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The Prevalence of Enterobacteriaceae among Outpatients with Urinary Tract Infections in Zakho City, Kurdistan Region-Iraq

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Abstract

The family Enterobacteriaceae is the leading cause of both hospital- and community-acquired urinary tract infections. The purpose of this study was to estimate the rate of infection with Enterobacteriaceae among outpatients suffering from UTIs at two major hospitals in Zakho city. This study was conducted over the period of 5 months from the 1st of September 2021 till the end of January 2022, during this period a total of 454 midstream urine samples were collected from outpatients with UTIs of both genders and different ages (≤ one year to > 50 years). The isolated enterobacterial species were identified according to their biochemical characteristics using conventional standard methods. The result showed that 52.64% (239/454) of the tested urine samples were infected with species of Enterobacteriaceae. The most commonly detected species with their rates of infections were: *Escherichia coli* (69.46 %) and *Klebsiella pneumoniae* (27.20 %). In females, the overall rate of infection was higher over all ages than in males (85.36% vs 14.64%) with the highest rate being among the ages ≤1-10 and >10-20 years, which was 91.67%. Married patients of both genders showed a slightly higher rate than single ones (53.62% vs 51.12%), and married women showed a higher rate than single ones (86.49% vs 83.52%). Urban residents had a higher infection rate than those living in camps and rural areas (53.85%, 48.48%, and 45.45%), respectively. This study concluded that members of Enterobacteriaceae are the major causative agents of UTIs, with *E. coli* being the predominant isolated bacterial species. The rate of infection was higher in females, married patients and urban residents.

***Keywords*:** *UTIs, Enterobacteriaceae, E. coli, K. pneumoniae*

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I. INTRODUCTION

Urinary Tract Infections (UTIs) are the second most prevalent community-acquired infections globally, following upper respiratory tract infections in clinical practice (Koksal *et al*., 2019). Uncomplicated (uUTIs) and complicated (cUTIs) are the major types of UTIs (Johnson, 2017). uUTIs generally impact healthy individuals that have a urinary tract with no structural or neurological abnormalities, resulting from uropathogens that inhabit the intestine and then contaminate the urethra accidentally, migrate and colonize the bladder (Klein and Hultgren, 2020). cUTIs is characterized by the presence of urinary tract abnormalities that increase the risk of infection, including catheterization, various functional or anatomical disorders such as obstructive uropathy, neurogenic bladder, urinary retention, pregnancy, calculi presence and renal insufficiency (Gomila *et al*., 2018; Flores-Mireles *et al*., 2015). UTIs are generally named according to the infection site: urethritis is urethra inflammation, whereas ureter inflammation is called ureteritis and bladder and

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kidney inflammation are referred to as cystitis and pyelonephritis (Huang *et al*., 2022).

The majority of UTIs, both nosocomial and community-acquired, are caused by bacteria belonging to the Enterobacteriaceae family (Bader *et al*., 2020). UTIs affect people of all ages and populations, although various factors, such as age, race, gender, genetics, nocturnal enuresis, sexual activity, and circumcision in males, all these factors cause bacteriuria to occur more or less for any individual (Storme *et al*., 2019). Other potential causes of UTIs include poor toilet habits, infrequent micturition, incomplete bladder emptying in children, urine and fecal elimination, pregnancy in females, and prostate enlargement among males (Sjögren *et al*., 2017). Sexually active women, in particular, are more susceptible to developing urinary tract infections (UTIs) than men. Antimicrobial resistance, which occurs when the periurethral flora is damaged by long-term antibiotic usage, makes it easier for uropathogens to colonize and infect the urinary tract, which in turn leads to a higher risk of developing UTIs (Gondim *et al*., 2018).

UTIs can be asymptomatic with no sign of infection, or it may develop several clinical symptoms such as painful urination, urgency, frequency, the sensation of the need to urinate following urination, dysuria, pyuria, and abdominal and back pain (Al Lawati *et al*., 2024).

Enterobacteriaceae, especially *E. coli*, are a major public health concern regarding urinary tract infections due to their high prevalence and the challenges posed by antibiotic resistance. Because of the limited studies in Zakho city on this aspect, the present study aimed to investigate the prevalence of Enterobacteriaceae causing urinary tract infections among outpatients in major hospitals in Zakho city and to evaluate the relationship between Enterobacteriaceae and some risk factors.

