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RESEARCH TITLE

Prevalence, Bacterial Etiology, and Antimicrobial Susceptibility Pattern of Asymptomatic Bacteriuria among Pregnant Women in Misurata, Libya

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Abstract

Background: Asymptomatic bacteriuria (ASB) is a common but often overlooked condition during pregnancy that can progress to symptomatic urinary tract infection, pyelonephritis, preterm labour, and low birth weight if left undetected and untreated. No local data on ASB were previously available for Misurata, Libya.

Objective: To determine the prevalence of ASB among pregnant women in Misurata, identify the causative bacterial isolates, evaluate the diagnostic accuracy of dipstick chemical examination (nitrite and leukocyte esterase), and assess the antimicrobial susceptibility pattern of the isolated uropathogens.

Methods: This descriptive cross-sectional study was conducted between November 2023 and August 2024 at the Lamis Clinic and Misurata Medical Centre. Clean-catch midstream urine samples were collected from 234 asymptomatic pregnant women and analyzed by chemical dipstick, microscopy, and quantitative culture. Bacterial isolates were identified by standard biochemical tests and API-20E, and antimicrobial susceptibility was determined by the Kirby-Bauer disc diffusion method, with E-test used to confirm vancomycin MIC in methicillin-resistant Staphylococcus aureus (MRSA) isolates.

Results: ASB was detected in 27 of 234 women (11.53%). Gram-negative bacteria (59.25%) predominated over Gram-positive bacteria (40.74%). Klebsiella pneumoniae was the most frequent isolate (33.33%), followed by coagulase-negative staphylococci (29.62%), Escherichia coli (22.22%), Staphylococcus aureus (11.11%), and Pseudomonas aeruginosa (3.7%). No statistically significant associations were found between ASB and age, parity, trimester, or medical history ($p > 0.05$). The nitrite and leukocyte esterase dipstick tests showed low sensitivity (18.75% and 25.93%, respectively) but high specificity (99.54% and 90.87%), while pus cell count had the highest sensitivity (37.04%) among the screening tests. Gram-negative isolates were most susceptible to piperacillin-tazobactam and amikacin (81.2%), while Gram-positive isolates were most susceptible to cefuroxime and doxycycline (90.9%). Extended-spectrum beta-lactamase (ESBL) production was detected in 33.3% of Gram-negative isolates.

Conclusion: ASB affects a notable proportion of pregnant women in Misurata. Dipstick screening alone is unreliable for detecting ASB, and quantitative urine culture remains the diagnostic gold standard. Routine screening and culture-guided antimicrobial therapy are recommended to reduce maternal and fetal complications.

Key Words: *Asymptomatic bacteriuria; pregnancy; urinary tract infection; antimicrobial susceptibility; Klebsiella pneumoniae; Misurata, Libya.*

عنوان البحث

مدى انتشار البيلة الجرثومية اللاعرضية، ومسبباتها البكتيرية، ونمط حساسيتها للمضادات الميكروبية لدى النساء الحوامل في مصراتة، ليبيا

المستخلص

الخلفية :تُعدّ البيلة الجرثومية اللاعرضية (ASB) حالة شائعة، لكنها غالبًا ما تُهمَل خلال الحمل، وقد تتطور إلى التهاب عرضي في المسالك البولية، أو التهاب حويضة الكلية، أو ولادة مبكرة، أو انخفاض وزن المولود عند الولادة إذا لم تُكتشف وتُعالج. ولم تكن تتوافر سابقًا بيانات محلية عن البيلة الجرثومية اللاعرضية في مدينة مصراتة، ليبيا.

الهدف :تحديد مدى انتشار البيلة الجرثومية اللاعرضية لدى النساء الحوامل في مصراتة، والتعرّف إلى العزلات البكتيرية المسببة لها، وتقييم الدقة التشخيصية للفحص الكيميائي بشرائط تحليل البول (النتريت وإنزيم إستيراز الكريات البيضاء)، وتحديد نمط حساسية الممرضات البولية المعزولة للمضادات الميكروبية.

