

Determinants of urinary tract infections among pregnant women in Gambo General Hospital, Ethiopia: a case-control study

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Abstract

Background

Urinary tract infections (UTIs) are among the most prevalent bacterial infections globally and represent a significant public health challenge, particularly in low-resource settings. Women are disproportionately affected due to anatomical predispositions, such as a shorter urethra and proximity to fecal flora. During pregnancy, this susceptibility is further heightened by physiological changes—including hormonal shifts and mechanical compression—that compromise the urinary tract's natural defense mechanisms.

Objective

This study aimed to identify the determinants of urinary tract infections among pregnant women attending antenatal care at Gambo General Hospital, Kore District, West Arsi Zone, Oromia Region, Ethiopia, in 2026.

Methods

A facility-based case-control study was conducted from January to March 2026. A total of 174 participants—58 cases and 116 controls—were recruited. Data were collected using structured questionnaires and medical record reviews, administered digitally via Kobo Toolbox. Bivariate and multivariable logistic regression analyses were performed using SPSS Version 32.0 to identify independent determinants of UTI.

Results

First trimester (AOR = 4.11; 95% CI: 1.17–14.50), second trimester (AOR = 2.42; 95% CI: 1.02–5.74), grand multigravida status (AOR = 2.87; 95% CI: 1.28–6.44), history of catheterization (AOR = 5.33; 95% CI: 1.38–20.54), low daily water intake <1L (AOR = 4.16; 95% CI: 1.23–14.06), improper genital hygiene (AOR = 4.35; 95% CI: 1.23–15.40), and sexual activity (AOR = 2.57; 95% CI: 1.11–5.92) were significantly associated with UTI. Improper genital hygiene was reported by 82.2% of participants, and inadequate hydration by 45.4%.

Conclusion

Maternal UTI in this setting is driven by preventable clinical and behavioral gaps rather than physiological inevitability alone, with heightened vulnerability in early gestation. The strong associations with catheterization, hygiene, and hydration highlight a critical need for standardized prenatal counseling and stricter clinical protocols. Ultimately, integrating early screening with community-based education is essential to reducing the infection burden in resource-limited environments.

Background

Urinary tract infections (UTIs) are among the most common bacterial infections globally and represent a significant public health challenge [1, 2]. UTI is characterized by the presence and proliferation of microorganisms in any part of the urinary tract—including the kidneys, ureters, bladder, and urethra [3]. Due to anatomical characteristics like a shorter urethra and a heightened risk of fecal contamination, women are especially vulnerable to these infections [4]. This susceptibility is significantly heightened during pregnancy, as physiological changes further compromise the urinary tract's natural defenses [5, 6].

Pregnancy introduces a spectrum of anatomical and physiological changes that heighten the risk of UTIs [6]. Hormonal fluctuations lead to ureteral dilation and urinary stasis, while mechanical changes such as vesicoureteral reflux further compromise the urinary tract's natural defenses [4]. These changes promote a favorable setting for bacterial growth [2]. The importance of this issue is emphasized by documented links between UTIs during pregnancy and negative obstetric effects, such as intrauterine growth restriction, preeclampsia, premature rupture of membranes, low Apgar scores, preterm birth, and higher rates of cesarean delivery [3, 7].

UTIs are most commonly attributed to bacterial pathogens [8, 9]. *Escherichia coli* remains the predominant cause, while other organisms—such as *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterobacter* species, *Staphylococcus saprophyticus*, and group B beta-hemolytic *Streptococcus*—also contribute to the infection burden [10].

Several host factors predispose pregnant women to UTIs, including previous UTI episodes, preexisting diabetes, increased parity, low socioeconomic status, immunosuppression, tobacco use, and delayed enrollment in prenatal care [1, 11, 12]. These multifactorial influences on UTI development during pregnancy underscore the pressing need to further investigate and address the diverse challenges that predispose women to these infections, particularly in high-burden settings.

Despite the substantial global burden of UTIs and a regional prevalence of 9.8%–26.6% among pregnant women in Ethiopia, understanding of specific risk factors in low-resource settings remains fragmented and contradictory [1, 4, 11, 12]. Existing literature presents conflicting findings regarding the roles of parity [4, 9, 13], maternal age [14–16], and socioeconomic status versus hygiene practices [4, 17]. These persistent inconsistencies, combined with a reliance on cross-sectional studies, hinder the development of targeted screening and prevention protocols within Ethiopian antenatal care. To address these gaps, this study employed a case-control design to identify the socio-demographic, obstetric, behavioral, and clinical determinants of UTIs among pregnant women attending Gambo General Hospital, West Arsi Zone, Oromia, Ethiopia, providing evidence-based insights to inform regional clinical guidelines and maternal health policies.

Methods

Study design, area and period

An unmatched, hospital-based case-control study was conducted from January 1 to March 30, 2026, at Gambo General Hospital, situated in Lepis Kebele, Kore District, West Arsi Zone, Oromia Regional State,

Ethiopia. Established in 1929, the institution functions as a primary referral center providing comprehensive preventive, curative, and maternal healthcare—including routine antenatal care (ANC)—for the surrounding communities.

Eligibility Criteria

Inclusion Criteria

Pregnant women of any gestational age attending the ANC clinic at Gambo General Hospital during the study period were eligible if they were aged 18 years or older and provided written informed consent.

Cases

To be classified as a case, a study participant must meet both of the following criteria simultaneously:

- **Symptomatic Presentation:** Presence of at least one clinical sign or symptom indicative of a urinary tract infection (e.g., dysuria, urinary frequency, urinary urgency, or suprapubic pain) assessed during clinical evaluation.
- **Microbiological Confirmation:** Quantitative isolation of significant bacteriuria defined as $\geq 10^5$ CFU/mL of a single uropathogen (or a predominant uropathogen in cases of clear clinical relevance) from a properly collected clean-catch midstream urine specimen, confirmed via standard laboratory culture methods.

Controls

To be classified as a control, a study participant must meet both of the following criteria simultaneously:

- **Absence of Infection:** No clinical signs or symptoms of a urinary tract infection (no dysuria, frequency, urgency, or suprapubic pain) at the time of data and specimen collection, verified through participant interview and antenatal care medical record review.
- **Microbiological Exclusion:** Absence of significant bacteriuria ($< 10^5$ CFU/mL or no growth) on the urine culture analysis performed during the same visit.

