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ORIGINAL ARTICLE

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Culture-Confirmed Bacteriuria During Pregnancy in Sana'a, Yemen: Prevalence, Associated Factors, Clinical Correlates, and Resistance Patterns

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ABSTRACT

Background: Bacteriuria during pregnancy is an important maternal health concern, particularly in settings with limited microbiological diagnostic services. This study estimated the prevalence of culture-confirmed bacteriuria and examined associated factors, clinical correlates, and antibiotic susceptibility patterns among pregnant women in Sana'a, Yemen.

Methods: A facility-based cross-sectional study was conducted among 203 pregnant women attending two healthcare facilities in Sana'a from April to October 2026. Sociodemographic, obstetric, and clinical data were collected using a structured questionnaire. Midstream urine specimens were cultured, and significant bacteriuria was defined as ≥10^5 CFU/mL of a single bacterial species. Isolates were identified using conventional microbiological methods, and antibiotic susceptibility was assessed using the disk diffusion method. Associations were examined using chi-square or Fisher's exact tests, and crude odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) were reported. Statistical significance was set at *P* value <0.05.

Results: Culture-confirmed bacteriuria was detected in 29 women (14.3%; 95% CI: 9.8–19.9). *Escherichia coli* was the predominant isolate (48.3%), followed by *Staphylococcus aureus* (37.9%), *Enterococcus* spp. (10.3%), and *Citrobacter freundii* (3.4%). No significant associations were found with sociodemographic or obstetric characteristics. Urinary urgency was the only symptom significantly associated with bacteriuria (OR = 2.4, 95% CI: 1.05–5.30; P = 0.045). The highest resistance rates were observed for amoxicillin-clavulanic acid (89.7%) and ampicillin (82.8%), with 93.1% of isolates resistant to at least three tested antibiotics.

Conclusion: Culture-confirmed bacteriuria remains an important concern among pregnant women attending antenatal care in Sana'a, with *E. coli* being the predominant bacterial isolate. Sociodemographic and obstetric factors and urinary symptoms have limited value in identifying affected women. Resistance to commonly used antibiotics underscores the need for reliable diagnosis, standardized susceptibility testing, culture-guided treatment, and routine antimicrobial resistance surveillance.

Keywords: Culture-confirmed bacteriuria ▪ Pregnancy ▪ Bacterial etiology ▪ Clinical correlates ▪ Antibiotic susceptibility ▪ Yemen

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1. Introduction

Urinary tract infections (UTIs) are common during pregnancy and represent important concerns for maternal and perinatal health.[1] Physiological and anatomical changes during pregnancy, including ureteral compression by the enlarging uterus and subsequent urinary stasis, may increase susceptibility to UTIs.[1,2] In settings with limited access to antenatal care (ANC) and laboratory services, timely diagnosis and appropriate treatment may be particularly challenging.

Untreated bacteriuria can progress to pyelonephritis, a potentially serious complication of pregnancy. A prospective cohort study found that pregnant women with untreated asymptomatic bacteriuria (ASB) had a higher risk of developing pyelonephritis.[3] The prevalence of ASB during pregnancy varies considerably across geographical regions and healthcare settings. Systematic reviews and meta-analyses have estimated pooled ASB prevalence estimates of 11.1% in Africa and 18.5% in Latin America.[4,5]

Previous studies in Yemen have reported considerable variation in UTI prevalence among pregnant women. In Al-Mukalla, a prevalence of 30% was reported among pregnant women attending a maternity hospital in 2005,[6] while a prevalence of 24.3% was reported among pregnant women in Sana'a in 2007.[7] Subsequently, Edrees and Anbar (2020) found culture-positive bacteriuria in 18% of pregnant women attending three hospitals in Sana'a,[8] and Al-Shehari et al. (2025) reported culture-positive bacteriuria in 22.8% of pregnant women attending hospitals in Sana'a.[9] In contrast, a substantially higher prevalence of 60% was reported in Damt district, Al-Dhale governorate.[10] These differences may partly reflect variations in participant characteristics, recruitment settings, diagnostic criteria, and microbiological procedures. The ongoing humanitarian and economic challenges in Yemen may also affect access to antenatal services and microbiological testing, as reflected in assessments of health service availability.[11]

Studies in Yemen have identified Gram-negative bacteria, particularly Escherichia coli, as leading causes of culture-positive bacteriuria in pregnant women. *E. coli* accounted for 41.6–50% of bacterial isolates in Sana'a and 42.9% in Al-Dhale.[8-10] Other reported bacterial species include *Staphylococcus aureus*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *Proteus mirabilis*, and coagulase-negative staphylococci.[8-10] The relative frequencies of these organisms vary across studies, and the clinical significance of Gram-positive isolates should be interpreted in relation to specimen quality, possible contamination, bacterial identification, and clinical presentation.

