

Prevalence and Isolation of *Escherichia coli* in Male and Female UTI Patients in Sabratha region

Salma .M. Elswah^{1*}, Mohamed. O. Albasha², Alansary R. Elkhoully³

¹ Department of botany faculty of science – Zawia university Libya

² Department of zoology faculty of science – Zawia university Libya

³ Department of biology faculty of science – Regdalin, Sabratha University, Libya.

*Email: alanelkouly@gmail.com

انتشار وعزل بكتيريا الإشريكية القولونية لدى مرضى التهابات المسالك البولية من الذكور والإناث في منطقة صبراتة

سالمة محمد السويح^{1*}، محمد عمر الباشا²، الأنصاري رفعت الخولي³

¹ قسم علم النبات، كلية العلوم، جامعة الزاوية، ليبيا

² قسم علم الحيوان، كلية العلوم، جامعة الزاوية، ليبيا

³ قسم الأحياء، كلية العلوم، رقدالين، جامعة صبراتة، ليبيا

Received: 14-01-2026	Accepted: 13-03-2026	Published: 21-03-2026
		
<p>Copyright: © 2026 by the authors. This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).</p>		

Abstract

Background: Urinary tract infections (UTIs) are among the most common bacterial infectious diseases encountered in clinical practice and account for significant morbidity and high medical costs. *Escherichia coli* is the most predominant pathogen causing 80-90% of community-acquired UTIs and 30-50% of nosocomial-acquired UTIs.

Objectives: the aim of this study is to evaluate the presence of *E.coli* in the Urinary tract infection (UTIs) in different age and sex patients in the area of the study.

Methods: The present study was conducted at Sabratha hospital during the period of October - December 2025. The samples were collected from UTIs patients ($n= 629$) (384) females and (245) males, who were registered in this research and the urine samples were taken aseptically for microbial culture. Patients were divided into 18 age groups.

Results: A total of patients ($n= 629$): (384) females and (245) males of urine were cultured on CLED agar, equal or more than 105 CFU/ml of a single potential pathogen was interpreted as positive. Out of these samples (236): (138) females and (98) males gave positive growth on CLED agar. On the other hand, total percentage of prevalence in female samples recorded (35.93%) while the highest percentage of infection from the total positive samples recorded in

(0-5) age group (19.56%). In male samples the total percentage of prevalence recorded (40.0%) while the highest percentage of infection from the total positive samples recorded in (0-5) age group (37.75%).

Conclusion : This study showed a significant prevalence of urinary tract infections among the examined patients using CLED agar. Although more samples were collected from females, the proportion of positive cases was slightly higher in males. The highest infection rates were observed in children aged 0–5 years in both genders. These findings suggest increased susceptibility to infection in early childhood. Routine urine culture is essential for accurate diagnosis of UTIs. Early detection helps in effective treatment and prevention of complications.

Findings: The data revealed a predominance of the traditional production system, with 42.5% of respondents indicating that theoretical education is the prevailing model. Multiple regression analysis identified funding adequacy ($\beta = 0.31, p < 0.001$), academic staff efficiency ($\beta = 0.27, p < 0.001$), and infrastructure quality ($\beta = 0.22, p = 0.002$) as the three strongest predictors of perceived institutional productivity, collectively explaining 41.3% of the variance ($R^2 = 0.413, F(5,432) = 57.42, p < 0.001$). A strong consensus favored curriculum reform (75.3%, 95% CI: [71.3%, 79.4%]) and the adoption of a dual education model (75.3%) as primary development strategies.

Originality/Value: This paper presents an empirical classification of educational production systems in Libya, contributing to the limited body of research on higher education productivity in conflict-affected Arab states. We propose a measurable development model built on three pillars—institutional governance reform, effective industrial partnership development, and the establishment of a sustainable financing system—operationalized through Key Performance Indicators (KPIs) and phased implementation timelines.

Keywords: UTI- E. coli – age groups.

المخلص

تُعد التهابات المسالك البولية (UTIs) من أكثر الأمراض البكتيرية شيوعاً في الممارسة السريرية، حيث تُسبب معدلات مرتفعة من المراضة وتكاليف طبية كبيرة. وتُعد بكتيريا الإشريكية القولونية (*Escherichia coli*) العامل الممرض الأكثر شيوعاً، إذ تسبب ما بين 80–90% من الحالات المكتسبة من المجتمع و30–50% من الحالات المكتسبة داخل المستشفيات.

