

The frequency and antibiotic sensitivity patterns of uropathogens isolated from urinary tract infection patients in Basra (Iraq)

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Urinary tract infections (UTIs) are common across both sexes and age demographics, resulting from bacterial infection of the urinary system, and their severity has intensified due to the increase in bacterial resistance to antibiotics. This study aimed to isolate and identify the causes of UTI in Basra, Iraq, and to clarify their antibiotic resistance pattern. 140 mid-stream urine samples were collected from patients with symptoms of infection at Al Fayha Teaching Hospital and Al-Sadr Teaching Hospital. The bacterial strains were identified biochemically and confirmed using the VITEK system, which was used to detect the anti-biogram pattern of bacterial identification. Of the 140 samples collected from November 2022 to March 2023, 101 samples showed positive growth. The infection rate among females (55.3%) was higher than males (44.6%), with no significant differences. Females showed higher infection rates than males across all age groups, except for individuals over 60 years of age, where the proportion of infected males exceeded that of females. The present investigation revealed that the predominant gram-positive bacterium was *Staphylococcus aureus*, with a frequency of 25.7%, followed by *Staphylococcus epidermidis* at 18.4%. Among the Gram-negative bacteria, *Escherichia coli* (23.9%) was the predominant species, followed by *Pseudomonas aeruginosa* (11.9%). The majority of gram-positive isolates were resistant to cefoxitin, benzylpenicillin, oxacillin, erythromycin, and fusidic acid. Gram-negative bacteria exhibit elevated resistance to ticarcillin, piperacillin, and ciprofloxacin. *S. aureus* was the predominant isolate, and linezolid, nitrofurantoin, and tigecycline were identified as the most efficacious antibiotics against gram-positive bacteria, with 100% sensitivity.

Keywords: uropathogens; antimicrobial susceptibility test; MRSA; UTI; multidrug resistance.

Introduction

Urinary tract infections (UTIs) are among the most prevalent infectious diseases globally, affecting almost 150 million individuals across various age groups (Luty et al., 2020; Murugan et al., 2021). They occur in both community and healthcare settings. Clinical symptoms vary from uncomplicated UTI (uUTIs) to complicated UTI (cUTIs) (Mancuso et al., 2023). uUTIs are acute urinary tract infections that can be random and recurrent (Raeispour & Ranjbar, 2018). Moreover, they usually develop in individuals who have not been previously diagnosed with functional or anatomical abnormalities of the urinary tract. Additionally, cUTIs often occur in patients with anatomical and functional abnormalities of the urinary tract (Khauli et al., 2019). Several factors affect UTI rates, including sex, age, catheter use, hospitalization, and antibiotic use (Storme et al., 2019).

Females are especially susceptible to UTIs and constitute the majority of annual medical visits (Kot, 2019). In females potential factors contributing to the elevated incidence of UTIs, such as the short length of the urethra, which facilitates rapid bacterial migration to the bladder, the anatomical closeness of the urethra to the anus, and a decrease in *Lactobacillus* species (specifically *L. crispatus* and *L. iners*), which are crucial for urinary system health by generating metabolic byproducts, including hydrogen peroxide and lactic acid, which inhibit the adhesion of *E. coli* and reduce its infectivity (Del Prete et al., 2019).

A diverse microbial population lives in urine, and these microorganisms are important, even in healthy people without symptoms. They defend against UTIs and support the mucosal immune system. Additionally, they preserve the urothelial cell integrity (Samanci et al., 2020). Urinary tract infection results from the abnormal colonization of pathogenic bacteria from neighboring areas (Odoki et al., 2019). The infection can spread quickly from the lower to the upper urinary tract, and vice versa, owing to the closed system of the urinary tract (Baquero et al., 2021). The predominant bacterial causal agents of tract infections are *E. coli*, *Klebsiella* spp., *Enterobacter* spp., *Proteus* spp., and *Staphylococcus* spp. (Gharbi et al., 2019). Currently, patho-

genic bacteria causing UTIs demonstrate resistance to several antibiotics, presenting a considerable health threat owing to the likelihood of treatment failure in patients (Alshareef et al., 2020; Vigila et al., 2020). The constant migration of individuals, the inappropriate use of antimicrobial agents, and the increase in consumption have all contributed to the rise in multidrug-resistant strains (Nadeem et al., 2020). The patterns of resistance of bacterial infections to antibiotics vary globally, influencing antibiotic selection, dose, and treatment duration. Therefore, data on antibiotic resistance patterns serve as a basic reference for selecting appropriate and effective antibiotics for the treatment of UTIs, thereby reducing the spread of antibiotic-resistant bacteria (Tilahun et al., 2021). Continuous monitoring of antibiotic resistance patterns in Iraq is essential to prevent indiscriminate drug administration and to ensure the appropriate use of antibiotics. This study aimed to isolate and identify bacteria from UTI patients in Basra, Iraq and assess their antibiotic susceptibility patterns to determine the most effective antibiotics for UTIs in our community.

