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Prevalence, Risk Factors and Antibiotic Susceptibility of Urinary Tract Infections among Pregnant Women: A Study in Damt District Yemen

Fawaz Al-Badaii[1,2]*, Mohammed Al-Tairi[2], Amina Rashid[2], Sumaya Al-Morisi[2] and Najla Al-Hamari[2]

[1]Department of Biology-Microbiology Section, Faculty of Applied Science, Thamar University, Dhamar, Yemen.
[2]Department of Medical Laboratory, Qualitative College of Academic Sciences, Damt City, Yemen.

Abstract

Urinary tract infections are the most common illnesses that impact pregnant women. This study aimed to investigate bacterial urinary tract infections and antibiotic susceptibility profiles in pregnant women. This study was conducted on pregnant women between April and October 2021 in clinics and hospitals in the Damt district. Midstream urine samples were collected, cultured, identified and tested for antibiotic susceptibility. The prevalence of UTI in pregnant women was 210/350 (60%). *Escherichia coli* accounted for 90/210 (42.9%), *Staphylococcus aureus* 50/210 (23.8%), and *Klebsiella pneumoniae* 25/210 (11.9%). *Staphylococcus epidermidis, Pseudomonas aeruginosa,* and *Proteus mirabilis* exhibited 15/210 (7.1%) of each with the moderately identified bacterial species. Antimicrobial sensitivity testing showed that bacterial isolates were resistant to amoxicillin (80-100%), ceftriaxone (40-70%), gentamycin (0-60%), amikacin (0-50%), tetracycline, ciprofloxacin, azithromycin, and amoxiclav (0-40%), and azithromycin (0-30%). Significant bacteriuria was associated with age ($p = 0.01$), pregnancy trimesters ($p = 0.00$), gestation ($p = 0.00$), and residence ($p = 0.03$), whereas there was no association with education ($p = 0.05$). Most isolates have become resistant toward antibiotic used in the study treatments, especially ceftriaxone and amoxicillin. Therefore, it is recommended that pregnant women undergo health education on the prevalence and causes of urinary tract infections.

Keywords: Bacterial Infection, Urinary Tract, Antibiotic Susceptibility, Pregnant Women, Yemen

***Correspondence:** fawaz.albadai@tu.edu.ye

Abbreviations: CFU: Colony-Forming Unit: UTI: Urinary Tract Infection: UTIs: Urinary Tract Infections, CLSI: Clinical and Laboratory Standards Institute, CLED agar: Cystine Lactose Electrolyte Deficient agar

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INTRODUCTION

The most frequent bacterial infection in women is urinary tract infection.[1,2] The small urethra and colonization of the per-urethral area by gastrointestinal pathogens are the leading causes of this. Pathogens rise from the per-urethral region to colonize the urinary bladder or kidneys. Acute pyelonephritis during pregnancy is linked to septicemia and spontaneous preterm delivery.[3,4] Advances in gestational age are frequently accompanied by increased micturition incidence and lower abdomen discomfort. Thus, it is probable that a pregnant woman's clinical diagnosis of a UTI will be less precise than that of a woman who is not pregnant. Because women are more likely to have UTIs than men, newlywed women have been referred to as having honeymoon cystitis.[5,6]

About 25% of women between the ages of 16 and 35 who get a UTI go on to get another one within six months, making them 40 times more likely than men to do so.[7] Asymptomatic bacteriuria is frequently temporary in females of reproductive age and does not need antibiotic treatment. 20% to 30% of women with Asymptomatic bacteriuria do, however, experience acute pyelonephritis during pregnancy.[8,9] Women frequently contract urinary tract infections, and many of them do so multiple times throughout their lifetime. The female anatomy is one of the risk factors for urinary tract infections in women because women's urethras are shorter than men's, which allows bacteria to enter the bladder more easily.[10,11] In addition, the infection may be more likely to develop in women who use birth control methods that involve the use of a female diaphragm for contraception, as well as those experiencing menopause, due to factors such as weakened immune system, diabetes, sickle cell anemia, neurogenic bladder damage, a history of recurrent or persistent UTIs prior to conception, smoking, and being under the age of. [9,12]