تهدف هذه الدراسة إلى تقييم وجود بكتيريا الإشريكية القولونية في حالات التهابات المسالك البولية لدى المرضى من مختلف الأعمار والجنسين في منطقة الدراسة.

أجريت هذه الدراسة في مستشفى صبراتة خلال الفترة من أكتوبر إلى ديسمبر 2025. تم جمع العينات من مرضى التهابات المسالك البولية (عددهم 629)، منهم 384 أنثى و245 ذكراً، حيث أُخذت عينات البول بطريقة معقمة لإجراء الزرع الميكروبي. وتم تقسيم المرضى إلى 18 فئة عمرية.

تمت زراعة عينات البول على وسط CLED، واعتُبرت النتيجة إيجابية عند وجود $\leq 10^5$ وحدة مكونة للمستعمرات/مل (CFU/ml) لمرض واحد.

من بين هذه العينات، أظهرت 236 عينة نمواً إيجابياً (138 إناث و98 ذكور). بلغت نسبة الانتشار لدى الإناث 35.93%، بينما سُجلت أعلى نسبة إصابة في الفئة العمرية (0–5 سنوات) بنسبة 19.56%.

أما لدى الذكور، فقد بلغت نسبة الانتشار 40.0%، وكانت أعلى نسبة إصابة أيضاً في الفئة العمرية (0-5 سنوات) بنسبة 37.75%. أظهرت الدراسة انتشاراً ملحوظاً لالتهابات المسالك البولية بين المرضى باستخدام وسط CLED. وعلى الرغم من أن عدد العينات من الإناث كان أكبر، إلا أن نسبة الحالات الإيجابية كانت أعلى قليلاً لدى الذكور. كما سُجلت أعلى معدلات الإصابة لدى الأطفال بعمر 0-5 سنوات في كلا الجنسين، مما يشير إلى زيادة القابلية للإصابة في مرحلة الطفولة المبكرة. وتُعد زراعة البول الروتينية ضرورية للتشخيص الدقيق، حيث يُسهم الكشف المبكر في تحسين العلاج والوقاية من المضاعفات..

الكلمات المفتاحية: التهابات المسالك البولية (UTI) – الإشريكية القولونية – الفئات العمرية.

Introduction:

Urinary tract infections (UTIs) are among the most frequently occurring bacterial infections. It is estimated that symptomatic UTIs lead to approximately 7 million outpatient clinic visits, 1 million emergency department visits, and 100,000 hospital admissions each year (Schappert, 1999). UTIs are also the leading cause of hospital-acquired infections, representing up to 35% of all nosocomial infections. Additionally, they rank as the second most common cause of bacteremia among hospitalized patients (Stamm, 2002; Weinstein *et al.*, 1990). In the United States, the annual healthcare costs associated with community-acquired UTIs alone are estimated to reach about \$1.6 billion (Foxman, 2002).

A urinary tract infection (UTI) is defined as the active multiplication of microorganisms within the urinary tract (Akter *et al.*, 2016). UTIs are considered one of the most significant and widespread infectious diseases affecting people worldwide (Burhan, 2017). Due to their potential complications, they can affect several vulnerable organs of the urinary system, including the bladder, ureters, and urethra (Ullah and Almugadam, 2018).

UTIs occur approximately 14 times more frequently in women than in men, largely because women have a shorter urethra located closer to the anus. As a result, up to 40% of women experience at least one UTI during their lifetime, and many suffer from recurrent infections. In contrast, UTIs are less common in men because the prostate gland produces bactericidal substances and contains zinc (Zn), both of which play an important role in inhibiting and killing microorganisms such as *Escherichia coli* (Faraji *et al.*, 2012).

Escherichia coli is a major cause of urinary tract infections (UTIs) worldwide. Therefore, understanding the distribution and prevalence of UTIs is essential for improving infection control measures. In one study, 70 patients of different ages and both sexes who were diagnosed with UTIs were examined. The isolated bacteria were identified using conventional biochemical tests, and antimicrobial susceptibility testing was carried out on Mueller–Hinton agar using the Kirby–Bauer disk diffusion method. The findings showed that the prevalence of UTIs was higher in females (68%) compared to males (32%). The highest prevalence rate was observed among individuals aged 21–40 years (30%), followed by those over 80 years old (7%). In terms of antibiotic sensitivity, *E. coli* isolates from males aged 61–80 years (9 patients) showed the highest susceptibility to antibiotics such as TZP, FOS, F, IMP, AK, and SCF, followed by females aged 1–20 years (9 patients) (Rahman *et al.*, 2019).