II. Materials And Methods

A. Sample collection

During the period from 1st of September 2021 until the end of January 2022, a total number of 454 midstream urine samples were collected from outpatients attending two hospitals in Zakho city (Emergency Hospital and Zakho General Hospital). Each sample was placed in a clean, clearly labeled screw-topped sample container fully labeled with patients' information after taking informed consent from adult patients or the accompanied parents for infants and children. The documented patient's information included Gender, age, marital status, and residence, which were written on a special questionnaire form designed for the study.

B. Bacterial Identification

The collected urine samples were immediately processed in the bacteriology laboratory in Zakho University. After obtaining the urine samples from patients, a loopful of urine was immediately cultured by the streaking method on MacConkey agar and incubated at 37ºC for 24h. In the following day, from the suspected Enterobacteriaceae plates a single colony was selected and subcultured on MacConkey agar and again incubated at 37ºC for 24h to obtain pure bacterial colonies. For bacterial identification, the obtained pure colonies were cultured on different selective culture media, followed by performing different biochemical tests such as Indole, Methyl red, Citrate utilization, Voges-Proskauer, TSI, Catalase and Oxidase (Leboffe and Pierce, 2021).

C. Statistical analysis

Descriptive statistics including frequency, percentages, standard deviation and graphs that used in the research for providing a lucid representation of the data analyzed, statistical package for social science version 17.0 for windows (SPSS) and Microsoft Excel 2021 was used to test the level of significance of the obtained results. The relationship between discrete variable and outcome of interest was tested using Chi-squared test at 5% (p<0.05) confidence interval.

D. Ethical considerations

The ethical approval for performing the study was obtained from the General Directorate of Health in Zakho City (approval No. 5872021-8-1).

III. Results

Out of the collected samples, 239/454 were identified as members of Enterobacteriaceae at a rate of 52.64%. Depending on cultural and biochemical characteristics, with a higher infection rate in females than males (85.36% vs 14.64%) (Table 1).

Table 1. Enterobacteriaceae distribution among both genders in the examined urine samples

Examined urine samples	Positive sample for Enterobacteriaceae		Gender			
			Female		Male	
	No.	%	No.	%	No.	%
454	239	52.64	204	85.36	35	14.64

Out of the identified and isolated enterobacterial species: *Escherichia coli* constituted the highest rate at 69.46% (166 /239), followed by *Klebsiella pneumoniae* at 27.20% (65 /239). While *Proteus mirabilis* and *Morganella morganii* accounted for 2.5% (6 /239) and 0.84% (2 /239), respectively (Figure 1).

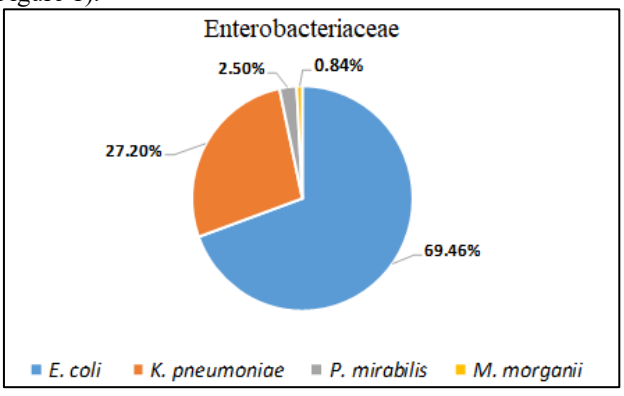

Figure 1. Prevalence of Enterobacteriaceae among UTIs patients.

The relationship between the rate of Enterobacteriaceae with patient age and gender is illustrated in Table (2) and Figure (2). The highest infection rate with Enterobacteriaceae among both genders and all age groups was found within the ages >20-30 years at 58.00%, with statistically significant (*P*=0.029) differences between both parameters. As gender is concerned, females showed higher rates of infection over all ages than males (85.36% vs 14.64%), with the highest rate being among the age groups ≤1-10 and > 10- 20 years which was 91.67%. However, in males, the highest rate of infection was detected in the age group >50 years, which was 34.78%.

Table 2. Prevalence of the Enterobacteriaceae according to patient's gender and age.

