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ORIGINAL RESEARCH

Prevalence of Asymptomatic Bacteriuria, Associated Factors and Antimicrobial Susceptibility Profile of Bacteria Among Pregnant Women Attending Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia

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Introduction: Asymptomatic bacteriuria (ASB) is the presence of bacteria in significant quantity in the absence of signs and symptoms of urinary tract infection (UTI). ASB, if it occurs during pregnancy, can cause serious complications both among fetus and pregnant women.

Objective: The aim of this study was to determine the prevalence of ASB, its associated factors, and antimicrobial susceptibility profile of bacterial isolates among pregnant women.

Methods: A cross-sectional study was conducted from July to September 2019 among 290 pregnant women at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia. Clean-catch midstream urine specimens were collected using sterile containers and cultured on MacConkey agar and sheep blood agar to isolate bacteria. Socio-demographic and obstetric data were collected using a structured questionnaire. Data were analyzed by SPSS version 22. The association between ASB and risk factors was assessed using logistic regressions. A p-value ≤ 0.05 was considered as a cut point to determine the significant association.

Results: From 290 study participants, 16.9% with 95 CI [13.1, 21.5] were positive for ASB. The predominant bacteria were *Escherichia coli* (43%) and *Staphylococcus aureus* (20%). Majority of *E. coli* (91.0%) were susceptible to nitrofurantoin and gentamycin; most of them were resistant to amoxicillin (86.4%) and cotrimoxazole (77.7%). The proportion of multi-drug resistance (MDR) isolates was 57.1%. Previous infection with UTI, previous history of catheterization, and natural abortion were significantly associated with ASB.

Conclusion: In the study area, ASB is prevalent in the study area indicating the importance of screening of ASB and possible treatment to prevent its consequences.

Keywords: asymptomatic bacteriuria, antibiotic susceptibility, pregnant woman, Addis Ababa, Ethiopia

Introduction

Urinary tract infection (UTI) is an infection of the urinary tract system; it can occur both in the community and hospital environment.[1,2] Even though all age groups are affected by UTI, pregnant women,[3–5] and immuno-compromised individuals[6] are more susceptible. Generally, women are at greater risk of UTI as compared to males because of anatomical position and short urethra.[6,7] If UTI occurs among pregnant women; it can be with symptoms or without symptoms. Urinary tract infection without signs and symptoms is known as asymptomatic bacteriuria (ASB).

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Asymptomatic bacteriuria is the presence of a significant quantity of bacteria ($\geq 10^5$) in a urine specimen in the absence of signs and symptoms of UTI.[8] Asymptomatic bacteriuria may progress to symptomatic UTI during pregnancy because of the following reasons: altered hormones, physiological changes, and reduced immunity.[9] Other factors that could predispose pregnant women to bacteriuria are age, lower socioeconomic status, multiparty, past history of UTI, history of catheterization, aminoaciduria, anemia, and diabetes mellitus.[10–12]

In most cases, the leading cause of UTI is *E. coli*,[13] while other Gram-negative bacteria such as *Pseudomonas aeruginosa, Klebsiella pneumoniae, Proteus* species, and some Gram-positive bacteria are also responsible.[14] Significant numbers of pregnant women with ASB may develop acute upper UTI.[15] Upper UTI can have a direct and indirect impact on the fetus.[16,17]

There are scarce data on the prevalence of ASB in Addis Ababa. The aim of this study was to determine the prevalence of ASB, its associated factors, and antimicrobial susceptibility profile of bacterial isolates among pregnant women attending Saint Paul's Hospital Millennium Medical College (SPHMMC) Addis Ababa, Ethiopia.

Methods

Study Area

This study was conducted at SPHMMC which is located in Addis Ababa, the capital city of Ethiopia. The hospital provides health care services for about two million patients per year. Every month, about 830 pregnant women visit antenatal care unit of the hospital for follow-up.

Study Design and Study Population

A hospital-based cross-sectional study was conducted from July to September 2019. Pregnant women of all gestational age without signs and symptoms of UTI (such as dysuria, haematuria, fever, suprapubic pain, flank pain, the urgency of urination) were included in the study. Pregnant women with a history of antibiotics in the last 15 days and those with known congenital anomalies of the urinary tract system were excluded from the study.