المنهجية :أُجريت هذه الدراسة الوصفية المقطعية خلال الفترة من نوفمبر 2023 إلى أغسطس 2024 في عيادة لميس والمركز الطبي مصراتة. جُمعت عينات بول من منتصف المجرى بطريقة النظافة من 234 امرأة حامل لا يعانين من أعراض، وحُللت باستخدام الشرائط الكيميائية، والفحص المجهري، والزرع الكمي. وحُدّدت العزلات البكتيرية بالاختبارات الكيميائية الحيوية القياسية ونظامAPI-20E ، كما حُدّدت حساسيتها للمضادات الميكروبية بطريقة انتشار الأقراص لكيربي-باور، مع استخدام اختبار E-test لتأكيد الحد الأدنى للتركيز المثبط للفانكومايسين في عزلات المكورات العنقودية الذهبية المقاومة للميثيسيلين (MRSA).

النتائج :كُشفت البيلة الجرثومية اللاعرضية لدى 27 امرأة من أصل 234، بنسبة بلغت 11.53%. وسادت البكتيريا سالبة الغرام بنسبة 59.25% مقارنة بالبكتيريا موجبة الغرام بنسبة 40.74%. وكانت *Klebsiella pneumoniae* أكثر العزلات شيوعًا بنسبة 33.33%، تلتها المكورات العنقودية سالبة التخثر بنسبة 29.62%، ثم *Escherichia coli* بنسبة 22.22%، والمكورات العنقودية الذهبية بنسبة 11.11%، و *Pseudomonas aeruginosa* بنسبة 3.7%. ولم تُسجّل ارتباطات ذات دلالة إحصائية بين البيلة الجرثومية اللاعرضية وكل من العمر، وعدد الولادات، ومرحلة الحمل، والتاريخ المرضي .($p > 0.05$) وأظهر اختبارا النتريت وإستيراز الكريات البيضاء حساسية منخفضة بلغت 18.75% و25.93% على التوالي، مقابل نوعية مرتفعة بلغت 99.54% و90.87%، في حين حقّ عدد الخلايا الصديدية أعلى حساسية بين اختبارات التحري، إذ بلغت 37.04%. وكانت العزلات سالبة الغرام الأكثر حساسية للبيبيراسيلين-تازوباكتام والأميكاسين بنسبة 81.2%، بينما كانت العزلات موجبة الغرام الأكثر حساسية للسيفوروكسيم والدوكسيسيكلين بنسبة 90.9%. وكُشف عن إنتاج إنزيمات بيتا-لاكتاماز واسعة الطيف (ESBL) في 33.3% من العزلات سالبة الغرام.

الاستنتاج :تؤثر البيلة الجرثومية اللاعرضية في نسبة ملحوظة من النساء الحوامل في مصراتة. ولا يُعتمد على الفحص بشرائط تحليل البول وحده للكشف عنها، بينما يظل زرع البول الكمي المعيار الذهبي للتشخيص. ويوصى بالتحري الروتيني وإجراء زرع البول، مع اعتماد العلاج بالمضادات الميكروبية الموجّه بنتائج الزرع والحساسية، للحد من المضاعفات لدى الأم والجنين.

الكلمات المفتاحية: البيلة الجرثومية اللاعرضية؛ الحمل؛ التهاب المسالك البولية؛ الحساسية للمضادات الميكروبية؛ كليبسيلا الرئوية؛ مصراتة، ليبيا.

1. Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections encountered during pregnancy and represent a significant public health concern worldwide. Owing to a shorter urethra and its anatomical proximity to the vagina and anus, women are more susceptible than men to UTIs, and this susceptibility is further increased during pregnancy.

Asymptomatic bacteriuria (ASB) is defined as significant bacterial growth in the urine (typically $\geq 10^5$ CFU/mL) in the absence of clinical symptoms of UTI. Globally, ASB affects approximately 2–10% of pregnant women, although reported prevalence varies widely (from about 4% to over 45%) depending on geographic region, population characteristics, and screening methodology. Physiological changes of pregnancy—including ureteral dilatation, reduced bladder tone, elevated progesterone levels, glucosuria, and relative immune modulation—create a favourable environment for bacterial colonization and ascent within the urinary tract.