Age groups (years)	Examined samples No.	Positive samples No. %	Female No. %	Male No. %
≤ 1-10	22	12 (54.55)	11 (91.67)	1 (8.33)
>10- 20	98	48 (48.98)	44 (91.67)	4 (8.33)
>20- 30	150	87 (58.00)	78 (89.66)	9 (11.11)
>30- 40	87	39 (44.83)	33 (84.62)	6 (15.38)
>40- 50	56	30 (53.57)	23 (76.67)	7 (23.33)
>50	41	23 (56.10)	15 (65.21)	8 (34.78)
Total	454	239 (52.64)	204 (85.36)	35 (14.64)
P value = 0.029				

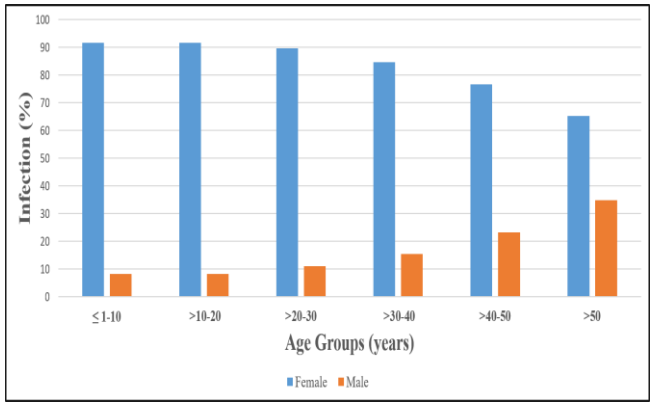

Figure 2. Prevalence of the Enterobacteriaceae according to patient's gender and age.

The results of the marital status among the infected females and males are shown in Table (3). The highest rate, 53.62% (148/239), was reported among the married patients, while 51.12% (91/239) were among the singles. From the married patients, 86.49% (128/148) were females and 13.51% (20/148) were males, while among single patients, 83.52% (76/91) were females and 16.48% (15/91) were males. Furthermore, the infection rate in married females was found to be higher than in single females (86.49% vs. 83.52%) respectively. However, in males, the highest infection rate was recorded in single males (16.48%) compared to married males (13.51%). Statistically, a significant difference was found (*P*=0.045).

Table 3. Distribution of Enterobacteriaceae regarding marital status.

Marital status	Examined sample No.	Positive samples No. %	Female No. %	Male No. %
Married	276	148 (53.62)	128 (86.49)	20 (13.51)
Single	178	91 (51.12)	76 (83.52)	15 (16.48)
Total	454	239 (52.64)	204 (85.36)	35 (14.64)
P value= 0.045				

The rate of infection with Enterobacteriaceae according to residency is illustrated in Table (4). Generally, urban residents showed the highest rate of infection 53.85% followed by camp and rural residents at rates of 48.48% and 45.45%, respectively. The majority of females with UTIs were from the city residents, at 88.18%, while in males, camp residents showed the highest rate of infection, at 31.25%. Statistically, a significant (*P*=0.014) relation was observed between gender and residency.

Table 4. Prevalence of Enterobacteriaceae regarding residence.

Residency	Examined samples No.	Positive samples No. %	Female No.%	Male No. %
Urban	377	203 (53.85)	179 (88.18)	24 (11.82)
Rural	44	20 (45.45)	14 (70.00)	6 (30.00)
Camp	33	16 (48.48)	11 (68.75)	5 (31.25)
Total	454	239 (52.64)	204 (85.36)	35 (14.64)
P value = 0.014				

IV. Discussion

The majority of bacteria that cause UTIs are members of the family Enterobacteriaceae (Foxman, 2010). This is confirmed by studies conducted on urinary tract infections and the type of bacterial pathogens associated with it. Assafi *et al*. (2015) who studied gram-negative bacteria prevalence in patients suffering from UTI in Duhok city reported an infection rate of (52.48%), with the highest rate being by *E. coli* (74.32%) followed by *K. pneumoniae* (10.81%). Similarly, in Duhok City, Abdullah (2019) reported that females had a higher rate than males 79.47% and 20.53%, respectively. In Erbil city, According to Salh (2022) stated that the most common causes of UTIs were Gram-negative bacteria at a rate of 99.6% with *E. coli* being the most common organisms accounting for 64.4% of infection rate, followed by *K. pneumoniae* (34.9%). In addition, Al-Jebouri and Mdish (2013) studied the bacteria isolated from patients with UTIs in Tikrit, Iraq, and reported that the majority of isolated bacterial species were found to be Gram-negative bacteria of the family Enterobacteriaceae, in particular, *E. coli* as it was isolated with a rate of 31%.

The predominance of Enterobacteriaceae, especially *E. coli*, in causing UTIs is because they are part of the gastrointestinal (GI) tract normal flora. The anatomical proximity of the urethra to the anus facilitates the transfer of these bacteria from the gut to the urinary tract, possessing specific virulence factors that enhance colonization and infection, in addition to

various human behaviors and medical practices that facilitate their introduction and persistence in the urinary system (Whelan *et al*., 2023). Their capacity to adhere to and invade uroepithelial cells, form biofilms, and evade immune responses makes them particularly effective at causing UTIs (Assouma *et al*., 2023).