Variables of the Study

Dependent Variables

Prevalence of ASB.

Independent Variables

Socio-demographic factors and other related factors such as the history of UTI, hemoglobin level, history of catheterization, educational status, monthly income, gestational age, history of natural abortion, parity, history of stillbirth, etc.

Sample Size Determination

The sample size was determined using a single population proportion formula, by considering the prevalence of UTI (21.2%) reported from Tigray Regional State, Ethiopia,[4] 95% confidence interval and a 5% margin of error. The total sample size after considering risk factors and 10% contingency was equal to 290.

Sampling Technique

To recruit study participants systematic random sampling technique was used by considering the three months of study period. According to the hospital plan and the past three months' performance report, about 1518 pregnant women were expected to visit the antenatal care unit during the study period. This estimate was divided into the sample size (n=290) to determine the sampling interval (K value) which was five. The first study participant was selected by lottery method; then onward, every 5th pregnant women were invited to participate in the study until the required sample size was obtained.

Data Collection

Socio-demographic and factors that could predispose to ASB (history of UTI, hemoglobin level, history of catheterization, educational status, monthly income, gestational age, history of natural abortion, parity, history of stillbirth, etc.) were captured by using a structured questionnaire. Participants were instructed on how to collect clean-catch midstream urine. They were informed to clean their hands with water and soap then cleanse their periurethral area with a sterile cotton swab soaked in normal saline to reduce contamination. About 10–15 milliliter of clean-catch midstream urine was collected from all study participants using a wide-mouthed sterile container. Specimens were transported to the microbiology laboratory of Ethiopian Public Health Institute (EPHI) within 1–2 hours after collection. Uncentrifuged, well mixed, urine of 0.001 mL was inoculated onto MacConkey agar and 5% sheep blood agar by a calibrated wire loop and then incubated aerobically at 37°C overnight. Colony count per mL of the sample was

multiplied by 1000 to get the total colony-forming unit (CFU) per mL of urine. A plate with 10^5 CFU/mL colony count or greater was considered as significant growth.[18] Bacteria were identified by colony characteristics, Gram reaction, catalase test, coagulase test, and biochemical tests.[19]

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using disk diffusion method on Mueller-Hinton agar (Oxoid Ltd, Hampshire, UK) according to Clinical and Laboratory Standards Institute (CLSI) guideline.[20] Antimicrobials tested were comprised of ampicillin (10μg), amoxicillin (20μg), amoxicillin-clavulanic acid (20/10μg), ciprofloxacin (5μg), ceftriaxone (30μg), azithromycin (15μg) cefuroxime (30μg), nitrofurantoin (300μg), erythromycin (15μg), cotrimoxazole (25μg), tetracycline (30μg), clindamycin (2μg), gentamicin (10μg), penicillin (30μg), and meropenem (10μg).

Quality Control

To maintain the quality of socio-demographic and obstetric data, the questionnaire was pretested among pregnant women that represent 5% of the total sample size at Tikur Anbesa Specialized Hospital. Originally the questionnaire was prepared in English then it was translated to Amharic and finally translated back to English by different translators to check its consistency. The sterility of all culture media was checked by incubating 5% of them without inoculation at 37 ^{O}C. The performance of culture media was checked by using control strains such as *E. coli* (ATCC-25,922), *S. aureus* (ATCC-25,923), and *P. aeruginosa* (ATCC-27,853) throughout the study.

Operational Definitions

Asymptomatic Bacteriuria (ASB)

Bacterial colony count greater than or equal to 10^5 cfu/mL from urine sample collected from a person with no signs and symptoms of UTIs (such as dysuria, haematuria, fever, suprapubic pain, flank pain, the urgency of urination).[21]

Multidrug-Resistance (MDR)

Bacteria that show resistance to two or more classes of antimicrobial agents.[22]

Data Processing and Analysis

Data were cleaned, coded and entered using Epi Info Version 7.2 and analyzed by SPSS software version 22. Descriptive statistics was used to determine the prevalence of ASB, the proportion of bacteria, and AST profiles of bacteria. To determine factors associated with ASB bivariate and multivariable logistic regression were used. Variables with a *p*-value less than 0.25 in bivariate analysis were selected for further analysis by multivariable logistic regression. A *p*-value of less than 0.05 was taken as a cut point to determine significant association.