Antibiotic resistance presents an additional challenge in the management of urinary infections during pregnancy. Previous studies in Yemen have reported resistance to several commonly used antibiotics, although susceptibility patterns vary across bacterial species and healthcare settings. In Damt district, resistance ranged from 80% to 100% for amoxicillin and from 40% to 70% for ceftriaxone among the bacterial isolates tested.[10] More recently, a retrospective microbiological investigation in Sana'a reported high resistance to amoxicillin (94.1%) and ampicillin (85.9%) among uropathogens isolated from patients with suspected UTIs.[12] Although the latter investigation was not restricted to pregnant women, these findings raise concerns about the effectiveness of commonly used empirical antibiotics and highlight the need for population-specific susceptibility data. Moreover, antibiotic selection during pregnancy requires consideration of both the susceptibility of the isolated organism and maternal-fetal safety.[1]

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Therefore, local antibiotic susceptibility data are essential for guiding appropriate treatment and promoting responsible antibiotic use.

Despite previous studies, evidence on the prevalence, associated factors, clinical correlates, and antibiotic resistance patterns of bacteriuria among pregnant women in Sana'a remains limited and heterogeneous. This study aimed to estimate the prevalence of culture-confirmed bacteriuria, examine associated sociodemographic and obstetric factors and clinical correlates, and describe bacterial isolates and their antibiotic susceptibility patterns among pregnant women attending two health facilities in Sana'a, Yemen.

2. Methods

2.1. Study design, setting and participants

A facility-based cross-sectional study was conducted from April to October 2026 in Sana'a City, Yemen, to determine the prevalence of culture-confirmed bacteriuria, identify the causative bacterial pathogens, and assess their antibiotic susceptibility patterns among pregnant women. The study was carried out at two healthcare facilities: the University of Science and Technology Hospital, a tertiary care hospital, and Al-Soneena Medical Center, a primary-care facility.

The study included pregnant women attending the obstetrics and gynecology clinics at both facilities during the study period. Women at any gestational age were eligible for inclusion if they agreed to participate and provided written informed consent. Women with known urinary tract abnormalities or renal failure were excluded, and those who declined to participate were not enrolled.

2.2. Sample size and sampling

The sample size was determined using OpenEpi version 3.01 (www.openepi.com), based on a previously reported bacteriuria prevalence of 22.8% among pregnant women in Sana'a,[9] a 95% confidence level, a 6% margin of error, and a design effect of 1. The minimum required sample size was 188 participants. However, 203 pregnant women were ultimately enrolled. Consecutive sampling was used to recruit eligible pregnant women attending the participating health facilities until the required sample size was reached.

2.3. Data collection

Data were collected using a structured questionnaire administered by trained nursing staff after obtaining informed consent. The questionnaire collected sociodemographic information, including age, place of residence, education, and employment status; obstetric characteristics, including gestational age, gravidity, parity, and obstetric history; and clinical information, including chronic diseases, previous UTIs, current urinary symptoms, and recent antibiotic use.

2.4. Urine sample collection and processing

Participants were instructed on proper clean-catch midstream urine collection to reduce specimen contamination. Approximately 10 mL of urine was collected in a sterile, pre-labeled container. Urine specimens were transported to the Microbiology Laboratory within 1–2 hours of collection and processed within two hours of arrival. Specimens that could not be processed immediately were refrigerated at 4–8 °C and cultured within 24 hours.

2.5. Urine culture and bacterial identification

Urine specimens were inoculated onto blood agar and MacConkey agar using a calibrated 0.001-mL loop. Inoculated plates were incubated aerobically at 37 °C for 24 hours and examined for bacterial growth. A urine culture was considered positive for significant bacteriuria when a single bacterial species grew at a concentration of ≥10^5 colony-forming units per milliliter (CFU/mL), consistent with

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the culture threshold described by the American College of Obstetricians and Gynecologists.[1]

Bacterial isolates were identified by colony morphology, Gram staining, and standard biochemical tests. Gram-negative isolates were further identified using oxidase, indole, citrate utilization, urease, and triple sugar iron tests. Gram-positive isolates were identified using catalase, coagulase, and novobiocin susceptibility tests, as appropriate.

2.6. Antibiotic susceptibility testing

Antibiotic susceptibility was assessed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar, following Clinical and Laboratory Standards Institute (CLSI) guidelines.[13] Bacterial suspensions were standardized to 0.5 McFarland turbidity and evenly spread onto Mueller-Hinton agar plates. Following application of antibiotic disks and incubation, inhibition zone diameters were measured and interpreted according to CLSI criteria. The antibiotics evaluated were aztreonam, gentamicin, tetracycline, amikacin, ampicillin, amoxicillin-clavulanic acid, levofloxacin, ceftriaxone, norfloxacin, ciprofloxacin, imipenem, and cefuroxime.

2.7. Data analysis

Data were analyzed using IBM SPSS Statistics, version 26 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies and percentages. Associations between participant characteristics and culture-confirmed bacteriuria were examined using the chi-square or Fisher's exact test. Crude odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated for selected comparisons. A *P*-value <0.05 was set for statistical significance.

3. Results

3.1. Sociodemographic and obstetric characteristics

Of the 203 pregnant women, 57.6% were older than 25 years, 92.1% lived in urban areas, and 90.1% were unemployed. Secondary or higher education was reported by 82.8% of participants. Of the 188 women with recorded gestational age, 47.9% were in their second trimester, while 38.9% of all participants were primigravidae (Table 1).

