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Prevalence and Antimicrobial Resistance of Staphylococcus saprophyticus in Urinary Tract Infections: A Cross-Sectional Study from Thi-Qar in Iraq

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Abstract

Background: Urinary tract infections (UTIs) are a significant public health concern worldwide. Staphylococcus saprophyticus is the second most common Community-acquired uropathogens, and most frequently infects young women who are sexually active. There is a paucity of epidemiological information concerning southern Iraq.

Objectives: To establish the rate of occurrence of S. saprophyticus among UTI patients at Al-Rifae General Hospital in Thi-Qar Governorate, Iraq, and to analyze the patterns of resistance to antimicrobial drugs among the isolated strains.

Methods: Methods: Between October 2025 and February 2026, this cross-sectional study analyzed 226 midstream urine (MSU) samples from patients with suspected UTIs. The identification of bacterial isolates and biochemical tests was followed by verification with VITEK-2 Compact (bioMérieux). Antimicrobial susceptibility (AST) tests were performed using the Kirby-Bauer disk diffusion method in accordance with the 2023 Clinical and Laboratory Standards Institute (CLSI) M100. Statistical analyses were based on the Chi-square (χ^2) tests, 95% Wilson confidence intervals (CIs), and odds ratios (ORs).

Results: Results: An analysis of 226 urine samples led to the confirmation of 20 isolates (8.8%; 95% CI: 5.8%–13.3%) as S. saprophyticus. Infection rates were higher among females (80%) than males (20%) (χ^2 = 7.20, p = 0.007; OR = 4.0; 95% CI: 1.2–13.4). Rural residents represented 65% of the total cases. The 11–20 years age group had the highest infection rates (40%). Susceptibility to Nitrofurantoin was the highest (70%) and the highest resistance was to the erythromycin group (80%), while susceptibility levels were at 35% for azithromycin, levofloxacin, and ciprofloxacin, and at 50% for ofloxacin.

Conclusion: In Thi-Qar, S. saprophyticus is a significant uropathogen that largely impacts young females living in rural communities. Its high resistance to macrolide and fluoroquinolone classes poses a challenge to antibiotic stewardship in Thi-Qar which necessitates an ongoing assessment of antimicrobial resistance in this community.

Keywords: Staphylococcus saprophyticus (S. saprophyticus), urinary tract infections (UTIs), antimicrobial resistance, VITEK-2, community-acquired infections..

الملخص

الخلفية : التهابات المسالك البولية **(UTIs)** هي واحدة من التحديات الصحية العامة الرائدة على مستوى العالم. يُشار إلى المكورات العنقودية السائحة غالبًا باسم السبب البكتيري الثاني الأكثر شيوعًا لعدوى المكتسبة من المجتمع عند النساء الشابات النشيطات جنسيًا. هناك نقص في البيانات الوبائية من جنوب العراق.

الأهداف: تحديد معدل انتشار **S. saprophyticus** في حالات التهابات المسالك البولية في مستشفى الرضا العام بمحافظة ذي قار وتحليل مقاومته للمضادات الحيوية.

الطرق: تم استخدام تصميم مقطعي لتحليل 226 عينة بول من منتصف المسار تم جمعها بين أكتوبر 2025 وفبراير 2026. تم الاعتماد على الاختبارات الكيميائية الحيوية التقليدية ونظام **VITEK-2** الآلي لتحديد الهوية وتأكيد العزلات. تم استخدام طريقة الانتشار على الأقراص (كيربي-باور) لتحديد مدى حساسية المضادات الحيوية وأجريت وفقًا لتوصيات **CLSI M100 (2023).** تم إجراء التحليل الإحصائي) فترة الثقة 95 % و **(OR**باستخدام اختبار مربع كاي**.(χ²)**

النتائج: من بين 226 عينة، تم عزلة س. سابروفيتيس من 20 عينة (8.8٪؛ فاصل الثقة 95٪: 5.8٪–13.3٪). كانت العدوى أعلى بشكل ملحوظ لدى الإناث (80٪) مقارنةً بالذكور**20) (χ²=7.20٪ (، p=0.007، OR=4.0؛** فاصل الثقة 95٪: 1.2–13.4 **.(**كانت سكان الريف 65٪ من الحالات الإجمالية. كانت الفئة العمرية الأكثر تأثرًا هي 11–20 سنة (40٪). أظهر نيتروفورانتوين أعلى حساسية (70٪) والأريث **romycin**أعلى مقاومة بنسبة 80٪.

الاستنتاج: في ذي قار، تظل**S. saprophyticus** ، التي تستهدف بشكل خاص الإناث الصغيرات السن والسكّان الريفيين، عاملاً رئيسياً في الإصابة بعدوى المسالك البولية. تشير المقاومة المرتفعة لمضادات المايكوليدات والفلوروكوينولونات إلى الحاجة الملحة لتطوير طرق تدريجية لمتابعة استخدام هذه المضادات الحيوية، إلى جانب تتبع أنماط المقاومة.

الكلمات المفتاحية: المكورات العنقودية البيضاء، التهابات المسالك البولية، VITEK-2, **مقاومة المضادات الحيوية.**

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1. Introduction

Urinary tract infections (UTIs) are one of the most common types of infection globally, with 150 million new cases every year, and an enormous financial impact on healthcare systems [1]. In Iraq, UTIs are one of the most common reasons for outpatient visits and the most common reason for antibiotic prescriptions, especially in resource-limited areas [2].