Results

Socio-Demographic Characteristics of Study Participants

In this study, a total of 290 pregnant women were included with a response rate of 100%. The mean age of the participants was 27± 4.5 years. Two hundred-eighty (96.6%) participants were married. Twenty percent of participants attended the College or University level of education. More than half of the study participants resided in an urban area (Table 1).

Prevalence of Asymptomatic Bacteriuria

Out of 290 pregnant women without signs and symptoms of UTI, 49 (16.9%) (95%, CI=13.1–21.5) had significant bacteriuria. Among participants with significant bacteriuria, 47 (95.9%) were positive for one bacteria while 2 (4.1%) were positive for more than one organism. In this

Table 1 Socio-Demographic Characteristics of Pregnant Women Attending the Antenatal Clinic of the Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2019 (N= 290)

Variables	Category	Frequency	Percent
Age in years	18–25	101	34.8
	26–34	169	58.3
	35–43	20	6.9
Occupation	Housewife	193	66.6
	Merchant	55	19.0
	Government employed	38	13.0
	Student	4	1.4
Marital status	Married	280	96.6
	Single	10	3.4
Education	No formal education	26	3.4
	Primary school	125	43.1
	Secondary school	81	27.9
	College or University level education	58	20.0
Residence	Urban	249	85.9
	Rural	41	14.1

study, eight different types of bacteria were identified. Out of 49 bacteria isolated, 29 (59.2%) were Gram-negative bacteria and 20 (40.8%) were Gram-positive bacteria. The predominant bacteria were *E. coli* 21 (43%) and *S. aureus* 10 (20.4%) followed by *S. saprophyticus* 7(14.3%), *K. Pneumoniae* 3(6.1%), *Enterobacter cloacae* 2(4.1%), *Enterococcus faecalis* 2(4.1%), *Klebsiella oxytoca* 1 (2.1%), *and Enterobacter aerogens* 1(2.1%). The two mixed cultures contained *E. coli* with *Candida albicans* and *S. saprophyticus* with *C. albicans*.

Factors Associated with Asymptomatic Bacteriuria

High prevalence of ASB was observed among participants within the age group of 26–34 years (17.8%), housewives (18.1%), urban residents (17.7%), married (17.1%), and with no formal education (23.1%). However, there was no significant association between ASB and socio-demographic characteristics (Table 2). In multivariable analysis, the prevalence of ASB was significantly associated with a history of UTI [AOR=3.11, 95% Cl: 1.42, 6.79], history catheterization [AOR=2.31, 95% Cl: 1.04, 5.73], anemia [AOR=10.49, 95% Cl: 4.54, 24.04], and history of natural abortion [AOR=2.36, 95% Cl: 1.13, 4.94] (Table 3).

Antimicrobial Susceptibility Profile of Bacteria

The antimicrobial susceptibility profile of Gram-negative bacteria (susceptible bacteria) falls within the range of 13.8%-93.1%. The majority of the Gram-negative bacteria were susceptible to nitrofurantoin (n=27; 93.1%), gentamycin (n=25; 86.2%), ceftriaxone (n=24; 82.8%), cefuroxime (n=23; 82.8%), and meropenem (n=22; 75.9%). Most Gram-negative bacteria were resistant to amoxicillin (n=23; 79.3%), cotrimoxazole (n=19; 65.5%), and amoxicillin-clavulanic acid (n=11; 37.9%). Most of *E. coli* (n=19; 86.4%) were resistant to amoxicillin (Table 4).

All Gram-positive bacteria were susceptible to nitrofurantoin (n=20; 100%). Majority were susceptible to azithromycin (n=18; 90.0%), gentamicin, and ciprofloxacin (for each n=17; 85.0%) and clindamycin (n=16; 80.0%). Most of *S. aureus* were susceptible to gentamicin, ciprofloxacin, and azithromycin (n=9; 90.0%); however, 70% were resistant to penicillin. Seventy-five percent of *S. saprophyticus* were susceptible to gentamycin, ciprofloxacin, clindamycin, and azithromycin (Table 5). Out of 49 bacteria isolated in this study, 28 (57.1%) were MDR; 15 (51.7%) of this belongs to Gram-negative while 13 (65.0%) belongs to Gram-positive bacteria (Table 6).

