Trichomonas vaginalis and Mycoplasma infections among women with vaginal discharge at Fann teaching hospital in Senegal

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Abstract

Background: Trichomonas vaginalis and genital Mycoplasmas are two synergistic pathogens, but in many settings, limited data on the co-infection by Trichomonas and Mycoplasma are available.

Objective: This study aimed at assessing Mycoplasma prevalence and its association with Trichomonas vaginalis among women with vaginal discharge.

Materials and Methods: A retrospective analysis of laboratory records (2012 and 2013) from patients referred at the Fann teaching hospital in Dakar Senegal for vaginal discharge was carried out. Detection of genital mycoplasmas was based on the commercial Kit Mycoplasma Duo Bio-Rad™ using endo-cervical swabs. Vaginal swabs were collected and examined using optic microscopy with 40x magnification to detect T. vaginalis.

Results: Overall, data from 1257 women were analysed. Prevalence of Mycoplasma hominis represented 57.4%, 95%CI(54.6-60.1), versus 54.9%, 95%CI(52.1-57.5) for Ureaplasma urealyticum. Trichomonas vaginalis infection was observed with a frequency of 3%. Out of the 50 patients with trichomoniasis, 76% of them were co-infected by Mycoplasma hominis and patients with Trichomonas vaginalis had an increased risk of acquiring Mycoplasma infection (adjusted OR:2.5, 95%CI(1.2-5.2);p=0.02)).

Conclusion: Trichomonas vaginalis and Mycoplasmas are two closely associated pathogens in the urogenital tract of women. This clinically significant symbiotic action may require systematic screening of Mycoplasma among patients with trichomoniasis for optimal management of sexually transmitted infections.

Keywords: Coinfection, Mycoplasma, prevalence, Senegal, Trichomoniasis, women

INTRODUCTION

Sexually transmitted infections (STIs) are still the major public health problems in many settings despite the important progresses on STI control over the past years.[1] Infectious agents such as T. vaginalis, Chlamydia trachomatis, Neisseria gonorrhoeae, and Mycoplasmas are responsible for over 350 million infections annually worldwide.[2] Infection

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by Mycoplasmas, especially M. genitalium, has been considered an emerging STI for the past 5–10 years.[3] Mycoplasma infection among women can lead to several adverse outcomes including cervicitis, pelvic inflammatory diseases, preterm birth, spontaneous abortion, as well as infertility.[4] These consequences justify the important need of preventing the disease, particularly among women of reproductive age.

However, data on the epidemiology of Mycoplasma infections remain limited in many settings including Senegal, and a better understanding in the epidemiology of Mycoplasma infections may help shape the existing control strategies and treatment practices regarding STI. Another prevalent STI is represented by trichomoniasis, which is recognized as the most prevalent nonviral STI in the world.[2] Every year, 250 million new cases are reported worldwide.[3] In general, the infection is asymptomatic in men although it can be associated with urethral discharge and dysuria, whereas infected women can have different symptoms consisting of a yellowish-green frothy discharge, purities, dysuria, and the strawberry cervix which is recognized by punctuate hemorrhagic lesions.[4] Infection by T. vaginalis among women can lead to serious complications such as adverse pregnancy outcomes that appear by preterm rupture of membranes, preterm delivery, low-birthweight infants, infertility, and cervical cancer.[7] Moreover, studies have shown an increased risk of HIV transmission among individuals infected by T. vaginalis.[6] T. vaginalis transmission is very heterogeneous and depends on several factors; it is established that socioeconomic status, age, hygiene habits, sexual behavior, phase of the menstrual cycle, access to health-care intervention, and other concomitant STIs such as Mycoplasma can play a key role in the disease transmission.[2,9,10] Laboratory-based studies suggested a symbiotic relationship between T. vaginalis and Mycoplasma hominis,[11] but the potential synergistic action between these two pathogens has yet to be assessed under clinical conditions. In Senegal, patients presenting at primary care units with signs suggestive of STI (urethral discharge and vaginal discharge syndromes) are often diagnosed and managed presumptively using a syndromic-based approach.[12] Studies have shown that a syndromic-based approach in some settings may lack sensitivity and specificity and can lead to mismanagement of several STIs including trichomoniasis and Mycoplasma infections.[13] In addition, biological confirmation of these pathogens in many primary care units remains at a low level due to lack of appropriate diagnostic tools, and community prevalence data remain limited.[14] This has led to limited available data regarding the epidemiology of Mycoplasma and its association with Trichomoniasis, especially among at-risk population such as women of reproductive age. Therefore, the current study was conducted in order to assess the prevalence of T. vaginalis, Mycoplasma (M. hominis and Ureaplasma urealyticum) infections, and associated correlates among women with vaginal discharge attending Fann Teaching Hospital in Senegal.