Although *E. coli* is commonly found in large numbers as part of the normal gut microbiota in adults, the diversity of its strains within the intestinal reservoir has only been investigated in limited populations, excluding many patients with bacteremia (Apperloo-Renkema *et al.*, 1990). Studying the gut microbiota in bacteremic patients is challenging because these

individuals are often critically ill, and stool samples are not routinely collected or clinically indicated. While routinely collected specimens could potentially serve as accessible samples, most patients with suspected bacteremia receive empirical antimicrobial therapy within one hour of hospital admission, in accordance with international sepsis guidelines. Consequently, enteric samples are often exposed to antibiotics and may also be stored under refrigeration for extended periods before reaching diagnostic laboratories, which can influence the composition of the microbiota (**Hibbing et al., 2010**).

Enteric samples obtained from patients with *Escherichia coli* bacteremia showed a median of one RAPD pattern (range 1–4), whereas patients without *E. coli* bacteremia demonstrated a median of two patterns (range 1–5). Importantly, in large-scale clinical investigations, the observed diversity of *E. coli* among hospitalized individuals was not influenced by the type of sample collected (rectal swab versus stool), nor by increasing the number of tested colonies from 10 to 20. Overall, hospitalized patients exhibited relatively limited enteric *E. coli* diversity, which was further reduced in those with *E. coli* bacteremia. This decreased diversity suggests that, during bloodstream infection, dominant strains may outcompete other lineages within the gut microbiota (**Mosavie et al., 2019**).

In another study, *E. coli* was identified as the most common pathogen responsible for UTIs, accounting for 93.55% of isolates in pediatric patients, 60.24% in adults, and 45.83% in elderly individuals. High resistance rates were observed to ampicillin (82.76%, 58%, and 63.64%) and co-trimoxazole (51.72%, 42%, and 59.09%) among *E. coli* isolates from pediatric, adult, and elderly groups, respectively (**Alanazi et al., 2018**).

The majority of UTIs are caused by *E. coli* bacteria, followed by *Proteus* spp., *Staphylococcus saprophyticus*, *Klebsiella* spp. and other *Enterobacteriaceae* (**Kahlmeter, 2000**). However, among bacteria causing UTIs, *E. coli* is considered as the most predominant cause of both community and nosocomial UTIs. Antibiotics commonly recommended for treatment of UTIs include co-trimoxazole, ciprofloxacin and ampicillin (**Foxman .2010**). However, there is global increase in antibiotic resistance among urinary tract pathogens, including resistance pattern observed in Saudi Arabia (**Al Yousef, et al 2016**), which limit treatment options.

Elkhouly et al., (2025) concluded that, *Escherichia coli* was the most common pathogen affecting both male and female patients, with the highest infection rate of 22.43% occurring in individuals aged 11 to 20 years. Among the antibiotics tested, imipenem, a broad-spectrum beta-lactam, showed the strongest overall effectiveness, impacting 71 bacterial cultures in total. *E. coli* demonstrated the greatest susceptibility to imipenem, with a rate of 56.3% (40 cultures). Gentamicin also showed considerable activity, affecting 38 cultures, while erythromycin was the least effective antibiotic against the bacterial strains evaluated in this study.

A significant gap in knowledge exists due to the lack of large-scale studies and comprehensive surveys on urinary tract infections (UTIs) in Libya. Current research is limited in scope and often focuses on small or localized populations, which restricts the understanding of UTI prevalence, pathogen distribution, and antibiotic resistance patterns across the country. This shortage of broad, systematic data hampers the development of effective infection control strategies and evidence-based treatment guidelines tailored to the Libyan population. Therefore, there is a critical need for extensive, nationwide studies to provide a clearer picture of UTI epidemiology and improve patient outcomes.

Materials and Methods

Study area.

The present study was conducted at Sabratha central hospital during the period of October - December 2025.

Sampling.