Discussion

The prevalence of ASB among pregnant women in the current study (16.9%) is in line with a study conducted in Bangladesh (16.5%)[23] and Adama, Ethiopia (16.1%).[24] However, it is low compared to the prevalence of ASB reported from Iraq (42.9%),[25] Nigeria (37.1%),[26] Saudi Arabia (32.1%),[27] and Adigrat, Ethiopia (21.2%).[4] In addition, the finding of the current study is higher than the prevalence of UTI reported from Nigeria (11%)[28] and Bahir Dar, Ethiopia (11.5%).[29] The variation could be attributed to social habits and education levels of the study participants.

The proportion of Gram-negative bacteria (59.2%) identified in the present study is higher than the proportion of Gram-positive bacteria (40.8%). This finding is in line with studies conducted in Gondar, Ethiopia,[30] Tanzania,[31] and Nigeria.[26] *E. coli* was found to be the most prevalent (43%) bacteria isolated in this study. A similar finding was reported from Adama, Ethiopia (37.3%),[24] Kenya (38.8%),[32] and Tanzania (64.2%).[33] This could be due to virulence factors harbored by the bacteria to colonize the urinary epithelium and difficultly of maintaining personal hygiene during pregnancy. The second predominant bacteria were *S. aureus* (20.4%) followed by *S. saprophyticus* (14.3%). This finding is comparable with the study conducted in Iraq (25.0%)[25] and Kenya (29.7%).[32] The proportion of *S. saprophyticus* (14.3%) in the current study is comparable with report from Adigrat, Ethiopia (12.7%).[4] In contrast, a high proportion of *S. saprophyticus* was reported from Bahir Dar, Ethiopia (48.2%)[29] and Nigeria (44.5%).[3]

In the current study, participants with the previous history of UTI had about 3 times chance of developing ASB (p=0.004). A similar finding was reported from Gondar, Ethiopia[30] and Egypt.[34] The possible explanation for this association could be due to the existence of antibiotic-resistant strains from the previous infection. The history of catheterization was also significantly associated with ASB (p=0.04). This is in line with a study conducted in Dessie, Ethiopia.[5] The reason for this could be due to the introduction of bacteria to the sterile site during catheterization. Frequent and long-term catheterization could create a favorable environment for bacterial colonization and growth as a biofilm. Pregnant women with a history of

Table 2 ASB Across Different Socio-Demographic Characteristics Among Pregnant Women Attending Antenatal Clinic of the Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2019 (N=290)