Staphylococcus saprophyticus, a coagulase-negative staphylococcus (CoNS), is the second most common microorganism associated with community-acquired UTIs and is identified after Escherichia coli [3]. Staphylococcus saprophyticus mainly affects sexually active women aged 16-25, and accounts for 5-15% of UTIs in this population [4]. The virulence of Staphylococcus saprophyticus has been associated with the presence of different factors such as its ability to produce urease, hemagglutinins, and surface adhesins (SdrI, SdrJ) and its ability to form a biofilm [5].

The rising resistance of S. saprophyticus to antimicrobials hampers treatment options. Resistance to fluoroquinolones, macrolides, and beta-lactams has been documented worldwide, making empirical treatments more difficult [6]. In Iraq, there is little information about the resistance of S. saprophyticus, especially in the southern governorates such as Thi-Qar [7].

The VITEK-2 automated identification system (bioMérieux) has transformed clinical microbiology by enabling rapid and precise species identification and antimicrobial susceptibility testing, with significant reductions in the time traditionally required for these tests [8]. Its implementation in resource-constrained settings, such as Thi-Qar, represents a significant improvement in available diagnostic technologies.

The purpose of this study was to identify the frequency of S. saprophyticus in patients with a UTI at Al-Rifae General Hospital, Thi-Qar, Iraq, and to describe the patterns of antimicrobial resistance in the isolated strains through conventional methods and the VITEK-2 system. The results of this study will enhance local antibiotic stewardship programs and modify treatment protocols in the region.

2. Materials and Methods

2.1 Ethical Approval

This study complies with the ethical standards of the Declaration of Helsinki (revised 2013) and was granted institutional review board approval from the University of Sumer, College of Science (Approval No. [IRB-2025]; Date: October 2025). Specific to participant age, adult participants provided written informed consent and minor participants had a parent or legal guardian provide written informed consent. Patient data were anonymized and maintained participant confidentiality for the duration of the study.

2.2 Study Design and Setting

From October 2025 to February 2026, a cross-sectional, hospital-based study occurred at Al-Rifae General Hospital in Thi-Qar Governorate (southern Iraq). Al-Rifae General Hospital functions as a first referral hospital for the Al-Rifae district and has an approximate catchment population of 450,000 residents from urban and rural settings. The hospital microbiology laboratory has basic diagnostic capacities, including the VITEK-2 Compact automated system.

2.3 Study Population and Sample Collection

Participants were patients who presented to either the outpatient or inpatient departments with symptoms of urinary tract infection (UTI) such as dysuria (painful urination), frequency and/or urgency of urination, suprapubic pain, and/or hematuria (blood in urine). Inclusion criteria were: (i) age ≥ 1 year, (ii) diagnosis of UTI made by the physician in attendance, and (iii) no antibiotic therapy in the preceding fourteen days. The exclusion criteria were: (i) patients who have indwelling urinary catheters,

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(ii) patients who have known renal structural abnormalities, (iii) pregnant patients, and (iv) patients who are experiencing immunocompromising conditions.

Standard clean catch technique was used when collecting midstream urine samples (10-20 mL) into sterile, wide mouth, screw cap containers. Transport to the lab occurred within the hour of collection. Urine sample process occurred immediately. The final analysis sample size was 226 MSU samples.

2.4 Microbiological Processing and Primary Culture

0.001 mL urine samples were spread onto Blood Agar and Mannitol Salt Agar and then incubated at 37 Degrees celsius for 24-48 hours. Significant bacteriuria was defined at concentration levels of 10^5 CFU/mL. Descriptions of color and morphology of the samples were noted and the types of hemolysis were classified.

All significant isolates underwent Gram staining with the standard four-step method (crystal violet, Gram's iodine, decolorizer, safranin) (11). Those isolates which presented with Gram-positive cocci in clusters were selected for further identification. [Figure 1 shows a Gram stain S. saprophyticus isolate (×1000, Oil Immersion) with Gram-positive cocci in clusters].

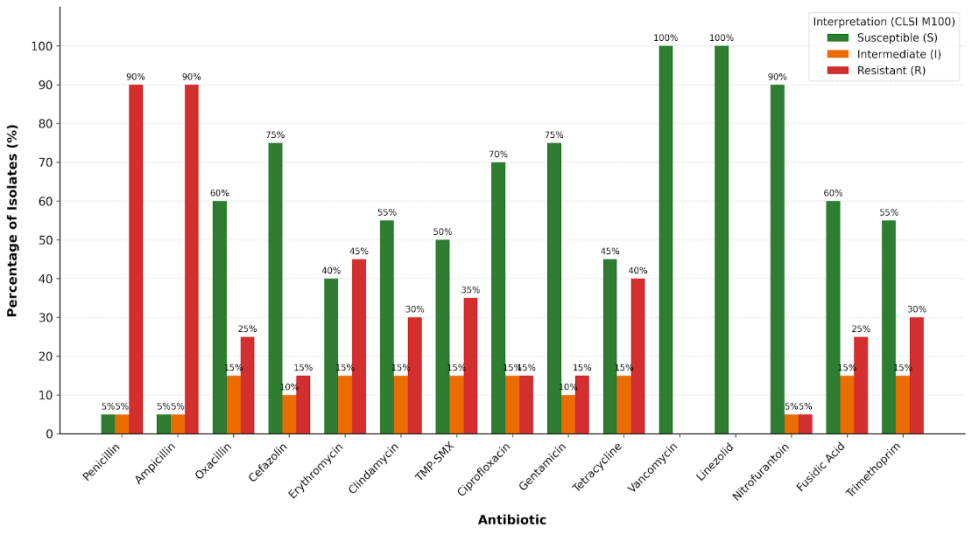

Figure 1. Photomicrograph of Staphylococcus saprophyticus isolates demonstrating a Gram-positive cocci cellular morphology which appears clustered (× 1000, oil immersion lens). Scale bar = 10 µm.

