Section: Miscellaneous

Original Research Article

ANTIMICROBIAL SUSCEPTIBILITY PROFILE OF UREAPLASMA AND MYCOPLASMA HOMINIS IN FEMALES WITH GENITAL INFECTIONS

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ABSTRACT

Background: Genital mycoplasmas, particularly Ureaplasma urealyticum and Mycoplasma hominis, are increasingly recognized as significant pathogens in female genital infections and adverse reproductive outcomes. Emerging antimicrobial resistance further complicates management. This study aimed to determine the prevalence and antibiotic susceptibility patterns of these organisms in symptomatic females.

Materials and Methods: A cross-sectional study was conducted among 193 females presenting with genital infection symptoms at a tertiary care center. Endocervical and high vaginal swabs were cultured for genital mycoplasmas. Antimicrobial susceptibility testing was performed using standardized broth microdilution methods. Statistical analysis was conducted using chi-square testing, with $p < 0.05$ considered significant.

Results: The overall prevalence of genital mycoplasmas was 41.5% (95% CI: 34.6–48.7). Ureaplasma urealyticum (35.2%) was more common than M. hominis (15%), with 8.8% co-infection. Infection was significantly associated with the 26–35 years age group ($p = 0.04$) and pregnancy ($p = 0.019$). Doxycycline demonstrated high susceptibility (>80%) in both organisms. Macrolide resistance was substantial, particularly in M. hominis (>60%). Multidrug resistance was observed in 35% of isolates. Azithromycin resistance was significantly higher than doxycycline resistance ($p < 0.001$).

Conclusion: Genital mycoplasmas are prevalent among symptomatic women, with concerning levels of macrolide and fluoroquinolone resistance. Doxycycline remains the most reliable therapeutic option in this setting. Continuous surveillance and rational antibiotic use are essential to curb rising resistance.

Keywords: Genital mycoplasmas; Ureaplasma urealyticum; Mycoplasma hominis; Antibiotic resistance; Doxycycline.

INTRODUCTION

Mycoplasma hominis and Ureaplasma urealyticum are small, cell-wall–less bacteria belonging to the class Mollicutes. Because they lack a peptidoglycan cell wall, they are intrinsically resistant to β-lactam antibiotics and require specialized media or molecular methods for detection.[1] Their fastidious growth requirements and the historical reliance on culture mean that true prevalence and clinical relevance have often been underestimated in routine diagnostic laboratories.[2]

Ureaplasma spp. commonly colonize the lower genital tract of sexually active women; reported colonization rates vary widely in the literature (from single-digit percentages to >60% in some populations), depending on age, sexual behaviour, and the detection method used. Mycoplasma hominis is generally less frequent than Ureaplasma but is still a commonly isolated organism in symptomatic women.[3,4] Colonization does not always equal disease, which complicates interpretation of positive test results—differentiating between asymptomatic carriage and pathogenetic infection requires

correlation with clinical signs, inflammatory markers and (ideally) quantitative molecular results.[5]

Both organisms have been implicated in a spectrum of female genital tract disorders. Ureaplasma urealyticum has been associated with non-gonococcal urethritis, cervicitis, and adverse reproductive outcomes including spontaneous abortion, preterm labour and chorioamnionitis.[6] Mycoplasma hominis has been linked to pelvic inflammatory disease (PID), postpartum fever, and septic complications in obstetric settings.[7] Evidence for causation varies: while several observational studies and meta-analyses suggest an association with adverse pregnancy outcomes, confounding by co-infections and differences in study design mean that the strength of these associations is still debated.[6,7]

Conventional culture methods are slow, insensitive, and require specialized media; nucleic acid amplification tests (NAATs) and multiplex PCR assays have increased detection sensitivity and turnaround time. However, NAATs may detect low-level colonization as well as infection, and many assays do not quantify bacterial load or differentiate viable from nonviable organisms—factors that affect clinical decision making.[8] Additionally, standardized susceptibility testing for these organisms is not as widely available or harmonized as for classical bacterial pathogens, limiting clinicians' ability to tailor therapy based on verified minimum inhibitory concentrations (MICs).[9]