Table 1: Sociodemographic and obstetric characteristics of the study population (*N* = 203)

Characteristics	*n* (%)
Age group (years)	
≤25	86 (42.4)
>25	117 (57.6)
Residence [a]	
Urban	186 (92.1)
Rural	16 (7.9)
Educational status	
No formal education	12 (5.9)
Primary	23 (11.3)
Secondary	74 (36.5)
University and above	94 (46.3)
Employment status	
Unemployed	183 (90.1)
Employed	20 (9.9)
Gestational trimester [b]	
First	43 (22.9)
Second	90 (47.9)
Third	55 (29.3)
Gravidity	
Primigravida	79 (38.9)
Multigravida	124 (61.1)

[a] One missing case; [b] 15 missing cases.

3.2. Prevalence of culture-positive bacteriuria

Among 203 pregnant women, 29 had significant bacterial growth on urine culture, corresponding to a prevalence of 14.3% (95% CI: 9.8–19.9). The remaining 174 participants (85.7%) had no significant bacterial growth.

3.3. Association of sociodemographic and obstetric characteristics with culture-confirmed bacteriuria

Table 2 shows that culture-confirmed bacteriuria was more frequent among women aged ≤25 years (16.3%) than those aged >25 years (12.8%), although the difference was not statistically significant (*P* = 0.545). Similarly, urban residents had a higher prevalence of bacteriuria than rural residents (15.1% *vs.* 6.2%), with

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no statistically significant association (*P* = 0.477). The highest prevalence was observed among women with university-level education or higher (17.0%), followed by those with no formal education (16.7%), with no significant association between educational status and bacteriuria (*P* = 0.708). Bacteriuria was also more frequent among unemployed than employed women (14.8% *vs.* 10.0%), but the association was not significant (*P* = 0.745).

Regarding obstetric characteristics, the prevalence of bacteriuria was slightly higher during the second trimester (14.4%) than during the first (14.0%) and third (10.9%) trimesters, without a statistically significant association (*P* = 0.822). The prevalence was slightly higher among primigravid than multigravid women (15.2% vs. 13.7%), but the difference was not statistically significant (*P* = 0.838), as shown in Table 2.

Table 2: Association of sociodemographic and obstetric characteristics with culture-confirmed bacteriuria among pregnant women at two healthcare facilities in Sana'a, Yemen, 2026

Characteristics	N	Culture-confirmed bacteriuria		P value
		n (%)	OR (95% CI)	
Age group (years)				
≤25	86	14 (16.3)	1.3 (0.60–2.91)	0.545
>25	117	15 (12.8)	Reference	
Residence				
Urban	186	28 (15.1)	2.7 (0.34–20.93)	0.477
Rural	16	1 (6.2)	Reference	
Educational status				
No formal education	12	2 (16.7)	1.0 (0.19–4.88)	
Primary	23	3 (13.0)	0.7 (0.19–2.76)	0.708
Secondary	74	8 (10.8)	0.6 (0.24–1.47)	
University and above	94	16 (17.0)	Reference	
Employment status				
Unemployed	183	27 (14.8)	1.6 (0.34–7.10)	0.745
Employed	20	2 (10.0)	Reference	
Gestational trimester				
First	43	6 (14.0)	1.3 (0.40–4.44)	0.822
Second	90	13 (14.4)	1.4 (0.49–3.87)	
Third	55	6 (10.9)	Reference	
Gravidity				
Primigravida	79	12 (15.2)	1.1 (0.51–2.51)	0.838
Multigravida	124	17 (13.7)	Reference	

OR, odds ratio; CI, confidence interval.

3.4. Association of clinical correlates with culture-confirmed bacteriuria

Table 3 shows that culture-confirmed bacteriuria was more frequent among women with preeclampsia than those without (33.3% vs. 13.4%), although the association was not statistically significant (*P* = 0.122). Women with diabetes mellitus had a higher prevalence of bacteriuria than those without diabetes (42.9% *vs.* 13.3%), but the association was not significant (*P* = 0.062). No cases of bacteriuria were detected among women with chronic hypertension, compared with 14.7% among those without hypertension (*P* = 0.597). Bacteriuria was slightly more frequent among women with a history of anemia (15.6% *vs.* 14.0%; *P* = 0.786), previous UTI (17.3% *vs.* 12.3%; *P* = 0.413), or stillbirth (18.0% *vs.* 13.1%; *P* = 0.485), but none of these associations was significant. Women with a history of early neonatal death also had a higher prevalence of bacteriuria than those without such a history (31.2% *vs.* 12.9%), although the difference did not reach statistical significance (*P* = 0.060).

Table 3 also shows that urinary urgency was the only symptom significantly associated with culture-confirmed bacteriuria, with a higher prevalence among women reporting urgency than those without this symptom (22.8% *vs.* 11.1%; OR = 2.4, 95% CI 1.05–5.30; *P* = 0.045). Bacteriuria was also more frequent among women reporting dysuria (19.7% *vs.* 11.1%; *P* = 0.101), urinary frequency (16.8% *vs.* 12.1%; *P* = 0.422), and fever (18.5% *vs.* 12.4%; *P* = 0.285), but these associations were not significant. In contrast, the prevalence was slightly lower among women reporting suprapubic pain (13.7% *vs.* 14.7%; *P* = 1.000) or flank pain (12.7% *vs.* 14.6%; *P* = 0.832), with neither symptom showing a significant association.