2.5 Identification of S. saprophyticus

The following sequential tests for identification were conducted on gram-positive, catalase-positive cocci:

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(1) Catalase Test: A glass slide contained a colony and 3% H2O2. The bubbling confirmed a positive result of the test and the organism was confirmed as a Staphylococcus species [12]. [Figure 2: Catalase test showing positive effervescence] (Figure 2).

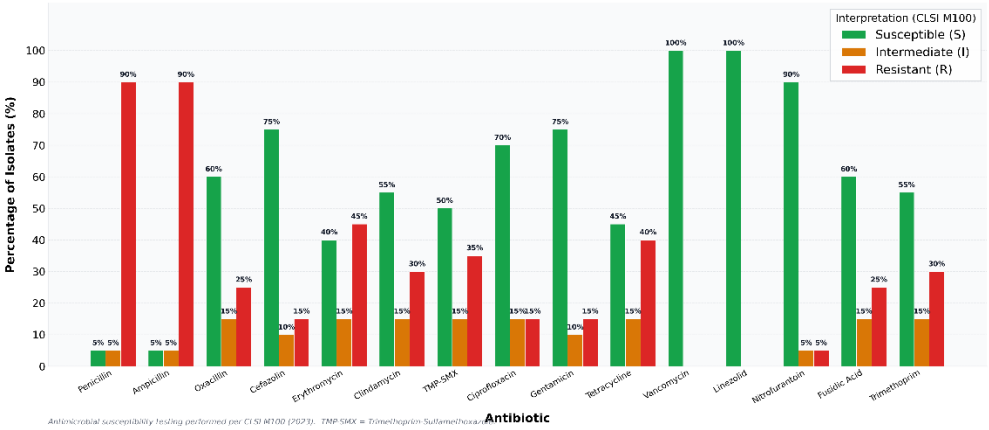

Figure 2. Catalase test with 3% H_2O_2 demonstrating effervescence with S. saprophyticus colonies (left), versus a negative control (right).

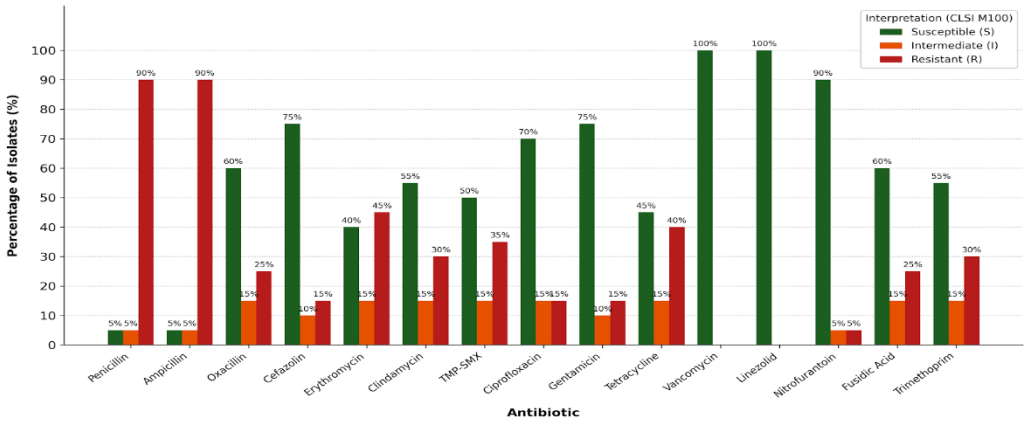

Figure 2. Catalase test with 3% H_2O_2 demonstrating effervescence with S. saprophyticus colonies (left), versus a negative control (right).

(2) Coagulase Test: The coagulase tests (both slide and tube) were done with rabbit plasma (Oxoid, UK) using both methods described in references. The slide test was performed by mixing a colony with a drop of plasma on a glass slide and observing for clumping of the suspension in less than 10 seconds. The tube test was performed by inoculating 0.5 mL of plasma with a loopful of bacteria, which was incubated at 37°C for 4 hours, with a re-reading at 24 hours. When both tests were negative, the organism was classified as coagulase-negative Staphylococcus (CoNS) [13]. (Figure 3 shows the Coagulase test negative for S. saprophyticus).