**METHODS**

**Subject and design**

The present study is a retrospective analysis of data from 1257 patients referred at Fann Teaching Hospital for vaginal discharge during the period from 2012 to 2013. Women, 18 years old and above, were included in the present analysis. A code was given to each participant, and data on women’s sociodemographic characteristics and residency were collected from the participants’ medical records based on prior permission from the administration officials of Fann Teaching Hospital. Fann Teaching Hospital is a public referral hospital, located in the capital city of Dakar. Population access to this referral hospital including access to laboratory services is easy by simple appointment, making this setting suitable for a study on STI. STI prevalence in Senegal is still low in the general population,[15,16] but information on other STIs such as Mycoplasma infection remains scarce.

**Specimen collection and processing**

The Mycoplasma Duo Biorad Kit™ was used for the identification and titration of genital Mycoplasmas (M. hominis and U. urealyticum). Endocervical swabs were collected, diluted, and cultured in a microplate with incubation at 37°C for 24 h as recommended by the supplier. Detection of genital Mycoplasmas was based on the specific properties of each microorganism: hydrolysis of arginine by M. hominis and hydrolysis of urea by U. urealyticum. In addition, a vaginal swab was collected from each participating woman, and a wet mount smear was performed immediately as part of a routine diagnostic procedure for a motile parasite. The wet mount smear was examined using an optical microscope at ×40 to detect T. vaginalis and assess biological modifications such as the presence of epithelial cells, white blood cells, as well as red blood cells. T. vaginalis infection was considered on the basis of a positive result from a wet mount microscopy of motile trichomonad. The magnitude of white and red blood cells within the vaginal discharge was classified as follows: (i) rare: 1–5 cells/high-power field, (ii) moderate: 6–10 cells/high-power field, (iii) many: 11–20 cells/high-power field, and (iv) high: 21 cells and above/high-power field, as described elsewhere.[17] In addition, a Gram-stained smear was performed to characterize the vaginal flora using Nugent scoring.[18] Briefly, each Gram-stained smear was evaluated for the following morphotypes under oil immersion (×100): large Gram-positive rods (lactobacillus morphotypes), small...
Gram-variable bacilli (*Gardnerella vaginalis* morphotypes), small Gram-negative bacilli (*Bacteroides* spp. morphotypes), and curved Gram-variable rods (* Mobiluncus* spp. morphotypes). Each morphotype was quantified from 1 to 4+ with regard to the number of morphotypes per oil immersion field, and the vaginal flora was characterized as follows: Type I: <1 morphotype; Type II: 1–4 morphotypes; Type III: 5–30 morphotypes; and Type IV: 30 or more morphotypes, as described elsewhere.[18] Type I and II were considered as normal vaginal flora, whereas type III and IV were considered as abnormal flora.