Developed and developing nations should screen for and treat Asymptomatic bacteriuria during pregnancy to lower the chance of developing acute pyelonephritis.[13,14] Nonetheless, the advantages of screening for Asymptomatic bacteriuria during pregnancy have been questioned in light of more rigorous study designs to determine the relationship between Asymptomatic bacteriuria and acute pyelonephritis in pregnancy.[15,16] Up to 85% of infections in women resulting from UTIs are caused by *Escherichia coli*.[10,11,17,18] Other Enterobacteriaceae and gram-positive bacteria are blamed for the remaining illnesses.[18,19] UTIs are a substantial, under-recognized risk factor for pregnancy morbidity and poor birth outcomes in low-income countries.[20] UTIs can develop during pregnancy and show signs of severe cystitis or pyelonephritis, or they can place restrictions on a woman and cause asymptomatic bacteriuria. The Infectious Diseases Society of America recommends that all women in high-income nations undergo screening for and treatment for asymptomatic bacteriuria by urine culture at least once in the first trimester.[21]

The highest infection rates among pregnant women are a matter of concern because there is a knowledge gap regarding the causes of urinary tract infections in women and because there are few attitudes and practices in place to prevent and control infection. The spread of urinary tract infections among pregnant women in Yemen, particularly in Damt district and its surrounding areas, is one of the most prevalent diseases among women. These diseases may be caused by various factors related to the environment in which the infected women live as well as possible reasons related to diseases of the urinary system. This investigation aimed to isolate and identify the bacteria that caused urinary tract infections in pregnant women in Damt. Additionally, it assessed the bacteria obtained from infected pregnant women's bodies for antibiotic resistance.

MATERIALS AND METHODS

Study area and population

The study was carried out in Damt district, which is 1884 meters above sea level and situated between 43.30 and 44.50 degrees latitude and 14 and 15 degrees longitude. According to Singh and Masuku,[22] the sample size was determined as follows: $n = Z^2P (1-P) /D^2$, where Z is at the z score for a 95% confidence interval equaling 1.96; P is the prevalence (given by[23] as 30%), and D is the acceptable error (5%). A 5% non-response rate and 1.5 times the design effect were also incorporated into the formula. A subjective questionnaire based on symptoms led to the collection of 340 samples plus 10 (a total of 350), of which 210 were later confirmed microbiologically as positive UTI cases.

Sampling, processing and ethical considerations

The study's ethical review and approval were conducted by the Qualitative College of Academic Sciences in the city of Damt and the Health Office in the Al-Dhale governorate, Yemen. The sampling was carried out from April to October 2021. Only 210 of the 350 samples from pregnant women with urinary tract infections were bacterially infected. Various hospitals and private clinics in Damt City provided samples in sterile containers, labelled and promptly stored inside the icebox. After that, proceed immediately to the lab for the inspection. Pregnant women's names, ages, symptoms, education levels, gestation, trimesters, and residence were recorded. Ethics-related administrative and clinical permission was obtained. Before the data was collected, each participant submitted their written informed consent. The confidentiality of all information gathered during the investigation ensured the study's sole purpose and its exclusive usage.

