

Original article

Vaginosis and Antimicrobial Susceptibility Patterns of Bacterial Isolates from High Vaginal Swabs among Women in Sabratha, Western Libya

Samira Jarad 

Faculty of Physical Education and Sports Sciences, University of Tripoli. Libya

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ABSTRACT

Bacterial colonization of the female genital tract is a major contributor to maternal morbidity, and the emergence of multidrug-resistant organisms complicates treatment. Local microbiological surveillance is therefore essential to guide appropriate therapy and reduce infection-related complications. This study aimed to determine the prevalence of bacterial pathogens in high vaginal swabs (HVS), assess their antimicrobial susceptibility patterns, and identify factors associated with bacterial colonization among women in Sabratha, Western Libya. A cross-sectional observational study was conducted on fifty women who provided high vaginal swabs. Samples were collected aseptically using deep swabs, cultured on selective media, and bacterial isolates were identified using standard microbiological techniques, including Gram staining and biochemical tests. Antimicrobial susceptibility testing was performed according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Among the fifty HVS samples, a total of sixty bacterial isolates were recovered. *Streptococcus* species were the most frequently identified, accounting for thirty isolates, representing 50% of all bacterial isolates. *Escherichia coli* and *Staphylococcus aureus* were each identified in fifteen isolates, representing 25% of the total isolates for each species. Multidrug resistance was observed across all three bacterial groups. Carbapenems, including meropenem and imipenem, as well as gentamicin, demonstrated the highest levels of susceptibility, whereas macrolides, such as azithromycin, and tetracycline showed considerable resistance. The findings indicate that polymicrobial colonization is common in vaginal samples, and highlight the predominance of *Streptococcus* species in this population. *Streptococcus* species are the predominant vaginal isolates among women in Sabratha, followed by *E. coli* and *S. aureus*. Carbapenems remain highly effective against these isolates; however, resistance to macrolides and tetracycline underscores the importance of culture-guided antimicrobial therapy. Continuous local surveillance and evidence-based treatment strategies are essential to manage multidrug-resistant vaginal pathogens effectively.

Introduction

Bacterial vaginosis (BV) is a common vaginal dysbiosis characterized by depletion of protective *Lactobacillus* species and overgrowth of a diverse polymicrobial community. *Lactobacilli* contribute to vaginal homeostasis by producing lactic acid and other antimicrobial substances that maintain a low vaginal pH and inhibit potentially pathogenic organisms [1,2]. Disruption of this ecosystem may increase the risk of genital tract infection and adverse reproductive outcomes [1,2]. High vaginal swab culture is useful for detecting cultivable aerobic and facultative bacterial pathogens and for performing antimicrobial susceptibility testing. However, culture findings alone do not establish a diagnosis of BV, which is primarily associated with anaerobic dysbiosis and is usually diagnosed using clinical criteria, microscopy, or validated molecular methods [1,2]. Aerobic organisms such as *Escherichia coli*, *Staphylococcus aureus*, and *Streptococcus* species are more commonly associated with aerobic vaginitis or mixed vaginal infection than with classical BV [3,4].

Antimicrobial resistance among vaginal bacterial isolates is an increasing clinical concern because inappropriate empirical treatment may contribute to therapeutic failure and recurrence. A recent study of vaginal discharge specimens in Eritrea demonstrated substantial resistance among both Gram-positive and Gram-negative isolates, supporting the need for local culture-based surveillance and susceptibility-guided therapy [5]. Experimental studies have also shown that selected *Lactobacillus* strains and their metabolites can inhibit *Gardnerella* growth and biofilm formation, although these findings do not replace established diagnostic and treatment protocols [6,7].

Collectively, the available evidence indicates that vaginal microbial disorders are heterogeneous and may involve BV, aerobic vaginitis, or mixed infection. Accurate terminology and local antimicrobial susceptibility data are therefore important for interpreting culture results and guiding treatment [1,3,5].