3.5. Distribution of bacterial isolate and resistance measures

Among the 29 culture-positive specimens, 15 isolates (51.7%) were Gram-negative and 14 (48.3%) were Gram-positive, according to their identified species. *E. coli* was the most common isolate (14/29, 48.3%), followed by *S. aureus* (11/29, 37.9%),

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Enterococcus species (3/29, 10.3%), and *C. freundii* (1/29, 3.4%). Resistance to at least three tested antibiotic agents was observed in 27 isolates (93.1%) (Table 4).

Isolates were resistant to a mean of 5.21 ± 1.84 antibiotics, with an overall mean multiple antibiotic resistance (MAR) index of 0.44 ± 0.16. The highest mean MAR index was observed in *E. coli* (0.46 ± 0.17), followed by *S. aureus* (0.45 ± 0.15), *Enterococcus* spp. (0.39 ± 0.05), and *C. freundii* (0.17). All *S. aureus* and *Enterococcus* isolates and 92.9% of E. coli isolates were resistant to at least three antibiotics. The single *C. freundii* isolate was resistant to two antibiotics (Table 4).

3.6. Antibiotic susceptibility of bacterial isolates

Table 5 presents the antibiotic susceptibility patterns of the bacterial isolates. The highest resistance rates were observed for amoxicillin-clavulanic acid (89.7%) and ampicillin (82.8%), followed by cefuroxime (58.6%) and tetracycline (51.7%). Resistance patterns varied across bacterial species. All *E. coli* isolates (100%) were reported as resistant to ampicillin and amoxicillin-clavulanic acid, while 78.6% and 64.3% were resistant to cefuroxime and tetracycline, respectively. Similarly, all *S. aureus* isolates (100%) were reported as resistant to amoxicillin-clavulanic acid, while 81.8% were resistant to ampicillin and 54.5% to cefuroxime. All three *Enterococcus* spp. isolates (100%) were resistant to tetracycline. The single *C. freundii* isolate was reported as resistant to amoxicillin-clavulanic acid and ampicillin.

Table 3: Association of clinical correlates with culture-confirmed bacteriuria among pregnant women at two healthcare facilities in Sana'a, Yemen, 2026

Characteristics	*N*	Culture-positive *n* (%)	Culture-negative *n* (%)	OR (95% CI)	P value
Preeclampsia					
Yes	9	3 (33.3)	6 (66.7)	3.2 (0.76–13.72)	0.122
No	194	26 (13.4)	168 (86.6)	Reference	
Chronic hypertension					
Yes	6	0 (0.0)	6 (100.0)	0.4 (0.02–8.01)	0.597
No	197	29 (14.7)	168 (85.3)	Reference	
Diabetes mellitus					
Yes	7	3 (42.9)	4 (57.1)	4.8 (0.67–30.44)	0.062
No	196	26 (13.3)	170 (86.7)	Reference	
History of anemia					
Yes	32	5 (15.6)	27 (84.4)	1.1 (0.40–3.23)	0.786
No	171	24 (14.0)	147 (86.0)	Reference	
Previous UTI					
Yes	81	14 (17.3)	67 (82.7)	1.5 (0.68–3.28)	0.413
No	122	15 (12.3)	107 (87.7)	Reference	
History of stillbirth					
Yes	50	9 (18.0)	41 (82.0)	1.5 (0.62–3.45)	0.485
No	153	20 (13.1)	133 (86.9)	Reference	
Previous early neonatal death					
Yes	16	5 (31.2)	11 (68.8)	3.1 (0.98–9.60)	0.060
No	186	24 (12.9)	162 (87.1)	Reference	
Dysuria					
Yes	76	15 (19.7)	61 (80.3)	2.0 (0.89–4.34)	0.101
No	126	14 (11.1)	112 (88.9)	Reference	
Urinary frequency					
Yes	95	16 (16.8)	79 (83.2)	1.5 (0.66–3.23)	0.422
No	107	13 (12.1)	94 (87.9)	Reference	
Urinary urgency					
Yes	57	13 (22.8)	44 (77.2)	2.4 (1.05–5.30)	0.045
No	144	16 (11.1)	128 (88.9)	Reference	
Fever					
Yes	65	12 (18.5)	53 (81.5)	1.6 (0.71–3.58)	0.285
No	137	17 (12.4)	120 (87.6)	Reference	
Suprapubic pain					
Yes	73	10 (13.7)	63 (86.3)	0.9 (0.40–2.10)	1.000
No	129	19 (14.7)	110 (85.3)	Reference	
Flank pain					
Yes	71	9 (12.7)	62 (87.3)	0.9 (0.36–1.99)	0.832
No	130	19 (14.6)	111 (85.4)	Reference	

OR, odds ratio; CI, confidence interval.

Table 4: Distribution and antibiotic resistance characteristics of bacterial isolates from pregnant women at two healthcare facilities in Sana'a, Yemen, 2026 (*N* = 29)

Bacterial isolate	*n* (%)	Number of antibiotics resisted mean ± SD	MAR index mean ± SD	Isolates resistant to ≥3 antibiotics *n*(%)
Gram-negative bacilli	**15 (51.7)**			
Escherichia coli	14 (48.3)	5.43 ± 1.99	0.46 ± 0.17	13 (92.9)
Citrobacter freundii	1 (3.4)	2.00 (single isolate)	0.17 (single isolate)	0 (0.0)
Gram-positive cocci	**14 (48.3)**			
Staphylococcus aureus	11 (37.9)	5.36 ± 1.80	0.45 ± 0.15	11 (100.0)
Enterococcus spp.	3 (10.3)	4.67 ± 0.58	0.39 ± 0.05	3 (100.0)

MAR, multiple antibiotic resistance; SD, standard deviation.