The samples were collected from UTIs patients ($n= 629$) (384) females and (245) males, who were registered in this research and the urine samples were taken aseptically for microbial culture. The sterile containers were properly labelled with the name, age and sex of the patients. The samples were transported to the laboratory and processed within 1–2 hours of collection. If a delay was expected, samples were stored at 4 °C to prevent bacterial overgrowth.

Inoculation and Culturing

A calibrated sterile loop (0.001 mL) was used to inoculate the urine sample onto Cysteine Lactose Electrolyte Deficient (CLED) agar. The inoculation was performed using the streak plate method to allow for the isolation of discrete colonies. The inoculated plates were incubated aerobically at 37 °C for 18–24 hours in an inverted position.

Colony Count and Interpretation

After incubation, colonies were counted to estimate bacterial load. A colony count of $\geq 10^5$ colony-forming units (CFU)/mL of a single organism was considered significant and indicative of urinary tract infection. Plates showing growth of more than one type of organism were recorded as mixed culture and excluded from further analysis.

Culturing.

20 μ l of the specimen is inoculated through an incinerated wire loop on CLED-agar. The inoculation was performed through the streaking method inside a flow hood. After inoculation incubates the plates for 24 hours at 37°C in an inverted position. After 24 hours of incubation, if more than one type of organism was isolated, results were recorded as "mixed culture," and are excluded from this study. Equal to 10⁵ CFU/ml of a single potential microorganism is interpreted as positive.

Gram staining

A gram stain was performed to confirm and identify the pathogen and bacteria were searched in pus cells in urine. While, the Gram-negative rods were identified by gram staining, and such type of culture was then inoculated by streaking to MacConkey agar for subculturing. MacConkey agar is used to isolate and differentiate the Gram-negative enteric bacilli (**Croxen et al, 2013**).

Results and discussion

A total of patients ($n= 629$): (384) females and (245) males of urine were cultured on CLED agar, equal or more than 10⁵ CFU/ml of a single potential pathogen was interpreted as positive. Out of these samples (236): (138) females and (98) males gave positive growth on CLED agar.

Based on the provided data table (1) , (total sample = 384), the overall UTI prevalence is 35.93% (138 positive cases). The highest age-specific prevalence rates were observed in the 66–70 years group (66.66%), followed by 46–50 years (55.55%) and 36–40 years (47.22%). Moderate prevalence was noted in the 16–20 years and 61–65 years groups (40% each). In contrast, the lowest prevalence was recorded in the 71–75 years group (0%). In terms of contribution to total positive cases, the 0–5 years group accounted for the largest proportion (19.56%), followed by 6–10 years (16.66%) and 36–40 years (12.31%). Overall, UTIs were distributed across all age groups, with higher proportional burden in early childhood and middle-aged adults, while the highest infection rates within groups were more prominent

among older adults. **Rahman *et al* 2019** reported that, in age group 1- 20 the prevalence rate of UTI was less in males which is 02% and in females, it was high i.e., 17%, and total of which is 19% which was 11% less than the age groups of 21-40 which are 30%. Our results are in agreement with their results if we collected the patients in one group. Our results also are in agreement with those of (**Flores-Mireles *et al* ,2015**) who concluded that, the pathogenesis of the UTI typically starts with contamination of the per urethral space by uropathogens residing in the gut, followed by colonization of the urethra and ascending migration to the bladder. Moreover, UTIs are predominantly caused by uropathogenic *Escherichia coli* (UPEC), which is responsible for over 80% of community-acquired infections, while healthcare-related infections are associated with *Staphylococcus*, *Klebsiella*, *Enterobacter*, *Proteus*, and *Enterococcus* (**Foxman, 2012**).

Table 1: Prevalence rate of (UTIs) due to *E. coli* percentage wise in females.

Age Range	Negative	positive	Total	% for each group	%from the total prevalence
0 - 5	62	27	89	30.33	19.56
6 – 10	38	23	61	37.7	16.66
11 – 15	12	6	18	33.33	4.34
16 – 20	6	4	10	40	2.89
21 – 25	30	14	44	31.81	10.14
26 – 30	24	14	38	36.84	10.14
31 – 35	19	5	24	20.83	3.62
36 – 40	19	17	36	47.22	12.31
41 – 45	11	4	15	26.66	2.89
46 - 50	4	5	9	55.55	3.62
51 – 55	7	3	10	30	2.17
56 – 60	7	4	11	36.36	2.89
61- 65	3	2	5	40	1.44
66 - 70	3	6	9	66.66	4.34
71 – 75	1	0	1	0	0
76 – 80	0	1	0	100	0.72
81 -85	0	2	0	100	1.44
86 – 90	0	1	0	100	0.72
Total	246	138	384	35.93	