Bacteria cultivation and identification

The samples were directly streaked onto the CLED agar, blood agar, MacConkey agar, mannitol salt agar, and nutrient agar plates (Himedia®, India), and the plates were then incubated aerobically at 37°C for 24 hours. After incubation, the cultures on CLED agar were evaluated using established standards, keeping in mind that a count of more than 100000 CFU/mL suggests a urinary tract infection. Then, pathogenic bacteria were determined by Gram stain, morphology, and motility tests in addition to conventional biochemical traits like catalase, coagulase, and oxidase tests, indole and motility tests with H2S production on sulphide indole motility medium, citrate utilization, the triple sugar iron agar test, and fermentation using sugars.[24-27]

Antibacterial susceptibility test

On Muller-Hinton agar (Himedia®, India), the Kirby-Bauer disc diffusion method was used to assess susceptibility to antimicrobial drugs. Isolated colonies are prepared using the direct colony suspension method and suspended in 5 ml of sterile saline to a turbidity of 0.5 McFarland standard.[28,29] A Muller-Hinton agar plate is equally inoculated with a sterile cotton swab after being dipped into a bacterial test mixture.[27,30] By using sterilized forceps, the antibiotic discs are positioned on the plates. The plates were incubated overnight at 37°C (18–24 hours). A clear zone or ring appears around the disc when the agent inhibits after incubation. The diameter of the inhibition zone around the discs' centres has been measured in millimetres, and the CLSI recommendations interpret the results. Based on the zone of inhibition size, the isolates' sensitivity to the antibiotics was classified as susceptible, intermediate, or resistant.[31,32] The antibiotics tested were Azithromycin (AZM 30µg), Ceftriaxone (CTR 30µg), Gentamycin (GNM 10µg), Amikacin (AMC30µg) Amoxiclav (AMC 30µg), Ciprofloxacin (CIP 5µg), and Tetracycline (TRC30µg) (HiMedia®, India).

Quality Control

All materials, equipment, and procedures required for the study were adequately controlled. All specimens were immediately processed after collection. Only specimens which produced more significant than 10^5 CFU/mL of urine were considered significant for the study. *Escherichia coli* and *Staphylococcus aureus* strains from the central laboratory in Sana'a, Yemen, were used as the standard reference for testing sterility and performance of culture media and antibiotic discs. Generally,[28] guidelines were strictly followed.

Data Analysis

The data were analyzed using descriptive statistics for UTI prevalence, frequency, percentages, and Chi-square test where applicable. All statistical tests were performed using SPSS software version 22 and Microsoft Excel 2016.

RESULTS

Of the 350 pregnant women with UTIs who participated in this study, 210 women (60%) were infected by bacteria, while 140 women (40%) were not infected with any bacteria. From the total of 210 infected women, the highest infection rates were recorded for *Escherichia coli* 90 (42.9%),

Table 1. Distribution of bacterial urinary tract infections based on age in pregnant women

Bacteria	Age				Pearson Chi-square	p-value
	<20	20-40	>40	Frequency		
Staphylococcus aureus	8	37	5	50	22.66, df,10	0.012
Staphylococcus epidermidis	0	10	5	15		
Escherichia coli	15	58	17	90		
Klebsiella pneumoniae	2	13	10	25		
Pseudomonas aeruginosa	3	10	2	15		
Proteus mirabilis	0	15	0	15		
Total	28	143	39	210		

Table 2. Distribution of bacterial urinary tract infections based on trimesters in pregnant women

Bacteria	Trimester of pregnancy				Pearson Chi-square	p-value
	First	Second	Third	Frequency		
Staphylococcus aureus	14	11	25	50	38.16, df =10	0.00
Staphylococcus epidermidis	8	5	2	15		
Escherichia coli	30	15	45	90		
Klebsiella pneumoniae	9	3	13	25		
Pseudomonas aeruginosa	5	6	4	15		
Proteus mirabilis	0	11	4	15		
Total	66	51	93	210		

Staphylococcus aureus 50 (23.8%), and *Klebsiella pneumoniae* 25 (11.9%), while the rate of infection was low for *Staphylococcus epidermidis, Pseudomonas aeruginosa,* and *Proteus mirabilis* with 15 (7.1%) infections of each.