Therapeutic options are constrained by the organisms' lack of cell wall (rendering β-lactams ineffective) and by emerging resistance to other classes. Historically, macrolides, tetracyclines (especially doxycycline) and fluoroquinolones have been used; however, growing reports describe macrolide and fluoroquinolone resistance in Ureaplasma and variable susceptibility in M. hominis (which can possess intrinsic macrolide resistance in some strains).[10] Regional and temporal variability in susceptibility patterns is well documented, underscoring the need for local surveillance to guide empirical therapy, particularly in pregnant women and in severe invasive infections where prompt effective therapy is critical.[10,11]

Given the diagnostic complexity, variable clinical impact, and evolving resistance patterns of M. hominis and U. urealyticum, contemporary data on their prevalence and antimicrobial susceptibility in symptomatic female populations are essential. Local prevalence and susceptibility profiles inform empirical treatment choices, help identify emerging resistance trends, and support antimicrobial stewardship efforts in gynecologic and obstetric practice.[12] This study therefore aimed to determine the prevalence of M. hominis and U. urealyticum among females presenting with genital infections at our centre and to characterize their antibiotic susceptibility patterns, providing actionable data for clinicians and microbiology laboratories.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective cross-sectional observational study conducted in the Department of Microbiology in collaboration with the Department of Obstetrics and Gynecology at a tertiary care teaching hospital. The study was carried out over a period of 24 months, from June 2023 to May 2025. The primary objective was to determine the prevalence of Mycoplasma hominis and Ureaplasma urealyticum in females presenting with clinical features suggestive of genital tract infection and to evaluate their antimicrobial susceptibility patterns.

Study Population: The study population comprised females aged 18–45 years attending the gynecology outpatient department or admitted to the obstetrics and gynecology wards with symptoms suggestive of lower or upper genital tract infections. Clinical features included abnormal vaginal discharge, lower abdominal pain, dyspareunia, dysuria, intermenstrual bleeding, pelvic tenderness, or clinical suspicion of cervicitis or pelvic inflammatory disease. Pregnant women presenting with signs of genitourinary infection were also included.

Patients who had received systemic antibiotics within the preceding two weeks, those with known immunocompromised status (e.g., HIV infection, long-term corticosteroid therapy), and those unwilling to provide informed consent were excluded from the study.

Sample Size and Sampling Technique: The sample size was calculated based on the anticipated prevalence of genital mycoplasmas from previous regional studies (approximately 43%, as reported in a study by Ravichandran et al., with a 95% confidence interval and 5% margin of error [13]. Using the standard formula for prevalence studies ($n = Z^2pq/d^2$), the minimum required sample size was estimated to be 193 participants. Consecutive eligible patients fulfilling inclusion criteria during the study period were enrolled after obtaining written informed consent.

Specimen Collection: Specimen collection was performed in the gynecology outpatient procedure room under strict aseptic precautions. Following insertion of a sterile, non-lubricated Cusco's speculum, excess cervical mucus and vaginal discharge were gently removed using a sterile cotton swab to reduce contamination with commensal flora. Two sterile Dacron-tipped swabs with plastic shafts were used for each participant. One high vaginal swab was collected from the posterior fornix by rotating the swab for approximately 10 seconds to ensure adequate sampling of secretions. A second swab was inserted 1–2 cm into the endocervical canal and rotated gently for 10–15 seconds to obtain epithelial cells and endocervical secretions. Care was taken to avoid contact with the vaginal walls during withdrawal of the swab.

Immediately after collection, each swab was inoculated into sterile Mycoplasma transport medium (Pleuropneumonia-like organism [PPLO] broth supplemented with 20% horse serum, 10% yeast extract, L-arginine, urea, phenol red indicator, and selective antibiotics such as polymyxin B and amphotericin B to suppress contaminating flora). The specimens were labeled with a unique identification number and transported to the microbiology laboratory in a temperature-controlled container within 1–2 hours. If processing was delayed, samples were stored at 4°C and inoculated within 24 hours to preserve viability and prevent overgrowth of contaminants.