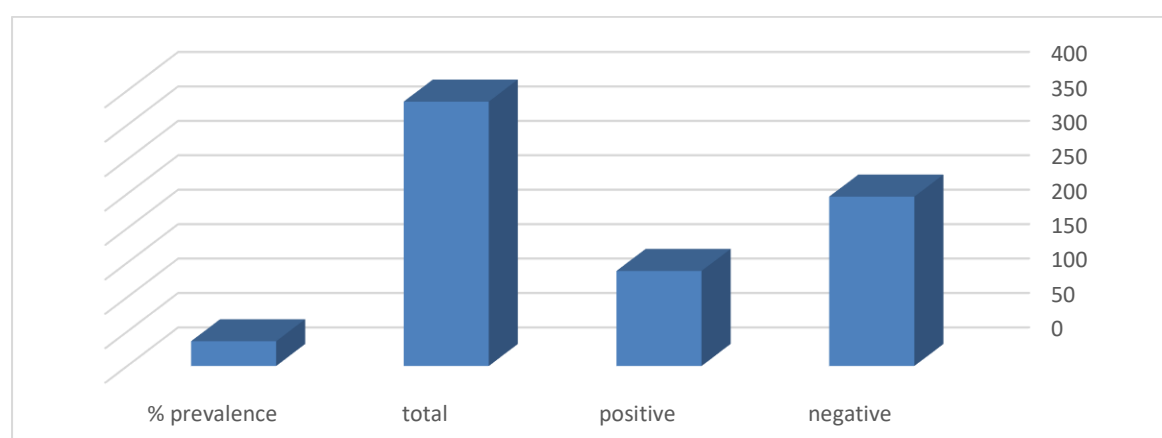


Figure (1): percentage of female prevalence, total number of persons , negative and positive.

Data presented in table (2) cleared that (total sample = 245), the overall prevalence of UTI is 40% (98 positive cases). The highest age-specific prevalence rates were observed in the 81–85, 86–90, 91–95, and 96–100 years groups (100% each), followed by 71–75 years (75%) and 16–20 years (66.66%). Moderate prevalence was noted in the 51–55 years group (57.14%) and 0–5 years group (49.33%). The lowest prevalence was recorded in the 41–45 years group (0%). Regarding contribution to the total positive cases, the 0–5 years group accounted for the largest proportion (37.75%), followed by 6–10 years (7.14%) and 76–80 years (6.12%). Overall, while the highest proportional burden of UTI was seen in early childhood, the highest infection rates within age groups were more evident among elderly patients. **Rahman et al 2019** reported that, in the age group 21–40 the prevalence rate of UTI in males was 02% which was less than the female's prevalence rate which was 28%. In this age group, the prevalence rate of urinary tract infection was high from the female isolates of the entire age groups. This finding is in agreement with our results. In the age groups (41–45), (46–50), (51–55) and (56–60) the prevalence with *E. coli* bacteremia ranged between (2.17–2.89%). Data obtained by **Rahman et al 2019** showed high prevalence in the same age groups in comparison with our results with 11% urinary tract infection in females and 08% in males.

In the age group of 61–80, the males have 17% of urinary tract infection and females have 08% of urinary tract infection, which was 09% high from females of this age group. The age group Above 80 have a prevalence rate of 07%, which was less as compared to the entire age groups (**Rahman et al 201**).

Table 2: Prevalence rate of UTI due to *E. coli* percentage wise in males

Age Range	Negative	positive	Total	% for each group	%from the total prevalence
0 - 5	38	37	75	49.33	37.75
6 – 10	32	7	39	17.94	7.14
11 – 15	6	3	9	33.33	3.06
16 – 20	1	2	3	66.66	2.04
21 – 25	9	3	12	25.00	3.06
26 – 30	7	2	9	22.22	2.04
31 – 35	6	4	10	40.0	4.08
36 – 40	15	5	20	25.00	5.10
41 – 45	10	0	10	0.00	0
46 -50	5	4	9	44.44	4.08
51 – 55	5	2	7	57.14	2.04
56 – 60	4	2	6	33.33	2.04
61- 65	3	2	5	40.00	2.04
66 - 70	3	2	5	40.00	2.04
71 – 75	1	3	4	75.00	3.06
76 – 80	2	6	6	33.33	6.12
81 -85	0	4	4	100	4.08
86 – 90	0	4	4	100	4.08
91 – 95	0	4	4	100	4.08
96 – 100	0	2	2	100	2.04
Total	147	98	245	40.00	