Material and methods

Isolation of uropathogen bacteria. In this cross-sectional study, urine samples were obtained from Al Fayha Teaching Hospital and Al-Sadr Teaching Hospital in Basra City over five months (November 2022–March 2023). A total of 140 midstream urine samples were aseptically collected from patients showing signs and symptoms of UTI, and these samples were transferred to the laboratory. Microbiological analyses were performed on the day of collection. According to the methodology outlined in Monica (2006), urine culture involved inoculating samples onto sterile blood agar, MacConkey agar, eosin methylene blue, and mannitol salt agar plates. The plates were incubated aerobically at 37 °C for 24 h. In the current study, all media were supplied by Oxoid, United Kingdom.

Inclusion and exclusion criteria. This study included patients of both sexes, aged > one year, diagnosed with urinary tract infection (UTI), while excluding pregnant women and patients with diabetes.

Identification and antibiotic susceptibility test screening. The initial identification of distinct colonies was performed by biochemical tests. Identification was confirmed using the Vitek® 2 Compact system (bioMérieux) with ID-N and ID-P cards.

For antimicrobial susceptibility testing, the isolates were tested on a Vitek-2 system, following the manufacturer's instructions. AST-P580 cards were used for Gram-positive bacteria, including Cefoxitin, Penicillin, Benzyl-penicillin, Oxacillin, Gentamicin, Tobramycin, Levofloxacin, Moxifloxacin, Erythromycin, Clindamycin, Linezolid, Teicoplanin, Vancomycin, Tetracycline, Tigecycline, Fosfomycin, Nitrofurantoin, Fusidic Acid, Rifampicin, and Trimethoprim-Sulfamethoxazole.

For Gram-negative bacteria, AST-N222 cards were used, which included antibiotics, such as Ticarcillin, Ticarcillin-Clavulanic acid, Piperacillin, Piperacillin-Tazobactam, Ceftazidime, Cefepime, Aztreonam, Imipenem, Meropenem, Amikacin, Gentamicin, Tobramycin, Ciprofloxacin, Colistin, Minocycline, and Trimethoprim-Sulfamethoxazole.

The cards inoculated with a bacterial suspension were automatically loaded into the VITEK 2 instrument for incubation and reading. The results were reported as "susceptible" or "resistant" based on the standards of the Clinical Laboratory Standards Institute (29th Edition).

Ethics statement. The research committee of the Training and Development Center, Basra Health Department, Iraq, granted permission for the conduct of this study (No. 282/2022 dated 6/11/2022). This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. All participants in the current investigation were informed prior to sample collection, and verbal consent was obtained from each patient.

Statistical analysis. The study results are presented in the text, tables, and graphs. The significant differences between groups were analyzed using SPSS (Statistical Package for Social Sciences, version 22 (SPSS, IBM Company, Chicago, IL, USA) via a chi-square test. Statistical significance was set P-value ≤ 0.05.

Results

UTI prevalence in studied patients. Of the 140 midstream urine samples collected during the study (80 were from females and 60 from males). A total of 39 samples (27.85%) exhibited negative growth, whereas 101 samples (72.1%) showed positive growth, comprising 94 instances of bacterial infection and seven cases of yeast infection (Table 1). In the current study, 52 (55.3%) bacterial infections occurred in females and 42 (44.6%) occurred in males, with no significant differences (P = 0.533). Regarding age distribution, the current study reported significant differences (P = 0.051) in the rates of infection among the tested age groups (Table 1); females had higher infection rates than males in all age groups, with no significant differences except for the above 60 years group, where males demonstrated a significantly higher infection rate (P = 0.017) than females (Table 1).

