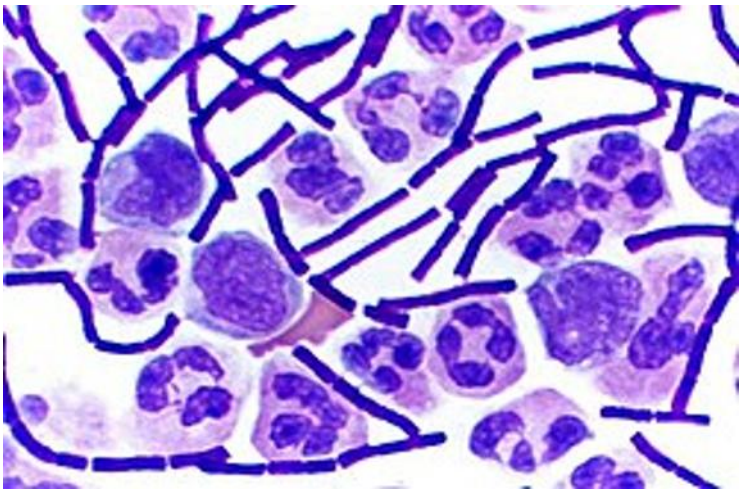
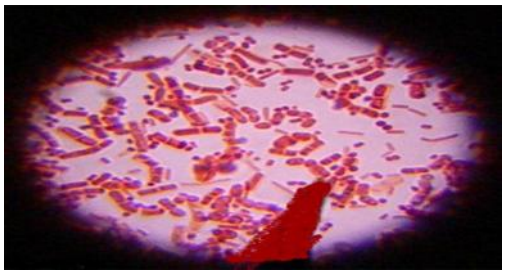


Gram staining was used to stain Klebsiella bacteria, and the result was negative, as shown in the figure 7-3



Distribution of patients by age group

The bacterial group was identified, and the study group was divided into 20 samples from patients with urinary tract infections into four age groups as shown in Table 3-1 . The highest incidence of urinary tract infections was observed in the 30-39 age group, with 9 cases recorded, representing 45%.

This was followed by the second age group, 20-29, where the study recorded five cases, representing 25%.

The third age group, 40-49, recorded four cases, representing 20%.

The last age group recorded two cases, representing 10%, as shown in Figure 1-3. And you analyzed the statistical results and found no significant differences

Table 1-3 of study sample distribution by age groups

Age in years	Number	Percentage
20-29	5	25%
30-39	9	45%
40-49	4	20%
50-59	2	10%
the total	20	100%

Distribution of Bacterial Isolates According to Gender

The findings of the present study indicate that urinary tract infections were more prevalent among females than males. A total of 12 cases (60%) were reported in females, whereas 8 cases (40%) were recorded in males, as shown in Table 3.3. And you analyzed the statistical results and found no significant differences.

Table 3-2 illustrating bacterial infection and its relationship to certain medical conditions.

medical condition	Number	Ratio
diabetes	7	35%
bladder nerve compression disease	5	25%

Table 3.3: Distribution of bacterial isolates according to gender

Gender	Number of Cases	Percentage
Female	12	60%
Male	8	40%

Distribution of Bacterial Isolates in the Study Population

The current study identified four different bacterial species among the collected samples. Escherichia coli (E. coli) was the most frequently isolated organism, accounting for 8 cases (40%). This was followed by Klebsiella pneumoniae (6 cases, 30%), Staphylococcus aureus (4 cases, 20%), and Proteus species (2 cases, 10%), as presented in Table 3.4.

And you analyzed the statistical results and found no significant differences.

Table 3.4: Distribution of bacterial isolates in study and control samples

Bacterial Species	Study Samples (n=20)	Percentage	Control Samples (n=10)	Total
E. coli	8	40%	0	8
Klebsiella pneumonia	6	30%	0	6
Staphylococcus aureus	4	20%	0	4
Proteus spp.	2	10%	0	2
Total	20	100%	0	20

DISCUSSION

Urinary tract infection (UTI) is a common bacterial infection that affects parts of the urinary system, including the bladder, urethra, ureters, and kidneys. It occurs when microorganisms, most commonly bacteria, enter the urinary tract and multiply, leading to inflammation and symptoms such as painful urination, frequent urge to urinate, and lower abdominal discomfort. UTIs are more prevalent in females due to anatomical factors; however, they can affect both sexes and all age groups. Early

diagnosis and appropriate antimicrobial treatment are essential to prevent complications, especially when the infection ascends to the kidneys(Bharati et al., 2023).

According to studies conducted at Al-Hakeem Teaching Hospital (Hooton et al., 2010; Sobel et al., 2011), urinary tract infections were investigated in both genders. The infection rate was found to be 100% through culturing samples on Blood agar, MacConkey agar, and Chocolate agar. The results of the current study showed that several types of bacteria could be isolated and identified, including Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, and Proteus mirabilis. These findings are consistent with a previous study (Weinstein et al., 2008), which reported that UTIs are predominantly caused by Gram-negative bacteria, particularly Escherichia coli, along with other pathogens such as Klebsiella and Proteus species.