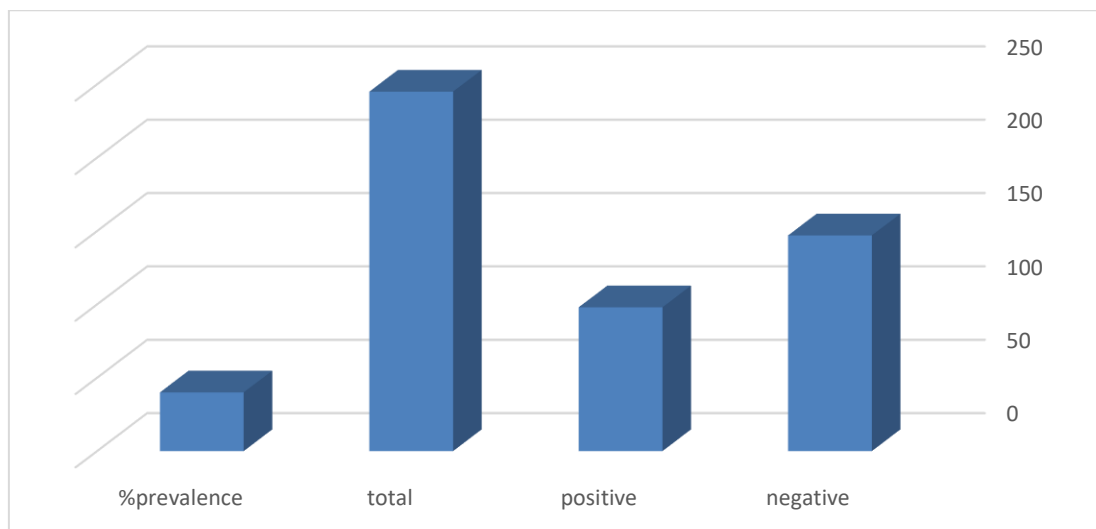


Figure (2): percentage of male prevalence, total number of persons , negative and positive.

Fig (3) shows the percentage of total UTI prevalence broken down by age groups for females and males. Among females, the highest percentage of total UTI cases is concentrated in the youngest age group (0–5 years), with a steady low percentage across most adult age groups before a sharp increase in the older age groups (especially 91–100). In contrast, males have relatively low percentages across most age groups but show a significant spike in the oldest age group (96–100 years). Female UTI prevalence is generally higher in early childhood and then again increases in elderly age groups. Male UTI prevalence remains low and stable until old age, where it sharply rises. This suggests that UTIs are more common in young girls and elderly women, while in males, UTIs mostly affect the very elderly population.