Isolation and identification of bacterial isolates from UTI patients. Biochemical tests validated by VITEK2 revealed that these bacterial isolates belonged to 13 species. Of these, 54 bacterial isolates belonged to Gram-positive bacteria, among them, *Staphylococcus aureus* (n = 28) was the most prevalent, followed by *S. epidermidis* (n = 21), *S. hominis* (n = 2), other coagulase negative *Staphylococcus* spp. (n = 2), and one isolate of *Enterococcus faecalis*. The remainder of the bacterial growth was identified as 48 isolates of aerobic Gram-negative bacteria. The predominant isolates were *E. coli* (n = 26), followed by *Pseudomonas aeruginosa* (n = 13), *Klebsiella pneumoniae* (n = 3), *Proteus mirabilis* (n = 2), and one isolate each of *Acinetobacter baumannii*, *Sphingomonas paucimobilis*, *Pseudomonas putida* and *Shigella flexneri* (Fig. 1).

Antibiotic susceptibility profile. Various groups of antibiotics were evaluated against all pathogenic bacteria recovered from patients with tract infections categorized by genus type. The identified bacteria exhibited varying levels of antibiotic resistance. Specifically, all *S. aureus* isolates exhibited resistance to cefoxitin (100%), benzyl-penicillin (100%), and oxacillin (100%), with 89% resistance to erythromycin

and 85.7% resistance to fusidic acid. Conversely, the highest sensitivities were observed for nitrofurantoin (100%), linezolid (100%), and tigecycline (100%) (Table 2). *E. coli*, the most predominant Gram isolate, demonstrated strong resistance to ticarcillin (100%), piperacillin (100%), and ciprofloxacin (80.7%). In contrast, a high sensitivity rate was observed for amikacin (Table 3).

Table 1
Demographics data and characteristics of collected samples

Character		No. (%)				
Collected samples	female	80 (57.14)				
	male	60 (42.85)				
	total	140				
Positive growth N = 101 (72.1%)	female	52 (55.3)				
	male	42 (44.6)				
	P-value	0.533				
	Gram +	54 (52.94)				
	Gram -	48 (47.05)				
bacterial isolate		102				
Yeast		7 (6.4)				
Negative growth		39 (27.8)				
Age groups	Total sample, %	gender	N0. infected, %	No. non-infected, %	P-value	P-value
1-15	8 (5.7)	female	3 (37.5)	2 (25)	0.465	
		male	1 (12.5)	2(25)		
16-30	39 (27.8)	female	15(38.8)	7(17.94)	0.332	
		male	9(23.0)	8(20.51)		
31-45	38 (27.1)	female	20(52.6)	4(10.5)	0.846	0.051
		male	12(31.5)	2(5.2)		
46-60	37 (26.4)	female	12(32.4)	12(32.4)	0.666	
		male	8(21.6)	5(13.5)		
over 61 years	18 (12.8)	female	2(11.11)	3(16.6)	0.017	
		male	12(66.6)	1(5.5)		

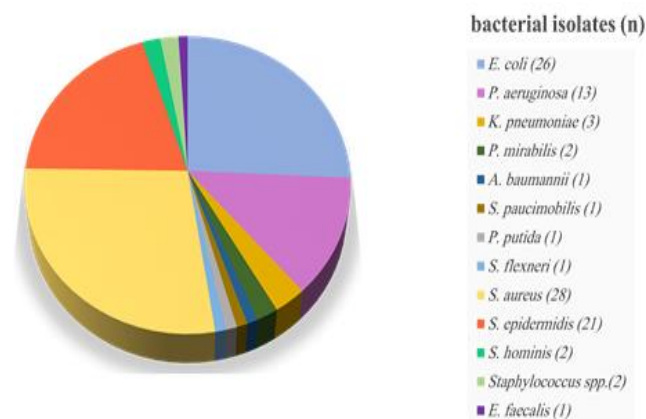


Fig. 1. Frequency of bacterial isolates of UTI patients

The current investigation showed that most bacterial isolates were multidrug resistant (MDR), the proportion of Gr+ MDR isolates for *S. aureus* was 100%, followed by *S. epidermidis* 90%, and 100% for each of *S. hominis* and *E. faecalis*, finally 50% of *Staphylococcus* spp. isolates were represented by MDR bacterial pathogens, while Gr-MDR isolates were 69% for *E. coli*, 54% for *P. aeruginosa*, and 100% for *P. mirabilis*, *A. baumannii*, *P. putida*, and *S. flexneri* (Fig. 2).

Discussion

Since antibiotic resistance pattern of MDR bacteria isolated from patients with UTIs can vary across topography and vary with time, a deeper understanding of the prevalence and resistance pattern of these microorganisms in our society is important and the current study sought to achieve it.