According to age, the distribution of UTIs among pregnant women recorded the highest rate of infections among women aged 20–40. *Escherichia coli* recorded the highest number in this age group, with 58 of 90 infections, followed by *Staphylococcus aureus* (37 of 50). In comparison, the lowest infection rate was among women aged less than 20 years, whereas *Proteus mirabilis* exhibited the lowest prevalence of infection, with zero infections at this age. The chi-square test showed a significant association between the age group and the bacterial infection ($X^2 = 22.66$; degree of freedom = 10; $p = 0.012$), as shown in Table 1.

According to Table 2, the distribution of UTIs by pregnancy trimester showed that third-trimester pregnant women had the most significant infection rate and second-trimester pregnant women had the lowest. *Escherichia coli* was the most prevalent bacteria, accounting for 90 of the 210 bacterial isolates. The highest number of *Escherichia coli* was found in the third pregnancy trimester (45/210), followed by the first pregnancy trimester (30/210), and the second trimester with 15 of 210 infections. The second most prevalent bacteria among the pregnancy trimesters were *S. aureus* (50/210), followed by *Klebsiella pneumoniae* (25/210), then *Staphylococcus epidermidis, Pseudomonas aeruginosa,* and *Proteus mirabilis*, with 15 infections of each. The chi-square test showed a significant association between the pregnancy trimesters and the bacterial infection ($X^2 = 38.16$; degree of freedom = 10; $p = 0.00$).

According to the distribution of UTIs based on whether it was the first pregnancy (primigravida) or was preceded by more than one pregnancy (multigravida), multigravida women had the highest UTIs, while primigravida women had the lowest rate. *Escherichia coli* recorded high infection rates among primigravida women (37/210) and multigravida women (53/210), followed by *Staphylococcus aureus* bacteria, accounting for 21 and 29 infections, respectively. In comparison, *Proteus mirabilis* recorded the lowest

Table 3. Distribution of bacterial urinary tract infections based on gestation in pregnant women

Bacteria	Gestation			Pearson Chi-square	p-value
	Primigravida	Multigravida	Frequency		
Staphylococcus aureus	21	29	50	222.7, fd=9	0.00
Staphylococcus epidermidis	6	9	15		
Escherichia coli	37	53	90		
Klebsiella pneumoniae	11	14	25		
Pseudomonas aeruginosa	6	9	15		
Proteus mirabilis	7	8	15		
Total	88	122	210		

Table 4. Distribution of bacterial urinary tract infections based on education in pregnant women

Bacteria	Education level				Pearson Chi-square	p-value
	Illiterately	Elementary	Secondary	High		
Staphylococcus aureus	24	13	10	3	24.76, df,15	0.05
Staphylococcus epidermidis	6	4	4	1		
Escherichia coli	40	30	10	10		
Klebsiella pneumoniae	11	8	6	0		
Pseudomonas aeruginosa	7	4	3	1		
Proteus mirabilis	10	0	5	0		
Total	98	59	38	15		

infections among primigravida women (7/210) and multigravida women (8/210), as shown in Table 3. The chi-square test showed a significant association between the number of pregnancies and the bacterial isolates (X^2 = 222.7; degree of freedom = 9; p = 0.00).

Table 4 shows the distribution of UTIs by educational level, showing that women with a high school education had the fewest UTIs (15/210), whereas women with illiteracy and elementary education had the highest rates of bacterial infections (98/210 and 59/210, respectively). The most prevalent bacterium was *Escherichia coli*, responsible for 40/210, 30/210, 10/210, and 10/210 samples from the groups of women with no education, and those with elementary education, secondary education, and high school education, respectively. According to education level, *Staphylococcus aureus* was the second most common bacterium, with 24/210, 13/210, 10/210, and 3/210 for women who were illiterate and had only an elementary education, a secondary education and a high school education, respectively. Based on education level, *Proteus mirabilis* had the lowest infection rate among pregnant women, with no infection in women with high or elementary education. According to Table 4, the chi-square test revealed no correlation between educational attainment and bacterial isolates (X^2 = 24.76; degree of freedom = 15; p = 0.05).