Exclusion Criteria

Pregnant women were excluded if they:

- Were currently receiving antibiotic therapy for any indication or had taken antimicrobials within the preceding 14 days.
- Had a history of chronic kidney disease, structural renal anomalies (e.g., hydronephrosis), neurogenic bladder dysfunction, or prior urological surgery.
- Declined to provide informed consent.

Sample Size Determination

The sample size was calculated using Epi Info™ version 7.2.7.0 (CDC, Atlanta, GA, USA) for an unmatched case-control study design. Parameters were evaluated across key maternal UTI risk factors from literature, including prior UTI history [4], educational level [2], sexual activity [17], genital itchiness [2], and urinary catheterization history [8].

Assuming a 95% confidence level ($\alpha = 0.05$), 80% power ($\beta = 0.20$), and a 1:2 case-to-control ratio, genital itchiness produced the maximum required sample size (control exposure: 7.5%; AOR: 4.3; case exposure: 26.0%) [2]. This yielded an unadjusted sample size of 156 participants (52 cases and 104 controls). Factoring in a 10% non-response rate, the final sample size comprised 174 pregnant women (58 cases and 116 controls).

Data Collection Procedure

Socio-demographic characteristics, behavioral risk factors, obstetric history, clinical parameters, and healthcare utilization factors were collected using a structured, interviewer-administered questionnaire deployed on KoboToolbox software (v2024.1.0) (the English version of the questionnaire is provided as Supplementary File 1). Clinical variables—including gestational age, presenting urinary symptoms (dysuria, frequency, urgency, suprapubic pain), and medical history (e.g., prior UTI episodes, diabetes mellitus, urinary catheterization)—were obtained through participant interviews and cross-verified against antenatal care medical records.

Specimen Collection and Transport

Participants received standardized instructions on the clean-catch technique to self-collect 10–20 mL of midstream urine into sterile, wide-mouthed, screw-cap containers [18]. Specimens were stored in cold boxes at 2–8°C and transported to the Microbiology Laboratory at Shashemene Referral Hospital within 24 hours to maintain bacterial viability and prevent microbial overgrowth.

Urine Culture and Bacterial Identification

A semi-quantitative culture method was executed using a 1- μ L calibrated platinum loop. Mixed urine specimens were inoculated onto Blood Agar, MacConkey Agar, and CLED Agar (HiMedia Laboratories, Mumbai, India) and incubated aerobically at 37°C for 18–24 hours. Significant bacteriuria was defined as the isolation of a single uropathogenic species at $\geq 10^5$ CFU/mL [19]. Isolates were identified to the species level using colony morphology, Gram staining, and standard biochemical panels [20].

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed via the Kirby-Bauer disk diffusion technique on Mueller-Hinton agar (HiMedia, India) following Clinical and Laboratory Standards Institute (CLSI M100) guidelines. Bacterial suspensions were standardized to a 0.5 McFarland turbidity equivalent [20].

The tested antimicrobial panel comprised ampicillin (10 μ g), Augmentin (20/10 μ g), cefazolin (30 μ g), cefuroxime (30 μ g), ceftriaxone (30 μ g), cefpodoxime (10 μ g), cephalixin (30 μ g), gentamicin (10 μ g), piperacillin-tazobactam (100/10 μ g), meropenem (10 μ g), nitrofurantoin (300 μ g), Fosfomycin (200 μ g), and

trimethoprim-sulfamethoxazole (1.25/23.75 µg). Antimicrobial agents were selected and reported for each isolate according to organism classification (Gram-negative vs. Gram-positive spectrum) and established clinical safety profiles in pregnancy. Zone diameters of inhibition were measured after 16–18 hours of aerobic incubation at 37°C and categorized as susceptible, intermediate, or resistant based on CLSI breakpoints [20].

Quality Control

To ensure data accuracy and procedure validation, reference strains including *Escherichia coli* (ATCC 25922), *Klebsiella pneumoniae* (ATCC 700603), *Staphylococcus aureus* (ATCC 25923), and *Streptococcus pneumoniae* (ATCC 49619) were routinely tested alongside clinical isolates to verify culture media performance, disk potency, and interpretive accuracy in accordance with CLSI standards [20].

Data Quality Assurance and Bias Minimization

Data quality was maintained across all stages of data collection and laboratory processing. The questionnaire was pre-tested on 5% of the sample size outside the study setting, translated into local language (Afaan Oromoo), and back-translated to English to ensure conceptual consistency. Data collectors underwent standardized training on study protocols, digital data capture, and interview techniques. Completed KoboToolbox records were audited daily for completeness and internal consistency using unique participant identification codes linked across clinical and laboratory records.

To minimize recall bias, interview data regarding medical history and symptoms were cross-verified against official antenatal care records using restricted recall windows. Selection bias was mitigated by prospectively recruiting consecutive cases and controls from the same source population under identical inclusion and exclusion criteria. Laboratory quality control was preserved through strict adherence to standard operating procedures, regular sterility checks of culture media, pre-testing of diagnostic reagents, and verification of isolate identification by a senior microbiologist.

Data analysis and interpretation

Upon completion of data collection using Kobo Toolbox software, the dataset was exported to the Statistical Package for the Social Sciences (SPSS) Statistics for Windows, Version 32.0 (IBM Corp., Armonk, NY) for cleaning, coding, and statistical analysis. Data quality assurance involved rigorous checks for missing values, logical inconsistencies, and outliers. Any discrepancies were resolved by cross-referencing with original Kobo records or field notes.

Descriptive statistics were applied to summarize the characteristics of both cases and controls. These included frequencies, proportions, means and standard deviations, depending on the nature and distribution of each variable. The distribution of potential determinants was visualized using tables for clarity.

Associations between categorical variables and UTI status were examined using chi-square tests, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to assess the strength of relationships between risk factors and UTIs. Bivariate logistic regression was performed to identify candidate variables.

Crude odds ratios (CORs) with 95% CIs were reported, and variables with a p-value ≤ 0.25 were considered for inclusion in the multivariable logistic regression model.