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Table 5: Antibiotic susceptibility patterns of bacterial isolates from pregnant women at two healthcare facilities in Sana'a, Yemen, 2026

Antibiotics	Result	All isolates (N = 29)	*E. coli* (N = 14)	*S. aureus* (N = 11)	*Enterococcus* spp. (N = 3)	*C. freundii* (N = 1)
		n (%)				
Imipenem (10 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	3 (100.0)	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Ciprofloxacin (5 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	3 (100.0)	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Amikacin (30 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	3 (100.0)	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Levofloxacin (5 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	3 (100.0)	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Norfloxacin (30 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	3 (100.0)	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gentamicin (10 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	3 (100.0)	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Ceftriaxone (30 µg)	S	28 (96.6)	13 (92.9)	11 (100.0)	-- --	1 (100.0)
	I	1 (3.4)	1 (7.1)	0 (0.0)	-- --	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	-- --	0 (0.0)
Tetracycline (30 µg)	S	13 (44.8)	5 (35.7)	7 (63.6)	0 (0.0)	1 (100.0)
	I	1 (3.4)	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)
	R	15 (51.7)	9 (64.3)	3 (27.3)	3 (100.0)	0 (0.0)
Aztreonam (30 µg)	S	10 (35.7)	6 (46.2)	-- --	0 (0.0)	1 (100.0)
	I	1 (3.6)	1 (7.7)	-- --	0 (0.0)	0 (0.0)
	R	17 (60.7)	6 (46.2)	-- --	3 (100.0)	0 (0.0)
Cefuroxime (30 µg)	S	8 (27.6)	1 (7.1)	3 (27.3)	-- --	1 (100.0)
	I	4 (13.8)	2 (14.3)	2 (18.2)	-- --	0 (0.0)
	R	17 (58.6)	11 (78.6)	6 (54.5)	-- --	0 (0.0)
Ampicillin (10 µg)	S	5 (17.2)	0 (0.0)	2 (18.2)	3 (100.0)	0 (0.0)
	I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	R	24 (82.8)	14 (100.0)	9 (81.8)	0 (0.0)	1 (100.0)
Amoxiclav (20/10 µg)	S	3 (10.3)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)
	I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	R	26 (89.7)	14 (100.0)	11 (100.0)	0 (0.0)	1 (100.0)

S, susceptible; I, intermediate; R, resistant.

4. Discussion

This study provides updated evidence on the prevalence, clinical correlates, bacterial etiology, and antibiotic susceptibility patterns of culture-confirmed bacteriuria among pregnant women attending primary and tertiary care facilities in Sana'a, Yemen. The overall prevalence of bacteriuria was 14.3%, with *E. coli* and *S. aureus* accounting for most bacterial isolates. Sociodemographic and obstetric characteristics showed no statistically significant associations with bacteriuria, whereas urinary urgency was the only clinical symptom that demonstrated a significant association in the unadjusted analysis. The antibiotic susceptibility findings also indicate substantial resistance to commonly tested β-lactam antibiotics, although some results require additional microbiological verification.

The prevalence of culture-confirmed bacteriuria observed in the present study (14.3%) is lower than that reported in previous studies among pregnant women attending healthcare facilities in Sana'a, which documented prevalence estimates of 24.3% in 2007, 18.0% in 2020, and 22.8% in 2025.[7-9] Higher estimates have also been documented elsewhere in Yemen, including 30% in Al-Mukalla and 60% in Damt district.[6,10] These differences may reflect variations in study populations, healthcare settings, recruitment procedures, clinical characteristics, and microbiological methods. The lower prevalence found in this study should not be taken as evidence

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of a temporal decline in bacteriuria in Sana'a, particularly because the available studies are not directly comparable and do not represent continuous population-based surveillance.

The prevalence found in this study is within the range reported by several hospital-based studies in neighboring countries and elsewhere in the Middle East. In the Jazan region of Saudi Arabia, bacteriuria was recently reported in 19.0% of pregnant women.[14] However, a larger retrospective study from the Eastern Province of Saudi Arabia reported ASB in only 3.4% of women.[15] In Jordan, ASB was recently reported among 23.5% of pregnant women,[16] whereas an overall culture-positive prevalence of 14.0% was reported in Sudan,[17] similar to the present finding. Prevalence estimates also vary in other regions. Studies from Ghana, Ethiopia, and India have reported ASB prevalences of 5.5%, 17.4%, and 21.2%, respectively, among pregnant women.[18-20] Importantly, several of these investigations included only asymptomatic pregnant women, whereas the present study did not distinguish ASB from symptomatic UTI. Consequently, differences in case definitions, participant selection, diagnostic procedures, and healthcare access limit direct comparisons between prevalence estimates.