As shown in Table 5, the distribution of UTIs based on residence revealed that the prevalence was high among women living in rural areas, in contrast to the lowest infection rates among women living in urban areas. The chi-square test showed a significant association between the residence and the bacterial infection (X^2 = 12.73; degree of freedom = 5; p = 0.03). For *Staphylococcus aureus*, the highest sensitivity was recorded against amikacin, which showed 100% sensitivity to the antibiotic. Gentamycin and tetracycline showed 80% sensitivity, followed by sensitivity to azithromycin, ciprofloxacin, and amoxiclav at a rate of 60%. At the same time, the highest resistance was recorded against ceftriaxone at 60% and amoxicillin at 100%. The most vigorous antibiotic resistance against *Staphylococcus epidermidis* was observed against ceftriaxone (70%) and amoxicillin (100%), whereas the highest antibiotic sensitivity was documented against amikacin and amoxiclav, both at 100%.

Table 5. Distribution of bacterial urinary tract infections based on residence in pregnant women

Bacteria	Residence			Pearson Chi-square	p-value
	Rural	Urban	Frequency		
Staphylococcus aureus	36	14	50	12.73, df5	0.03
Staphylococcus epidermidis	9	6	15		
Escherichia coli	78	12	90		
Klebsiella pneumoniae	18	7	25		
Pseudomonas aeruginosa	11	4	15		
Proteus mirabilis	8	7	15		
Total	160	50	210		

Table 6. Antibiotic susceptibility of bacterial isolates from pregnant women with UTIs

Antibiotic		*S. aureus* (n=25)	*S. epidermidis* (n=10)	*E. coli* (n=40)	*K. pneumoniae* (n=10)	*P. aeruginosa* (n=10)	*P. mirabilis* (n=10)
	S	20(80%)	6(60%)	36(90%)	10(100%)	4(40%)	10(100%)
Gentamycin	I	5(20%)	4(40%)	4(10%)	0(0%)	0(0%)	0(0%)
	R	0(0%)	0(0%)	0(0%)	0(0%)	6(60%)	0(0%)
	S	25(100%)	10(100%)	40(100%)	10(100%)	5(50%)	90(90%)
Amikacin	I	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	R	0(0%)	0(0%)	0(0%)	0(0%)	5(50%)	1(10%)
	S	15(60%)	3(30%)	20(50%)	4(40%)	3(30%)	6(60%)
Azithromycin	I	5(20%)	7(70%)	8(20%)	4(40%)	4(40%)	3(30%)
	R	0(0%)	0(0%)	12(30%)	2(20%)	3(30%)	1(10%)
	S	20(80%)	4(40%)	28(70%)	6(60%)	4(40%)	8(80%)
Tetracycline	I	0(0%)	3(30%)	4(10%)	0(0%)	2(20%)	2(20%)
	R	5(20%)	3(30%)	8(20%)	4(20%)	4(40%)	0(0%)
	S	15(60%)	2(20%)	32(80%)	6(60%)	6(60%)	5(50%)
Ciprofloxacin	I	5(20%)	8(80%)	4(10%)	4(40%)	0(0%)	2(20%)
	R	5(20%)	0(00%)	4(10%)	0(0%)	4(40%)	3(30%)
	S	0(0%)	0(0%)	12(30%)	0(0%)	2(20%)	4(40%)
Ceftriaxone	I	10(40%)	3(30%)	4(10%)	6(60%)	1(10%)	1(10%)
	R	15(60%)	7(70%)	24(60%)	4(40%)	7(70%)	5(50%)
	S	15(60%)	10(100%)	28(70%)	10(100%)	4(40%)	7(70%)
Amoxiclav	I	0(0%)	0(0%)	8(20%)	0(0%)	2(20%)	0(0%)
	R	10(40%)	0(0%)	4(10%)	0(0%)	4(40%)	3(30%)
	S	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	2(20%)
Amoxicillin	I	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	R	25(100%)	10(100%)	40(100%)	10(100%)	10(100%)	8(80%)