Table 2
Antibiotic resistance profile (%) of Gr+ bacterial isolates

Antimicrobial agent	<i>S. aureus</i> (n = 28)	<i>S. epidermidis</i> (n = 21)	<i>S. hominis</i> (n = 2)	Coagulase negative <i>Staphylococcus</i> (n = 2)	<i>E. faecalis</i> (n = 1)
Cefoxitin	100	100	100	100	–
Benzylpenicillin	100	100	100	100	–
Oxacillin	100	95	100	100	–
Gentamicin	61	53	0	0	–
TOB	61	53	0	0	–
Levofloxacin	61	31	50	50	100
Moxifloxacin	32	31	50	50	–
Erythromycin	89	79	100	50	100
Clindamycin	57	74	50	50	–
Linezolid	0	0	0	0	0
Teicoplanin	21	21	0	0	0
Vancomycin	21	26	0	0	0
Tetracycline	64	100	0	50	100
Tigecycline	0	0	0	0	0
Nitrofurantoin	0	0	0	0	0
Fusidic acid	86	79	50	100	–
Rifampicin	32	37	0	0	–
Trimethoprim/Sulfamethoxazole	4	0	50	50	–

Note: “–” – not performed.

Table 3
Antibiotic resistance profile (%) of Gr– bacterial isolates

Antimicrobial agent	<i>E. coli</i> (n = 26)	<i>P. aeruginosa</i> (n = 13)	<i>K. pneumoniae</i> (n = 3)	<i>P. mirabilis</i> (n = 2)	<i>A. baumannii</i> (n = 1)	<i>S. paucimobilis</i> (n = 1)	<i>P. putida</i> (n = 1)	<i>S. flexneri</i> (n = 1)
TC	100.0	84.6	100	100	100	100	100	100
TCC	61.5	53.8	33	50	100	0	100	0
PRL	100.0	84.6	100	50	100	0	0	100
TZP	26.9	69.2	0	50	100	0	0	0
CAZ	57.6	53.8	0	50	100	0	0	0
FEP	42.3	53.8	0	50	100	0	0	0
ATM	57.6	53.8	0	0	100	0	0	100
IPM	23.0	53.8	0	50	100	0	0	0
MRP	26.9	53.8	0	0	100	0	0	0
AK	15.3	53.8	0	0	–	0	0	0
CN	26.9	53.8	0	0	0	0	0	0
TOB	26.9	46.1	0	50	0	0	0	0
CIP	80.7	53.8	0	50	100	0	100	0
CS	–	0.0	–	–	0	0	–	–
MIN	46.0	–	0	100	0	0	0	0
SXT	69.2	–	33	0	0	0	100	100

Note: TC – Ticarcillin, TCC – Ticarcillin/Clavulanic acid, PRL – Piperacillin, TZP – Piperacillin/Tazobactam, CAZ – Ceftazidime, FEP – Cefepime, ATM – Aztreonam, IPM – Imipenem, MRP – Meropenem, AK – Amikacin, CN – Gentamicin, TOB – Tobramycin, CIP – Ciprofloxacin, MIN – Minocycline, RD – Rifampicin, SXT – Trimethoprim/Sulfamethoxazole, “–” – not performed.