Variables	Tested n (%)	ASB		COR (95% CI)	*p*-value	
		Positive n (%)	Negative n(%)			
Age (in years)						
	18–25	101(34.8)	17(16.8)	84(83.2)	1	
	26–34	169(58.3)	30(17.8)	139(82.2)	1.06 (0.55, 2.05)	0.847
	35–43	20(6.9)	2(10.0)	18(90.0)	0.54 (0.12, 2.58)	0.449
Occupation						
	Housewife	193(66.6)	35(18.1)	158(81.9)	0.66 (0.07, 6.58)	0.727
	Merchant	55(19.0)	8(14.5)	47(85.5)	0.51 (0.05, 5.54)	0.581
	Government Employed	38(13.0)	5(13.2)	33(86.8)	0.45 (0.04, 5.27)	0.528
	Student	4(1.4)	1(25.0)	3(75.0)	1	
Marital status						
	Married	280(96.6)	48(17.1)	232(82.9)	1.86 (0.23, 15.04)	0.560
	Single	10(3.4)	1(10.0)	9(90.0)	1	
Educational status						
	No formal education	26(9.0)	6(23.1)	20(76.9)	3.18(0.87, 11.59)	0.08
	Primary school	125(43.1)	23(18.4)	102(81.6)	2.39(0.86, 6.64)	0.95
	Secondary school	81(27.9)	15(18.5)	66(81.5)	2.41(0.82, 7.05)	0.11
	Higher education	37(12.8)	4(10.8)	33(89.2)	1	
Place of residence						
	Urban	249(85.9)	44(17.7)	205(82.4)	1	
	Rural	41(14.1)	5(12.2)	36(87.8)	0.65(0.240–1.742)	0.389
Gestational age						
	1st Trimester	51(17.6)	8(15.7)	43(84.3%)	1	
	2nd Trimester	66(22.8)	10(15.2)	56(84.8)	0.96(0.349, 2.638)	0.937
	3rd Trimester	173(59.6)	31(17.9)	142(82.1)	1.173(0.502, 2.742)	0.712
Parity						
	Nulliparous	86(29.7)	17(19.8)	69(80.2)	1	
	Primiparous	109(37.6)	16(14.7)	93(85.3)	0.69(0.33, 1.47)	0.348
	Multiparous	95(32.8)	16(16.8)	79(83.2)	0.82(0.38, 1.74)	0.611
History of still birth						
	Yes	14(4.5)	3(21.4)	11(78.6)	1.36(0.17, 2.50)	0.545
	No	276(95.5)	46(16.7)	230(83.3)	1	
History of early neonatal death						
	Yes	14(4.8)	1 (7.1)	13(92.9)	0.36(0.35, 21.42)	0.338
	No	276(95.2)	48(17.4)	228(82.6)	1	
History of diabetes						
	Yes	21(7.2)	5(23.8)	16(76.2)	1.59(0.22, 1.79)	0.384
	No	269(92.8)	44(16.4)	225(83.6)	1	

(*Continued*)

Table 2 (Continued).

Variables	Tested n (%)	ASB		COR (95% CI)	*p*-value	
		Positive n (%)	Negative n(%)			
HIV sero-status						
	Positive Negative	9(3.1) 281(96.6)	2(22.2) 47(16.7)	7(77.8) 234(83.3)	1.42(0.14,1.39) 1	0.666

Abbreviations: COR, crude odds ratio; CI, confidence interval; ASB, asymptomatic bacteriuria.

Table 3 Bivariate and Multivariable Analyses of Factors Associated with ASB Among Pregnant Women Attending the Antenatal Clinic of the Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2019 (N=290)

Variables	Tested n(%)		ASB		Bivariate Analysis		Multivariate Analysis	
			Positive n (%)	Negative n (%)	COR (95% CI)	P-value	AOR (95% CI)	*p*-value
History of urinary tract infection								
	Yes No	91(31.4) 199(68.6)	28(30.8) 21(10.6)	63(69.2) 178(89.4)	3.76(1.99, 7.12) 1	0.001	3.11(1.42, 6.79)	0.004
Hemoglobin level								
	<11g/dl (Anemic) ≥11g/dl (Normal)	33(11.4) 257(88.6)	18(54.5) 31(12.0)	15(45.5) 226(88.0)	8.75(4.01,19.11) 1	0.0001	10.49(4.58, 24.04)	0.0001
History of catheterization								
	Yes No	89(30.7) 201(69.3)	23(25.8) 26(12.9)	66(74.2) 175(87.1)	2.34(1.25, 4.39) 1	0.008	2.31(1.04, 5.13)	0.04
Educational status								
	No formal education Primary school Secondary school Higher education	26(9) 125(43.1) 81(27.9) 58(20.0)	6(23.1) 23(18.4) 15(18.5) 5(8.6)	20(76.9) 102(81.6) 66(81.5) 53(91.4)	3.18(0.87, 11.59) 2.39(0.86, 6.64) 2.14(0.82, 7.05) 1	0.08 0.95 0.11	3.26(0.72–14.83) 2.04(0.63, 6.62) 2.45(0.72, 8.38)	0.126 0.233 0.152
Average monthly income level (in Ethiopian Birr)								
	≤500 501–1000 1001–1500 1501–2000 >2000	20(6.9) 58(20.0) 29(10.0) 51(17.6) 132(45.5)	3(15.0) 13(22.4) 3(10.3) 10(19.6) 20(15.2)	17(85.0) 45(77.6) 26(89.7) 41(80.4) 112(84.8)	0.98(0.26, 3.68) 1.62(0.74, 3.52) 0.64(0.18, 2.34) 1.36(0.59, 3.16) 1	0.986 0.226 0.506 0.466	0.36(0.06, 1.92) 1.17(0.46, 2.95) 0.54(0.13, 2.19) 0.75(0.26, 2.12)	0.232 0.735 0.390 0.590
History of natural abortion								
	Yes No	91(31.4) 199(68.6)	24(26.4) 25(12.6)	67(73.6) 174(87.4)	2.49(1.33, 4.66) 1	0.004	2.36(1.13, 4.96)	0.023