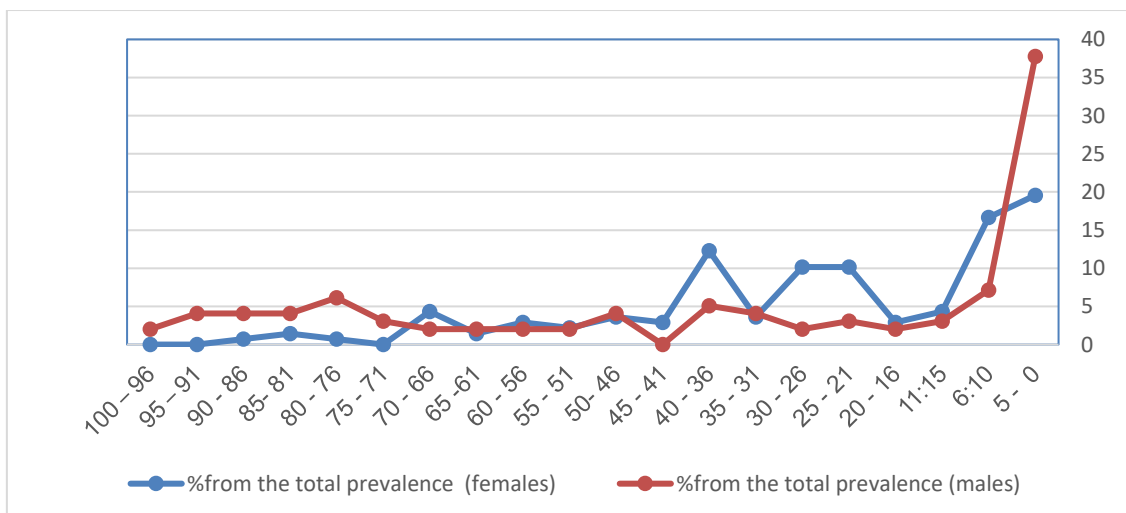


Figure (3): percentage of male and female prevalence for all age groups.

Figure (4) illustration visually represents a urinary tract infection (UTI). It shows the key organs involved in the urinary tract—the kidneys, ureters, bladder, and urethra—highlighting how bacteria (depicted as colorful rod-shaped and spherical microbes) invade and multiply

within the urinary system, leading to infection. This image effectively conveys how UTIs occur when harmful microorganisms colonize parts of the urinary tract.

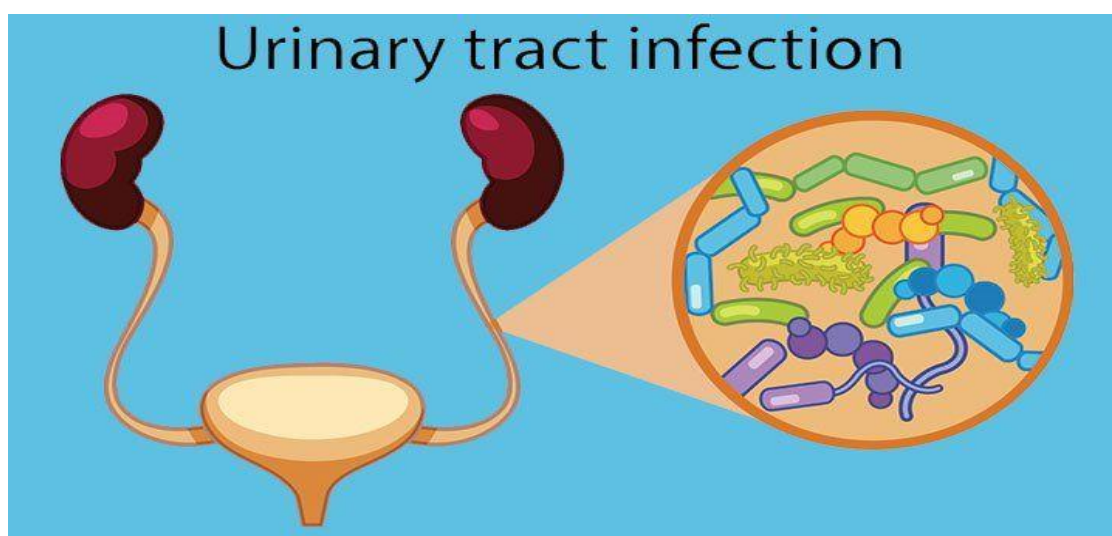


Figure (4) Most *E.coli*-caused UTIs occur in the lower urinary tract (the bladder and urethra), though in worse cases bacteria can travel up to the kidneys. Shutterstock