Multivariable logistic regression served as the primary analytical method to adjust for potential confounding and identify independent predictors of UTIs among pregnant women. Adjusted odds ratios (AORs) with 95% CIs were reported. Model adequacy was assessed using the Hosmer–Lemeshow goodness-of-fit test, and multicollinearity was evaluated using variance inflation factors (VIFs).

All statistical tests were two-sided, with statistical significance defined as $p < 0.05$. Results were interpreted in the context of existing literature and presented through both statistical outputs and narrative summaries to ensure accessibility for diverse audiences, including clinicians, researchers, and policymakers.

Operational definitions

Proper Genital Hygiene Practice: Self-reported practice of washing the genital area with water and mild soap at least once daily, and wiping from front to back after using the toilet.

Adequate Daily Water Intake: Consumption of at least 2 liters (approximately 8 cups) of water per day.

Sexual Activity (Active): Engaging in sexual intercourse during the current pregnancy at a frequency of at least once per week. This included participants who self-reported sexual activity as either "occasional" (1–3 times per week) or "frequent" (more than 3 times per week).

Sexual Activity (Inactive): Engaging in sexual intercourse less than once per week or not at all during the current pregnancy.

Results

Baseline Characteristics and Behavioral Patterns of Study Participants

A total of 174 pregnant women participated in this unmatched case-control study, comprising 58 cases and 116 controls. The mean age of the participants was 28.8 ± 4.7 years, with the majority falling within the 26–34 age group (58.6%, $n = 102$). More than half of the women were in their second trimester (55.7%, $n = 97$), followed by the third (34.5%, $n = 60$) and first trimesters (9.8%, $n = 17$). Additionally, 45.4% ($n = 79$) reported a daily water intake of less than one liter, while 25.9% ($n = 45$) consumed more than two liters. Hand hygiene practices before meals were high at 90.2% ($n = 157$), though a substantial proportion of the participants (82.2%, $n = 143$) reported inadequate proper genital hygiene. Moreover, the vast majority of participants had limited antenatal care (ANC) engagement, with 90.2% ($n = 157$) attending three or fewer sessions. All distribution data are summarized in (Table 1).

Table 1. Baseline Characteristics and Behavioral Patterns of cases and controls among pregnant women at Gambo General Hospital, West Arsi zone, Ethiopia, 2026.

Variable	Category	Frequency	Case	Control
Maternal Age (Years)	≤25	45 (25.9)	16 (9.2)	29 (16.7)
	26-34	102 (58.6)	34 (19.5)	68 (39.1)
	≥35	27 (15.5)	8 (4.6)	19 (10.9)
Educational Attainment	No formal Education	34 (19.5)	11 (6.3)	23 (13.2)
	Primary	113 (64.9)	40 (23.0)	73 (42.0)
	Secondary	23 (13.2)	7 (4.0)	16 (9.2)
	Tertiary	4 (2.3)	0 (0.0)	4 (2.3)
Occupational Status	Housewife	122 (70.1)	45 (25.9)	77 (44.3)
	Farming	43 (24.7)	11 (6.3)	32 (18.4)
	Animal Husbandry	6 (3.4)	1 (0.6)	5 (2.9)
	Teacher	2 (1.1)	0 (0.0)	2 (1.1)
	Medical Professional	1 (0.6)	1 (0.6)	0 (0.0)
Average Monthly Income (ETB)	<5000ETB	97 (55.7)	28 (16.1)	69 (39.7)
	≥5000ETB	77 (44.3)	30 (17.2)	47 (27.0)
Household Size	≤5	35 (20.1)	14 (8.0)	21 (12.1)
	>5	139 (79.9)	44 (25.3)	95 (54.6)
Gestational Age	1 st Trimester	17 (9.8)	9 (5.2)	8 (4.6)
	2 nd Trimester	97 (55.7)	32 (18.4)	65 (37.4)
	3 rd Trimester	60 (34.5)	17 (9.8)	43 (24.7)
Parity	Nulliparous	4 (2.3)	0 (0.0)	4 (2.3)
	Primiparous	14 (8.0)	8 (4.6)	6 (3.4)
	Multiparous	130 (74.7)	37 (21.3)	93 (53.4)
	Grand Multiparous	26 (14.9)	13 (7.5)	13 (7.5)
Gravidity	Primigravida	2 (1.1)	0 (0.0)	2 (1.1)
	Multigravida	88 (50.6)	23 (13.2)	65 (37.4)
	Grand Multigravida	84 (48.3)	35 (20.1)	49 (28.2)
History of UTI	No	126 (72.4)	40 (23.0)	86 (49.4)
	Yes	48 (27.6)	18 (10.3)	30 (17.2)
History of Catheterization	No	160 (92.0)	48 (27.6)	112 (64.4)

	Yes	14 (8.0)	10 (5.7)	4 (2.3)
Comorbidity	No	162 (93.1)	51 (29.3)	111 (63.8)
	Yes	12 (6.9)	7 (4.0)	5 (2.9)
Contraceptive Use during Pregnancy	No	171 (98.3)	57 (32.8)	114 (65.5)
	Yes	3 (1.7)	1 (0.6)	2 (1.1)
Antibiotic Use during Pregnancy	No	151 (86.8)	49 (28.2)	102 (58.6)
	Yes	23 (13.2)	9 (5.2)	14 (8.0)
History of Adverse Pregnancy Outcome	No	146 (83.9)	45 (25.9)	101 (58.0)
	Yes	28 (16.1)	13 (7.5)	15 (8.6)
Daily Water Intake	Rarely (< 1L)	79 (45.4)	34 (19.5)	45 (25.9)
	Moderately (1L - 2L)	50 (28.7)	18 (10.3)	32 (18.4)
	Frequently (> 2 L)	45 (25.9)	6 (3.4)	39 (22.4)
Hand Hygiene before meals	Not Always	17 (9.8)	4 (2.3)	13 (7.5)
	Always	157 (90.2)	54 (31.0)	103 (59.2)
Proper genital hygiene practice	No	143 (82.2)	53 (30.5)	90 (51.7)
	Yes	31 (17.8)	5 (2.9)	26 (14.9)
Private sanitation	No	60 (34.5)	19 (10.9)	41 (23.6)
	Yes	114 (65.5)	39 (22.4)	75 (43.1)
Frequency of Sexual Activity	No	20 (11.5)	8 (4.6)	12 (6.9)
	Rarely	106 (60.9)	25 (14.4)	81 (46.6)
	Occasionally	24 (13.8)	14 (8.0)	10 (5.7)
	Frequently	24 (13.8)	11 (6.3)	13 (7.4)
Condom Use	No	169 (97.1)	57 (32.8)	112 (64.4)
	Yes	5 (2.9)	1 (0.6)	4 (2.3)
Sugary Food Consumption	No	78 (44.8)	28 (16.1)	50 (28.7)
	Yes	96 (55.2)	30 (17.2)	66 (37.9)
Traditional medicines Use	No	126 (72.4)	37 (21.3)	89 (51.1)
	Yes	48 (27.6)	21 (12.1)	27 (15.5)
Frequency of ANC Visits	Limited (≤ 3)	157 (90.2)	51 (29.3)	106 (60.9)
	Standard (>3)	17 (9.8)	7 (4.0)	10 (5.7)

