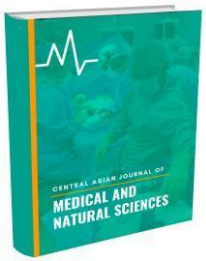

CENTRAL ASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES
https://cajmns.centralasianstudies.org/index.php/CAJMNS
Volume: 06 Issue: 04 |October 2025 ISSN: 2660-4159

.

Article

Antibiotic Profile for Bacteria Isolated from Urinary Tract Infection in Babylon Province

Zainab Hafedh Jameel*[1], Safaa A. Al-Isawi[2]

1. Directorate of Education in Babylon, Iraq
2. Al furat AL-Awsat technical university, Institute Babylon technic, Iraq

*Correspondence: za91ha@gmail.com

Abstract: The purpose of this work was to ascertain the antibiotic profile of bacteria extracted from patient urinary tract infections (UTIs) from community urine samples. Commonly including bacterial and, occasionally, fungal or viral infections, urinary tract infections (UTIs) are healthcare concerns. Antibiotic resistance has grown out of the illogical prescribing and usage of antibiotics in UTI therapy. From male and female patients in several hospitals in Babylon province, Iraq, urine samples (152) were gathered with an age range of 1 to 80 years. In 67% of the samples—99/152—the research noted increase. Of the samples, 78% showed gram-negative bacteria; Gram-positive bacteria were recorded in 22%. Among women, the UTI prevalence was 73%; among men, it was 27%. The most prevalent uropathogenic bacteria were Escherichia coli (46%, 46/99), followed by, Staphylococcus aureus (25%, 25/99), Enterobacter cloacae (9, 9/99), Proteus mirabilis (6%, 6/99), Klebsiella pneumoniae (6%, 6/99) , Streptococcus (3%, 3/99) , Acinetobacter (2%, 2/99) Pseudomonas aeruginosa (1%, 1/99) , and serratia marcescence (1%, 1/99). Pseudomonas aeruginosa , serratia marcescence, Proteus mirabilis, Streptococcus and Acinetobacter as being sensitive to imipenem (100%) and Escherichia coli (93%), sensitive to cefepime(100%) serratia marcescence and Acinetobacter, sensitive to meropenem (100%) serratia marcescence and Streptococcus, sensitive to Amikacin (100%) Acinetobacter and Pseudomonas aeruginosa, sensitive to gentamicin(100%) serratia marcescence, Acinetobacter and Pseudomonas aeruginosa. sensitive to ciprofloxacin(100%) Streptococcus. sensitive to cefotaxime(100%) serratia marcescence . sensitive to levofloxacin(100%) serratia marcescence . and resistant to ceftazidime (100%) serratia marcescence , Acinetobacter , Streptococcus and Pseudomonas aeruginosa. resistant to cefepime (100%) Pseudomonas aeruginosa. resistant to meropenem (100%) Pseudomonas aeruginosa. resistant to Amikacin(100%) serratia marcescence and Streptococcus. resistant to gentamicin(100%) Streptococcus. resistant to ciprofloxacin (100%) serratia marcescence and Pseudomonas aeruginosa. resistant to Ampicillin/sulbactam (100%) serratia marcescence, Klebsiella pneumoniae Streptococcus, and Pseudomonas aeruginosa . resistant to cefotaxime(100%) Pseudomonas aeruginosa and resistant to levofloxacin (100%) Pseudomonas aeruginosa.

Keywords: Antibiotic Profile, Bacteria Isolated, Urinary Tract Infection, Babylon, Iraq

Citation: Jameel, Z. H., Al-Isawi, S. A. Antibiotic Profile for Bacteria Isolated from Urinary Tract Infection in Babylon Province. Central Asian Journal of Medical and Natural Science 2025, 6(4), 1368-1376.

Received: 25th May 2025
Revised: 31th May 2025
Accepted: 13th Jun 2025
Published: 27th Jun 2025

1. Introduction

The most often occurring kind of infection globally are urinary tract infections (UTIs). Globally, especially among women, it is the most often occurring health issue. In hospitals and other healthcare environments, urinary tract infections pose a major challenge [1].

Before the age of seven, over 5% of girls and 2% of boys possess infections of the urinary tract (UTIs), so this bacterial infection is a major public health issue and a main source of morbidity in baby boys, women of all ages, as well as older males.

Adherence, toxin synthesis, immunological evasion, and iron acquisition are virulence factors utilized by the most common uropathogens [2].