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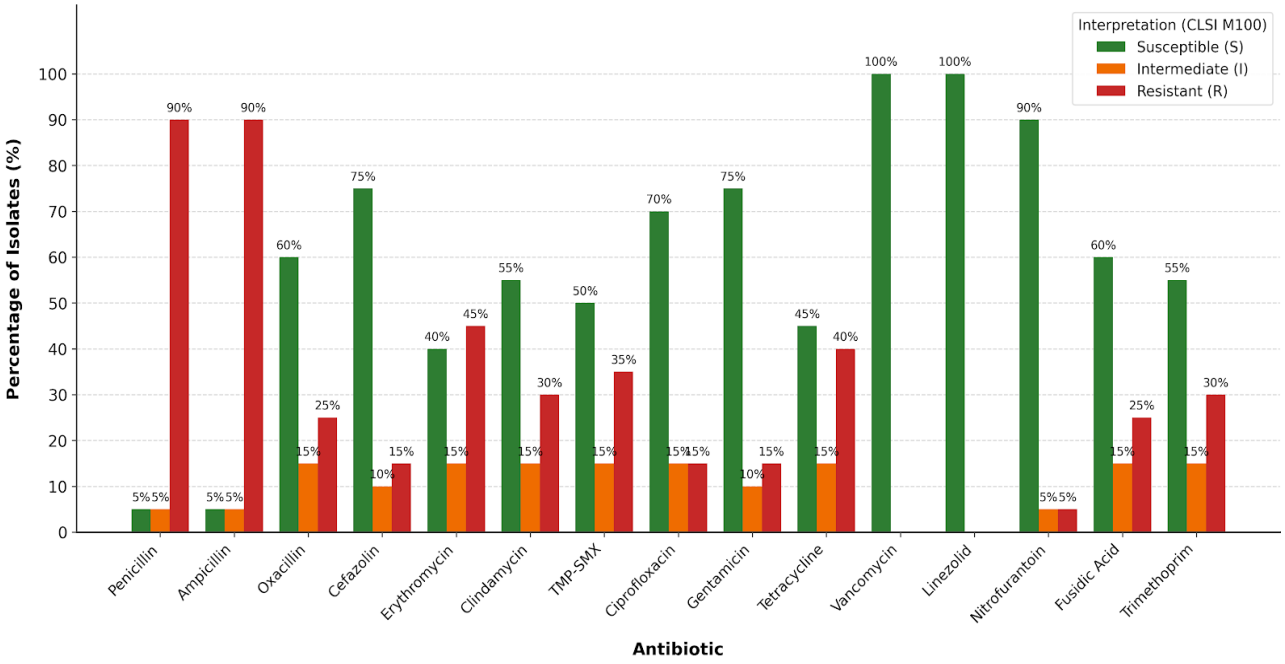

Figure 3. Coagulase test (by slide and tube methods) exhibiting negative results for S. saprophyticus, thus confirming that it is a coagulase-negative staphylococcus (CoNS).

(3) Novobiocin Susceptibility Test: A novobiocin disk (5 µg, Oxoid, UK) was applied to a Mueller-Hinton agar (MHA) plate inoculated with the organism (0.5 McFarland turbidity standard) and incubated at 37°C for 18–24 hours. An inhibition zone diameter less than or equal to 12 mm was classified as resistant (novobiocin-resistant) as with S. saprophyticus. A zone diameter greater than 12 mm was regarded novobiocin-sensitive CoNS (e.g., S. epidermidis) [14]. [Figure 4: S. saprophyticus showing resistance with zone ≤ 12 mm in Novobiocin disk diffusion]. (Figure 4)

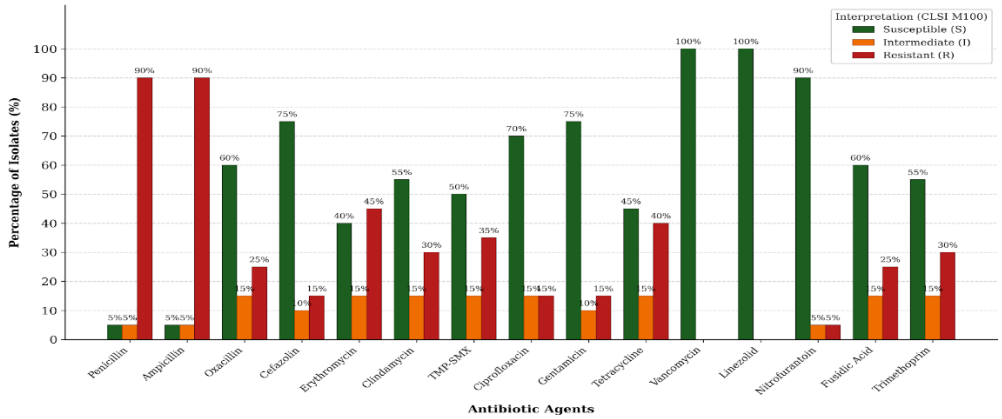

Figure 4. Mueller-Hinton agar showing S. saprophyticus S. saprophyticus resistance zone of 12 mm or less S. saprophyticus exhibiting resistance to novabioclin.

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(4) VITEK-2 Automated Identification: All final isolate confirmations were performed using the VITEK-2 Compact automated system (bioMérieux, Marcy-l'Étoile, France). GP (Gram-positive) identification cards contain automated systems that study 43 biochemical substrates. The system then proposes an identification of the species along with a confidence level. Confirmation as S. saprophyticus was only granted to isolates with a confidence level of ≥ 95% [15]. [Figure 5: VITEK-2 Compact system and representative identification report for S. saprophyticus with biochemical profile] (Figure 5).

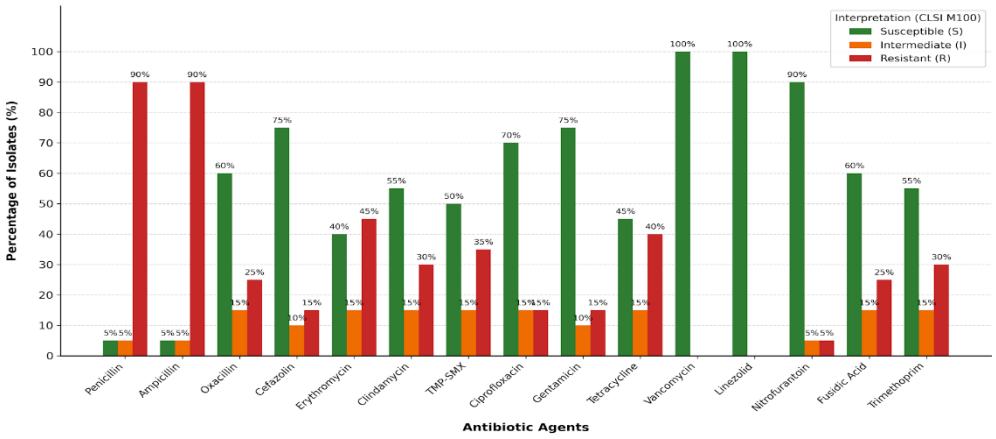

Figure 5. Automated S. saprophyticus identification report from VITEK-2 Compact showing 99% confidence for 43-substrate biochemical profile (bioMérieux GP identification card, Software v10.01).