Barriers for Accessing Healthcare	No	104 (59.8)	40 (23.0)	64 (36.8)
	Yes	70 (40.2)	18 (10.3)	52 (29.9)
Distance from the nearest Health facility	< 5 KM	87 (50)	33 (19.0)	54 (31.0)
	5 - 10 KM	63 (36.2)	20 (11.5)	43 (24.7)
	> 10 KM	24 (13.8)	5 (2.9)	19 (10.9)

Footnotes: Values are provided as numbers (n) and percentage (%), n (%).

Distribution of Isolated Uropathogens and Antimicrobial Susceptibility Profiles

Among the 58 clinical cases evaluated, significant bacteriuria ($\geq 10^5$ CFU/mL) was confirmed in all 58 urine specimens. Gram-negative bacilli constituted the majority of the isolates (55.2%, 32/58), while Gram-positive cocci accounted for 44.8% (26/58). *Escherichia coli* was the most predominant uropathogen (29.3%, 17/58), followed by *Staphylococcus saprophyticus* (19.0%, 11/58), *Staphylococcus aureus* (13.8%, 8/58), and *Klebsiella* species (12.1%, 7/58) (Table 2). Overall antimicrobial susceptibility testing revealed that meropenem (90.6%, 29/32), gentamicin (81.5%, 44/54), and piperacillin-tazobactam (75.0%, 24/32) demonstrated the highest levels of **susceptibility** against the isolated organisms. Conversely, high rates of resistance were observed for ampicillin (62.5%, 15/24), nitrofurantoin (44.4%, 24/54), and Augmentin (41.8%, 23/55) (Figure 1).

Table 2. Distribution of Isolated Uropathogens among cases in pregnant women at Gambo General Hospital, West Arsi zone, Ethiopia, 2026.

Organism Classification	Isolated Uropathogens	Frequency (n)	Percentage (%)
Gram-Negative	<i>E. coli</i>	17	29.3
	<i>K. pneumonia</i>	5	8.6
	<i>K. Oxytoca</i>	2	3.4
	<i>C. diversus</i>	2	3.4
	<i>P. mirabilis</i>	2	3.4
	<i>P. vulgaris</i>	1	1.7
	<i>C. freundii</i>	1	1.7
	<i>E. cloacae</i>	1	1.7
	<i>P. aeruginosa</i>	1	1.7
Gram-Positive	<i>S. saprophyticus</i>	11	19.0
	<i>S. aureus</i>	8	13.8
	<i>S. epidermidis</i>	3	5.2
	<i>E. faecalis</i>	2	3.4
	<i>S. agalactiae</i>	2	3.4
Total		58	100.0

Bivariate analysis of factors associated with UTIs

In the bivariate analysis, each variable was examined independently to assess its association with UTI status. Crude Odds Ratios (COR) with 95% confidence intervals were calculated using bivariate logistic regression. In accordance with the study methodology, all variables with a p-value ≤ 0.25 in this analysis were identified as candidate variables for the subsequent multivariable logistic regression model to control for potential confounders (Table 3).

Table 3. Bivariate analysis of determinants of UTI among pregnant women at Gambo General Hospital, West Arsi zone, Ethiopia, 2026

Variable	Category	Frequency	Case	Control	COR (95% CI)	p-value
Maternal Age (Years)	≤25	45 (25.9)	16 (9.2)	29 (16.7)	Ref	0.959
	26-34	102 (58.6)	34 (19.5)	68 (39.1)	0.89 (0.38-2.06)	
	≥35	27 (15.5)	8 (4.6)	19 (10.9)	0.94 (0.27-3.29)	
Educational Attainment	No formal Education	34 (19.5)	11 (6.3)	23 (13.2)	Ref	0.389
	Primary	113 (64.9)	40 (23.0)	73 (42.0)	1.00 (0.39-2.58)	
	Secondary and above	27 (15.5)	7 (4.0)	20 (11.5)	0.50 (0.14-1.76)	
Occupational Status	Unemployed	122 (70.1)	45 (25.9)	77 (44.3)	Ref	0.159*
	Employed	52 (29.9)	13 (7.5)	39 (22.4)	0.58 (0.28-1.24)	
Average Monthly Income (ETB)	<5000ETB	97 (55.7)	28 (16.1)	69 (39.7)	Ref	0.098*
	≥5000ETB	77 (44.3)	30 (17.2)	47 (27.0)	1.78 (0.90-3.54)	
Household Size	≤5	35 (20.1)	14 (8.5)	21 (12.1)	Ref	0.462
	>5	139 (79.9)	44 (25.3)	95 (54.6)	0.72 (0.30-1.73)	
Gestational Age	1 st Trimester	17 (9.8)	9 (5.2)	8 (4.6)	Ref	0.129*
	2 nd Trimester	97 (55.7)	32 (18.4)	65 (37.4)	0.48 (0.15-1.50)	
	3 rd Trimester	60 (34.5)	17 (9.8)	43 (24.7)	0.29 (0.08-1.00)	
Parity	Nulliparous/Primiparous	18 (10.3)	8 (4.6)	10 (5.7)	Ref	0.302