According to Table 5, amikacin and gentamycin had the most outstanding *Escherichia coli* sensitivity ratings of 100% and 90%, respectively, whereas ceftriaxone and amoxicillin had the highest ratings for resistance. UTI infection caused by *Klebsiella pneumoniae* recorded the highest sensitivity to gentamycin, amikacin, and amoxiclav (100%). In contrast, it was recorded that there was high resistance against ceftriaxone (40%) and amoxicillin (100%), as in table 6. Table 6 shows that for *Pseudomonas aeruginosa*, the antibiotics with the highest sensitivity were amikacin (50%) and ciprofloxacin (60%), whereas the medicines with the highest resistance were ceftriaxone (70%) and amoxicillin (100%). The highest sensitivity of *Proteus mirabilis* bacteria to antibiotics was observed for amikacin (90%) and gentamycin (100%), whereas the highest resistance was observed for ceftriaxone (50%) and amoxicillin (80%), as shown in Table 6.

DISCUSSION

It is potentially life-threatening when the urinary tract is infected, mainly when it develops in pregnant women. Despite advances in diagnosis and treatment, bacterial urinary tract infection remains a significant cause of pregnancy-related morbidity and mortality worldwide.[33,34] The causal factors behind urinary tract infections and the patterns of susceptibility to antibiotics among pregnant women can vary depending on location and time. Therefore, this data is crucial in providing information necessary to create infection control measures and establish antibiotic policies worldwide.[11,35,36]

In this study, the overall prevalence of urinary tract infections in pregnant women attending hospitals and clinics in Damt City was 60%. The prevalence of UTI 210/350 (60%) in this study was higher than the study conducted in the Al-Mukalla district, Yemen at 30%,[23] Eastern Ethiopia at 13.2%,[37] Bangladesh at 8.9%,[9] Southeast Ethiopia 26%,[38] Iran 17%,[39] and Sudan 12.1%.[40] However, this value was similar to the prevalence of UTI among pregnant women in Taiz Governorate, Yemen, at 58%.[33] This variation may be due to differences in environment, social habits, and personal hygiene standards or to the study subjects' low economic status. The differences in design and methodologies might also affect the comparison of prevalence in different surveys.[12,25,37,41] The prevalence rate of bacterial causing urinary tract infections among pregnant women in Damt City participating in the study was 60%, with 210 infected cases out of 350 samples. *Escherichia coli* recorded the highest prevalence rate with 42.9%, followed by 23.8% for *Staphylococcus aureus*, then 11.9% for *Klebsiella pneumoniae* and 7.1% for infections recorded for *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Proteus mirabilis*. The infection with *Escherichia coli* was high among women aged between 20-40 years, pregnant women in the third trimester, pregnant women with multigravida, illiterate women and pregnant women living in rural areas. *Escherichia coli* was sensitive to amikacin (100%), gentamycin (90%), ciprofloxacin (80%), tetracycline (70%), amoxiclav (70%) and azithromycin (50%), ceftriaxone (30%). These results agreed with the results reported by Al-Jawadi,[42] where the prevalence of urinary tract infections among pregnant women was 47.4%. Furthermore, *Escherichia coli* was the most isolated bacteria by 73.5%, hypersensitive to ciprofloxacin, gentamicin, ceftriaxone and amikacin. Their results stated that 79.5% of affected participants were in the 20-35 age group, 53.0% in the third trimester, and 41.0% in multigravida. Also, this study was consistent with those results reported by Masinde et al.[5] in Mwanza, Tanzania, who mentioned that *Escherichia coli* infected 47.2% of pregnant women. In addition, the results of this study disagreed with those reported by Parveen et al.[43] where the infection prevalence rate was 26.0%, with a high percentage in the age group 21-25 years, 44.61%. They also revealed a high rate of infection in the third trimester of pregnancy, 78.46%; also, their results found that multigravida is associated with increased urinary tract infection during pregnancy as well as the *Escherichia coli* was isolated from 88.5% of infected pregnant women, whereas the *Staphylococcus aureus* and *Klebsiella pneumoniae* exhibited the highest rate infection coming after *Escherichia coli*. The major contributing factor for isolating higher *Escherichia coli* is pregnancy urine stasis, favouring *Escherichia coli* strain colonization. *Klebsiella pneumoniae* is commonly found in wet areas and can infect pregnant women.[29,44,45] Another reason could be poor genital hygienic practices by pregnant women who may find it difficult to clean correctly after defecating or cleaning their genitalia after passing urine during their pregnancy.[6,11,13] The high prevalence rate in the study areas might be due to culture, practice, living standards and poverty, in addition to the study period and the methods employed for urine examination.[10,38,46]