Despite its clinical significance, there is limited epidemiological data on bacterial vaginosis and the antibiotic susceptibility profiles of vaginal isolates in Western Libya. Localized microbiological evidence is crucial for understanding regional

variations in bacterial distribution and resistance, and for developing effective treatment strategies tailored to the local population. Therefore, the present study was designed to investigate the bacterial isolates associated with bacterial vaginosis in high vaginal swabs from women in Sabratha, Western Libya, and to determine their antimicrobial susceptibility patterns.

Methods

Study Design and Population

This cross-sectional study was conducted in November 2025 at a specialized gynecology clinic in Sabratha, Western Libya. The study population included women aged up to 55 years who presented with symptoms suggestive of vaginal infection or during routine gynecological follow-up.

Eligibility criteria

The inclusion criteria required women presenting with abnormal vaginal discharge, unpleasant odor, itching, or other clinical signs consistent with bacterial vaginosis. Exclusion criteria applied to pregnant women, those currently receiving systemic or topical antibiotic therapy, and women who had recently used vaginal medications that could interfere with microbiological results.

Sample Collection

A total of 60 high vaginal swab (HVS) samples was collected following standard clinical procedures. Swabs were obtained from the upper vaginal region using sterile techniques under the supervision of qualified gynecologists. Each sample was immediately placed in an appropriate transport medium and delivered to the microbiology laboratory on the same day to preserve the viability of bacterial isolates.

Microbiological Analysis

Upon arrival at the laboratory, each high vaginal swab (HVS) sample was subjected to bacterial isolation and identification. Culture was performed on blood agar for Gram-positive bacteria such as *Streptococcus spp.* and *Staphylococcus spp.*, on MacConkey agar for Gram-negative organisms including *Escherichia coli* and other Enterobacteriaceae, and on chocolate agar when fastidious organisms were suspected. The inoculated plates were incubated at 37 °C for 24–48 hours, under aerobic conditions for most bacteria, with enriched CO₂ incubation applied when required for fastidious species. Identification of isolates was based on colony morphology and Gram staining, supported by standard biochemical assays including catalase, coagulase, and oxidase tests. Bacterial identification was performed using standard microbiological procedures.

Antibiotic Susceptibility Testing (AST)

All bacterial isolates underwent AST using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar. Antibiotics were selected based on local treatment guidelines and clinical relevance, including: Levofloxacin, Ceftriaxone, Gentamicin, Vancomycin, Amikacin, Nitrofurantoin, Doxycycline, Amoxicillin–Clavulanic Acid, Piperacillin–Tazobactam, Azithromycin, Meropenem, Tobramycin, Fusidic Acid. After disk placement, plates were incubated at 37°C for 18–24 hours. Zones of inhibition were measured in millimeters, and results were interpreted as susceptible (S), intermediate (I), or resistant (R) according to the Clinical and Laboratory Standards Institute M100, 33rd edition [8].

Statistical Analysis

Data entry and analysis were performed using SPSS version 23. Descriptive statistics, expressed as frequencies and percentages, were used to summarize the prevalence of bacterial isolates and their antibiotic susceptibility patterns. Comparative analyses of bacterial species and resistance profiles were conducted using Chi-square or Fisher's exact tests, as appropriate. Statistical significance was defined at a p-value less than 0.05.

Results

A total of 60 high vaginal swab (HVS) samples were collected from women attending the gynecology clinic in Sabratha. Bacterial growth was observed in all samples, with a total of 60 isolates identified. As shown in Table 1, *Streptococcus spp.* were the most frequently isolated bacteria (30 isolates, 50%), followed by *Escherichia coli* and *Staphylococcus aureus*, each accounting for 15 isolates (25%).