	Multiparous	130 (74.7)	37 (21.3)	93 (53.4)	0.41 (0.12-1.34)	
	Grand Multiparous	26 (14.9)	13 (7.5)	13 (7.5)	0.54 (0.11-2.52)	
Gravidity	Primigravida/Multigravida	90 (51.7)	23 (13.2)	67(38.5)	Ref	0.012*
	Grand Multigravida	84 (48.3)	35 (20.1)	49 (28.2)	2.96 (1.27-6.91)	
History of UTI	No	126 (72.4)	40 (23.0)	86 (49.4)	Ref	0.903
	Yes	48 (27.6)	18 (10.3)	30 (17.2)	1.05 (0.48-2.30)	
History of Catheterization	No	160 (92.0)	48 (27.6)	112 (64.4)	Ref	0.003*
	Yes	14 (8.0)	10 (5.7)	4 (2.3)	6.39 (1.74-23.47)	
Comorbidity	No	162 (93.1)	51 (29.3)	111 (63.8)	Ref	0.306
	Yes	12 (6.9)	7 (4.0)	5 (2.9)	2.64 (0.41-17.00)	
Antibiotic Use during Pregnancy	No	151 (86.8)	49 (28.2)	102 (58.6)	Ref	0.780
	Yes	23 (13.2)	9 (5.2)	14 (8.0)	0.81 (0.19-3.47)	
History of Adverse Pregnancy Outcome	No	146 (83.9)	45 (25.9)	101 (58.0)	Ref	0.436
	Yes	28 (16.1)	13 (7.5)	15 (8.6)	1.48 (0.55-3.97)	
Daily water intake	Rarely (< 1L)	79 (45.4)	34 (19.5)	45 (25.9)	Ref	0.040*
	Moderately (1L - 2L)	50 (28.7)	18 (10.3)	32 (18.4)	0.71 (0.32-1.55)	
	Frequently (> 2 L)	45 (25.9)	6 (3.4)	39 (22.4)	0.26 (0.09-0.74)	

Hand hygiene before meals	Not Always	17 (9.8)	4 (2.3)	13 (7.5)	Ref	0.430
	Always	157 (90.2)	54 (31.0)	103 (59.2)	0.90 (0.25-3.24)	
Proper genital hygiene practice	No	143 (82.2)	53 (30.5)	90 (51.7)	Ref	0.008*
	Yes	31 (17.8)	5 (2.9)	26 (14.9)	0.22 (0.07-0.68)	
Private sanitation	No	60 (34.5)	19 (10.9)	41 (23.6)	Ref	0.796
	Yes	114 (65.5)	39 (22.4)	75 (43.1)	1.11 (0.51-2.43)	
Frequency of Sexual Activity	Inactive/Rare	126 (72.4)	33 (19.0)	93 (53.4)	Ref	0.003*
	Active	48 (27.6)	25 (14.4)	23 (13.2)	0.30 (0.13-0.67)	
Sugary Food Consumption	No	78 (44.8)	28 (16.1)	50 (28.7)	Ref	0.668
	Yes	96 (55.2)	30 (17.2)	66 (37.9)	0.26 (0.33-1.34)	
Traditional medicines Use	No	126 (72.4)	37 (21.3)	89 (51.1)	Ref	0.410
	Yes	48 (27.6)	21 (12.1)	27 (15.5)	1.37 (0.65-2.91)	
Frequency of ANC Visits	Limited (≤ 3)	157 (90.2)	51 (29.3)	106 (60.9)	Ref	0.454
	Standard (> 3)	17 (9.8)	7 (4.0)	10 (5.7)	0.67 (0.24-1.90)	
Barriers for Accessing Healthcare	No	104 (59.8)	40 (23.0)	64 (36.8)	Ref	0.301
	Yes	70 (40.2)	18 (10.3)	52 (29.9)	1.85 (0.58-5.95)	
Distance from the nearest Health facility	< 5 KM	87 (50)	33 (19.0)	54 (31.0)	Ref	0.808

5 - 10 KM	63 (36.2)	20 (11.5)	43 (24.7)	1.23 (0.25-6.05)
> 10 KM	24 (13.8)	5 (2.9)	19 (10.9)	1.43 (0.44-4.67)

Footnotes: Values are provided as numbers (n) and percentage (%), n (%). COR: Crude Odds Ratio; CI: Confidence Interval.

Multivariable analysis of factors associated with UTIs

In the multivariable logistic regression analysis, several factors were independently associated with UTI. First trimester (AOR = 4.11; 95% CI: 1.17–14.50; p = 0.028), second trimester (AOR = 2.42; 95% CI: 1.02–5.74; p = 0.045), grand multigravida (AOR = 2.87; 95% CI: 1.28–6.44; p = 0.010), catheterization (AOR = 5.33; 95% CI: 1.38–20.54; p = 0.015), low water intake <1L (AOR = 4.16; 95% CI: 1.23–14.06; p = 0.022), improper genital hygiene (AOR = 4.35; 95% CI: 1.23–15.40; p = 0.023), and sexual activity (AOR = 2.57; 95% CI: 1.11–5.92; p = 0.027) remained significant determinants of UTI (Table 4).

Table 4. Multivariable analysis of determinants of UTI among pregnant women at Gambo General Hospital, West Arsi zone, Ethiopia, 2026

Variable	Category	Frequency	Case	Control	AOR (95% CI)	p- value
Occupational Status	Unemployed	122 (70.1)	45 (25.9)	77 (44.3)	1.45 (0.53- 3.97)	0.473
	Employed	52 (29.9)	13 (7.5)	39 (22.4)	Ref	
Average Monthly Income (ETB)	≥5000ETB	77 (44.3)	30 (17.2)	47 (27.0)	1.66 (0.76- 3.59)	0.203
	<5000ETB	97 (55.7)	28 (16.1)	69 (39.7)	Ref	
Gestational Age	1 st Trimester	17 (9.8)	9 (5.2)	8 (4.6)	4.11 (1.17- 14.50)	0.028*
	2 nd Trimester	97 (55.7)	32 (18.4)	65 (37.4)	2.42 (1.02- 5.74)	0.045*
	3 rd Trimester	60 (34.5)	17 (9.8)	43 (24.7)	Ref	
Gravidity	Grand Multigravida	84 (48.3)	35 (20.1)	49 (28.2)	2.87 (1.28- 6.44)	0.010*
	Primigravida/Multigravida	90 (51.7)	23 (13.2)	67(38.5)	Ref	
History of catheterization	Yes	14 (8.0)	10 (5.7)	4 (2.3)	5.33 (1.38- 20.54)	0.015*
	No	160 (92.0)	48 (27.6)	112 (64.4)	Ref	
Daily water intake	Rarely (< 1L)	79 (45.4)	34 (19.5)	45 (25.9)	4.16 (1.23- 14.06)	0.022*
	Moderately (1L - 2L)	50 (28.7)	18 (10.3)	32 (18.4)	2.89 (0.79- 10.54)	0.107
	Frequently (> 2 L)	45 (25.9)	6 (3.4)	39 (22.4)	Ref	
Proper genital hygiene practice	No	143 (82.2)	53 (30.5)	90 (51.7)	4.35 (1.23- 15.40)	0.023*
	Yes	31 (17.8)	5 (2.9)	26 (14.9)	Ref	