If left untreated, ASB can progress to symptomatic cystitis or acute pyelonephritis in up to 30–40% of cases, and has been associated with preterm labour, low birth weight, preeclampsia, and increased perinatal mortality. Because ASB is by definition clinically silent, routine screening—rather than symptom-triggered testing—is required to prevent these outcomes, and international guidelines (IDSA, USPSTF) recommend universal urine-culture screening early in pregnancy.

Despite this recognized importance, no data on the prevalence, causative organisms, or antimicrobial resistance patterns of ASB among pregnant women were previously available for Misurata, Libya. This gap limits evidence-based decisions on screening policy and empirical antibiotic choice in the local obstetric population. This study therefore aimed to (a) determine the prevalence of ASB and identify the responsible bacterial isolates, (b) evaluate the diagnostic accuracy of the dipstick nitrite and leukocyte esterase tests against urine culture, and (c) characterize the antimicrobial susceptibility pattern of the isolated uropathogens.

2. Materials and Methods

2.1 Study Design, Setting, and Population

A descriptive cross-sectional study was conducted between November 2023 and August 2024 at the Lamis Clinic and the Misurata Medical Centre, Misurata, Libya. Pregnant women attending antenatal care who had no clinical symptoms of UTI and who provided informed consent were eligible for enrolment. Women who had received antibiotics within the previous three days, those with known chronic renal disease or renal anomalies, and those presenting with symptoms of acute UTI were excluded. A structured questionnaire was used to record demographic, medical, and obstetric data for each participant.

2.2 Sample Collection and Laboratory Analysis

A total of 263 clean-catch midstream urine samples were collected; after excluding samples that did not meet eligibility criteria, 234 samples were included in the final analysis. Each sample underwent (i) chemical (dipstick) examination for nitrite, leukocyte esterase, and other standard parameters; (ii) microscopic examination of centrifuged sediment for red and white blood cells, epithelial cells, and bacteria; and (iii) quantitative urine culture on blood and MacConkey agar, incubated aerobically at 35–37 °C for 18–24 hours. A colony count $\geq 10^5$ CFU/mL was considered significant bacteriuria, consistent with the standard definition of ASB.

Bacterial isolates were identified using colony morphology together with catalase and

coagulase tests to differentiate staphylococcal species, the Novobiocin test to exclude Staphylococcus saprophyticus, and the API-20E biochemical panel for identification of Gram-negative organisms.

2.3 Antimicrobial Susceptibility Testing

Antimicrobial susceptibility was determined by the Kirby-Bauer disc diffusion method on Mueller-Hinton agar using a 0.5 McFarland standard inoculum, with zone diameters interpreted according to Clinical and Laboratory Standards Institute (CLSI 2023) breakpoints. The Double Disk Synergy Test (DDST) was used to screen Gram-negative isolates for extended-spectrum beta-lactamase (ESBL) production. Isolates of S. aureus identified as methicillin-resistant by the cefoxitin disc method were further evaluated by the E-test to determine the minimum inhibitory concentration (MIC) of vancomycin.

2.4 Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26. The prevalence of ASB was expressed as a percentage. Associations between ASB and demographic/clinical variables were tested using the Pearson chi-square test, with $p < 0.05$ considered statistically significant. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the nitrite, leukocyte esterase, and pus-cell-count screening tests were calculated against urine culture as the reference standard using standard 2×2 contingency-table formulas.

3. Results

3.1 Characteristics of the Study Population

Among the 234 pregnant women included, ages ranged from 17 to 48 years (mean 28.22 ± 6.96), and gestational age ranged from 3 to 40 weeks (mean 22.36 ± 10.39). Most participants (47.0%) were aged 17–27 years, 43.2% were aged 28–38 years, and 9.8% were ≥39 years. By trimester, 25.2% were in the first, 32.9% in the second, and 41.9% in the third trimester. Parity of 1–2 was most common (44.0%). A history of previous UTI was reported by 65.1% of participants, while 4.3% had hypertension and 3.8% had diabetes mellitus.