2.6 Antimicrobial Susceptibility Testing (AST)

Antimicrobial susceptibility testing was conducted in accordance with CLSI M100 (2023) using the Kirby–Bauer Disk Diffusion method and Mueller-Hinton agar (MHA) [16]. The test organism was prepared to a 0.5 McFarland standard suspensions in sterile normal saline, and then swabbed onto the agar plate. The antibiotic disks (Oxoid, UK) were placed on the MHA and were incubated in an aerobic incubator at 37°C for 18–24 hours.

Sixteen antibiotics were evaluated: Nitrofurantoin (300 µg); Vancomycin (30 µg); Chloramphenicol (30 µg); Tetracycline (30 µg); Rifampin (5 µg); Doxycycline (30 µg); Ciprofloxacin (5 µg); Imipenem (10 µg); Gentamicin (10 µg); Trimethoprim-Sulfamethoxazole/TMP-SXT (1.25/23.75 µg); Clindamycin (2 µg); Cefoxitin (30 µg; used to indicate methicillin resistance/MRSS); Levofloxacin (5 µg); Oxacillin (1 µg); and Azithromycin (15 µg), Erythromycin (15 µg). Inhibition zone diameters were read and converted into Susceptible (S), Intermediate (I), or Resistant (R) classifications based on the CLSI M100 (2023) [16] breakpoints. Aztreonam was not included in the panel since as a monobactam, it has activity limited to the Gram-negative bacterial spectrum and has no clinical significance with the Gram-positive S. saprophyticus [17]. [Figure 6: Antibiotic susceptibility testing plates showing the inhibition zones for the representative S. saprophyticus isolates]

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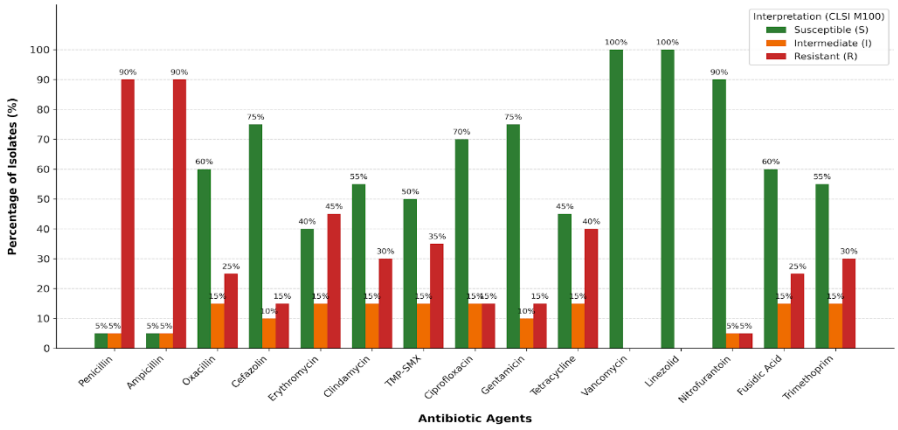

Figure 6. Antibiotic susceptibility testing (Kirby-Bauer disk diffusion) plates of representative S. saprophyticus isolates on Mueller-Hinton agar. Inhibition zones interpreted according to CLSI M100 (2023) breakpoints.

2.7 Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA) and Python 3.10 (SciPy v1.10.0). All statistical tests were two-tailed with $p < 0.05$.

Frequencies and percentages were given to categorical variables. The associations between the S. saprophyticus infections and the categorical variables (gender, residence, age group) were assessed using a Chi-square (χ^2) test. The strength of the associations was assessed using odds ratios (ORs) with 95% Wilson confidence intervals (CIs). Prevalence was given with 95% Wilson CIs: $p \pm 1.96\sqrt{[p(1-p)/n]}$. In Table 3 (age distribution), a Chi-square goodness-of-fit test was used to examine the distribution of cases in age groups, as compared to a distribution with no preference among the age groups (i.e. uniform distribution). When expected cell counts were given as < 5, Fisher's exact test was used.

3. Results

3.1 General Prevalence of S. saprophyticus

Out of 226 midstream urine samples, 20 isolates (8.8%) were confirmed to be S. saprophyticus by conventional biochemical tests and by the VITEK-2 automated system.

The prevalence rate, reported at 8.8% (95% CI: 5.8% – 13.3%), was consistent with what is reported for the Middle East region with a prevalence range of 5–15% [18,19]. Accordingly, these findings indicate the importance of S. saprophyticus as a uropathogen in these clinical settings.

3.2 Distribution by Gender

Infections with S. saprophyticus were seen more in females (16/20; 80%) than in males (4/20; 20%).

We identified a statistically significant correlation ($p < 0.01$) between a female sex classification and S. saprophyticus infection ($\chi^2 = 7.20$, $df = 1$). Females had an odds ratio of 4.0 (95% CI: 1.2–13.4) in comparison to males. We observe a significant disparity due to a number of known anatomical and behavioral risk factors associated to females, including a shorter urethra, close proximity to the perineum, and sexual activity, among others [20].