Laboratory Processing and Identification: Upon receipt in the laboratory, specimens were vortexed gently to homogenize the sample and inoculated into Mycoplasma selective broth and onto PPLO agar plates supplemented with arginine (for detection of Mycoplasma hominis) and urea (for detection of Ureaplasma urealyticum). The inoculated broth tubes were incubated at 35–37°C in a humidified incubator with 5% CO_2 and examined daily for up to 72 hours for evidence of growth indicated by a color change of the phenol red indicator (yellow to red for arginine hydrolysis; yellow to pink for urease activity).

Subculture from positive broth tubes was performed onto selective PPLO agar plates, which were incubated under similar conditions for 48–72 hours. Colony morphology was examined under a stereomicroscope at 40× magnification. Mycoplasma hominis was identified by its characteristic "fried-egg" appearance with a dense central zone embedded in the agar and peripheral spreading, along with arginine hydrolysis. Ureaplasma urealyticum was identified by the presence of tiny, brownish granular colonies on urea-containing agar and positive urease activity.

Where molecular facilities were available, species confirmation was performed using polymerase chain reaction (PCR) targeting specific conserved genes such as the 16S rRNA gene or urease gene for Ureaplasma spp. and the 16S rRNA or vaa gene for M. hominis. Appropriate positive and negative controls were included in each run to ensure validity of results.

Antibiotic Susceptibility Testing: Antimicrobial susceptibility testing was carried out using a commercially available Mycoplasma broth microdilution kit based on standardized microtitre plate methodology. The panel included antibiotics commonly used for treatment of genital mycoplasmas, namely doxycycline, azithromycin, erythromycin, clarithromycin, ciprofloxacin, levofloxacin, ofloxacin, and clindamycin.

Inoculum preparation was standardized to approximately 10^4 –10^5 color-changing units (CCU)/mL, and wells containing serial two-fold dilutions of antibiotics were inoculated and incubated at 35–37°C in 5% CO_2 for 24–48 hours. The minimum inhibitory concentration (MIC) was defined as the lowest antibiotic concentration that prevented color change in the broth medium.

Interpretation of MIC values was performed according to Clinical and Laboratory Standards Institute (CLSI) guidelines (where available) or manufacturer-recommended breakpoints specific for Mycoplasma and Ureaplasma species. Isolates were categorized as susceptible, intermediate, or resistant.

All culture media were quality-checked for sterility and performance prior to use. Internal quality control was maintained using reference control strains of M. hominis and U. urealyticum where available. Incubators and laboratory equipment were calibrated regularly, and all procedures were carried out in a biosafety cabinet under aseptic conditions to prevent contamination and ensure reproducibility of results.

Data Collection and Statistical Analysis: Demographic details, clinical presentation, obstetric history, and laboratory findings were recorded in a structured proforma. Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY, USA). Prevalence was expressed as percentages with 95% confidence intervals. Categorical variables were analyzed using Chi-square test or Fisher's exact test as appropriate. Continuous variables were expressed as mean ± standard deviation and compared using independent t-test or Mann–Whitney U test depending on data distribution. A p-value <0.05 was considered statistically significant.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee. All participants provided written informed consent prior to enrollment. Confidentiality of patient information was maintained throughout the study, and samples were processed using anonymized identification codes.

RESULTS

The study included 193 females with a mean age of 29.8 ± 6.4 years. The majority belonged to the 26–35 years age group (45.1%), followed by 18–25 years (28%) and 36–45 years (26.9%). Most participants were married (80.8%), and 35.2% were pregnant at presentation. The most common presenting complaint was abnormal vaginal discharge (73.1%), followed by lower abdominal pain (39.4%), dysuria (30.6%), dyspareunia (19.7%), and history of recurrent genital infection (33.2%). These findings indicate that the study population largely comprised reproductive-age women with symptomatic genital infections [Table 1].