Frequency of Sexual Activity	Active	48 (27.6)	25 (14.4)	23 (13.2)	2.57 (1.11-5.92)	0.027*
	Inactive/Rare	126 (72.4)	33 (19.0)	93 (53.4)	Ref	

Footnotes: Values are provided as numbers (n) and percentage (%), n (%). COR: Crude Odds Ratio; CI: Confidence Interval. * Significant.

VIF ranged from 1.03 to 1.32, indicating no significant multicollinearity. The final multivariable logistic regression model was statistically significant ($\chi^2 = 45.798$, $p < 0.001$). The model's goodness-of-fit was confirmed by both the Pearson test ($\chi^2 = 92.342$, $p = 0.183$) and the Hosmer-Lemeshow test ($\chi^2 = 10.234$, $p = 0.170$), indicating an adequate fit to the data.

Discussions

In the present study, significant bacteriuria was confirmed across all evaluated cases, with Gram-negative bacilli predominating over Gram-positive cocci, aligning with established epidemiological patterns frequently documented in Ethiopia and other international settings. Among individual isolates, *Escherichia coli* emerged as the leading uropathogen, a finding that aligns with established epidemiological data identifying *E. coli* as the primary etiological agent of urinary tract infections during pregnancy, largely facilitated by physiological stasis and specific virulence factors—including adhesins (fim and pap operons), toxins (hemolysin and cytotoxic-necrotizing factors), and siderophores (fyuA gene)—that enhance mucosal adherence and colonization capacity within the urinary tract [21].

Notably, the substantial recovery of Gram-positive organisms—particularly *Staphylococcus saprophyticus* and *Staphylococcus aureus*—underscores an important clinical spectrum in gestational UTIs. The prominent isolation of *Staphylococcus saprophyticus*, a recognized pathogen in young and pregnant populations, reflects the diversity of etiological agents involved in gestational infections beyond standard coliforms [22]. While these findings concur with regional studies across East Africa and elsewhere, variations in reported pathogen spectra across international literature are often attributable to differences in geographical distribution, underlying population demographics, study designs, and institutional healthcare practices.

Regarding antimicrobial susceptibility, meropenem, gentamicin, and piperacillin-tazobactam exhibited the highest activity against the isolated uropathogens, reflecting broad-spectrum coverage against resistant strains. Conversely, concerning levels of resistance were observed for frequently utilized empirical agents such as ampicillin, nitrofurantoin, and Augmentin. This elevated resistance profile presents a distinct clinical challenge in obstetric management, where therapeutic options are inherently restricted due to fetal safety constraints, increasing the vulnerability of pregnant patients to treatment complications and ascending renal involvement.

A pivotal finding in this study was the significant association between early gestational age and the presence of infection. The results indicate that the likelihood of being a case was significantly higher in the earlier stages of pregnancy compared to the third trimester. Specifically, mothers in their first trimester had

4.11 times higher odds of having a UTI (AOR = 4.11; 95% CI: 1.17–14.50; $p = 0.028$), while those in their second trimester also faced more than double the odds of infection (AOR = 2.42; 95% CI: 1.02–5.74; $p = 0.045$).

This study findings are strongly corroborated by research from Mogadishu [10], Assosa, Ethiopia [23], Adigrat, Ethiopia [24], Ghana [15], and Saudi Arabia [25], all of which observed a nearly identical trend. These studies consistently demonstrate that women in their first and second trimesters are significantly more likely to test positive for uropathogenic colonization, reinforcing the argument that the "window of vulnerability" opens much earlier than traditionally expected in clinical practice.

The epidemiological and biological rationale for this early-stage risk is multifaceted. Pregnancy-related UTIs typically initiate as early as week six, reaching a clinical peak between weeks 22 and 24 [10, 24]. This timing is not coincidental; it aligns with profound physiological shifts, including urethral dilation, heightened bladder volume, and a significant reduction in both bladder and urethral tone [10, 26]. These factors, largely driven by the early surge in gestational hormones, create a stagnant urinary environment that fosters rapid bacterial proliferation [10, 26]. While the mechanical pressure of the growing uterus in the third trimester is a known factor [10], our data suggests that the physiological "stasis" induced in the first and second trimesters serves as the primary catalyst for the initiation and establishment of the infection.

Grand Multigravida status—defined as women who have experienced five or more previous pregnancies—was strongly associated with the presence of infection. The results demonstrate that the odds of being a case were nearly three times higher among grand multigravida women compared to primigravida and multigravida participants (AOR = 2.87; 95% CI: 1.28–6.44; $p = 0.010$). This suggests a likelihood of infection that scales with the cumulative physiological burden of repeated gestations, consistent with findings from Nigeria [27], where high gravidity was an independent predictor of UTI.

Grand multigravida women have increased odds of UTI due to permanent anatomical changes from repeated gestations. Chronic progesterone exposure and pelvic floor stretching produce a lasting effect of increased bladder capacity and reduced urethral tone [28], leading to urinary stasis and incomplete emptying. This stagnant reservoir enables uropathogens to colonize and proliferate, as prolonged contact time promotes adhesion to the urothelium [29]. Thus, the structural "wear and tear" of the urinary tract positions grand multigravida women as a high-risk group where anatomical and microbial mechanisms converge to drive infection.

In this study, a history of catheterization emerged as the most potent clinical determinant, demonstrating the strongest association with UTI status. The data reveals that the likelihood of being a case was more than five-fold higher among women who had undergone catheterization compared to those who had not (AOR = 5.33; 95% CI: 1.38–20.54; $p = 0.015$). This high odds ratio highlights a critical iatrogenic risk factor within the clinical environment of the study area. Our findings were consistent with studies from Ethiopia showing that a history of catheterization increases the odds of having UTI [4, 8, 30–32] and a study from Pakistan [33].