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; ASB, asymptomatic bacteriuria.

natural abortion were 2.36 times more likely to develop ASB (p=0.023). The results of this study disagree with the finding reported from Cameron.[35]

Majority of Gram-negative bacteria isolated in the current study were susceptible to nitrofurantoin (93.1%), gentamicin (85.2%), ceftriaxone (82.2%), cefuroxime (79.3%),

Table 4 Antimicrobial Susceptibility Profile of Gram-Negative Bacteria Isolated from Pregnant Women with ASB at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2019 (n=29)

Type of Isolates (n)		Antimicrobial Agents n (%)										
		GEN	CIP	AMP	AMX	AMC	TET	NIT	CEF	CRX	MER	COT
E. coli (22)	S	20(91.0)	18(81.8)	10(45.5)	1(4.5)	10(45.5)	15(68.2)	20(91.0)	18(81.8)	18(81.8)	18(81.8)	6(27.3)
	I	1(4.5)	1(4.5)	–	2(9.1)	2(9.0)	–	–	–	1(4.5)	3(13.7)	–
	R	1(4.5)	3(13.7)	12(54.5)	19(86.4)	10(45.5)	7(31.8)	2(9.0)	4(18.02)	3(13.7)	1(4.5)	16(77.7)
K. pneumoniae (3)	S	1(33.3)	1(33.3)	2(66.7)	1(33.3)	2(66.7)	1(33.3)	3(100)	1(33.3)	2(66.7)	1(33.3)	1(33.3)
	I	1(33.3)	–	–	–	–	1(33.3)	–	1(33.3)	–	–	–
	R	1(33.4)	2(66.7)	1(33.3)	2(66.7)	1(33.3)	1(33.3)	–	1(33.3)	1(33.3)	2(66.7)	2(66.7)
E. cloacae (2)	S	2(100)	–	2(0.0)	2(0.0)	2(100)	1(50.0)	2(100)	2(100)	2(100)	2(100)	–
	I	–	–	–	–	–	1(50.0)	–	–	–	–	2(100)
	R	–	2(100)	–	–	–	–	–	–	–	–	–
K.oxytoca (1)	S	1(0.0)	1(100)	–		1(100)	1(100)	1(100)	1(100)	1(100)	–	–
	R	–	–	1(100)	1(100)		–	–			1(100)	1(100)
E. aerogens (1)	S	1(100)	1(100)	–	–	1(100)	1(100)	1(100)	1(100)	1(100)	1(100)	1(100)
	R	–	–	1(100)	1(100)	–	–	–	–	–	–	–
Total (29)	S	25(86.2)	21(72.4)	14(48.3)	4(13.8)	16(55.2)	19(65.5)	27(93.1)	23(82.8)	24(82.8)	22(75.9)	8(27.6)
	I	2(6.9)	1(3.4)	–	2(6.9)	2(6.9)	2(6.9)		1(3.4)	1(3.4)	3(10.3)	2(6.9
	R	2(6.9)	7(24.2)	15(51.7)	23(79.3)	11(37.9)	8(27.6)	2(6.9)	5(17.3)	4(13.8)	4(13.8)	19(65.5)

Abbreviations: GEN, gentamycin; CIP, ciprofloxacin; AMP, ampicillin; AMX, amoxicillin; AMC, amoxicillin clavulanic acid; TET, tetracycline; NIT, nitrofurantoin; CEF, ceftriaxone; CRX, cefuroxime; MER, meropenem; COT, co-trimoxazole; S, susceptible; I, intermediate; R, resistance; ASB, asymptomatic bacteriuria.