Regarding sociodemographic and obstetric characteristics, the present study identified no significant associations between bacteriuria and maternal age, residence, education, employment status, gestational trimester, or gravidity. This finding is consistent with the earlier study in Sana'a by Al-Ghalibi et al.,[7] which found no significant association between bacteriuria and maternal age or gestational trimester. Similarly, no significant associations were found with age, gestational age, or parity among pregnant women in Sudan.[17] In contrast, significant associations of UTIs with age, gestational trimester, and residence were reported among pregnant women in Damt district.[10] Associations with gestational age and parity were also reported in Jordan,[16] while a study from northern Ethiopia identified maternal age and gestational period among factors associated with ASB.[19] Differences between studies may reflect variations in population characteristics, sample sizes, statistical approaches, and the distribution of potential risk factors. Furthermore, the relatively small number of culture-positive cases in the present study limits statistical power, meaning that the absence of significant associations does not necessarily indicate an absence of clinically relevant relationships.

Among the clinical characteristics examined, bacteriuria was more frequent in women with diabetes mellitus (42.9% vs. 13.3%), preeclampsia (33.3% vs. 13.4%), and a history of early neonatal death (31.2% vs. 12.9%). However, none of these associations reached statistical significance. The higher proportion observed among women with diabetes is clinically relevant, although only seven participants reported it, limiting the precision of the estimate. In a study from Saudi Arabia, a significant association was found between higher glycated hemoglobin levels and bacteriuria,[14] whereas no significant association was found between ASB and diabetes or hypertension in Jordan.[16] These findings suggest that relationships between maternal comorbidities and bacteriuria may differ across populations and require evaluation using adequately powered studies. The higher proportion of bacteriuria among women with a history of early neonatal death also warrants cautious interpretation because the present cross-sectional study cannot establish a temporal or causal relationship between bacteriuria during the current pregnancy and previous adverse obstetric outcomes.

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Urinary urgency was the only symptom significantly associated with culture-confirmed bacteriuria. Although dysuria, urinary frequency, and fever were more frequent among culture-positive women, their associations were not statistically significant. The limited discriminatory value of urinary symptoms is consistent with findings from Sudan, where Hamdan et al.[17] reported no significant association between bacteriuria and several urinary symptoms. Physiological changes during pregnancy may contribute to urinary frequency and urgency independently of infection, potentially reducing the specificity of these symptoms.[21,22] Because urinary urgency was the only symptom that reached statistical significance among several comparisons, this finding should be interpreted cautiously. These observations reinforce the importance of microbiological confirmation rather than relying exclusively on clinical symptoms to identify bacteriuria during pregnancy.

E. coli was the predominant bacterial isolate in the present study, accounting for 48.3% of culture-positive specimens, followed by *S. aureus* (37.9%), *Enterococcus* spp. (10.3%), and *C. freundii* (3.4%). The predominance of *E. coli* is consistent with earlier Yemeni investigations, which reported proportions of 41.6–50.0% in Sana'a,[8,9] 41.5% in Al-Mukalla,[6] and 42.9% in Damt district.[10] Similar findings have been reported from other countries, including *E. coli* proportions of 42.4% in Sudan,[17] 39.2% in India,[20] and approximately 68% among culture-positive cases in Jordan.[16] The frequent isolation of *E. coli* is consistent with its established role as a major uropathogen, facilitated by intestinal colonization, periurethral contamination, and ascending infection.[23] Pregnancy-associated urinary stasis may further increase susceptibility to urinary tract colonization and infection.[1]

The relatively high proportion of *S. aureus* (37.9%) is another notable finding. Although *E. coli* is generally the predominant uropathogen, substantial proportions of *S. aureus* have also been reported in Sana'a (27.7%) and Damt District (23.8%).[8,10] Comparable findings have been documented in Sudan (39.3%) and India (34.3%).[17,20] Nevertheless, the bacterial distribution is not uniform across geographical settings. In Oman, *Klebsiella pneumoniae* (32.1%) was identified as the most frequent isolate among pregnant women with ASB, followed by *E. coli* (29.6%).[24] Such differences may reflect geographical variation, participant selection, specimen collection, bacterial identification methods, and local antimicrobial exposure. The relatively high frequency of *S. aureus* in the present study also highlights the importance of careful specimen collection and laboratory confirmation, since contamination or colonization cannot be excluded solely from a single positive culture.[25] These findings do not establish an increasing contribution of Gram-positive organisms over time.

This study revealed high rates of resistance to amoxicillin-clavulanic acid (89.7%) and ampicillin (82.8%), with all 14 *E. coli* isolates classified as resistant to both agents. These findings are broadly consistent with concerns raised by previous Yemeni investigations. In Damt district, resistance to amoxicillin ranged from 80% to 100% among the bacterial species investigated.[10] Similarly, resistance to ampicillin was reported among all Gram-negative isolates recovered from pregnant women in northern Ethiopia.[19] In contrast, only 56% of *E. coli* isolates from pregnant women in Jordan were susceptible to amoxicillin-clavulanic acid.[16] However, these findings contrast with the earlier Sana'a investigation by Edrees and Anbar, which reported comparatively favorable ampicillin susceptibility among *E. coli* isolates.[8] Such differences emphasize the need for

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standardized, organism-specific susceptibility testing before interpreting geographical or temporal variations in antimicrobial resistance. In particular, the present susceptibility results require verification of disk potencies, interpretive breakpoints, and the appropriateness of individual antibiotic-organism combinations before firm conclusions regarding empirical treatment can be drawn.