In this study, approximately half of the patients suffering from urinary tract infections were infected with Escherichia coli, which was detected using routine microbiological tests and confirmed by the VITEK 2 system.

Colonies Description

Staphylococcus aureus – Klebsiella pneumoniae – Escherichia coli – Proteus mirabilis

The colonies of the isolated bacteria showed characteristic morphological features on culture media. Staphylococcus aureus appeared as circular, smooth, convex colonies with a golden-yellow pigmentation and often exhibited beta-hemolysis on blood agar. Klebsiella pneumoniae produced large, mucoid, glistening colonies due to its thick polysaccharide capsule and appeared pink on MacConkey agar as a lactose fermenter. Escherichia coli formed medium-sized, round, moist colonies with smooth edges and a pink coloration on MacConkey agar. Proteus mirabilis was distinguished by its swarming growth pattern on blood agar, forming concentric rings, while appearing as pale, non-lactose fermenting colonies on MacConkey agar (Lorenz et al., 2009).

Gram staining was used for bacterial identification, and it was observed that Gram-negative staining was clearer, easier, and more distinguishable, especially when the bacterial cells appeared in rod-shaped (filamentous) forms, whereas Gram-positive bacteria appeared as small spherical (cocci) cells.

The current study recorded that the highest number of patients with urinary tract infections (UTIs) fell within the age group of 30-39 years, accounting for 45% (nine cases) (Stamm et al., 2005; Hooton et al., 2010), who indicated that UTIs are more prevalent among sexually active age groups.

In a study on the effect of bacteria on urinary tract infections, the results demonstrated that the incidence of infection increases in active age groups. Most previous studies have shown an increase in bacterial infection rates with age and sexual activity. A study conducted in Poland by Yamazaki et al. (2012) and Zdrodowska et al. (2006) also indicated a relationship between bacterial infection and age groups characterized by higher sexual activity.

Distribution of Infertile Patients Among Age Groups

The highest prevalence of UTIs was observed in the age group 30–39 years, accounting for 45% of cases. This finding aligns with previous studies indicating that UTIs are more common in sexually active age groups.

In a separate study, the results showed that infection rates increase in sexually active age groups.

Most previous studies have found an increase in bacterial infection rates with age and sexual activity (Yamazaki et al., 2012). A study conducted in Poland by Zdrodowska et al. (2006) indicated a relationship between bacterial infection and sexually active age groups.

Bacterial Infection and its Relationship to Sex and Other Diseases

Urinary tract infections occur as a result of bacterial contamination of the genitourinary tract. The incidence of infection in males is lower than in females due to anatomical differences, as females have a shorter urethra which facilitates bacterial entry, whereas in males the presence of the prostate gland and its secretions plays a protective role by reducing bacterial growth (Hooton et al., 2010).

Some diseases contribute to an increased risk of infection, such as spinal cord disorders and diabetes mellitus (Kupis et al., 2015). The present study showed that 35% (seven cases) of patients were diagnosed with diabetes mellitus. This may be explained by the fact that many diabetic patients suffer from neurogenic bladder dysfunction, which leads to incomplete bladder emptying and consequently difficulty in clearing bacteria from the urinary tract. In addition, elevated blood glucose levels provide a favorable environment for bacterial growth. Moreover, diabetes mellitus leads to suppression of the immune response, and this is attributed to functional impairment in the activity of phagocytic cells (Metchnikoff et al., 1908), who demonstrated the essential role of phagocytes in defending the body against bacterial infections.

The present study also demonstrated that a number of patients had associated pathological conditions such as spinal cord disorders. The study recorded five cases (25%) related to spinal cord disease, and these cases were accompanied by bacterial infection (Hooton et al., 2010). This can be explained by the fact that patients with neurogenic bladder have difficulty in bladder emptying, which promotes bacterial persistence and provides a suitable environment for bacterial growth (Jeannette et al., 2005).

Isolation of Bacteria from Urinary Tract Infection Samples

In this study, bacteria were identified from urinary tract infection samples using the VITEK 2 system, with GN+AST cards for Gram-negative bacteria and GP+AST cards for Gram-positive bacteria, according to the manufacturer's instructions. It was found that the VITEK 2 system integrates several advantages compared to routine tests, as it provides rapid identification with a high level of accuracy. This speed in diagnosis and result generation is due to its automated operation, simple methodology, and reliance on updated classification databases (Quesada et al., 2010).

The samples analyzed in this study mostly showed distinctive results, which can be attributed to the high accuracy of the VITEK 2 system (Munoz-Davila et al., 2012). Out of a total of 100 samples included in this study, the results were highly reliable.

Nordmann et al. (2013) stated that the use of the VITEK 2 system recorded a high rate of infection with Escherichia coli, indicating its major role as the predominant causative agent of urinary tract infections.

Control Samples

The results of the control samples in this study showed no presence of any type of bacteria in individuals who were not infected with urinary tract infections. The presence of any bacteria in urine samples is considered an indication of a pathological condition, as normal urine is typically sterile (Hooton et al., 2010).

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