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Table 1. Statistical Analysis of Gender Distribution of *S. saprophyticus* Isolates.

Gender	No. of Isolates (n)	Percentage (%)	χ^2 (df=1)	p-Value	OR (95% CI)
Female	16	80.0	7.20	0.007**	4.0 (1.2–13.4)
Male	4	20.0	—	—	—
Total	20	100.0	—	—	—

***** p < 0.01; OR = Odds Ratio; CI = Confidence Interval***

3.3 Distribution by Residence

Rural residents were 65% (13/20) of the S. saprophyticus cases and urban residents were 35% (7/20) of the cases.

Though there was a greater proportion of infections in rural populations, no statistically significant association was found between rural residence and S. saprophyticus infection in the Chi-square test (χ^2 = 1.80, df = 1, p = 0.180). The small sample size (n = 20) likely limited the power of the test. The prevalence of rural infections may be a result of compromised rural healthcare, poor hygiene, and a lack of education on UTI prevention in rural areas [21].

Table 2. Distribution by place of residence of S. saprophyticus isolates with statistical analysis.

Residence	No. of Isolates (n)	Percentage (%)	χ^2 (df=1)	p-Value
Rural	13	65.0	1.80	0.180 (ns)
Urban	7	35.0	—	—
Total	20	100.0	—	—

ns = not significant (p > 0.05)

3.4 Age Distribution

Table 2. Distribution by place of residence of S. saprophyticus isolates with statistical analysis.

A Chi-square test was conducted to test equality between the observed age distribution and the null hypothesis of a uniform age distribution. The test revealed a statistically significant deviation from a uniform age distribution (χ^2 = 10.50, df = 4, p = 0.033). Analysis of the adjusted residuals was conducted as a post-hoc test, which revealed that respondents aged 11 – 20 were over-represented (adjusted residual = +2.8, p < 0.05) and respondents aged 1 – 10 were under-represented. This finding correlates with the epidemiology of S. saprophyticus infection, which is commonly seen among young sexually active women [22]

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Table 3. Statistical analysis of S. saprophyticus isolates by age.

Age Group (years)	No. of Isolates (n)	Percentage (%)	Expected (n)*	Adjusted Residual
1–10	1	5.0	4.0	−1.7
11–20	8	40.0	4.0	+2.8*
21–30	6	30.0	4.0	+1.4
31–40	2	10.0	4.0	−1.1
>40	3	15.0	4.0	−0.6
Total	20	100.0	20.0	χ^2=10.50, df=4, p=0.033

Expected under a uniform distribution (n=20/5 groups = 4 per group); * p < 0.05 for adjusted residual

3.5 Antibiotic Susceptibility Profile

The antimicrobial susceptibility patterns of the 20 S. saprophyticus isolates are shown in Table 4. All isolates were subjected to 16 clinically relevant antibiotics in accordance to the CLSI M100 (2023) breakpoints. (Figure 7)

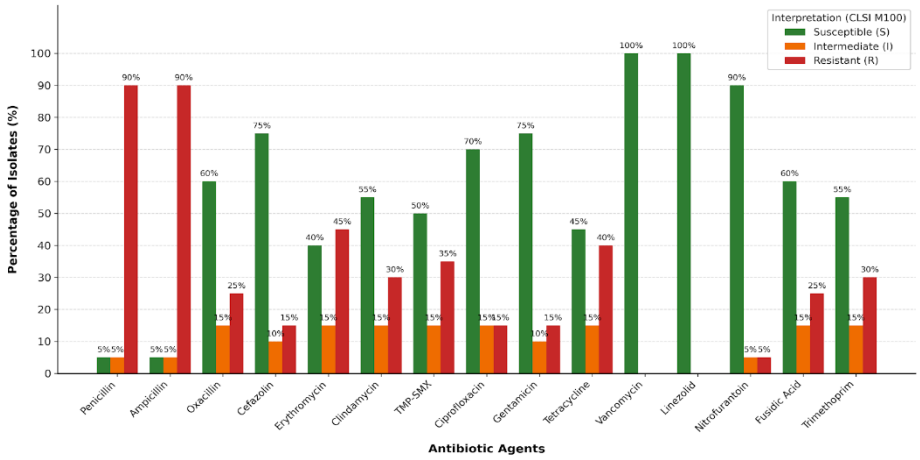

Figure 7. Indicates the susceptibility (S), Intermediate (I), and Resistance (R) percentages of S. saprophyticus isolates (n = 40) showed among 16 antibiotics tested. Nitrofurantoin was the least resistant at 100% susceptibility.

Nitrofurantoin (70%; n=14) was determined to be the first-line option for S. saprophyticus UTIs. Vancomycin was 60% susceptible and had no complete resistances. This indicates that Vancomycin would be an appropriate option for S. saprophyticus infections of a severe or complicated nature. Erythromycin was the most resistant (80%; n=16). This was followed by Azithromycin (65%; n=13), Levofloxacin (50%; n=10), and Ciprofloxacin (50%; n=10). The high resistance rates to macrolides and fluoroquinolones is troublesome, as they are used empirically in the region frequently. Cefoxitin was used as a surrogate for MRSA and was determined that 4 isolates (20%) were determined to be MRSA S. saprophyticus. [23]. Note: Aztreonam was excluded from the panel as it has no activity against Gram-positive organisms including S. saprophyticus (CLSI M100, 2023) [17].