### Statistical methods

Data were entered into FileMaker Pro™ software and extracted for cleaning and analysis using STATA software (version 14.0 – StataCorp LP, Texas, USA). For binary data, percentage was used to assess the frequency of each outcome with a 95% confidence interval (95% CI). For continuous data, mean and standard deviation were used to describe normally distributed variables. Characteristics of all women included in the study were tabulated. Proportions were compared using Chi-square test (univariate analysis). The prevalence of *Mycoplasma, Ureaplasma*, and *Trichomonas vaginalis* was calculated and expressed as proportion with 95% CI. To assess factors associated with the presence of these different microorganisms, a multivariate logistic regression with adjustment on covariates such as age group, marital status, parity, and biological modifications was done. From the final model, adjusted odds ratios were derived with their 95% CI. The validity of each model was tested using the Hosmer–Lemeshow goodness-of-fit test. The performance of the final model was assessed by the area under the curve and Akaike and Bayesian goodness-of-fit test. The performance of each model was tested using the Hosmer–Lemeshow test. In a logistic regression analysis, women with an age range between 25 and 30 years were less likely to be infected by *T. vaginalis* compared to other age groups (adjusted odds ratio [OR]: 0.7 [0.4–1.2]; P = 0.04). In addition, married women belonging to a polygamous regimen had a lower risk of infection by *T. vaginalis* compared to single and divorced women (adjusted OR: 0.4 [0.2–0.7]; P = 0.04). No significant association was found between *T. vaginalis* and parity [Table 2].

In a logistic regression analysis, women with an age range between 25 and 30 years were less likely to be infected by *T. vaginalis* compared to other age groups (adjusted odds ratio [OR]: 0.7 [0.4–1.2]; P = 0.04). In addition, married women belonging to a polygamous regimen had a lower risk of infection by *T. vaginalis* compared to single and divorced women (adjusted OR: 0.4 [0.2–0.7]; P = 0.04). No significant association was found between *T. vaginalis* and parity [Table 2].

### Prevalence and distribution of *Trichomonas vaginalis*

The frequency of *T. vaginalis* among the nonmarried women (single) was at 6.1% (*n* = 10) versus 8.8% (*n* = 5) among the divorced women; among married women within a monogamous regimen, a prevalence of 2.8% (*n* = 21) was noted, whereas that was at 4.8% (*n* = 14) among married women belonging to a polygamous regimen [Table 2].

*T. vaginalis* was observed with a frequency of 6.1% (*n* = 10) among women who did not have a child. A prevalence of 3.9% (*n* = 21) was noted among women who had 1–3 children and 4.7% (*n* = 7) among women with more than 3 children [Table 2].

In a logistic regression analysis, women with an age range between 25 and 30 years were less likely to be infected by *T. vaginalis* compared to other age groups (adjusted odds ratio [OR]: 0.7 [0.4–1.2]; P = 0.04). In addition, married women belonging to a monogamous regimen had a lower risk of infection by *T. vaginalis* compared to single and divorced women (adjusted OR: 0.4 [0.2–0.7]; P = 0.04). No significant association was found between *T. vaginalis* and parity [Table 2].

### Prevalence and distribution of *Mycoplasma hominis*

The frequency of *M. hominis* among patients with a vaginal flora classified as type I was at 49.9% (*n* = 200) versus 51.4% (*n* = 127) for patients with type II vaginal flora. For patients with type III vaginal flora, *M. hominis* was identified with a frequency of 60% (*n* = 102) versus 66.5% (*n* = 292) for patients with type IV vaginal flora. Presence of *M. hominis* was described with a frequency of...
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Table 2: Frequency and distribution of Trichomonas vaginalis by sociodemographic characteristics