In the present study, the mean multiple antibiotic resistance (MAR) index of 0.44 and resistance to at least three tested antibiotics in 93.1% of isolates suggest a substantial burden of resistance within the sample. However, resistance to three individual antibiotics does not necessarily meet the standardized definition of multidrug resistance (MDR), which requires acquired resistance to at least one antimicrobial agent in three or more categories.[26] Furthermore, MAR indices depend on the antimicrobial agents selected and the validity of species-specific susceptibility interpretations.[26,27] Intrinsic resistance and antimicrobial agents lacking appropriate interpretive criteria may further affect the reliability and comparability of these indices.[26,27]

From a clinical perspective, the findings support the importance of reliable urine culture and appropriately validated antimicrobial susceptibility testing in ANC. Evidence from a prospective cohort study in the Netherlands indicates that untreated ASB increases the risk of pyelonephritis, although the absolute risk is relatively low in the population studied.[3] Current recommendations from the American College of Obstetricians and Gynecologists (2023) support urine culture screening early in prenatal care and culture-guided management of significant bacteriuria.[1] The present study also highlights the need to evaluate antimicrobial susceptibility alongside pregnancy-specific treatment considerations, as in-vitro activity alone does not establish the clinical suitability of an antibiotic. Periodic surveillance using standardized microbiological methods is particularly important for informing antimicrobial stewardship and improving the management of urinary infections during pregnancy.

This study has several limitations. Its facility-based cross-sectional design, non-probability sampling, and relatively small number of culture-positive cases limit generalizability and statistical power, particularly for assessing uncommon conditions and species-specific resistance patterns. The design precludes causal inference, while the lack of multivariable adjustment and some missing data may affect observed associations. Failure to distinguish ASB from symptomatic infection further limits clinical interpretation. Bacterial identification relied on conventional methods without confirmatory testing or repeat cultures, and some susceptibility results require verification against species-specific breakpoints. The exclusion of nitrofurantoin and fosfomycin also limits clinical applicability. Finally, treatment outcomes, recurrence, and subsequent maternal and neonatal outcomes were not assessed. Larger multicenter studies using standardized microbiological methods, adjusted analyses, and prospective follow-up are warranted.

5. Conclusion

Culture-confirmed bacteriuria remains an important concern among pregnant women attending ANC clinics in Sana'a, with *E. coli* representing a major bacterial pathogen. Sociodemographic and obstetric characteristics alone do not provide a reliable basis for identifying affected women, while urinary symptoms have limited discriminatory value. The reported resistance to commonly used antibiotics highlights the importance of reliable

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bacterial identification, standardized antimicrobial susceptibility testing, and pregnancy-appropriate, culture-guided treatment. Strengthening microbiological diagnostic capacity and establishing regular antimicrobial resistance surveillance are essential for supporting effective clinical management and antimicrobial stewardship in maternal healthcare.