3.2 Prevalence and Bacterial Etiology of ASB

Significant bacterial growth consistent with ASB was detected in 27 of 234 samples, giving an overall prevalence of 11.53%. Gram-negative organisms accounted for 59.25% of isolates and Gram-positive organisms for 40.74%. Klebsiella pneumoniae was the predominant isolate (33.33%), followed by coagulase-negative staphylococci (29.62%), Escherichia coli (22.22%), Staphylococcus aureus (11.11%), and Pseudomonas aeruginosa (3.7%). All Gram-positive isolates tested were Novobiocin-sensitive, confirming the absence of S. saprophyticus among the isolates.

3.3 Association between ASB and Participant Characteristics

The highest ASB prevalence occurred in women aged 17–27 years (59.25%), followed by those aged 28–38 years (37%); the association with age was not statistically significant ($p = 0.300$). By trimester, ASB was most frequent in the third trimester (50.85%), but the difference across trimesters was not significant ($p = 0.526$). Among parity groups, women with 1–2 previous births had the highest rate of ASB (40.74%), with no significant association overall ($p = 0.701$). No significant associations were found between ASB and hypertension, diabetes mellitus, or previous UTI history ($p = 0.960$ and $p = 0.531$, respectively).

3.4 Diagnostic Accuracy of Dipstick Screening

Of the 234 participants, 4 were dipstick nitrite-positive and 29 were leukocyte-esterase-positive; significant pyuria (≥5 pus cells/HPF) was observed in 60 women. Compared with urine culture, the nitrite test showed sensitivity of 18.75% and specificity of 99.54%; the leukocyte esterase test showed sensitivity of 25.93% and specificity of 90.87%; and pus cell count showed the highest sensitivity (37.04%) but the lowest specificity (75.96%) among the three screening methods (Table 1).

Table 1. Diagnostic performance of dipstick nitrite, leukocyte esterase, and pus cell count against urine culture

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Nitrite	18.75	99.54	75.00	94.37
Leukocyte esterase	25.93	90.87	26.92	90.43
Pus cell count	37.04	75.96	16.67	90.29

3.5 Antimicrobial Susceptibility Patterns

Among Gram-negative isolates (n = 16), the highest susceptibility rates were seen with piperacillin-tazobactam and amikacin (81.2% each), followed by doxycycline (75%); the lowest susceptibility was observed for cefuroxime (12.5%) and amoxicillin-clavulanic acid (37.5% susceptible, 62.5% resistant). ESBL production, detected by DDST, was found in 5 of 15 tested Gram-negative isolates (33.3%), predominantly among K. pneumoniae (44.4%) and E. coli (16.7%) (Table 2).

Table 2. Antimicrobial susceptibility (% sensitive) of Gram-negative isolates (n = 16)

Antibiotic	Sensitive (%)	Intermediate (%)	Resistant (%)
Amoxicillin-clavulanic acid	25.0	12.5	62.5
Tetracycline	56.2	12.5	25.0
Cefuroxime	12.5	25.0	50.0
Doxycycline	75.0	12.5	18.8
Piperacillin-tazobactam	81.2	25.0	18.8
Amikacin	81.2	6.2	12.5
Cefoxitin	34.4	12.5	18.8
Cefepime	68.8	12.5	31.2
Meropenem	37.5	43.8	53.8
Nitrofurantoin	18.8	31.2	43.8
Gentamicin	12.5	37.5	43.8

Among Gram-positive isolates (n = 11: S. aureus n = 3, coagulase-negative staphylococci n = 8), the highest susceptibility was observed for cefuroxime and doxycycline (90.9% each), followed by gentamicin, nitrofurantoin, and amikacin (81.8% each); erythromycin and clindamycin showed the lowest susceptibility (9.1% each). Two S. aureus isolates were identified as methicillin-resistant (MRSA) by cefoxitin disc testing; E-test confirmed both remained fully vancomycin-susceptible, with MICs of 1.0 and 1.5 µg/mL, respectively (CLSI 2023 breakpoint ≤2 µg/mL) (Table 3).