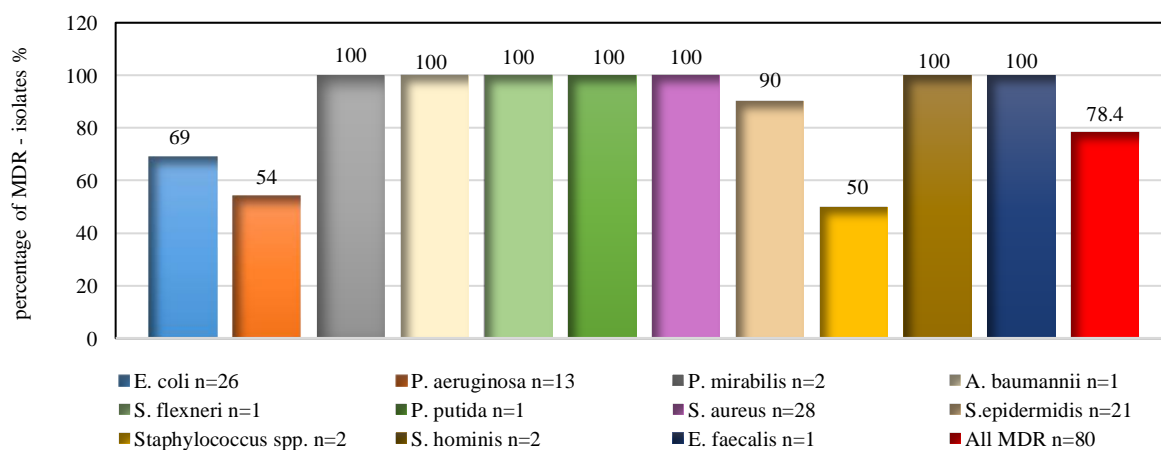


Fig. 2. Prevalence of MDR bacteria among tested isolates

Of the 140 mid-stream urine samples collected, 72% were positive for bacterial growth (Table 1). This result of frequency was close to Salman (2024) study, which showed 67% positive growth in Basra. This was higher than that reported by Al-Awkally et al. (2022) (12.4%) and Al-Jebouri & Mdish (2013). These variations in frequen-

cy in the study results could be due to the geographical distribution of the research, sample size, hygiene habits, awareness, educational attainment, community traditions, and gender (Al-Gashaa et al., 2020). Regarding sex, females recorded a higher prevalence of UTI (55.3%) than males (44.6%). This may be related with the sex hormone levels

(Deltourbe et al., 2022) and the short distance between the urethra and the anus. In addition, the short urethral length facilitates the entry of uropathogens into the bladder. This finding is consistent with those of most previous studies (Czajkowski et al., 2021; Thari et al., 2024). The prevalence of UTI in females depends on their age. The current investigation indicated that the majority of infections were recorded in the 31–45 age group. This was followed by the 16–30 and 46–60 age groups, while the lowest incidence was reported in those above 61 years. This high rate of infection in the menopausal stage may be correlated with sexual activity, while in the postmenopausal stage, it may be due to the deficiency of estrogen hormone levels (Jung & Brubaker, 2019). In contrast, this study recorded a high incidence of UTI in males aged > 61 years, while the incidence of infection at 1–14 years was the lowest. The main cause of this increasing incidence in males may be attributed to functional disorders of the prostate, incontinence, structural alterations of the urinary tract, and comorbidities such as diabetes and dialysis (Storme et al., 2019; Azab, 2021).

In the current study, *S. aureus* (25.7%) was the predominant uropathogen. *E. coli* followed with a percentage of 23.9%, and *S. epidermidis* (18.4%) among all isolates. It is interesting to note that all *S. aureus* isolates were identified as methicillin-resistant (MRSA). The prevalence of MRSA isolates associated with UTIs is greater than that indicated in recent studies conducted in Iraq, including Hami & Ibrahim (2023), which reported 75.7% of MRSA isolates by the oxacillin susceptibility test verified by the mec A gene, and Khaleel et al. (2021), which reported that 7.7% of tested isolates were MRSA, as identified by resistance to oxacillin and cefoxitin. Conversely, a study by Abbas & Hamim (2019) recorded that all *S. aureus* isolates were resistant to oxacillin without specifying whether they were MRSA or not. Urinary tract infections associated with MRSA are likely attributable to several factors, such as sex, age, and the existence of a chronic underlying illness, in addition to the presence of several virulence factors that enable them to evade host defense mechanisms, which is consistent with the study by Peni et al. (2023). In contrast, it is almost different from the results of Ali et al. (2020) and Alsultany et al. (2024), which indicated the predominance of *E. coli* isolates succeeded by *Klebsiella* species, and from Mohamed et al. (2020), which identified *E. coli* as a prevalent etiological agent, followed by *Staphylococcus* spp. This variation in the dominance of uropathogens among diverse patient populations could be due to several demographic, environmental, and clinical factors (Huang et al., 2022).

The resistance patterns of *E. coli* showed the highest rates of resistance to ticarcillin and piperacillin at 100%, followed by ciprofloxacin at 88%, and trimethoprim/sulfamethoxazole at 72% (Table 3). These values are substantially higher than those reported by Ait-Mimoune et al. (2022) and Jomehzadeh et al. (2022). Conversely, *E. coli* exhibited a high sensitivity to amikacin (84.7%). The sensitivity rates observed in this investigation were comparable to those reported in (Rahman et al., 2020) (88.7%).