References

- Akter T, Hossain MJ, Khan S, Sultana H, Fatema K, Sanjee S et al (2016).** Isolation, identification and antimicrobial susceptibility pattern analysis of *Escherichia coli* isolated from clinical samples of Bangladesh. *Asian Journal of Biomedical and Pharmaceutical Sciences*, 2016, 6(54).
- Apperloo-Renkema HZ, Van der Waaij BD and, Van der Waaij D.(1990).** Determination of colonization resistance of the digestive tract by biotyping of *Enterobacteriaceae*. *Epidemiol Infect.* 1990;105(2):355–61.
- Burhan O.(2017).** Isolation and Identification of Urinary Tract Infectious Bacteria and Exploring their Anti-drug Potential against Some Common Antibiotics. *J Microb Biochem Technology*. 2017; 9:6.
- Croxen MA, Law RJ, Scholz R, Keeney KM, Wlodarska M, Finlay BB (2013).** Recent advances in understanding enteric pathogenic *Escherichia coli*. *Clinical microbiology reviews*. 2013; 26(4):822-880.
- Elkhouly, A. R., Ekram Almosy, & Nora Almosy. (2025).** Study of bacterial and fungal infection of UTI patients in Sabratha and Jemil regions. *Libyan Journal of Contemporary Academic Studies*, 2(3), 50.: 3005-5970.
- Faraji R, Sabzi F, and Center IAC (2012).** Antimicrobial susceptibility of *Escherichia coli* isolated from patients with urinary tract infection referred to Imam Ali Hospital Kermanshah, Iran (2011). *Life Sci J*. 2012; 9(3):79-82.
- Flores-Mireles, A.L.; Walker, J.N.; Caparon, M. and Hultgren, S.J(2015).** Urinary tract infections: Epidemiology, mechanisms of infection and treatment options. *Nat. Rev. Microbiol*. 2015, 13, 269–284.
- Foxman, B (2002).** Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Am J Med* 2002; 113:5S–13S

- Foxman, B (2014).** Urinary tract infection syndromes: Occurrence, recurrence, bacteriology, risk factors, and disease burden. *Infect. Dis. Clin. North. Am.* 2014, 28, 1–13.
- Hibbing ME, Fuqua C, Parsek MR and, Peterson SB (2010).** Bacterial competition: surviving and thriving in the microbial jungle. *Nat Rev Microbiol.* 2010;8(1):15–25.
- Rahman. S.R, Mushtaq Ahmad, Baitul Islam, Amir Ullah, Mujeeb ur Rahman, Zahid Khan, Haroon, Shahbaz Ahmad and Ikram Ullah. (2019).** Isolation and identification of *Escherichia coli* from urine samples and their antibiotic susceptibility pattern. *Journal of Entomology and Zoology Studies* 2019; 7(3): 259-264.
- Schappert SM (1999).** Ambulatory care visits to physician offices, hospital outpatient departments, and emergency departments: United States, 1997. *Vital Health Stat* 13 1999; 143:i-iv, 1–39.
- Stamm WE (2002).** Scientific and clinical challenges in the management of urinary tract infections. *Am J Med* 2002; 113:1S–4S.
- Ullah A, Shah S, Almugadam B (2018).** Prevalence of symptomatic urinary tract infections and antimicrobial susceptibility patterns of isolated uropathogens in kohat region of Pakistan. *MOJ Biol Med.* 2018; 3(4):85-9.
- Weinstein MP, Towns ML, Quartey SM, et al (1990).** The clinical significance of positive blood cultures in the 1990s: a prospective comprehensive evaluation of the microbiology, epidemiology, and outcome of bacteremia and fungemia in adults. *Clin Infect Dis* 1997; 24:584–602.
- Mia Mosavie, Oliver Blandy, Elita Jauneikaite, Isabel Caldas, Matthew J. Ellington, Neil Woodford and Shiranee Sriskandan (2019).** Sampling and diversity of *Escherichia coli* from the enteric microbiota in patients with *Escherichia coli* bacteraemia. *BMC Res Notes* (2019) 12:335
- Alanazi M. Q, Fulwah Y. Alqahtani² and Fadilah S. Aleanizy (2018).** An evaluation of *E. coli* in urinary tract infection in emergency department at KAMC in Riyadh, Saudi Arabia: retrospective study. *Ann Clin Microbiol Antimicrob* (2018) 17:3.
- Kahlmeter. G (2000).** The ECO.SENS Project: a prospective, multinational, multicentre epidemiological survey of the prevalence and antimicrobial susceptibility of urinary tract pathogens—interim report. *J Antimicrob Chemother.* 2000;46(Suppl 1):15–22 (discussion 63–5).
- Foxman. B (2010).** The epidemiology of urinary tract infection. *Nat Rev Urol.* 2010;7(12):653–60.
- Al Yousef. S.A, et al (2016).** Clinical and laboratory profile of urinary tract infections associated with extended spectrum beta-lactamase producing *Escherichia coli* and *Klebsiella pneumoniae*. *Ann Clin Lab Sci.* 2016;46(4):393–400

Compliance with ethical standards*Disclosure of conflict of interest*

The authors declare that they have no conflict of interest.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of JLABW and/or the editor(s). JLABW and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.