Catheterization is an invasive procedure that can induce urethral mucosal injury and introduce bacterial organisms into the bladder, potentially leading to hematogenous bacterial spread due to failure in infection

prevention or poor aseptic technique [4]. Additionally, catheterization bypasses the urethral barriers, providing a direct conduit for uropathogens, while the indwelling device surface enables biofilm formation. In pregnant patients with physiological urinary stasis, this combination facilitates UTI emergence and recurrence [4, 29]

In this study, inadequate water intake emerged as a significant behavioral determinant of UTI. Participants who consumed less than 1 liter of water per day had more than four-fold increased odds of being a case compared to those with higher intake (AOR = 4.16; 95% CI: 1.23–14.06; $p = 0.022$). Notably, 79 (45.4%) of participants reported drinking less than one liter daily, indicating that nearly half of the pregnant women in this study were chronically under-hydrated. Our findings were consistent with a study from India [34] showing that low daily fluid consumption increases the odds of UTI in pregnant women.

From a physiological perspective, the "washout effect" of frequent micturition is a primary innate defense mechanism. Low water intake reduces voiding frequency and creates urinary stasis, allowing uropathogens to attach to the uroepithelium and multiply without mechanical flushing [29, 35]. In pregnant women, where progesterone already slows ureteral peristalsis, this lack of hydration facilitates uropathogen colonization and UTI emergence.

The relationship between personal hygiene and the presence of infection was one of the most clinically significant findings of this study. The results demonstrate that the likelihood of being a case was more than four times higher among women with improper genital hygiene practices compared to those with proper practices (AOR = 4.35; 95% CI: 1.23–15.40; $p = 0.023$). What makes this finding particularly alarming is the high prevalence of the risk factor itself; according to the descriptive data, a staggering 143 (82.2%) of the study participants reported improper genital hygiene. Our findings align with studies from Ethiopia [2], Saudi Arabia [36], and Iran [17]. The combination of a high odds ratio (4.35) and a high prevalence (82.2%) in our study indicates that genital hygiene is the single most important target for behavioral change.

From a microbiological perspective, this strong association is due to the anatomical vulnerability of the female urinary tract. The short length of the urethra and its extreme proximity to the anal opening facilitate the ascending migration of fecal flora. Improper hygiene, such as back-to-front wiping or irregular washing, acts as a mechanical transport mechanism that delivers these pathogens directly to the periurethral area. Once introduced, these pathogens can easily colonize the vaginal vestibule and ascend into the bladder [17, 36]. The high prevalence of poor hygiene in this study suggests that the majority of UTIs at Gambo General Hospital are driven by preventable "self-inoculation" due to a gap in basic health literacy.

Sexual activity during the current pregnancy was identified as a significant lifestyle determinant in the multivariable model. The results indicate that the likelihood of being a case was more than two and a half times higher among women who were sexually active (classified as occasional or frequent) compared to those who were inactive or rare (AOR = 2.57; 95% CI: 1.11–5.92; $p = 0.027$). In the descriptive analysis, 106 (60.9%) of the mothers reported rare sexual activity, which suggests that while the majority of the study population may be protected by this behavioral pattern, those who remain active face a significantly elevated odds of infection.

Our findings are consistent with studies from Ethiopia [37], Saudi Arabia [36], and Iran [17] showing that pregnant women who had frequent sexual intercourse (three or more times per week) had significantly higher odds of UTI.

From a mechanical and microbiological perspective, sexual intercourse acts as a physical catalyst for the translocation of uropathogens. The mechanical movement during coitus can massage bacteria from the vaginal and perineal areas into the urethral meatus, significantly increasing the risk of ascending infection [36, 37]. In pregnant women, the tissues of the urinary tract are already hyperemic and more susceptible to minor trauma, which can facilitate the adherence of pathogens to the urothelium [38].

Limitations

Despite the robust findings, this study has limitations. First, as a hospital-based study, the findings may not be fully representative of pregnant women who do not attend antenatal care at Gambo General Hospital. However, our consecutive sampling captured a broad spectrum of women attending the primary healthcare entry point, making findings relevant for similar rural Ethiopian settings. Second, the behavioral data—such as water intake, hygiene practices, and sexual activity—relied on self-reporting, which may introduce recall bias. Additionally, the face-to-face data collection method may have led to social desirability bias, particularly for sensitive questions such as those related to sexual activity, where mothers may have provided socially acceptable rather than accurate responses.

Conclusions

The findings of this study demonstrate that UTIs among pregnant women in the study area are the result of a multifaceted convergence of biological, clinical, and behavioral determinants. Central to these findings is the identification of an early "window of vulnerability," where the physiological and hormonal shifts of the first and second trimesters—rather than the mechanical pressures of late-stage pregnancy—serve as the primary drivers of uropathogenic colonization. This vulnerability is further compounded in grand multigravida women, whose cumulative history of gestation appears to result in lasting anatomical changes that favor urinary stasis and bacterial persistence.

Beyond these innate biological factors, this research highlights a significant "prevention gap" within the study population. The potent associations between UTI status and modifiable behaviors, such as inadequate hydration and improper genital hygiene, suggest that a substantial portion of these infections are driven by preventable "self-inoculation" and the failure of natural flushing mechanisms. Furthermore, the strong link between catheterization and infection identifies a critical iatrogenic component, where invasive clinical procedures act as a direct conduit for uropathogens.

In summary, this study concludes that maternal UTI in this resource-limited setting is not merely a common complication of pregnancy, but a consequence of identifiable physiological thresholds, clinical risks, and gaps in health literacy. The findings underscore that the risk of infection is highest when biological susceptibility meets preventable environmental and behavioral triggers.