Together, the organs, tubes, muscles, and nerves that make up the urinary system create, stores, and moves urine. A pair kidneys, a bladder, both ureters, a couple sphincter muscles, as well as the urethra together make up the urinary system.

Usually called acute cystitis or a bladder infection, a urinary tract infection (UTI) damages the urinary system. Changing the bottom of the urinary system, it is discovered that it is a simple cystitis, a bladder disease; yet, changing the upper urinary tract, it is found to be pyelonephritis, a kidney infection. While lower urinary tract symptoms include pain or frequent urination, pyelonephritis symptoms also include fever and flank discomfort (or both)[3].

A main organism causing UTIs is many bacteria. Gram-positive microbes (GPB) account for 10%–15% of the disease; gram-negative microbes cause 80%–85%.

Escherichia coli and other Enterobacteriaceae are main etiological agents of urinary tract infections. Among the various species that remaining agents are connected with, the GPB is one. Usually ubiquitous as well as resistant to antibiotics are Enterococcus, , Streptococcus agalactiae, Bacillus subtilis, Streptococcus pyogens, Staphylococcus aureus, Enterococcus faecalis, and Staphylococcus saprophyticus [4].

Obviously, the best criterion for urinary tract infections examination incorporates test and clinical information. According to the present approaches, the specimen is submitted to urine culture as well as antibiogram treatments following the confirmation and quantification of the existence of bacteria. While the latter studies antibacterial sensitivity, the former helps to identify species. But at least 24 hours of incubation are required for such acts. This extended interval and usually painful symptomatology help to explain why the patient first uses empirical therapy [5].

Although medicines can help cure urinary tract infections, past extensive use of antibiotics without appropriate sensitivity testing has undoubtedly resulted in a rise in the fraction of UTI bacteria resistant to reasonably priced and readily accessible antibiotics. A first step towards evidence-based empirical antibiotic prescription is knowledge of local antimicrobial resistance patterns [6].

Globally threatening human health, healthcare systems, and the availability of efficient therapies for lethal infections is antimicrobial resistance (AR). Because of the declining value of present antibiotics and the dearth of new antibiotics on the market, AR is expected to be the main cause of worldwide death by 2015. Among the anthropogenic causes of antimicrobial resistance include overuse and abuse of antibiotics, erroneous diagnosis, and the preventative use of antibiotics in animal farming. Given antibiotics are commonly used in clinical environments to treat bacterial illnesses, the rise in multidrug-resistant bacterial strains raises serious public health issues [7].

tandard definitions for several types of drug-resistant bacteria are proposed here by an international assembly of department heads from specialized organizations including the European Centre for Prevention and Control of Disease, the Bureau of Infectious Diseases, the Department of Health and Human Services, the Centre for Disease Prevention and Control, and the Division of Epidemiology at Tel Aviv Sourasky Medical Centre. MDR, or multiple drug resistant: Referring to strains in three or more antimicrobial groups not responsive to one or more antibiotic medicines,

Saying microorganisms not sensitive to any of the antibiotic drugs in just either one or two antimicrobial classes, "extensive" or "very" drug resistance (XDR),

"Pan drug resistant" (PDR) Referring to isolates resistant to all listed antibiotics [8].

Globally and in Europe, the greatest resistance rates of uropathogens were seen for fluoroquinolones, cephalosporins, and aminoglycosides, which are the primary types of antimicrobials recommended for treating UTIs. Aminoglycosides and the trimethoprim-sulfamethoxazole combination exhibit moderate yet escalating resistance, trailing behind carbapenems, macrolides, and vancomycin, which demonstrate a fast and concerning rise in resistance levels [9].

2. Materials and Methods

2.1. Sample Collection

Gathering of specimens This study gathered 152 isolates overall from UTIs found in different hospitals in Babylon province between September 2024 and May 2025. Iraq with an age range from 1to 80years.

2.2. Culturing and Identification of Bacteria

Isolates (99 isolates) were distributed as follows: Escherichia coli (46), staphylococcus (25), klebsal. Pneumon (6), Enterobacter cloacae (9), serratia marcescence (1), Proteus (6), Streptococcus (3) , Acinobacter (2),and Pseudomonas (1).

After incubation at 37°C, colonial shape on MacConkey agar (HiMedia Laboratories, Mumbai, Maharashtra, India) revealed UTIs isolates. Following product recommendations, isolates were further verified as presumed UTIs using VITEK 2 Compact (bioMérieux, France). For subsequent study, The Brain Heart Infusion Broth (BHIB, HiMedia Laboratories) to 30% glycerol at −20°C housed the UTIs isolates.