Out of 193 participants, 80 (41.5%; 95% CI: 34.6–48.7) tested positive for genital mycoplasmas. Ureaplasma urealyticum was isolated in 68 cases (35.2%; 95% CI: 28.5–42.3), while Mycoplasma hominis was detected in 29 cases (15.0%; 95% CI: 10.3–20.9). Co-infection with both organisms was observed in 17 participants (8.8%; 95% CI: 5.3–

13.6). U. urealyticum was the predominant organism isolated in this cohort [Table 2].

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n = 193).

Variable	Frequency (n)/Mean ± SD	Percentage (%)
Age (years)	29.8 ± 6.4	
Age Group (years)		
18–25	54	28
26–35	87	45.1
36–45	52	26.9
Marital Status		
Married	156	80.8
Unmarried	37	19.2
Pregnant at Presentation	68	35.2
Presenting Complaints		
Abnormal vaginal discharge	141	73.1
Lower abdominal pain	76	39.4
Dysuria	59	30.6
Dyspareunia	38	19.7
History of recurrent genital infection	64	33.2

Table 2: Prevalence of Ureaplasma urealyticum and Mycoplasma hominis (n = 193).

Organism	Positive (n)	Prevalence (%)	95% CI
Ureaplasma urealyticum	68	35.2	28.5–42.3
Mycoplasma hominis	29	15	10.3–20.9
Co-infection	17	8.8	5.3–13.6
Total Mycoplasma positive	80	41.5	34.6–48.7

Prevalence expressed as percentage with 95% confidence interval (CI).

Mycoplasma positivity was significantly associated with age group (p = 0.04). The highest positivity rate was observed among women aged 26–35 years (50.6%), compared to 33.3% in 18–25 years and 34.6% in 36–45 years age groups. Pregnancy status also showed a statistically significant association with infection (p = 0.019). Pregnant women demonstrated higher positivity (52.9%) compared to non-pregnant women (35.2%). These findings suggest that reproductive-age women and pregnant females constitute higher-risk groups for genital mycoplasma infection [Table 3].

Table 3: Association of Mycoplasma Positivity with Age Group and Pregnancy Status (n = 193).

Variables	Positive (n=80)	Negative (n=113)	p-value
	Frequency (%)		
Age Group (years)			
18–25 (n=54)	18 (33.3)	36 (66.7)	0.040
26–35 (n=87)	44 (50.6)	43 (49.4)	
36–45 (n=52)	18 (34.6)	34 (65.4)	
Pregnancy Status			
Pregnant (n=68)	36 (52.9)	32 (47.1)	0.019
Non-pregnant (n=125)	44 (35.2)	81 (64.8)	

Chi-square test applied; p < 0.05 considered statistically significant.

Among Ureaplasma urealyticum isolates (n = 68), the highest susceptibility was observed to doxycycline (85.3%), followed by clarithromycin (70.6%) and azithromycin (67.6%). Notably, resistance was highest against ciprofloxacin (38.2%) and levofloxacin (32.4%). Macrolide resistance ranged between 23.5% and 26.5%. For Mycoplasma hominis isolates (n = 29), doxycycline (82.8%) and clindamycin (79.3%) demonstrated the highest susceptibility rates. However, marked resistance to macrolides was observed, with erythromycin resistance at 65.5% and azithromycin resistance at 62.1%. Fluoroquinolone resistance ranged from 34.5% to 34.5%. These findings indicate preserved doxycycline efficacy but rising resistance to macrolides and fluoroquinolones [Table 4].

Table 4: Antibiotic Susceptibility Patterns of Ureaplasma urealyticum (n = 68) and Mycoplasma hominis (n = 29).