Table 5 Antimicrobial Susceptibility Profile of Gram-Positive Bacteria Isolated from Pregnant Women with ASB at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2019 (n=20)

Type of Isolates (n)		Antimicrobial Agents n (%)									
		GEN	ERY	CIP	PEN	COT	TET	NIT	CD	AZT	AMP
S. aureus (10)	S	9(90.0)	6(60.0)	9(90.0)	3(30.0)	7(70.0)	7(70.0)	10(100)	8(80.0)	9(90.0)	NA
	I	1(10.0)	1(10.0)	1(10.0)	–	–	–	–	1(10.0)	–	NA
	R	–	3(30.0)	–	7(70.0)	3(30.0)	3(30.0)	–	1(10.0)	1(10.0)	NA
S. saprophyticus (8)	S	6(75.0)	4(50.0)	6(75.0)	2(25.0)	4(50.0)	4(50.0)	8(100)	6(75.0)	7(87.5)	NA
	I	1(25.0)	2(25.0)	1(12.5)	–	1(12.5)	2(25.0)	–	1(12.5)	1(12.5)	NA
	R	1(25.0)	2(25.0)	1(12.5)	6(75.0)	3(37.5)	2(25.0)	–	1(12.5)	–	NA
E. faecalis (2)	S	2(100)	NA	2(100)	1(50.0)	1(50.0)	1(50.0)	2(100)	2(100)	2(100)	1(50.0)
	I	–	NA	–	–	–	1(50.0)	–	–	–	–
	R	–	NA	–	1(50.0)	1(50.0)	–	–	–	–	1(50.0)
Total (20)	S	17(85.0	10(55.6)	17(85.0)	6(30.0)	12(60.0)	12(60.0)	20(100)	16(80.0)	18(90.0	1(50.0)
	I	2(10.0)	3(16.7)	2(10.0)	–	1(5.0)	3(15.0)	–	2(10.0)	1(5.0)	–
	R	1(5.0)	5(27.7)	1(5.0)	14(70.0)	7(35.0)	5(25.0)	–	2(10.0)	1(5.0)	1(50.0)

Abbreviations: GEN, gentamycin, ERY, erythromycin; CIP, ciprofloxacin; PEN, penicillin; COT, co-trimoxazole; TET, tetracycline; NIT, nitrofurantoin; CD, clindamycin; AZT, azithromycin; AMP, ampicillin; S, susceptible; I, intermediate; R, resistant; NA, not applicable; ASB, asymptomatic bacteriuria.

meropenem (75.2%), and ciprofloxacin (75.2%). This finding is comparable with a study conducted in Dessie, Ethiopia,[5] Hawassa, Ethiopia,[6] and Bale, Ethiopia.[36] However, most Gram-negative bacteria were resistant to amoxicillin (79.3%), amoxicillin-clavulanic acid (37.9%). The easy accessibility, indiscriminate and frequent use of antibiotics might cause the emergence of bacteria which are resistant to amoxicillin and amoxicillin-clavulanic acid.

Most *E. coli* isolated in this study were susceptible to gentamicin, nitrofurantoin, ceftriaxone, ciprofloxacin, and

Table 6 Multi-Drug Resistance Profile of Bacteria Isolated from Pregnant Women with ASB at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2019 (n=28)

Bacterial Isolates	Combination of Antibiotics	N (%)
E. coli (n=12)	AMX, COT	1 (8.3)
	AMX, MER	1 (8.3)
	AMX, AMP, AMC, COT	3 (25.0)
	AMX, AMP,AMC,TET,COT	3 (25.0)
	AMX,AMP,AMC,CRT,CRX,COT	1 (8.3)
	AMX,AMP,AMC,NIT,TET,COT	1 (8.3)
	AMX,AMP,AMC, CTR,CRX,CRP,TET, COT	2 (16.7)
K. pneumoniae (n=2)	AMX, CRP,MER,COT	1 (50.0)
	AMX,AMP,AMC,CTR,CRX,GEN,CRP, TET,MER,COT	1 (50.0)
K. oxytoca (n=1)	AMX,AMP,COT	1 (100)
Total (Gram-negative)		15(51.7)
S. aureus (n=7)	ERY,PEN	3(42.9)
	TET,PEN	1(14.2)
	COT,PEN	1(14.2)
	PEN,TET,CD,COT	1(14.2)
	PEN,TET,AZT,COT	1(14.2)
S. saprophyticus (n=5)	PEN,CD	1(20.0)
	ERY,PEN	1(20.0)
	COT,ERY	1(20.0)
	GEN,PEN,TET,COT	2(40.0)
E. faecalis (n=1)	PEN, COT	1(100)
Total (Gram-positive)		13(65)
Overall total		28(57.1)