2.3. Antibacterial Susceptibility Test

Antibiotic sensitivity was evaluated in relation to this using the disk diffusion test rather than (CLSI, 2022) [10].

Ten antimicrobial discs (Bioanalyze/ Turkey) including Amikacin, Gentamycin, ceftazidime, cefepime, Imipenem, Meropenem, ciprofloxacin, cefotaxine, levofloxacin and Ampicillin/sulbactam were tested against all gram-negative and positive isolates. Mueller-Hinton agar (Himedia, India) was used for a Kirby Bauer disc diffusion test with antimicrobial sensitivity. After overnight incubation at 37 ºC, the findings were found by applying Clinical and Laboratory Standards Institute recommendations for zone of inhibition. rug-resistant bacteria.

3. Results

The Age-Based Frequency Distribution of UTI Patients Figure 1 displays the frequency distribution of UTI patients by age. The age range of those affected was 1 year to over 60. However, the majority of patients in this study were between the ages of 21 and 30.

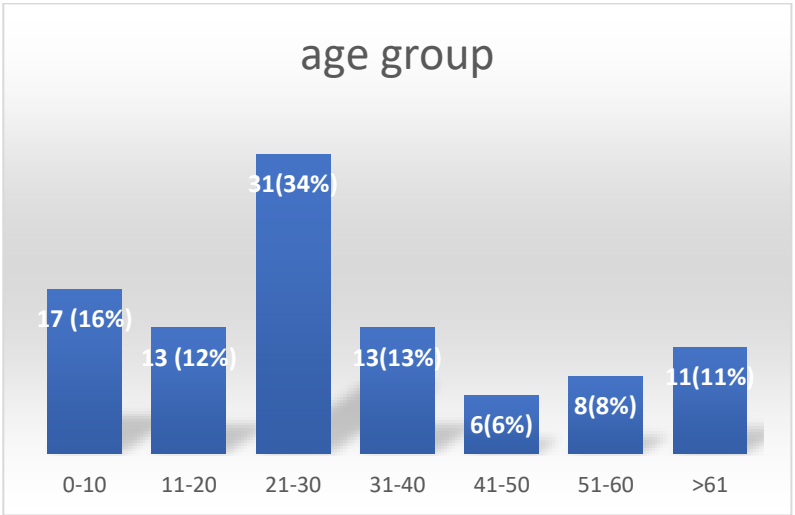

Figure 1. display of the incidence spreading of patients with UTI according to oldness.

3.1. Distribution of UTI Patients' Frequencies Considering Gender

One hundred UTI patients were included in the current investigation. 73% of UTI patients were female, compared to 27% of male patients, see Figure 2.

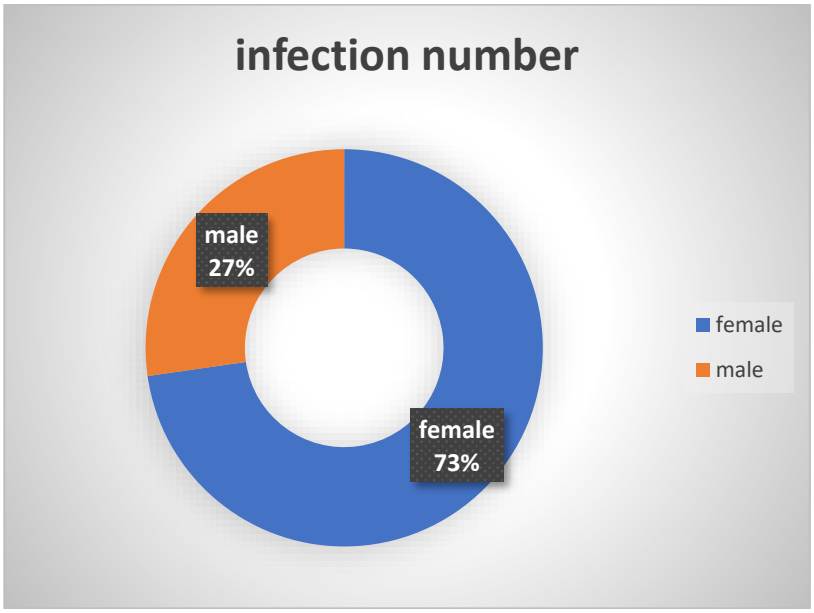

Figure 2. Explaining the spreading of patients with UTI based on sex.