Recommendations

Based on the study's findings, several targeted interventions are recommended across clinical and community levels. Healthcare providers at Gambo General Hospital and similar rural facilities should prioritize routine UTI screening during the first and second trimesters, as well as for grand multigravida women and those with a history of catheterization. Antenatal care counseling must be strengthened to provide explicit education on proper perineal hygiene—specifically front-to-back wiping—and the importance of maintaining adequate hydration and safe sexual practices. Given that catheterization emerged as the strongest clinical determinant, there is an urgent need for strict adherence to aseptic techniques and the limitation of catheter use to absolute medical indications. To improve diagnostic precision, hospital administration should invest in basic microbiology culture facilities, enabling pathogen identification and antimicrobial susceptibility testing to guide targeted therapy. At the policy level, the Kore District Health Office should integrate community-based education campaigns focusing on hygiene and hydration into existing maternal health programs. Finally, future research should move toward longitudinal designs to evaluate neonatal outcomes such as preterm delivery and low birth weight, alongside multicenter studies that can establish regional uropathogen profiles and antibiotic resistance patterns.

Abbreviations

ANC Antenatal Care

AOR Adjusted Odds Ratio

COR Crude Odds Ratio

DALYs Disability Adjusted Life Years

GGH Gambo General Hospital

IRB Institutional Review Board

QC Quality Control

SOP Standard Operating Procedures

UTI Urinary Tract Infection

Declarations

Ethical approval and consent to participate

Ethical approval for this study was granted by the Health Research Ethical Review Committee of the Oromia Health Bureau (Reference No. BFO/HQ/106/18; Addis Ababa) ((Supplementary File 2). Written informed consent was secured from all participants following a thorough explanation of the research purpose and procedures. Strict confidentiality was maintained throughout all stages of the study, and all collected data

were used exclusively for research objectives. The recruitment period for this study began on **01/01/2026** and ended on **30/03/2026**. All methods were performed following the relevant guidelines and regulations.

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Availability of data and materials

The data set used can be obtained from the corresponding author.

Clinical trial number

Not applicable.

Authors' contributions

DSA: Proposal development, laboratory work, data analysis and preparation of the manuscript.

KUB: Data collection, supervision of laboratory work, review of the manuscript.

GWA: Supervision of the study, data analysis and review of the manuscript.

JGD: Supervision of the study, data analysis and review of the manuscript.

TDW: Data collection, supervision of laboratory work and review of the manuscript.

OG: Data collection, supervision of laboratory work and review of the manuscript.

KA: Proposed the study, supervised the study, data analysis and review of the manuscript.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Figures

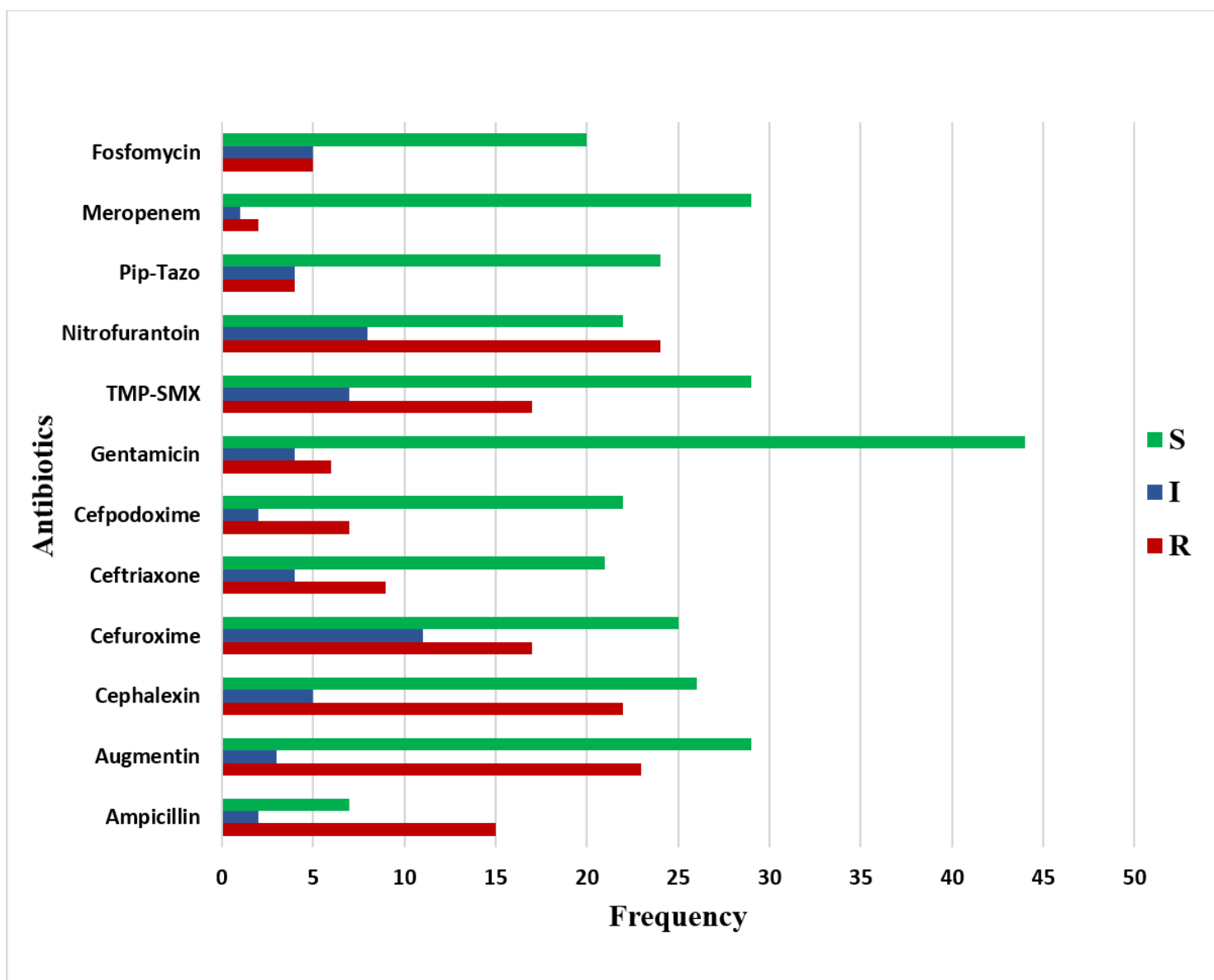


Figure 1

Antimicrobial Susceptibility Profiles of Uropathogens among cases in pregnant women at Gambo General Hospital, West Arsi zone, Ethiopia, 2026.

Footnotes: R: Resistance, I: Intermediate, S: Susceptible

Supplementary Files

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