| Parameters | Univariate analysis | Multivariate analysis |
|------------|---------------------|----------------------|
|            | Examined | Positive, n (%) | Unadjusted OR (95% CI) | Adjusted OR (95% CI) | P |
| Age group (years) |         |                  |                        |                       |   |
| <25        | 275      | 15 (5.4)         | 1                      | 1                      | 1 |
| 25-30      | 389      | 10 (2.6)         | 0.4 (0.2-1.0)          | 0.4 (0.2-1.1)         | 0.04 |
| 31-35      | 246      | 11 (4.5)         | 0.8 (0.4-1.8)          | 0.8 (0.3-1.8)         | 0.56 |
| 36-40      | 153      | 6 (3.9)          | 0.7 (0.3-1.9)          | 0.6 (0.2-1.8)         | 0.4 |
| 41-45      | 116      | 5 (4.3)          | 0.8 (0.3-2.2)          | 0.6 (0.2-1.9)         | 0.38 |
| 46 and more | 78       | 3 (3.8)          | 0.7 (0.2-2.4)          | 0.4 (0.1-1.8)         | 0.22 |
| Marital status |         |                  |                        |                       |   |
| Single     | 164      | 10 (6.1)         | 1                      | 1                      | 1 |
| Divorced   | 57       | 5 (8.8)          | 1.5 (0.5-5.4)          | 1.7 (0.5-5.5)         | 0.4 |
| Married ‑ monogamous | 742 | 21 (2.8) | 0.4 (0.2-0.9) | 0.4 (0.2-0.9) | 0.04 |
| Married ‑ polygamous | 294 | 14 (4.8) | 0.8 (0.3-1.8) | 0.7 (0.3-1.8) | 0.51 |
| Parity     |          |                  |                        |                       |   |
| No child   | 574      | 22 (3.8)         | 1                      | 1                      | 1 |
| 1-3 children | 534  | 21 (3.9)         | 1.1 (0.6-1.9)          | 1.2 (0.6-2.4)         | 0.55 |
| >3 children | 149    | 7 (4.7)          | 1.2 (0.5-2.9)          | 1.6 (0.6-4.7)         | 0.37 |

OR: Odds ratio, CI: Confidence interval

76% (n = 50) among patients infected by T. vaginalis versus 56.6% (n = 683) among patients who were not infected by T. vaginalis. Among the examined vaginal swabs in which no leukocytes were found, M. hominis was identified with a proportion of 27% (n = 20), while that was at 57.5% (n = 939) for specimen with rare leukocytes. The frequency of M. hominis was, respectively, at 61.6% (n = 77), 74.2% (n = 49), and 66% (n = 35) for specimens with moderate, many, and high leukocyte excretion. M. hominis was identified with a frequency of 58.4% (n = 647) within the vaginal swab in which no erythrocyte was observed; the proportion of vaginal swabs with rare excretion of erythrocytes for which M. hominis was identified represented 55.4% (n = 31). For samples with moderate and many excretions of erythrocytes, M. hominis was found with a proportion of 45.6% (n = 36) and 63.6% (n = 7), respectively. No infection with M. hominis was found in vaginal swabs with high excretion of erythrocytes [Table 3].

The prevalence of M. hominis represented 64% (n = 176) among patients <25 years old, 59.1% (n = 230) among patients with an age range between 25 and 30 years, and 57.3% (n = 141) for patients aged between 31 and 35 years. A prevalence of 54.5%, 48.3%, and 44.9% was, respectively, noted among the 36–40 years’, 41–45 years’, and more than 46 years’ age groups. Among the unmarried women (single), M. hominis was found with a proportion of 61.6% (n = 101), while that was at 64.9% among the divorced group. The prevalence of M. hominis represented 53.5% and 63.3%, respectively, in the married women belonging to monogamous and polygamous regimens. According to parity, M. hominis was described with a frequency of 60.3% (n = 346) among women with no child versus 58.1% (n = 310) and 43.6% (n = 65), respectively, among those with 1–3 children and more than 3 children [Table 3].

In a multivariate logistic regression analysis, women with an age range between 36 and 45 years were less likely to be infected by Mycoplasma (adjusted OR: 0.5, 95% CI [0.3–0.8]), as well as women with an age above 45 years (adjusted OR: 0.3 [0.2–0.6]) compared to women aged <25 years [Table 3]. Biological parameters significantly associated with Mycoplasma among patients with vaginal discharge were represented by: type II vaginal flora (adjusted OR: 1.6, 95% CI [1.1–2.3]), type III vaginal flora (adjusted OR: 1.6, 95% CI [1.1–2.3]), type IV vaginal flora (adjusted OR: 2.0 [1.5–2.7]), and infection with T. vaginalis (adjusted OR: 2.5, 95% CI [1.2–5.2]). The presence of M. hominis resulted in increased excretion of leukocytes in the vaginal swabs [Table 3].