3.2. The proportion of bacteria isolated from UTI patients

Only 99 (67%) of the 100 samples tested positive for the presence of significant bacteria, according to the culture results. 53 (33%) of the samples, however, did not exhibit bacterial growth. Figure 3 displayed the bacterially isolated related UTI.

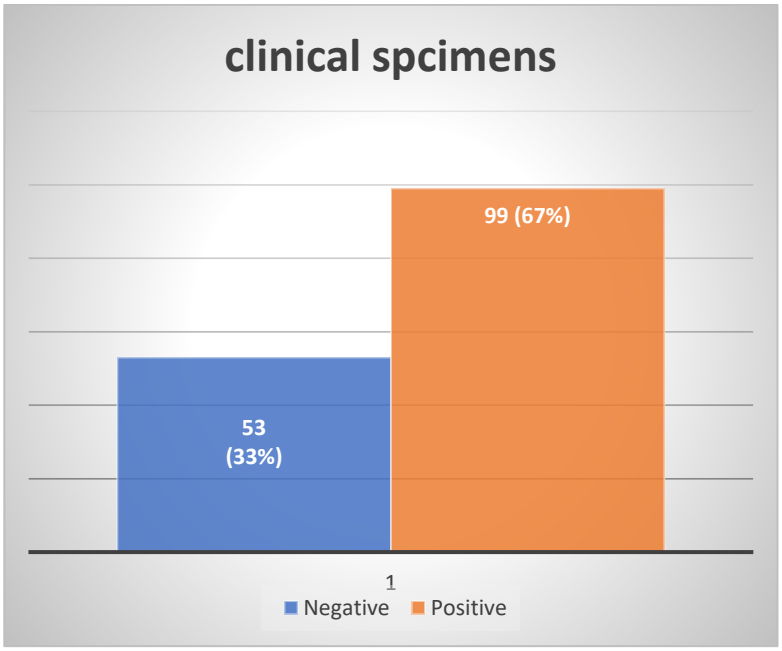

Figure 3. Distribution of microorganisms that cause UTIs.

This study's detailed analysis The most common bacteria were E. coli (64.0%), Staphylococcus and Enterococcus cloaca (9%), Proteus and Klebsiella (6%, 2.88%), Streptococcus (3%), Acintobacter (2%), and Pseudomonas (1%).

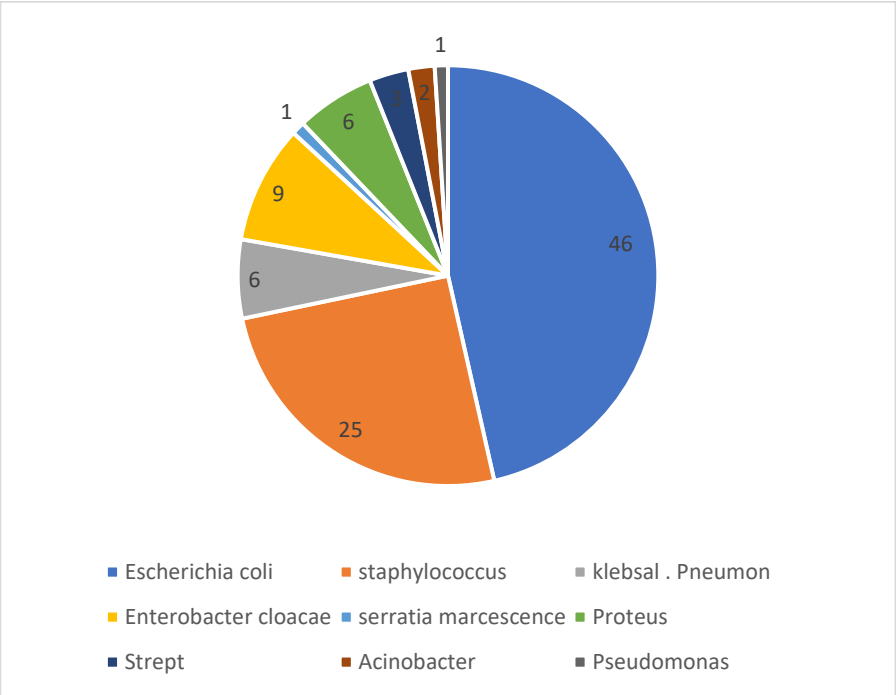

Figure 4. Pie chart showing distribution of patients with urinary tract infection according to causative agent.