Antibiotic	Susceptible	Intermediate	Resistant
	Frequency (%)		
Ureaplasma urealyticum (n=68)			
Doxycycline	58 (85.3)	4 (5.9)	6 (8.8)
Azithromycin	46 (67.6)	5 (7.4)	17 (25.0)
Erythromycin	44 (64.7)	6 (8.8)	18 (26.5)
Clarithromycin	48 (70.6)	4 (5.9)	16 (23.5)
Ciprofloxacin	34 (50.0)	8 (11.8)	26 (38.2)
Levofloxacin	40 (58.8)	6 (8.8)	22 (32.4)
Mycoplasma hominis (n=29)			
Doxycycline	24 (82.8)	2 (6.9)	3 (10.3)
Azithromycin	8 (27.6)	3 (10.3)	18 (62.1)
Erythromycin	6 (20.7)	4 (13.8)	19 (65.5)
Clindamycin	23 (79.3)	3 (10.3)	3 (10.3)
Ciprofloxacin	14 (48.3)	5 (17.2)	10 (34.5)
Levofloxacin	16 (55.2)	3 (10.3)	10 (34.5)

Among the 80 Mycoplasma-positive isolates, 31 (38.8%) showed no resistance, 21 (26.3%) were resistant to one antibiotic class, and 28 (35%) exhibited multidrug resistance (≥2 classes). The distribution of resistance patterns did not significantly differ from equal distribution ($p = 0.254$). Comparison of resistance between doxycycline and azithromycin revealed a significantly higher resistance rate for azithromycin (43.8%) compared to doxycycline (11.3%) ($p < 0.001$). This highlights azithromycin resistance as a growing therapeutic concern [Table 5].

Table 5: Multidrug Resistance Pattern and Comparative Antibiotic Resistance (n = 80 isolates).

Variables	Frequency	Percentage (%)	p-value
Resistance Pattern			
No resistance	31	38.8	0.254
Resistant to 1 class	21	26.3	
Resistant to ≥2 classes	28	35	
Antibiotic			
Doxycycline	9	11.3	<0.001
Azithromycin	35	43.8	

Chi-square test applied; $p < 0.05$ considered significant.

DISCUSSION

The present study evaluated the prevalence and antimicrobial susceptibility patterns of Ureaplasma urealyticum and Mycoplasma hominis among females presenting with symptomatic genital infections in a tertiary care setting. The overall prevalence of genital mycoplasmas was 41.5% (95% CI: 34.6–48.7), indicating a substantial burden in reproductive-age women. Ureaplasma urealyticum (35.2%) was more frequently isolated than M. hominis (15%), with co-infection observed in 8.8% of cases. These findings are consistent with several Indian and international studies by Rajan et al., Moridi et al., Leli et al., Boujemaa et al., and Cutoiu et al., reporting prevalence rates ranging from 30% to 50% in symptomatic women, with Ureaplasma species predominating.[14-18] The higher isolation rate of U. urealyticum may be attributed to its greater colonization potential in the lower genital tract and its ability to persist in a polymicrobial vaginal ecosystem.[17,18]

Age-wise analysis revealed a statistically significant association between infection and the 26–35 years age group (50.6% positivity; $p = 0.04$). This age group corresponds to peak sexual and reproductive activity, which may increase exposure risk. Similar age-related trends have been documented in previous epidemiological studies by Moridi et al., and Boujemaa et al., where sexually active reproductive-age women demonstrated higher colonization and infection rates.[15,17] Biologically, hormonal influences on vaginal mucosal immunity and microbiota composition during the reproductive years may facilitate persistence of Mollicutes organisms.[19]

Pregnancy was significantly associated with higher mycoplasma positivity (52.9% vs. 35.2% in non-pregnant women; $p = 0.019$). This finding aligns with evidence suggesting that pregnancy-related immunomodulation and altered vaginal microbiome dynamics may predispose to colonization.[20] Genital mycoplasmas have been implicated in adverse obstetric outcomes such as preterm labor, premature rupture of membranes, and chorioamnionitis. The observed high prevalence among pregnant women in this study underscores the need for careful microbiological evaluation in this vulnerable group, particularly in symptomatic cases.[21]