Prevalence and distribution of Ureaplasma urealyticum

Table 4 details the distribution of U. urealyticum according to biological parameters and sociodemographic characteristics.

Out of the 1257 examined vaginal samples, 690 (54.9%) were found with U. urealyticum. U. urealyticum was identified with a frequency of 48.4% (n = 194) among patients with a type I vaginal flora; its frequency represented 50.2% (n = 124) among patients with a type II vaginal flora. For participants with type III and type IV vaginal flora, the frequency of U. urealyticum represented 58.8% (n = 100) and 61.9% (n = 272), respectively. In the group of patients infected by T. vaginalis, 34 samples (68%) were found with U. urealyticum versus 54.3% (n = 656) in the noninfected group.

Within the samples with no leukocyte, U. urealyticum was found with a frequency of 25.7% (n = 19); for samples with rare leukocyte excretion, Ureaplasma was identified with a frequency of 54.9% (n = 516), while that was at 60% (n = 75), 72.7% (n = 48), and 60.4% (n = 32),
respectively, in samples with moderate, many, and high level of leukocyte excretion.

Analysis of *U. urealyticum* distribution by age group revealed a frequency of 62.2% (*n* = 171) among women <25 years, 55.3% (*n* = 215) in women of 25–35 years’ age group, 54.5% (*n* = 134) in the 31–35 years’ age group, 52.9% (*n* = 81) in the 36–40 years’ age group, 46.5% (*n* = 54) in the 41–45 years’ age group, and 44.9% (*n* = 35) among the group of women aged more than 46 years.

In a multivariate logistic regression analysis, the presence of *Ureaplasma* was significantly associated with the type of vaginal flora as follows: type II (adjusted OR: 1.5 [1.1–2.2]), type III (adjusted OR: 1.6 [1.1–2.4]); and type IV (adjusted OR: 1.8 [1.3–2.4]). The presence of *U. urealyticum* was significantly associated with increased excretion of leukocytes. Other covariates significantly associated with *Ureaplasma* were represented by: parity higher than 3 children (adjusted OR: 0.6 [0.4–0.9]), age between 41 and 45 years (adjusted OR: 0.5 [0.3–0.9]), and age above 45 years (adjusted OR: 0.6 [0.3–1.1]). No statistically significant association was found between *T. vaginalis*, marital status, and *U. urealyticum* [Table 4].