The present study revealed that all the MRSA isolates were resistant to cefoxitin, benzylpenicillin, and oxacillin, with 88% and 81% resistance to erythromycin and fusidic acid, respectively. This finding is higher than that of Hamza & Fazaa (2023) and is in agreement with a recent Algerian investigation that reported 100% cefoxitin resistance (Benyagoub, 2024). Furthermore, all the MRSA isolates were sensitive to linezolid, nitrofurantoin, and tigecycline (100%). This rate of linezolid sensitivity has been reported by the Annual Appraisal of Potency and Spectrum program (ZAAPS), which globally monitors linezolid resistance (Mendes et al., 2016).

According to an antibiogram, the present study reported that 78.4% of total bacterial isolates were MDR. This result is similar to that of Wabe et al. (2020) but higher than that of Gebremariam et al., (2019). The high rates of MDR strains, which are of great concern, have been increasing significantly in our society for several reasons, such as the random dispensing of antibiotics when the cause is not bacterial (fungal or viral), inappropriate and excessive utilization of antibiotics, especially broad-spectrum antibiotics, and self-medication without prescription. All these factors have led to the development of antibiotic resistance. Therefore, it is necessary to continuously moni-

tor the pattern of bacterial resistance in hospitals to ensure that the appropriate antibiotic is dispensed.

Conclusion

The present study determined that MRSA and *E. coli* were the predominant causative agents of urinary tract infections. Linezolid, nitrofurantoin, and tigecycline are among the most effective antibiotics for treating urinary tract infections caused by MRSA. Amikacin showed the highest efficacy against *E. coli*. Ongoing assessment of bacterial antibiotic susceptibility is crucial before antibiotic therapy is carried out to guarantee efficient management of tract infections. Moreover, it is important to instruct healthcare workers and patients on the proper utilization of antibiotics to prevent the emergence of multidrug-resistant bacterial strains.

All data used in this study are available upon request from the corresponding author.

There are no conflicts of interest.

References

- Abbas, A. A. R., & Hamim, S. S. (2019). Serological and molecular detection of *Staphylococcus aureus* isolated from UTI patients. *University of Thi-Qar Journal*, 14(4), 64–79.
- Ait-Mimoune, N., Hassaine, H., & Boulanoir, M. (2022). Bacteriological profile of urinary tract infections and antibiotic susceptibility of *Escherichia coli* in Algeria. *Iranian Journal of Microbiology*, 14(2), 156.
- Al-Awkally, N. A. M., Ibrahim, H. K., Ali, M. D., Muthanna, F. M., Al-Awkally, A. M., & Yousuf, A. (2022). Study of antibiotic sensitivity pattern in urinary tract infection. *International Journal of Health Sciences*, 6, 8896–8913.
- Al-Gashaa, F. A. S., Al-Baker, S. M., Obiad, J. M., & Alrobiai, F. A. (2020). Prevalence of urinary tract infections and associated risk factors among patients attending medical city hospital in Baghdad City, Iraq. *American Journal of Infectious Diseases*, 16(2), 77–84.
- Ali, E. T., Abdullah, A. S., & Keshi, R. M. A. (2020). Antibiotic susceptibility manner of the bacteria causes urinary tract infections in Basra, South Iraq. *Journal of Pure and Applied Microbiology*, 14(1), 541–546.
- Al-Jebouri, M. M., & Mdish, S. A. (2013). Antibiotic resistance pattern of bacteria isolated from patients of urinary tract infections in Iraq. *Open Journal of Urology*, 3(2), 124–131.
- Alshareef, H., Alfahad, W., Albaadani, A., Alyazid, H., & Talib, R. B. (2020). Impact of antibiotic de-escalation on hospitalized patients with urinary tract infections: A retrospective cohort single center study. *Journal of Infection and Public Health*, 13(7), 985–990.
- Alsultany, H. A., Alshibly, I. K., & Al-Hasnawy, H. H. (2024). IL-8 antibacterial innate immunity in Iraqi women with urinary tract infections. *Medical Journal of Babylon*, 21(2), 491–492.
- Azab, K. (2021). Prevalence and relation of urinary tract infection bacterial pathogens to sex and ages among patients in three arab countries. *Al-Azhar Journal of Pharmaceutical Sciences*, 63(1), 194–206.
- Baquero, F., Martínez, J. L., F. Lanza, V., Rodríguez-Beltrán, J., Galán, J. C., San Millán, A., Cantón, R., & Coque, T. M. (2021). Evolutionary pathways and trajectories in antibiotic resistance. *Clinical Microbiology Reviews*, 34(4), 19–50.
- Benyagoub, E. (2024). Methicillin, β -lactams, and clindamycin resistance profiles of *Staphylococcus aureus* strains isolated from patients with UTI in Bechar Province (Algeria). *Anti-Infective Agents*, 22(1), 54–65.
- Czajkowski, K., Broś-Konopielko, M., & Teliga-Czajkowska, J. (2021). Urinary tract infection in women. *Menopausal Review*, 20(1), 40–47.
- Del Prete, R., Ronga, L., Addati, G., Magrone, R., Abbasciano, A., Di Carlo, D., & Santacroce, L. (2019). A retrospective study about the impact of switching from nested PCR to multiplex real-time PCR on the distribution of the human papillomavirus (HPV) genotypes. *Medicina*, 55(8), 418.
- Deltourbe, L., Lacerda Mariano, L., Hreha, T. N., Hunstad, D. A., & Ingersoll, M. A. (2022). The impact of biological sex on diseases of the urinary tract. *Mucosal Immunology*, 15(5), 857–866.
- Gebremariam, G., Legese, H., Woldu, Y., Araya, T., Hagos, K., & Gebreyesus Washun, A. (2019). Bacteriological profile, risk factors and antimicrobial susceptibility patterns of symptomatic urinary tract infection among students of Mekelle University, Northern Ethiopia. *BMC Infectious Diseases*, 19, 950.
- Gharbi, M., Drysdale, J. H., Lishman, H., Goudie, R., Molokhia, M., Johnson, A. P., Holmes, A. H., & Aylin, P. (2019). Antibiotic management of urinary tract infection in elderly patients in primary care and its association with