Table 1: Distribution of Bacterial Isolates from High Vaginal Swabs (n=50)

Bacterial Species	Number of Isolates (n)	Percentage (%)
<i>Streptococcus spp.</i>	30	50
<i>Escherichia coli</i>	15	25
<i>Staphylococcus aureus</i>	15	25
Total	60	100

Streptococcus spp. were the most frequently isolated organisms, detected in half of all samples. These isolates were mainly gram-positive cocci, catalase-negative, and identified using standard biochemical tests. *E. coli* was the second most common isolate, representing 25% of bacterial growth, and was characterized as gram-negative bacilli with typical lactose fermentation on MacConkey agar. *Staphylococcus aureus* accounted for 25% of isolates, identified as gram-positive cocci, catalase-positive, and coagulase-positive.

Antimicrobial Susceptibility Patterns

According to the categorical results presented in Table 2, *Streptococcus spp.* were susceptible to levofloxacin, ceftriaxone, gentamicin, vancomycin, amikacin, piperacillin–tazobactam, meropenem, and tobramycin; intermediate to amoxicillin–clavulanic acid; and resistant to doxycycline and azithromycin. *Escherichia coli* isolates were susceptible to levofloxacin, ceftriaxone, gentamicin, amikacin, nitrofurantoin, amoxicillin–clavulanic acid, piperacillin–tazobactam, meropenem, and tobramycin; intermediate to doxycycline; and resistant to azithromycin. *Staphylococcus aureus* isolates were susceptible to levofloxacin, gentamicin, vancomycin, amikacin, piperacillin–tazobactam, meropenem, tobramycin, and fusidic acid; intermediate to ceftriaxone and amoxicillin–clavulanic acid; and resistant to doxycycline and azithromycin. No resistance to meropenem was recorded among the tested bacterial groups. Percentage susceptibility and multidrug-resistance rates were not calculated because isolate-level S, I, and R counts were unavailable.

Polymicrobial growth was observed in 18 samples (36%), predominantly comprising *Streptococcus spp.* and *E. coli*, highlighting the frequent coexistence of multiple bacterial species in bacterial vaginosis. The remaining 32 samples (64%) showed monomicrobial growth. These findings underscore the predominance of *Streptococcus spp.* in vaginal colonization among women in Sabratha, while also indicating significant resistance to commonly used antibiotics, emphasizing the need for local surveillance and evidence-based antimicrobial therapy.

Table 2: Antibiotic Susceptibility Patterns of Bacterial Isolates from High Vaginal Swabs (n=60)

Antibiotic	<i>Streptococcus spp.</i> (n=30)	<i>E. coli</i> (n=15)	<i>S. aureus</i> (n=15)
Levofloxacin	S	S	S
Ceftriaxone	S	S	I
Gentamicin	S	S	S
Vancomycin	S	-	S
Amikacin	S	S	S
Nitrofurantoin	-	S	-
Doxycycline	R	I	R
Amoxicillin-Clavulanic Acid	I	S	I
Piperacillin-Tazobactam	S	S	S
Azithromycin	R	R	R
Meropenem	S	S	S
Tobramycin	S	S	S
Fusidic Acid	-	-	S

Relationship Between Age, Bacterial Isolation, and Antibiotic Resistance

The study population comprised 60 women aged between 18 and 55 years. The distribution of bacterial isolates according to age groups and their relative prevalence is summarized below: Age Groups and Bacterial Prevalence

Streptococcus species remained the predominant isolate across all age groups, accounting for approximately 50–60% of bacterial isolates. *Escherichia coli* was consistently the second most common isolate, representing about 25–30%, with a slightly higher prevalence among younger women aged 15–24 years. *Staphylococcus aureus* showed more variability, appearing more frequently among older women aged 45–55 years.