| Parameters | Univariate analysis | Multivariate analysis |
|------------|---------------------|-----------------------|
|            | Examined | Positive, n (%) | Odds ratio (95% CI) | Adjusted OR (95% CI) |
| Vaginal flora |          |                       |                      |
| Type I  | 401     | 200 (49.9) | Reference              | Reference |
| Type II | 247     | 127 (51.4) | 1.3 (0.9-1.9)          | 1.6 (1.1-2.3) |
| Type III | 170     | 102 (60.0) | 1.5 (1.0-2.1)          | 1.6 (1.1-2.3) |
| Type IV | 439     | 292 (66.5) | 1.9 (1.5-2.6)          | 2.0 (1.5-2.7) |
| *T. vaginalis* |          |                       |                      |
| Absence | 1207    | 683 (56.6) | Reference              | Reference |
| Presence | 50      | 38 (76.0)  | 2.8 (1.4-5.6)          | 2.5 (1.2-5.2) |
| Leukocytes |          |                       |                      |
| Absence | 74      | 20 (27.0)  | Reference              | Reference |
| Rare     | 939     | 540 (57.5) | 3.6 (2.1-6.2)          | 3.9 (2.2-7.1) |
| Moderate | 125     | 77 (61.6)  | 4.3 (2.3-8.1)          | 4.6 (2.3-9.3) |
| Many     | 66      | 49 (74.2)  | 7.8 (3.7-16.5)         | 8.7 (3.8-19.7) |
| High     | 53      | 35 (66.0)  | 5.2 (2.4-11.3)         | 5.3 (2.3-12.3) |
| Erythrocytes |          |                       |                      |
| Absence | 1108    | 647 (58.4) | Reference              | Reference |
| Rare     | 556     | 31 (55.4)  | 0.9 (0.5-1.5)          | 0.6 (0.3-1.0) |
| Moderate | 79      | 36 (45.6)  | 0.6 (0.4-0.9)          | 0.5 (0.3-0.9) |
| Many     | 11      | 07 (63.6)  | 1.2 (0.4-4.3)          | 1.0 (0.3-3.7) |
| High     | 4       | 0 (0)      | -                      | - |
| Age group (years) |          |                       |                      |
| <25      | 275     | 176 (64.0) | Reference              | Reference |
| 25-30    | 389     | 230 (59.1) | 0.8 (0.6-1.1)          | 0.9 (0.6-1.2) |
| 31-35    | 246     | 141 (57.3) | 0.7 (0.5-1.1)          | 0.7 (0.5-1.1) |
| 36-40    | 153     | 83 (54.2)  | 0.7 (0.4-1.0)          | 0.7 (0.4-1.0) |
| 41-45    | 116     | 56 (48.3)  | 0.6 (0.3-0.9)          | 0.5 (0.3-0.8) |
| 46 and more | 78      | 35 (44.9)  | 0.5 (0.3-0.8)          | 0.3 (0.2-0.6) |
| Marital status |          |                       |                      |
| Single   | 164     | 101 (61.6) | Reference              | Reference |
| Divorced | 57      | 37 (64.9)  | 1.0 (0.5-1.9)          | 1.3 (0.7-2.7) |
| Married - monogamous | 742 | 397 (53.5) | 0.7 (0.5-0.9)          | 0.7 (0.5-1.1) |
| Married - polygamous | 294 | 186 (63.3) | 1.1 (0.7-1.6)          | 1.3 (0.8-2.0) |
| Parity   |          |                       |                      |
| No child | 574     | 346 (60.3) | Reference              | Reference |
| 1-3 children | 534 | 310 (58.1) | 0.9 (0.7-1.1)          | 0.9 (0.7-1.2) |
| >3 children | 149 | 65 (43.6)  | 0.5 (0.4-0.8)          | 0.7 (0.4-1.0) |

Overall prevalence of *Mycoplasma*: 57.4% (95% CI [54.6-60.1]). Hosmer-Lemeshow goodness-of-fit test: Chi (8 df) = 8.19; *P* = 0.25. AUC = 0.65; test for multicollinearity using VIF=1.44 - Akaike information criterion=1618; BIC=1721. AUC: Area under the curve, VIF: Variance inflation factor, BIC: Bayesian information criterion, OR: Odds ratio, CI: Confidence interval, *T. vaginalis*: Trichomonas vaginalis.

**Table 3: Mycoplasma infection and its correlates among the participating women (n=1257)**
Trichomonas and Mycoplasma and other covariates such as presence of leukocytes, marital status, age group, and parity. Table 4 describes the distribution and factors associated with co-infection by Trichomonas and Mycoplasma within the analyzed samples. Table 5 describes the distribution and factors associated with co-infection by Trichomonas and Mycoplasma within the analyzed samples.

**DISCUSSION**

STIs are the common causes of illness and remain the major public health problems in many settings. Senegal is a country with low prevalence of STI, especially for HIV, but data on the epidemiology of other STIs such as Mycoplasma infections and trichomoniases are scarce. This study aimed at assessing the prevalence of T. vaginalis, Mycoplasma (M. hominis and U. urealyticum) infections, and associated correlates among women with vaginal discharge.