- bloodstream infections and all cause mortality: Population based cohort study. *British Medical Journal*, 364, 1525.
- Hami, I. A., & Ibrahim, K. S. (2023). Incidence of methicillin-resistant *Staphylococcus aureus* (MRSA) recovered from patients with urinary tract infections in Zakho City / Kurdistan-Iraq. *Science Journal of University of Zakho*, 11(1), 91–97.
- Hamza, E. N. H., & Faza, S. A. (2023). Antibiotic effectiveness against *Staphylococcus aureus* isolated from clinical cases in Babylon hospitals. *Medical Journal of Babylon*, 20(3), 536–539.
- Huang, L., Huang, C., Yan, Y., Sun, L., & Li, H. (2022). Urinary tract infection etiological profiles and antibiotic resistance patterns varied among different age categories: A retrospective study from a tertiary general hospital during a 12-year period. *Frontiers in Microbiology*, 12, 813145.
- Jomehzadeh, N., Saki, M., Ahmadi, K., & Zandi, G. (2022). The prevalence of plasmid-mediated quinolone resistance genes among *Escherichia coli* strains isolated from urinary tract infections in Southwest Iran. *Molecular Biology Reports*, 49(5), 3757–3763.
- Jung, C., & Brubaker, L. (2019). The etiology and management of recurrent urinary tract infections in postmenopausal women. *Climacteric*, 22(3), 242–249.
- Khaleel, R. A., Alfurajji, N., Waleed Hussain, B., Nassar, M. F., & Ebrahimzadeh, F. (2021). Methicillin-resistant *Staphylococcus aureus* in urinary tract infections; prevalence and antimicrobial resistance. *Journal of Renal Injury Prevention*, 11(1), e8.
- Khali, R., Abou Heidar, N., Degheili, J., & Yacoubian, A. (2019). Management of urinary tract infection in women: A practical approach for everyday practice. *Urology Annals*, 11(4), 339–346.
- Kot, B. (2019). Antibiotic resistance among uropathogenic *Escherichia coli*. *Polish Journal of Microbiology*, 68(4), 403–415.
- Luty, R. S., Fadi, A. G., Najm, J. M., Abduljabbar, H. H., & Kashmar, S. A. A. (2020). Uropathogens antibiotic susceptibility as an indicator for the empirical therapy used for urinary tract infections: A retrospective observational study. *Iranian Journal of Microbiology*, 12(5), 395–404.
- Mancuso, G., Midiri, A., Gerace, E., Marra, M., Zummo, S., & Biondo, C. (2023). Urinary tract infections: The current scenario and future prospects. *Pathogens*, 12(4), 623.
- Mendes, R. E., Hogan, P. A., Jones, R. N., Sader, H. S., & Flamm, R. K. (2016). Surveillance for linezolid resistance via the Zyvox® annual appraisal of potency and spectrum (ZAAPS) programme (2014): Evolving resistance mechanisms with stable susceptibility rates. *Journal of Antimicrobial Chemotherapy*, 71(7), 1860–1865.
- Mohamed, D., Ibrahim, S., & Suleman, S. (2020). Microbial causes of urinary tract infection and its sensitivity to antibiotics at Heevi Pediatric Teaching Hospital / Duhok City. *Medical Journal of Babylon*, 17(1), 109.
- Murugan, M., Rani, K. R. B., Wins, J. A., Ramachandran, G., Guo, F., Mothana, R. A., Noman, O. M., Nasr, F. A., & Siddiqi, M. Z. (2022). Green synthesized ZnO NPs as effective bacterial inhibitor against isolated MDRs and biofilm producing bacteria isolated from urinary tract infections. *Journal of King Saud University – Science*, 34(1), 101737.