Table 3. Antimicrobial susceptibility (% sensitive) of Gram-positive isolates (n = 11)

Antibiotic	Sensitive (%)	Intermediate (%)	Resistant (%)
Amoxicillin-clavulanic acid	36.4	-	63.6
Tetracycline	36.4	-	63.6
Cefuroxime	90.9	-	9.1
Doxycycline	90.9	-	9.1
Azithromycin	45.5	27.3	9.1
Amikacin	81.8	9.1	9.1
Cefoxitin	63.6	27.3	9.1
Erythromycin	9.1	72.7	18.2
Clindamycin	9.1	72.7	18.18
Nitrofurantoin	81.8	18.2	-
Gentamicin	81.8	9.1	9.1

4. Discussion

This study found an ASB prevalence of 11.53% among asymptomatic pregnant women in Misurata, Libya, which lies within—though toward the upper end of—the globally reported range of 2–10%. This finding is comparable to the 10% prevalence reported by Elzayat et al. (2017) in Egypt, but higher than the 5.5% reported in Ghana (Labi et al., 2015), and considerably lower than the markedly elevated rates reported in some Nigerian studies (43–74%). Such wide variation across settings likely reflects differences in population socioeconomic status, healthcare access, hygiene practices, and screening methodology rather than a single underlying biological cause.

ASB was numerically more frequent among younger women (17–27 years) and in the third trimester, consistent with several previous reports, although in this study none of these associations reached statistical significance—an observation shared with a number of other studies (Patel et al., 2022; Mwei et al., 2018; Imade et al., 2010; Kovavisarach et al., 2009) and attributable, at least in part, to limited statistical power given the modest number of positive cases (n = 27).

Unlike most previous studies in which Escherichia coli was the predominant uropathogen, this study identified Klebsiella pneumoniae as the leading isolate (33.3%), a pattern also reported in a subset of other regional studies. This may reflect local variation in bacterial ecology, antibiotic-use practices, or hygiene behavior, and highlights the importance of local surveillance rather than reliance on data from other settings when selecting empirical therapy.

The dipstick nitrite and leukocyte esterase tests performed poorly as stand-alone screening tools in this population, with sensitivities of only 18.75% and 25.93%, respectively—values lower than most previously published figures, though their high specificity (>90%) supports their usefulness for confirming, rather than excluding, infection. This limited sensitivity means that a substantial proportion of true ASB cases would be missed if dipstick testing alone were used for screening, reinforcing that quantitative urine culture should remain the reference standard for ASB screening in pregnancy, in line with IDSA and USPSTF recommendations.

Antimicrobial susceptibility testing showed that piperacillin-tazobactam, amikacin, and doxycycline retained good activity against Gram-negative isolates, while cefuroxime and amoxicillin-clavulanic acid showed considerable resistance; a third of Gram-negative isolates

were ESBL producers, a concerning finding for empirical therapy. Among Gram-positive isolates, cefuroxime, doxycycline, gentamicin, nitrofurantoin, and amikacin were most active, whereas erythromycin and clindamycin showed high resistance. These patterns underscore the necessity of culture-guided, rather than purely empirical, antibiotic selection for ASB in this population, and the value of monitoring ESBL and MRSA prevalence locally.

This study has some limitations, including its single-region, two-site sampling frame and the relatively small number of ASB-positive cases, which limited the power to detect associations with risk factors. Larger multi-centre studies would help clarify risk-factor associations and track resistance trends over time.

5. Conclusion

Asymptomatic bacteriuria affected 11.53% of pregnant women screened in Misurata, Libya, with Klebsiella pneumoniae and coagulase-negative staphylococci as the leading uropathogens. No sociodemographic or obstetric factor was significantly associated with ASB in this sample. Dipstick nitrite and leukocyte esterase tests showed poor sensitivity despite high specificity, confirming that quantitative urine culture remains the diagnostic gold standard. Isolated uropathogens were generally most susceptible to doxycycline and amikacin and least susceptible to amoxicillin-clavulanic acid, with notable ESBL production among Gram-negative isolates. Routine culture-based screening at the first antenatal visit (12–16 weeks), followed by culture-guided antimicrobial therapy, is recommended to reduce maternal and fetal complications associated with untreated ASB.

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