Furthermore, the result disagreed with those reported by Lee et al.,[9] who found that *Staphylococcus aureus* and *Klebsiella pneumoniae* were high among women between 20-29 years, particularly during the third trimester, as well as the pregnant women with multigravida. Furthermore, they found that the rate of infection with *Staphylococcus aureus* and *Klebsiella pneumoniae* based on the education level was high among illiterate pregnant women and pregnant women living in urban areas. Also, they found that *Staphylococcus aureus* recorded high sensitivity to gentamycin (91%), azithromycin

(42%) and ceftriaxone (71%), with 91% and 85 respectively, as well as *Klebsiella pneumoniae* sensitive to ceftriaxone (88%), azithromycin (83%), and gentamycin (91%). Furthermore, these results agreed with the results reported by Al Haddad,[23] who evaluated the prevalence of urinary tract infection among pregnant women, which was 30% of these bacterial infection caused by *Escherichia coli* (41.5%), followed by *Staphylococcus aureus* at 19.5% and *Klebsiella pneumoniae* at 9.8%, where was *Staphylococcus aureus* sensitive to gentamycin, cefotaxime, and cephalexin while was resistant to ciprofloxacin, but *Klebsiella pneumoniae* was sensitive to ciprofloxacin, gentamycin and amikacin; their results stated that 53.7% of affected participants were in the 15-24 age group, 48.8% in the third trimester. Additionally, this study was inconsistent with the results by Adugna et al. (2018) 37, which showed that the overall prevalence of UTI was 13.2%. *Escherichia coli* was the most frequently isolated organism at 40%, followed by *Klebsiella pneumoniae* and *Staphylococcus aureus*. They also found that the highest infection prevalence concerning age was in the age group between 25 to 34 years and the second and third trimesters of pregnancy, with 36.3%.

In this study, Streptococcus epidermidis, *Pseudomonas aeruginosa*, and *Proteus mirabilis* exhibited the lowest infection rate among pregnant women. The infection rate was high among women aged between 20 and 40, particularly during the first and second trimesters. In addition, multigravida women, illiterate pregnant women, and women in rural areas showed a high level of infection with *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Proteus mirabilis*. These bacteria recorded high sensitivity to amikacin, followed by amoxiclav, gentamycin, azithromycin and tetracycline. These results were relatively agreed with the results reported by Yasmin et al.[47] where the infection rate reached 6.12% for Pseudomonas. aeruginosa and 4.08% for *Proteus mirabilis*. Also, their study of urinary tract infection showed that 48.97% of infection was in the age group between 21 - 25 years, followed by the age group 26 - 30 years (36.73%), and showed higher rates of infection in the third trimester compared to the second trimester and first trimesters. By comparing the results of this study with other studies, we found that the most common bacterial agents that cause urinary tract infections among pregnant women are *Escherichia coli*, followed by *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Proteus mirabilis*, respectively. Variations in the prevalence of urinary tract infections may be explained by differences in the socioeconomic of the community, pregnancy-associated physiological changes, educational level, environment, personal hygiene, and maternal age, which are risk factors for UTI among pregnant women.[19,35,48]