Table 1. The percentage of bacterial pathogens isolated from urinary tract infections that exhibit resistance (R) to antimicrobial treatments.

Antibiotic	*Escherichia Coli*	*Staphylococcus*	*Klebsal . Pneumon*	*Enterobacter Cloacae*	*Serratia Marcescence*	*Proteus*	*Strept*	*Acinobacter*	*Pseudomonas*
Ceftazidime	43%	76%	83%	56%	100%	67%	100%	100%	100%
Cefepime	43%	32%	83%	56%	0%	67%	67%	0%	100%
Imipenem	7%	12%	33%	22%	0%	0%	0%	0%	0%
Meropenem	37%	8%	66%	33%	0%	50%	0%	50%	100%
Amikacin	54%	44%	50%	33%	100%	50%	100%	0%	0%
Gentamicin	28%	52%	66%	11%	0%	50%	100%	0%	0%
Ciprofloxacin	65%	20%	66%	22%	100%	33%	0%	50%	100%
Ampicillin/ Sulbactam	70%	60%	100%	33%	100%	67%	100%	50%	100%
Cefotaxime	59%		66%	44%	0%	67%	33%	50%	100%
Levofloxacin	52%	48%	50%	44%	0%	50%	67%	50%	100%

The antibiotic sensitivity patterns of the identified bacterial isolates showed that E. coli had 70%,65 %, 59%, resistance to Ampicillin/sulbactam and ciprofloxacin, cefotaxime respectively .Enterococcus showed equal 56% resistance to ceftazidime and cefepime Klebsiella pneumonia , proteus mirabilis ,Serratia and Pseudomonas spp. showed resistance to Ampicillin /sulbactam. Serratiaspp. Streptococcus spp, Acintobacter and Pseudomonas spp. Showed 100% resistance to ceftazidime

Staphylococcus aureus showed resistant to ceftazidime76%. Streptococcus spp. Showed 100% to Amikacin ,Gentamycin .Ampicillin /sulbactam. Proteus miribalis showed

10% equal resistance to ceftazidime, cefepime, Ampicillin/sulbactam pseudomonas showed 100% resistance to ceftazidime, cefepime, meropenem, ciprofloxacin, Ampicillin /sulbactam, cefotaxime and levofloxacin.

Table 2. Proportion (%) of bacterial pathogens isolated from urinary tract infections that exhibit sensitivity (S) to antimicrobial agents.

Antibiotic	***Escherichia Coli***	***Staphylococcus***	***Klebsal . Pneumon***	***Enterobacter Cloacae***	***Serratia Marcescence***	***Proteus***	***Strept***	***Acinobacter***	***Pseudomonas***
Ceftazidime	43%	76%	83%	56%	100%	67%	100%	100%	100%
Cefepime	43%	32%	83%	56%	0%	67%	67%	0%	100%
Imipenem	7%	12%	33%	22%	0%	0%	0%	0%	0%
Meropenem	37%	8%	66%	33%	0%	50%	0%	50%	100%
Amikacin	54%	44%	50%	33%	100%	50%	100%	0%	0%
Gentamicin	28%	52%	66%	11%	0%	50%	100%	0%	0%
Ciprofloxacin	65%	20%	66%	22%	100%	33%	0%	50%	100%
Ampicillin/ Sulbactam	70%	60%	100%	33%	100%	67%	100%	50%	100%
Cefotaxime	59%		66%	44%	0%	67%	33%	50%	100%
Levofloxacin	52%	48%	50%	44%	0%	50%	67%	50%	100%

The results of antibiotic susceptibility showed that the isolated bacteria were highly sensitive to cefepime, meropenem , Amikacin and gentamycin (100%) followed by (93%) imipenem and less sensitive to ceftazidime, Ampiciline/sulbactam. 57%,67% respectively.

4. Discussion

One of the most prevalent and dangerous diseases of the human urinary system that may develop in both community and hospital settings is urinary tract infection (UTI).

The most common method of treating UTIs is empirical, and the pathogen type and anticipated patterns of antibiotic resistance are used to decide the selection criteria for antimicrobial agents. Therefore, it is necessary to regularly check the bacteria that cause UTIs and their pattern of antibiotic susceptibility in the area [11].