Ethical approval

The study was approved by the Research Ethics Committee of the University of Science and Technology, Sana'a, Yemen (Approval No. UST-UREC-1448-00119). All participants provided written informed consent to participate voluntarily after receiving information about the study objectives and procedures. Confidentiality was maintained using identification codes instead of personal identifiers.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. American College of Obstetricians and Gynecologists' Committee on Clinical Consensus–Obstetrics. Urinary tract infections in pregnant individuals. Obstet Gynecol. 2023;142:435–45. DOI ● PubMed ● Google Scholar
2. Wolf P, Le Lanne D, Menger I, Bsaibes A, Reinhardt W, Dreyfuss J, et al. The upper urinary tract in pregnant women. Physiopathologic, ultrasonic and urographic study. Ann Urol (Paris). 1984;18:347–9. PubMed ● Google Scholar
3. Kazemier BM, Koningstein FN, Schneeberger C, Ott A, Bossuyt PM, de Miranda E, et al. Maternal and neonatal consequences of treated and untreated asymptomatic bacteriuria in pregnancy: a prospective cohort study with an embedded randomised controlled trial. Lancet Infect Dis. 2015;15:1324–33. DOI ● PubMed ● Google Scholar
4. Awoke N, Tekalign T, Teshome M, Lolaso T, Dendir G, Obsa MS. Bacterial profile and asymptomatic bacteriuria among pregnant women in Africa: a systematic review and meta analysis. EClinicalMedicine. 2021;37:100952. DOI ● PubMed ● Google Scholar
5. de Souza HD, Diório GRM, Peres SV, Francisco RPV, Galletta MAK. Bacterial profile and prevalence of urinary tract infections in pregnant women in Latin America: a systematic review and meta-analysis. BMC Pregnancy Childbirth. 2023;23:774. DOI ● PubMed ● Google Scholar
6. Al-Haddad AM. Urinary tract infection among pregnant women in Al-Mukalla district, Yemen. East Mediterr Health J. 2005;11:505–10. PubMed ● Google Scholar
7. Al-Ghalibi SM, Al-Moayad E, Al-Jaufy A. Bacterial urinary tract infection among pregnant women in Sana'a City Yemen. Arab Gulf J Sci Res. 2007;25(1–2):23–31. Google Scholar
8. Edrees WH, Anbar AAM. Prevalence and antibacterial susceptibility of bacterial uropathogens isolated from pregnant women in Sana'a, Yemen. PSM Biol Res. 2020;5:157–65. Google Scholar
9. Al-Shehari WA, Edrees WH, Al-Awar MS, Ahmed AM, Al-Hadheq AA. Antimicrobial susceptibility profiles of uropathogenic bacteria isolated from pregnant women, Yemen. Al-Razi Univ J Med Sci. 2025;9(2):14–25. DOI ● Google Scholar
10. Al-Badaii F, Al-Tairi M, Rashid A, Al-Morisi S, Al-Hamari N. Prevalence, risk factors and antibiotic susceptibility of urinary tract infections among pregnant women: a study in Damt District Yemen. J Pure App Microbiol. 2023;17(2):1065–75. DOI ● Google Scholar
11. World Health Organization. HeRAMS Yemen Baseline Report 2023: Maternal and newborn services. Geneva: WHO; 2023.
12. Al-Mehdar AA, Thawaba ZA, Al-Shami HZ, Al-Haifi AY, Al-Worafi Y, Al-Shami AS. Bacterial etiology and antimicrobial resistance patterns of urinary tract infections in Sana'a, Yemen. J Pharm Res Int. 2026;38(2):34–51. DOI ● Google Scholar
13. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. 34th ed. Wayne (PA): Clinical and Laboratory Standards Institute; 2024.
14. Medani IE, Hakami A, Altraifi A, Abdelmageed MM, Khormi A, Chourasia U, et al. Bacteriuria profile and antimicrobial sensitivity among pregnant women attending antenatal care at Jazan and Sabyia general hospitals, Jazan Region, KSA: A cross-sectional study. Int J Gynaecol Obstet. 2025;170:751–9. DOI ● PubMed ● Google Scholar
15. AlShamlan NA, AlOmar RS, Aldossary R, Alahmari M, Alghamdi A, AlGhamdi M, et al. The epidemiology, associated factors and bacterial profile of asymptomatic bacteriuria in pregnant women: a retrospective chart review study in Saudi Arabia. Int J Womens Health. 2022;14:1749–59. DOI ● PubMed ● Google Scholar
16. Qatawneh A, Shaqour RAE, Al-Amayreh I, Abuhussein H, Abd Alnabi A, Alaiwah M, et al. The prevalence of asymptomatic bacteriuria among Jordanian pregnant women. Int J Womens Health. 2025;17:4923–31. DOI ● PubMed ● Google Scholar
17. Hamdan HZ, Ziad AH, Ali SK, Adam I. Epidemiology of urinary tract infections and antibiotics sensitivity among pregnant women at Khartoum North Hospital. Ann Clin Microbiol Antimicrob. 2011;10:2. DOI ● PubMed ● Google Scholar
18. Labi AK, Yawson AE, Ganyaglo GY, Newman MJ. Prevalence and associated risk factors of asymptomatic bacteriuria in ante-natal clients in a large teaching hospital in Ghana. Ghana Med J. 2015;49:154–8. DOI ● PubMed ● Google Scholar
19. Tadesse S, Kahsay T, Adhanom G, et al. Prevalence, antimicrobial susceptibility profile and predictors of asymptomatic bacteriuria among pregnant women in Adigrat

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General Hospital, Northern Ethiopia. BMC Res Notes. 2018;11:740. DOI ● PubMed ● Google Scholar

20. Agarwal A, Pandey S, Maheshwari U, Singh MP, Srivastava J, Bose S. Prevalence of asymptomatic bacteriuria and antimicrobial resistance profile among pregnant females in a tertiary care hospital. Indian J Community Med. 2021;46:469–73. DOI ● PubMed ● Google Scholar
21. Haider G, Zehra N, Munir AA, Haider A. Risk factors of urinary tract infection in pregnancy. J Pak Med Assoc. 2010;60:213–6. DOI ● PubMed ● Google Scholar
22. Gendel G, Nolan R. Pregnant patient in the emergency department: an observational investigation of predictive values of symptoms and lab measures in predicting culture confirmed urinary tract infection. Am J Emerg Med. 2021;44:439–40. DOI ● PubMed ● Google Scholar
23. Nielsen KL, Stegger M, Godfrey PA, et al. Adaptation of *Escherichia coli* traversing from the faecal environment to the urinary tract. Int J Med Microbiol. 2016;306:595–603. DOI ● PubMed ● Google Scholar
24. Al-Hinai U, Al-Habsi N, Kościuszko Z, Al-Busaidi I. Microbiological and antimicrobial susceptibility pattern of asymptomatic bacteriuria in pregnant women attending SQUH. Oman Med J. 2024;39:e610. DOI ● PubMed ● Google Scholar
25. Mason CY, Sobti A, Goodman AL. *Staphylococcus aureus* bacteriuria: implications and management. JAC Antimicrob Resist. 2023;5:dlac123. DOI ● PubMed ● Google Scholar
26. Magiorakos AP, Srinivasan A, Carey RB, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect. 2012;18:268–81. DOI ● PubMed ● Google Scholar
27. Wagner BA, Dargatz DA, Morley PS, Keefe TJ, Salman MD. Analysis methods for evaluating bacterial antimicrobial resistance outcomes. Am J Vet Res. 2003;64:1570–9. DOI ● PubMed ● Google Scholar

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