The percentage of resistance of all bacteria in this study is alarming, given that it was resistance to amoxicillin (100%), ceftriaxone (40-70%), tetracycline (0-40%), gentamycin (0-60%), ciprofloxacin (0-40%), azithromycin (0-30%), amikacin (0-50%), and amoxiclav (0-40%). *Pseudomonas aeruginosa* and *Escherichia coli* showed an elevated resistance level to most antibiotics, as in Table 6. It is well-known that most bacteria are inherently resistant to antibiotics due to the increasing acquisition of resistant plasmid.[29,49] Our study revealed that bacterial isolates were 100% resistant to amoxicillin that is a commonly prescribed first-line antibiotic for treating urinary tract infections and is known for its effectiveness against many bacteria causing UTIs. While generally safe and well-tolerated, its efficacy can vary depending on the bacterial strain and clinical situation.[36] This rate of resistance was similar to the previous study done in Yemen[33] and Ethiopia,[24], which reported 100% resistance in both country. Our study revealed a higher rate of resistance to ceftriaxone (70%) compared to previously documented rates in Yemen, which were 60% and 40%, as reported in studies by Al-Jendy and Al-Ofairi[33] and Al Haddad,[23] respectively. This resistance rate was similar to a report from Ethiopia (80%).[9] This high resistance rate of bacterial isolates against amoxicillin could be due to the production of inhibitors-resistant β-lactamase.[25,50,51] Based on susceptibility tests of antibiotics in the present study, *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Proteus mirabilis* were resistant to ceftriaxone and ampicillin which are commonly used antibiotics for treating urinary tract infections due to their broad-spectrum activity against many bacteria.[52] But based on the results of this study, these two antibiotics cannot be used in treating urinary tract infections, particularly in the study area. Therefore, the choice of antibiotic and duration of treatment can be based on several factors, including the patient's medical history, antibiotic resistance, and severity of infection.[52] The highest resistance may be due to misuse and frequent antibiotic usage.[30] However, we observed high sensitivity to amikacin and gentamycin; thus, they could be considered alternative options for treating UTIs.

CONCLUSION

The prevalence rate of bacterial urinary tract infections in pregnant women was sixty percent. *Escherichia coli* is the predominant microorganism, followed by *Staphylococcus aureus* and *Klebsiella pneumoniae*, which cause UTIs among pregnant women in Damt city. The Incidence of UTI caused by bacteria during the study period was recorded at the highest rate in ages between 20-40 years. In addition, the highest percentage of pregnant women with UTI related to bacteria according to trimester was in the third trimester. In the current study, we found that the highest infection of UTI based on education level was in pregnant women with illiteracy. In addition, the highest isolation rate of UTI among pregnant women caused by bacteria, according to gestation, was in women that have multigravida. Furthermore, there is considerably high resistance to some antimicrobial agents often used in treating UTIs, particularly ceftriaxone and amoxicillin. In this study, ciprofloxacin, amikacin, azithromycin, gentamicin, and amoxiclav were found to be the most effective antimicrobial agents against all isolated bacteria from UTI. These results highlight the potential effectiveness of these antibiotics in treating UTI caused by a wide range of bacteria, and could help inform clinical decision-making when selecting appropriate treatment options for UTI patients.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

FA designed the study, analyzed, interpreted the data, and reviewed and edited the manuscript for publication. MA, AR, SA, and NH contributed to sample collection, lab work, data analysis and draft manuscript preparation. All authors read and approved the final manuscript for publication.

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DATA AVAILABILITY

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

ETHICS STATEMENT

This study was approved by the Institutional Ethics Committee, Thamar University and the Qualitative College for Academic Sciences.

INFORMED CONSENT

Written informed consent was obtained from the participants before enrolling in the study.

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