Compared to the other age groups, a greater proportion of patients are between the ages of 21 and 30, as seen in figure (1). [12,13] supported this conclusion, however [14] disagreed. These results are supported by the documented statement that the elderly adult group had a greater rate of UTIs than other age groups. It was shown that the risk factors for increased UTI in the elderly population differed from those in the younger group. [15] Magelino The use of urinary catheters, age-related immune function abnormalities, and concomitant conditions such cancer, diabetes, neurological illnesses, and stroke were the primary risk factors. Previous history of urinary tract infections, nosocomial infections, poor urine flow, significant urine retention that compromises renal and kidney defense systems [16].

The current analysis revealed agreement with It has been shown in earlier research that UTIs are more common in women than in men worldwide, particularly in South Asian, Asian, and African nations. [17,18] Women's shorter urethra, which is located very close to the vagina and anal orifice, hormonal changes during menopause, bacterial exposure during sexual activity from a partner, the use of contraceptive methods, and

engaging in sexual activity using both the vagina and anal orifice could all be contributing factors to the higher prevalence of UTIs in female patients [19].

Furthermore, women's hormonal changes during the menstrual cycle play a crucial role in making them more vulnerable to UTIs. The age distribution between males and females seems to have a certain statistical relevance [20].

The results of the current study are in line with the majority of research, which indicated that Gram-negative bacteria, not Gram-positive bacteria, are the most frequent cause of UTIs. This is justified by the high concentration of Gram-negative bacteria in the intestine as well as the presence of distinctive virulence factors in these bacteria, such as their distinct structural makeup or the presence of particular adhesion proteins, which help the bacteria adhere to urinary epithelial cells and speed up the spread of urinary tract infections [21,22].

E. coli is the most common cause of UTIs because it has a number of virulence factors that it uses to attach itself to, invade, and harm the host, such as adhesins, toxins, iron acquisition factors, lipopolysaccharide capsules, and other invasins. The current study revealed that the most common organism encountered in the study was Escherichia coli (64.0%). This finding is consistent with studies conducted in different parts of the world [23].

This was comparable to what was achieved. [24] attainment 58%, this particular bacteria has been shown to be the primary reason of urinary tract infections, so its increased prevalence and the recurrence of infections make it especially important [25]. Enterococcus has been described as the second leading cause of UTIs 9% this result align with [26], Proteus. Mirabilis represented 6(99) came next Proteus. Mirabilis and Klebsella pneumonia 6(99) This outcome ran counter to that of a research carried out by [27]. From Gram-positive bacteria recovered from urinary tract infections samples, Staphylococcus spp. Was the most common species than streptococcus (25%). And correspondingly, 3%). This outcome is in line with the results of other research the outcome of present research agreement with regard to According to earlier research, S. aureus is among the most often occurring Gram-positive bacterial kinds UTIs [28]. Streptococcus spp. With a 3% prevalence of fewer detected gram positive bacteria in this research This outcome totally agreed Jameel 2019 (2), finding 3.88% and marginally agreed with [29]. Hadi et al. (2014) obtained substantially greater results when the rate of Streptococcus spp. Was 1.0% by [30].

Tektook et al, noted 13.7% of Streptococcus species. A major clinical issue in treating infections, particularly UTIs, is antibiotic resistance. Over time, resistance to drugs has grown; the evolution of resistance differs between nations too; all bacterial isolates having a sensitivity 100% to Imipinem Numerous studies conducted all over support these findings [31].

Since the types of bacteria identified in the research exhibited minimal levels of resistance to these antibiotics, they are seen as one of the better alternatives even if this may be a decent sign of their efficiency.

Since bacteria, especially Gram-negative, showed higher levels of resistance to antibiotics with a beta-lactam ring in their structure, carbapenem antibiotics including meropenem and imipenem have become the drugs of choice to treat UTIs that express resistance to treatment by other antibiotics. They lack beta-lactam rings in their structure [32].

The present investigation did, however, record reports of resistance to carbapenems (imipenem). Therefore, health-conscious authorities have to be mindful of developing antibiotic resistance that can make treatment of UTI and/or other bacterial infections a big problem. Date details to help choose suitable therapies [33, 34].

Studies of great relevance include those focused on the assessment of Resistance rates to antibiotics in identified human groups since These findings ought to alert the health authorities about resistance to infection treatment. Studies on antibiotic resistance have to

be conducted concurrently with incorrect antibiotic usage in some groups. Unmanaged and unregulated use of antibiotics induces Resistance patterns must be varied over infectious bacteria as time passes and the formation of genetic alterations in pathogenic bacteria generating resistance develops consistently over time. First-line choice in UTI treatment is non-beta lactam antibiotics imipenem, amikacin, and ciprofloxacin as they tend to be more active against uropathogens E. coli.