Antibiotic susceptibility analysis demonstrated preserved efficacy of doxycycline against both U. urealyticum (85.3%) and M. hominis (82.8%). This is in agreement with multiple surveillance studies by Ramazanzadeh et al., Skiljevic et al., Wen et al., and Song et al., which consistently report high tetracycline susceptibility among genital mycoplasmas.[22-25] The mechanism likely reflects the continued effectiveness of tetracyclines targeting the

30S ribosomal subunit, coupled with relatively lower selective pressure compared to macrolides.[25]

In contrast, macrolide resistance was substantial, particularly in M. hominis, where erythromycin and azithromycin resistance exceeded 60%. This finding is biologically plausible, as M. hominis is known to possess intrinsic or acquired resistance mechanisms against certain macrolides due to differences in ribosomal binding sites.[26] Even among U. urealyticum, macrolide resistance ranged from 23% to 26%, reflecting increasing selective pressure from widespread empirical macrolide use for syndromic management of genital infections. Comparable resistance rates have been reported in recent studies by Nazarzadeh et al., and Piñeiro et al., suggesting a global trend of declining macrolide efficacy.[27,28]

Fluoroquinolone resistance was also notable, with ciprofloxacin resistance reaching 38.2% in U. urealyticum and 34.5% in M. hominis. Mutations in quinolone resistance-determining regions (QRDR) of the gyrA and parC genes have been increasingly reported and likely contribute to these patterns. Rising fluoroquinolone resistance is clinically concerning given their historical role as second-line therapy.[29,30]

Importantly, multidrug resistance (resistance to ≥2 classes) was observed in 35% of isolates. Although the overall distribution of resistance categories did not significantly differ from equal distribution ($p = 0.254$), the clinical implication is substantial, as more than one-third of isolates exhibited resistance to multiple drug classes. Comparative analysis revealed significantly higher resistance to azithromycin (43.8%) compared to doxycycline (11.3%) ($p < 0.001$), reinforcing doxycycline as the more reliable empirical option in this setting.

The high prevalence of genital mycoplasmas combined with emerging antimicrobial resistance highlights the limitations of empirical syndromic therapy. In regions where macrolides are frequently prescribed, resistance surveillance becomes essential to guide treatment protocols. Routine susceptibility testing, although not universally available, may help optimize antibiotic stewardship and prevent further resistance escalation.[31]

Overall, this study demonstrates that genital mycoplasmas represent a significant etiological contributor to symptomatic genital infections among reproductive-age and pregnant women. While doxycycline retains good activity, rising resistance to macrolides and fluoroquinolones warrants cautious antibiotic selection and emphasizes the need for local antibiogram-based treatment strategies.

Limitations: This study was conducted at a single tertiary care center, which may limit generalizability to the broader population. As participants were symptomatic females, asymptomatic colonization rates could not be assessed. Molecular characterization of resistance mechanisms (e.g., QRDR mutations or macrolide resistance genes) was not performed, restricting mechanistic interpretation. Additionally, follow-up data on treatment outcomes were not evaluated. Despite these limitations, the study provides important region-specific prevalence and antimicrobial susceptibility data relevant for clinical decision-making.

CONCLUSION

This study demonstrates a high prevalence (41.5%) of genital mycoplasmas among symptomatic females, with Ureaplasma urealyticum being the predominant organism. Infection was significantly associated with reproductive age (26–35 years) and pregnancy, highlighting clinically vulnerable groups. While doxycycline retained high efficacy against both organisms, substantial resistance to macrolides and fluoroquinolones was observed, particularly among Mycoplasma hominis. Multidrug resistance in over one-third of isolates underscores the growing challenge of empirical therapy. These findings emphasize the importance of routine microbiological surveillance and local antibiogram-guided treatment strategies to optimize patient outcomes and strengthen antimicrobial stewardship in gynecological practice.

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