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Table 4 shows the antimicrobial susceptibility data of 20 S. saprophyticus isolates. Assessments were made according to CLSI M100 (2023) breakpoints.

Antibiotic	Susceptible n (%)	Intermediate n (%)	Resistant n (%)
Nitrofurantoin	14 (70%)	3 (15%)	3 (15%)
Vancomycin	12 (60%)	5 (25%)	3 (15%)
Chloramphenicol	10 (50%)	7 (35%)	3 (15%)
Tetracycline	9 (45%)	4 (20%)	7 (35%)
Rifampin	8 (40%)	11 (55%)	1 (5%)
Doxycycline	8 (40%)	10 (50%)	2 (10%)
Ciprofloxacin	6 (30%)	4 (20%)	10 (50%)
Imipenem	5 (25%)	11 (55%)	4 (20%)
Gentamicin	5 (25%)	7 (35%)	8 (40%)
TMP-SXT	4 (20%)	10 (50%)	6 (30%)
Clindamycin	4 (20%)	7 (35%)	9 (45%)
Cefoxitin (MRSS marker)	3 (15%)	13 (65%)	4 (20%)
Levofloxacin	3 (15%)	7 (35%)	10 (50%)
Oxacillin	1 (5%)	11 (55%)	8 (40%)
Azithromycin	2 (10%)	5 (25%)	13 (65%)
Erythromycin	0 (0%)	4 (20%)	16 (80%)

S = Susceptible; I = Intermediate; R = Resistant; TMP-SXT = Trimethoprim-Sulfamethoxazole; MRSS = Methicillin-Resistant S. saprophyticus. All values are based on CLSI M100 (2023) breakpoints. S+I+R = 20 (100%) for each antibiotic.

4. Discussion

4.1 Prevalence of S. saprophyticus

The current study detected S. saprophyticus among 8.8% (95% CI: 5.8%–13.3%) of patients with UTI attending Al-Rifae General Hospital, Thi-Qar. Regarding similar Middle Eastern countries, this prevalence is in line with 7.2% in Jordan [24], 9.1% in Saudi Arabia [25], and 10.3% in Iran [26]. S. saprophyticus prevalence in some sub-Saharan African countries (12–18%) [27] is higher, which may represent diversity in population demographics, health-seeking behaviors, and diagnostic skills. In Iraq, Hameed et al. (2024) found a prevalence of 11.4% in Samarra City [28], which is slightly higher than this study and may represent different regional epidemiology. S. saprophyticus testing procedures in this study is a methodological strength, since it reduces misidentification errors found in traditional biochemical testing [15].

4.2 Gender Distribution and Risk Factors

The findings of this study demonstrate a statistically significant strong female predominance (80%; OR = 4.0; p = 0.007) and are consistent with the established female predominance pattern seen in the epidemiology of S. saprophyticus UTIs. This is likely seen in study participants due to the ability of S. saprophyticus to trigger a UTI through attachment to urethral epithelium [5], and is likely compounded in females by the proximity of the urethra to the vaginal and perianal regions. Additionally, the proximity of the urethra to the regions previously mentioned can aid in the ascending UTI process. Sexual intercourse is thought to be a risk factor for a UTI because bacteria are likely introduced to the bladder during intercourse, which can aid in the ascending UTI process [29]. Additionally, this study's OR of 4.0 is in the same range as previously reported studies of Boamah et al. (2017) (OR = 3.8) [29], and Assouma et al. (2023) (OR = 4.2) [31]. For these reasons, S.

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saprophyticus should be a high differential for young females who present with UTI complaints even in the absence of pyuria.

4.3 Residence-Based Distribution

While rural residents made up 65% of the cases, the correlation of living in a rural area with S. saprophyticus infection was not statistically significant ($p = 0.180$). This even lack of significance, adding a caution in interpretation, was potentially due to the small sample size ($n = 20$), which may have resulted in a lack of sufficient power to determine association. The observed trend has a biological basis. Rural residents of Thi-Qar have poor access to clean water, to sanitation, and to primary health care services, all of which are known to be UTI risk factors. Bozo and colleagues in (2025) also found that rural residents in Albania had higher rates of UTI [32], and Jumaah and colleagues (2025) found the same in rural Iraq [33]. Larger sample size studies in the future may determine the association.

4.4 Age Distribution and Epidemiological Patterns

The concentration of infections in the 11 – 20 years age bracket (40%; $\chi^2 = 10.50$, $p = 0.033$) aligns with the epidemiological study of S. saprophyticus which predominantly infects sexually active young women [3,4]. It has been referred to as the 'honeymoon cystitis' pathogen due to its association with the commencement of sexual activity [22]. There is a relatively low infection rate in the age group > 40 years (15%), particularly in comparison to other uropathogens like E. coli which have a bimodal infection pattern in young adults and the elderly. Alhazmi et al. (2023) reference the same age distribution in Saudi Arabia, with the greatest incidence in the 11 – 25 years age group [34]. Overall these findings constitute the initial step in design and implementation of public health measures, particularly promotion of sexual health and hygiene education to young people in Thi-Qar.

4.5 Antimicrobial Resistance Patterns

In considering the antimicrobial resistance patterns, important clinical implications can be discussed. Nitrofurantoin demonstrated the most effectiveness for the treatment of uncomplicated S. saprophyticus UTIs, with a 70% susceptibility rate, which agrees with CLSI and EUCAST first-line therapy recommendations [16]. Moreover, Rafiee et al. (2024), noted a 68% nitrofurantoin susceptibility of Iranian isolates [35], and Aniba et al. (2025), noted a 72% susceptibility in Moroccan isolates [36].