5. Conclusion

The findings showed that urinary tract infections affect women more sensitively than they do men. Moreover, women with urinary tract infections often are younger than men with UTIs. Commonly found gram-negative bacteria abound, and E. coli is the main offender causing urinary tract infections. Still the best therapy for most bacteria causing urinary tract infections is imipenem. One feasible therapy choice are meropenem and gentamycin. Regarding antibiotics in Iraq, the research advised using both culture data and a dynamic standard established from annual updating of sensitivity reports.

REFERENCES

[1] S. M. Mhana and A. A. Aljanaby, "Bacteriological investigation of pathogenic bacteria causing urinary tract infections: A cross-sectional study," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 1215, no. 1, p. 012067, 2023.

[2] S. Mekonnen et al., "Bacterial profile, their antibiotic susceptibility pattern, and associated factors of urinary tract infections in children at Hiwot Fana Specialized University Hospital, Eastern Ethiopia," *PLOS One*, vol. 18, no. 4, p. e0283637, Apr. 2023.

[3] O. Faruk et al., "Microbial isolates from urinary tract infection and their antibiotic resistance pattern in Dhaka city of Bangladesh," *J. Knowl. Learn. Sci. Technol.*, vol. 2, no. 3, pp. 76–87, Dec. 2023.

[4] B. Rahman et al., "Determination of the antibiotic susceptibility pattern of Gram-positive bacteria causing urinary tract infection in Dhaka, Bangladesh," *Biomed. Biotechnol. Res. J.*, vol. 7, no. 3, pp. 432–437, Jul. 2023.

[5] M. Negri et al., "Prevalence and antimicrobial resistance profile of pathogens isolated from patients with urine tract infections admitted to a university hospital in a medium-sized Brazilian city," *Rev. Inst. Med. Trop. São Paulo*, vol. 66, p. e3, Jan. 2024.

[6] S. Kiiru et al., "Bacterial etiology of urinary tract infections in patients treated at Kenyan health facilities and their resistance towards commonly used antibiotics," *PLOS One*, vol. 18, no. 5, p. e0277279, May 2023.

[7] M. Harris et al., "Genetic factors that contribute to antibiotic resistance through intrinsic and acquired bacterial genes in urinary tract infections," *Microorganisms*, vol. 11, no. 6, p. 1407, May 2023.

[8] M. Guliciuc et al., "Exploring the dynamic role of bacterial etiology in complicated urinary tract infections," *Medicina*, vol. 59, no. 9, p. 1686, Sep. 2023.

[9] C. Mares et al., "Update on urinary tract infection antibiotic resistance—A retrospective study in females in conjunction with clinical data," *Life*, vol. 14, p. 106, 2024.

[10] Clinical and Laboratory Standards Institute, *Performance Standards for Antimicrobial Susceptibility Testing*, CLSI Document M100-S32, Wayne, PA, 2022.

[11] M. Kibret and B. Abera, "Prevalence and antibiogram of bacterial isolates from urinary tract infections at Dessie Health Research Laboratory, Ethiopia," *Asian Pac. J. Trop. Biomed.*, vol. 4, no. 2, pp. 164–168, 2014.

[12] A. Y. Jameel and D. M. Artoshi, "Prevalence of urinary tract infections and their antimicrobial sensitivity among diabetic and non-diabetic patients in Zakho," *Sci. J. Univ. Zakho*, vol. 7, no. 4, pp. 125–131, 2019.

[13] B. Arsalan et al., "Pathogen bacteria of the urinary tract isolated from urine cultures and their susceptability," *Am. J. Med.*, vol. 80, no. 2, pp. 208–214, 2014.

[14] M. J. Hossain et al., "Prevalence, antibiotic resistance pattern for bacteriuria from patients with urinary tract infections," *Health Sci. Rep.*, vol. 7, no. 4, p. e2039, 2024.

[15] E. Magliano et al., "Gender and age-dependent etiology of community-acquired urinary tract infections," *Sci. World J.*, vol. 2012, pp. 1–6, 2012.

[16] R. Ikram et al., "An outbreak of multi-drug resistant Escherichia coli urinary tract infection in an elderly population: a case-control study of risk factors," *BMC Infect. Dis.*, vol. 15, p. 224, 2015.