- Nadeem, S. F., Gohar, U. F., Tahir, S. F., Mukhtar, H., Pompukeewattana, S., Nukthamna, P., Moula Ali, A. M., Bavisetty, S. C. B., & Massa, S. (2020). Antimicrobial resistance: More than 70 years of war between humans and bacteria. *Critical Reviews in Microbiology*, 46(5), 578–599.
- Odoki, M., Almustapha Aliero, A., Tibyangye, J., Nyabayo Maniga, J., Wampande, E., Drago Kato, C., Agwu, E., & Bazira, J. (2019). Prevalence of bacterial urinary tract infections and associated factors among patients attending hospitals in Bushenyi District, Uganda. *International Journal of Microbiology*, 2019, 4246780.
- Peni, D. N., Ishaya, R., Lawal, R. Y., Yusuf, M., Gwandu, A. Z., & Danjuma, B. J. (2023). Prevalence and antibiotic pattern of *Staphylococcus aureus* and other uropathogens in urinary tract infection among patients attending General Hospital Argungu, Kebbi State, Nigeria. *Open Access Journal of Science Research*, 1(2), 29–35.
- Raeespour, M., & Ranjbar, R. (2018). Antibiotic resistance, virulence factors and genotyping of uropathogenic *Escherichia coli* strains. *Antimicrobial Resistance and Infection Control*, 7, 118.
- Rahman, F., Akhter, H., Hasnat, S., & Begum, N. (2020). Prevalence and antimicrobial sensitivity profile of uropathogens in a tertiary care hospital of Dhaka City. *Bangladesh Journal of Medical Microbiology*, 14(2), 3–11.
- Salman, M. S. (2024). Antibiotic resistance of bacteria isolated in urinary tract infections. *Journal of Contemporary Medical Sciences*, 10(2), 163–166.
- Samancı, S., Muhittin, Ç., & Muhammet, K. (2020). Çocukluk çağı idrar yolu enfeksiyonlarında antibiyotik direnci; tek merkez deneyimi. *Türk Pediatri Arşivi*, 55(4), 386–392.
- Storme, O., Tirán Saucedo, J., Garcia-Mora, A., Dehesa-Dávila, M., & Naber, K. G. (2019). Risk factors and predisposing conditions for urinary tract infection. *Therapeutic Advances in Urology*, 11, 19–28.
- Thari, A. M., Mohammed, K. A. S., & Abu-Mejdad, N. M. J. (2024). Antimicrobial susceptibility of bacterial clinical specimens isolated from Al-Sader Teaching Hospital in Basra-Iraq. *Asia Pacific Journal of Molecular Biology and Biotechnology*, 32(1), 76–84.
- Tilahun, M., Kassa, Y., Gedefie, A., & Belete, M. A. (2021). Emerging carbapenem-resistant Enterobacteriaceae infection, its epidemiology and novel treatment options: A review. *Infection and Drug Resistance*, 14, 4363–4374.
- Vigila, C. R., Athinarayanan, G., Mariselvam, R., Dhasarathan, P., & Ranjitsingh, A. J. A. (2020). Epidemiology of urinary tract infection in South India. *World Journal of Biology Pharmacy and Health Sciences*, 1(1), 25–32.
- Wabe, Y. A., Reda, D. Y., Abreham, E. T., Gobene, D. B., & Ali, M. M. (2020). Prevalence of asymptomatic bacteriuria, associated factors and antimicrobial susceptibility profile of bacteria among pregnant women attending Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia. *Therapeutics and Clinical Risk Management*, 16, 923–932.