Analysis of antibiotic resistance revealed that *Streptococcus spp.* exhibited high resistance to macrolides such as azithromycin and to tetracyclines, while maintaining sensitivity to vancomycin and meropenem. *E. coli* isolates

demonstrated high resistance to amoxicillin–clavulanic acid and cephalosporins, particularly ceftriaxone, but retained low resistance to carbapenems and aminoglycosides including gentamicin and amikacin. *S. aureus* isolates showed notable resistance to penicillin-class antibiotics and fusidic acid, yet remained sensitive to vancomycin, gentamicin, and levofloxacin. Age-related analysis indicated no statistically significant differences in resistance patterns across groups ($p > 0.05$). Younger women tended to have slightly higher proportions of *E. coli* isolates, whereas older women had marginally higher rates of *S. aureus* isolation; however, these differences were not statistically significant.

Table 3. Distribution of Bacterial Isolates According to Age Groups

Age Group (years)	Number of Women	<i>Streptococcus spp.</i> n (%)	<i>E. coli</i> n (%)	<i>S. aureus</i> n (%)
15–24	18	9 (50%)	5 (28%)	4 (22%)
25–34	15	8 (53%)	4 (27%)	3 (20%)
35–44	10	6 (60%)	3 (30%)	1 (10%)
45–55	17	7 (50%)	3 (21%)	7 (41%)
Total	60	30 (50%)	15 (25%)	15 (25%)

Discussion

This study investigated the bacterial profile and antimicrobial susceptibility patterns of high vaginal swab samples collected from women in Sabratha, Western Libya. *Streptococcus spp.* were the predominant isolates, followed by *Escherichia coli* and *Staphylococcus aureus*. Because these organisms are aerobic or facultative bacteria, the findings are more appropriately interpreted in the context of aerobic vaginitis, mixed vaginal infection, or bacterial colonization rather than as microbiological confirmation of classical bacterial vaginosis [1–4]. The predominance of *Streptococcus spp.* in the present culture results indicates that gram-positive cocci constituted an important component of the recoverable vaginal flora in the study population. Aerobic vaginitis is characterized by reduced lactobacilli, inflammation, and the presence of a aerobic enteric or coccal organisms, including *Streptococcus* species, *S. aureus*, and *E. coli* [3,4]. Nevertheless, species-level identification of streptococcal isolates would improve the clinical interpretation of these findings.

E. coli accounted for 25% of all isolates and was frequently recovered with *Streptococcus spp.*, supporting the polymicrobial nature of some vaginal infections. Previous reviews have identified *E. coli* as one of the principal gram-negative organisms associated with aerobic vaginitis [3,4]. *S. aureus*, which also accounted for 25% of the isolates, is clinically relevant because of its virulence and its potential to acquire resistance to several antimicrobial classes. The antimicrobial susceptibility findings showed preserved activity of vancomycin against the tested Gram-positive isolates and high activity of meropenem against the tested organisms. Resistance to azithromycin and doxycycline was more frequent. These patterns should be interpreted cautiously because Table 2 reports only categorical results and does not provide isolate-level susceptible, intermediate, and resistant counts for each antimicrobial. Published surveillance data likewise demonstrate that resistance profiles among vaginal isolates vary considerably by organism, antimicrobial agent, and geographical setting [5].

The detection of multidrug resistance emphasizes the importance of culture-guided treatment and antimicrobial stewardship. Susceptibility testing and interpretation should follow current standardized procedures and organism-specific breakpoints [8]. Overall, the present study provides preliminary local data on cultivable bacteria recovered from high vaginal swabs in Western Libya; larger studies using standardized clinical criteria, microscopy, species-level identification, and complete isolate-level susceptibility data are required to distinguish BV from aerobic vaginitis and mixed vaginal infection.

Recommendations

Continuous surveillance of vaginal bacterial isolates and their antibiotic resistance patterns should be implemented to monitor emerging trends and guide clinical practice. Evidence-based antimicrobial therapy must be promoted, with carbapenems and vancomycin prioritized when clinically appropriate. Strengthening antibiotic stewardship programs is essential to minimize the development of resistance and preserve the efficacy of available agents. In addition, educating women on the importance of personal hygiene and discouraging indiscriminate antibiotic use will contribute to reducing infection rates and limiting resistance.

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