[17] M. A. Belete and M. Saravanan, "A systematic review on drug resistant urinary tract infection among pregnant women in developing countries in Africa and Asia; 2005–2016," *Infect. Drug Resist.*, vol. 13, pp. 1465–1477, 2020.
[18] B. Poojar, "Methodology used in the study," *Asian J. Pharm. Clin. Res.*, vol. 7, pp. 1–5, 2017.
[19] A. Kushwaha, K. Pokharel, and A. R. Kadel, "Antibiotic resistance to Escherichia coli among urine culture-positive patients in a tertiary care hospital in Nepal: a descriptive cross-sectional study," *J. Nepal Med. Assoc.*, vol. 59, pp. 39–45, 2021.
[20] E. O. Omwenga et al., "Urinary tract infection among adults seeking Medicare at Kiambu Level 5 Hospital, Kenya: prevalence, diversity, antimicrobial susceptibility profiles and possible risk factors," unpublished.
[21] D. K. Govindarajan and K. Kandaswamy, "Virulence factors of uropathogens and their role in host pathogen interactions," *Cell Surf.*, vol. 8, p. 100075, 2022.
[22] N. A. J. Al-Tulaibawi, "Prevalence and sensitivity of bacterial urinary tract infection among adult diabetic patients in Misan Province, Iraq," *J. Pure Appl. Microbiol.*, vol. 13, no. 2, pp. 847–853, 2019.
[23] T. Kudinha, "The pathogenesis of Escherichia coli urinary tract infection," in *Escherichia coli - Recent Advances on Physiology, Pathogenesis and Biotechnological Applications*, A. Samie, Ed. Rijeka, Croatia: Intech, 2017, pp. 45–70.
[24] I. Altamimi et al., "Bacterial pathogens and antimicrobial susceptibility patterns of urinary tract infections in children during COVID-19 2019–2020: A large tertiary care center in Saudi Arabia," *Children*, vol. 10, p. 97, 2023.
[25] F. M. Mohammed and M. K. Saleh, "Prevalence of bacterial uropathogens in patients with acute, recurrent and chronic urinary tract infection in Kirkuk City, Iraq," *Edelweiss Appl. Sci. Technol.*, vol. 8, no. 6, pp. 624–631, 2024.
[26] M. Karimian et al., "Antibiotic susceptibility patterns of isolates from children with urinary tract infection in Isfahan, Iran: Impact on empirical treatment," *J. Glob. Antimicrob. Resist.*, vol. 9, pp. 3–7, 2017.
[27] H. Kamel and G. Ali, "Determine the prevalence of pathogens and their antibiotics sensitivity for patients suffering from urinary tract infections in Babylon, Iraq," *SAR J. Pathol. Microbiol.*, vol. 5, no. 3, pp. 59–66, 2024.
[28] I. Cock, N. Mavuso, and S. Van Vuuren, "A review of plant-based therapies for the treatment of urinary tract infections in traditional Southern African medicine," *Evid.-Based Complement. Altern. Med.*, vol. 2021, pp. 1–20, 2021.
[29] A. M. Hadi, F. H. Sheri, and A. A. Jaccob, "Urinary tract infection prevalence and antibiotic resistance: A retrospective study in Basra Governorate, Iraq," *Al-Mustansiriyah J. Pharm. Sci.*, vol. 14, no. 2, pp. 129–135, 2014.
[30] N. K. Tektook, K. I. Al-Lehibi, and R. K. Al-Husseinei, "Prevalence of some pathogenic bacteria causing UTI in diabetic patients in Baghdad City, Iraq," *Med. J. Babylon*, vol. 14, no. 2, pp. 260–266, 2017.
[31] M. M. Vakilzadeh et al., "Antimicrobial resistance among community-acquired uropathogens in Mashhad, Iran," *J. Environ. Public Health*, vol. 2020, pp. 1–7, 2020.
[32] I. N. Kadariswantiningsih et al., "Antibiotic resistance in Indonesia: A systematic review and meta-analysis of extended-spectrum beta-lactamase-producing bacteria (2008–2024)," *Trop. Med. Int. Health*, vol. 30, no. 4, pp. 246–259, 2025.
[33] S. Giri et al., "Prevalence and characterization of extended-spectrum β-lactamase-producing antibiotic-resistant *Escherichia coli* and *Klebsiella pneumoniae* in ready-to-eat street foods," *Antibiotics*, vol. 10, no. 7, p. 850, 2021.
[34] A. Mihankhah et al., "Prevalence and antibiotic resistance pattern of bacteria isolated from urinary tract infections in Northern Iran," *J. Res. Med. Sci.*, vol. 22, no. 1, p. 108, 2017.