Regarding the distribution of Enterobacteriaceae according to gender and age, the results obtained during this study are in accordance to a certain extent with the results of Ibrahim *et al*. (2021) in Zakho city, who reported that the age group of 41-50 years showed the highest infection rate of 46.67%. Furthermore, they added that females over all ages showed higher rates of infection than males and was the highest within the ages ≤1-10 and 11-20 years which was 95.45%. In males, however, the age group >51 recorded the highest infection rate, which was 16.67%. In Baghdad city, Al-Gasha'a *et al*. (2020) reported that females within the age group of 30-39 years showed the highest rate, 23.81%, while in males, it was within the ages of 50-59 years at 6.35%. In Iran, Tajbakhsh *et al*. (2015) reported the highest rates of UTIs within the age group of 20-29 years in females with a rate of 32.03%, while in males, a rate of 31.81% was recorded among the age group 40-49 years.

The detection of higher rates of UTIs in females is due to a combination of anatomical, hormonal, and behavioral factors. Bacterial entrance to the female urethra is facilitated by the fact that females have shorter urethra and its close proximity to the anus (Czajkowski *et al*., 2021), while hormonal changes and certain behaviors further increase their susceptibility (Deltourbe *et al*., 2022). Awareness and preventive measures, such as proper hygiene and careful management of risk factors, can help in reducing the prevalence of UTIs in women (Lean *et al*., 2019).

Higher incidence of UTIs in adults within the ages >20- 30 years can be attributed to the reason that at these ages, females are more sexually active (Mohammed *et al*., 2016). In elderly the high occurrence of UTIs may be due to anomalies in the urinary tract, urine and fecal incontinence, decline in the immune system, malnutrition, functional impairment, diabetes, and enlargement of the prostate in men (Harrington and Hooton, 2000; Das *et al*., 2006; Marques *et al*., 2012). However, Al-Taai *et al*. (2018) suggested that weak bodies and improper anal washing may cause UTIs in infants and children.

The result of this study regarding high prevalence of UTIs among married women are in accordance to the studies of Almukhtar (2018) in Kirkuk city, he reported high prevalence of UTIs among married and pregnant women with rates of 33.4 and 43%, respectively, while a lower rate of 23.6% was reported among the unmarried women. Al-Gasha'a (2020) in Baghdad, also, reported a higher rate of UTIs between married females as compared to unmarried (68.25% vs 31.75%). Similarly, in Babylon city, Al-Musawi and Al-Husseini (2021) reported the highest infection rate of 89.81% with uncomplicated UTIs, among married females, while only 9.26% were in singles. The reasons leading to females developing higher rate of UTIs includes the close distance between the urethra and anus, the urethra is shorter and wider, sexual behavior and incontinence. In addition, specific changes occur in women's bodies throughout life, like pregnancy, childbirth, and menopause. Therefore, their urinary tract and the muscles around it may be affected, the vaginal pH will be lowered and the poor hygienic conditions (Griebling, 2001; Khan *et al*., 2015).

Regarding residency, similar results were described by Ibrahim *et al*. (2021). They reported the highest rates of infection in both genders (40.56%) in urban resident with a high rate (91.6%) among females in Zakho city as compared with the rural and camps residents. While males living in rural areas showed the highest rate (40%) of UTIs. Almukhtar (2018) reported that the majority of UTIs in females were within the females that lived in rural areas (72.4%), while the rate of infection in urban areas was lower (27.6%).

Higher rates of UTIs among urban residents could be attributed to the fact that these infections are caused by different bacterial species (De Lusignan *et al*., 2018). High population density can be another cause of higher UTIs incidence within urban residents in addition to the differences in the life style between urban and rural residents. The nature of camp sanitation and a lack of concern for personal hygiene may contribute to the high rates of UTIs among camp residents (Ibrahim *et al*., 2021).

V. Conclusion

Enterobacteriaceae isolates are the most common bacterial species detected in UTI patients. Among the isolated Enterobacteriaceae, the predominant bacterial species isolated was *E. coli* followed by *K. pneumoniae*. Regarding the relationship between rate of infection, gender and age among patients, females showed the highest rate of infection as compared to males. While ages of >20-30 years exhibited the highest rate of infection. The rate of UTIs with Enterobacteriaceae was high among married patients and urban residents.

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