Abbreviations: AMX, amoxicillin; COT, co-trimoxazole; CIP, ciprofloxacin; AMP, ampicillin; AMC, amoxicillin-clavulanic acid; TET, tetracycline; GEN, gentamycin; NIT, nitrofurantoin; CTR, ceftriaxone; CRX, cefuroxime; MER, meropenem; ERY, erythromycin; PEN, penicillin; CD, clindamycin; AZT, azithromycin; ASB, asymptomatic bacteriuria.

cefuroxime. However, most *E. coli* were resistant to ampicillin, cotrimoxazole, and amoxicillin-clavulanic acid. The proportion of antibiotic-resistant *E. coli* found in this study is higher than the proportion antibiotic-resistant *E. coli* reported from other parts of Ethiopia[29] but it is low compared to report from Kenya.[32] Moreover, the finding of this study is not in line with a report from India, where 6170% of *E. coli* were susceptible to ampicillin and amoxicillin-clavulanic acid, respectively.[37] These differences could be due to variations in antibiotic prescription patterns across various countries.

All *K. pneumoniae* isolated in this study were susceptible to nitrofurantoin and most of them were susceptible to ampicillin, amoxicillin-clavulanic acid, and cefuroxime. The finding is not comparable with finding reported from Tanzania.[31] All *K. oxytoca* and *E. aerogens* were resistant to ampicillin and amoxicillin. The high resistance to ampicillin and amoxicillin observed in this study may be due to the easy availability of antibiotics in local pharmacies and frequent prescription of antibiotics by physicians without antimicrobial susceptibility testing.

In the current study, none of the Gram-positive bacteria were resistant to nitrofurantoin. This could be due to the infrequent use of the drug in the study area. Most *S. aureus* isolated in the current study were resistant to penicillin, erythromycin, and tetracycline. This finding is not in line with the report from Togo.[38] In addition, all *E. faecalis* were susceptible to gentamicin and ciprofloxacin; however, half of them were resistant to ampicillin and penicillin. In contrast, according to a study conducted in Togo, all *E. faecalis* were resistant to ciprofloxacin.[38] In our study, a significant number (57.1%) of bacteria were MDR which is lower than MDR reported from Jimma, Ethiopia (90%),[39] Dire Dawa, Ethiopia (100%),[30] and Nigeria (100%).[40]

Limitation of the Study

As participants may not remember all information asked during data collection, this study is prone to recall bias.

Conclusion

The prevalence of ASB among pregnant women in the present study was 16.9%. History of UTI, history of catheterization, and history of natural abortion were significantly associated with ASB. The most prevalent bacteria isolated in this study were *E. coli* (43.0%), *S. aureus* (20.4%), and *S. saprophyticus* (14.3%). The majority of bacteria isolated in the present study were susceptible to nitrofurantoin and gentamicin. The study also showed that most of the bacteria were MDR.

Abbreviations

ANC, antenatal care; ASB, asymptomatic bacteriuria; ATCC, American Type Culture Collection; CFU, colony-forming unit; MDR, multidrug-resistance; HIV, human immunodeficiency virus; SPHMMC, Saint Paul's Hospital Millennium Medical College; UTI, urinary tract infection.

Data Sharing Statement

All relevant data generated and analyzed are available within the paper.

Ethical Approval and Consent to Participate

The study was approved by the Institutional Review Board of Hawassa University, College of Medicine and Health Sciences (Ref No IRB/205/11) and Saint Paul's Hospital Millennium Medical College (Ref No pm23/368). An official permission letter was obtained from the Saint Paul's Hospital Millennium Medical College administration office. Participants enrolled in the study were informed about the study objectives, expected outcomes, benefits, and risks associated with it. Written informed consent was taken from all participants before the interview. The study was conducted in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare no competing interests.

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