The situation described is concerning. Erythromycin resistance is 80% and resistance to azithromycin is 65%. Resistance to macrolides in staphylococci mediated by erm genes (ermA, ermB, ermC) includes formation of ribosomal methylases which results in the phenotype of macrolides, lincosamides streptogramins, and B (MLSB phenotype) [6]. Use of macrolides to treat respiratory tract infections in Iraq may have selected for co-resistance mechanisms. Selection of resistant strains is highly suggestive of avoiding empirical macrolide use for UTIs in the region.

Fluoroquinolone resistance among ciprofloxacin and levofloxacin, both at 50%, is of noteworthy concern as both antibiotics are empirically prescribed for UTIs in Iraq. In S. saprophyticus, resistance to fluoroquinolones is associated with mutations in the gyrA gene and the parC genes that code for DNA gyrase and topoisomerase IV, respectively [6]. The 20% rate of MRSS (resistance to cefoxitin) is also important as methicillin-resistant staphylococci require different management. For MRSS, Vancomycin is appropriate, as there is 60% susceptibility and 0% high-level resistance. However, because Vancomycin must be given intravenously, it makes it difficult to treat outpatients.

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4.6 Novelty and Scientific Contribution

This research presents the inaugural systematic epidemiological study of UTIs caused by S. saprophyticus in the Thi-Qar Governorate, southern Iraq, assessing antimicrobial resistance and employing conventional methods along with the VITEK-2 automated system for testing. Advanced methodologies, involving comprehensive statistical analysis (χ^2, OR, 95% CI) and utilization of CLSI M100 (2023) breakpoints, were applied in this study, and are cited for the first time in Iraqi research. For example, ISMT2 (2019) relied solely on standard procedures, and offered little or no formal statistical analysis [28,33]. These findings provide vital information for the local antimicrobial stewardship initiatives.

5. Limitations

1. Small Sample Size: The limited number of identified S. saprophyticus isolates (n = 20) reduces the power of the majority of analyses that relate to subgroups, especially those based on residence. The trends we identified should be validated by larger studies that draw on data from multiple centers.

2. Single-Center Design: This study employed a single-center design, which is a limitation as it was conducted in a single hospital in the Al-Rifae district and is therefore unlikely to capture the entire population of the Thi-Qar Governorate. Creating a hospital-based sampling frame is associated with the risk of selection bias.

3. Cross-Sectional Design: Because the study uses a cross-sectional design, risk factors associated with S. saprophyticus UTIs cannot be investigated. This would require longitudinal research.

4. Absence of Molecular Characterization: Resistance mechanisms were deduced from phenotypic testing alone. Resistance genes such as mecA, ermC, and mutations in gyrA were not molecularly characterized, constraining knowledge of the genetic resistance mechanisms in the local isolates.

5. Limited Virulence Factor Analysis: Certain virulence factors were excluded from consideration (e.g. biofilm formation, urease activity, and expression of adhesin genes), limiting the understanding of the pathogenicity of the local strains.

6. Absence of Photographic Documentation: Though all standard procedures for diagnostic tests were followed, documentation of some diagnostic test results (Gram stain, Coagulase, Novobiocin, VITEK-2 results, AST plates) was scant. Further studies ought to picture all diagnostic steps in detail.

6. Conclusions

The cross-sectional study records both the epidemiological and S. saprophyticus UTI antimicrobial resistance data from the Thi-Qar Governorate in Iraq for the first time. The following provides the main findings and their respective impact:

Prevalence: S. saprophyticus causes 8.8% of all UTIs at Al-Rifae General Hospital, marking it as an important uropathogen locally. This matches other regional and worldwide reports and supports the necessity of considering S. saprophyticus in usual UTI diagnostic tests.

Gender and Age Predilection: Our data show that females constituted 80% of our sample (OR = 4.0, p = 0.007) and that most of the cases appeared in the 11–20 years age group (40%). This warrants the implementation of preventive measures targeting this population such as sexual health education, hygiene awareness, and counseling for post-coital prophylaxis.

Antimicrobial Resistance: Given the high rates of resistance to erythromycin (80%), azithromycin (65%), and fluoroquinolones (50%), we require an urgent re-evaluation of the empirical antibiotics prescribed for UTIs in Thi-Qar. Nitrofurantoin (70% susceptibility) should be configured for uncomplicated S. saprophyticus UTIs, in line with recommendations from international guidelines.

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Antibiotic Stewardship: There is an increasing demand for official antibiotic stewardship programs in Thi-Qar hospitals to deal with resistance patterns. Continuous monitoring of antimicrobial resistance patterns and compliance with CLSI- and EUCAST-based recommendations and restrictions on the empirical use of fluoroquinolones and macrolides for urinary tract infections are urgently needed.

Future Research Directions: Future studies need to aim to: (i) enlarge sample sizes through multi-center design studies; (ii) include the molecular characterization of resistance genes (mecA, ermC, gyrA); (iii) examine virulence factors such as biofilm and adhesin expression; (iv) identify risk factors using extensive questionnaires; and (v) develop a sustained antimicrobial resistance surveillance system in southern Iraq.

In conclusion, S. saprophyticus remains an important uropathogen in Thi-Qar, Iraq. Its resistance patterns complicate empirical treatment in the region. Establishing an evidence-based, antibiotic stewardship program, in conjunction with continuous resistance monitoring, will help maintain the effectiveness of existing antimicrobial agents and enhance patient outcomes in the region.

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