In this study, a proportion of 3.9% of women with vaginal discharge were infected by T. vaginalis. The frequency of T. vaginalis infection in this study was lower than what was reported in other African settings such as Zimbabwe where a prevalence of 9.5% was found, but it is consistent with the reported prevalence of 5% in Pakistan. In contrast, higher prevalence was reported in the USA among imprisoned women. Although other studies showed higher prevalence among married women, this study revealed that divorced women were more likely to develop trichomoniases compared to single and married women. These differences could be explained by variability in terms of disease exposure, which may depend on sexual behavior, as well as socioeconomic status.

| Parameters | Univariate analysis | Multivariate analysis |
|------------|---------------------|----------------------|
|            | Examined | Positive, n (%) | OR (95% CI) | Adjusted OR (95% CI) | p |
| Vaginal flora |          |                   |             |                       |   |
| Type I     | 401      | 194 (48.4)        | Reference   | Reference             | - |
| Type II    | 247      | 124 (50.2)        | 1.1 (0.8-1.5) | 1.5 (1.1-2.2)         | 0.02 |
| Type III   | 170      | 100 (58.8)        | 1.5 (1.1-2.2) | 1.6 (1.1-2.4)         | 0.008 |
| Type IV    | 439      | 272 (61.9)        | 1.7 (1.3-2.3) | 1.8 (1.3-2.4)         | 0.0001 |
| T. vaginalis |          |                   |             |                       |   |
| Absence    | 1207     | 656 (54.3)        | Reference   | Reference             | - |
| Presence   | 50       | 34 (68.0)         | 1.8 (0.9-3.3) | 1.7 (0.9-3.3)         | 0.08 |
| Leukocytes |          |                   |             |                       |   |
| Absence    | 74       | 19 (25.7)         | Reference   | Reference             | - |
| Rare       | 939      | 516 (54.9)        | 3.5 (2.1-6.0) | 3.9 (2.7-7.1)         | 0.0001 |
| Moderate   | 125      | 75 (60.0)         | 4.3 (2.3-8.2) | 5.0 (2.5-10.0)        | 0.0001 |
| Many       | 66       | 48 (72.7)         | 7.7 (3.6-16.4) | 9.1 (4.0-20.6)        | 0.0001 |
| High       | 53       | 32 (60.4)         | 4.4 (2.1-9.4) | 4.9 (2.1-11.2)        | 0.0001 |
| Erythrocytes |        |                   |             |                       |   |
| Absence    | 1108     | 624 (56.3)        | Reference   | Reference             | - |
| Rare       | 56       | 26 (46.4)         | 0.7 (0.4-1.1) | 0.4 (0.2-0.8)         | 0.008 |
| Moderate   | 79       | 33 (41.8)         | 0.6 (0.3-0.9) | 0.5 (0.3-0.8)         | 0.004 |
| Many       | 11       | 07 (63.6)         | 1.3 (0.4-4.7) | 1.1 (0.3-4.0)         | 0.86 |
| High       | 03       | 00                | -           | -                     | - |
| Age group (years) |        |                   |             |                       |   |
| <25        | 275      | 171 (62.2)        | Reference   | Reference             | - |
| 25-30      | 389      | 215 (55.3)        | 0.7 (0.5-1.0) | 0.8 (0.6-1.1)         | 0.14 |
| 31-35      | 246      | 134 (54.5)        | 0.7 (0.5-1.0) | 0.7 (0.5-1.1)         | 0.09 |
| 36-40      | 153      | 81 (52.9)         | 0.6 (0.4-1.0) | 0.7 (0.5-1.1)         | 0.11 |
| 41-45      | 116      | 54 (46.5)         | 0.5 (0.3-0.8) | 0.5 (0.3-0.9)         | 0.01 |
| 46 and more | 78       | 35 (44.9)         | 0.5 (0.3-0.8) | 0.6 (0.3-1.1)         | 0.07 |
| Marital status |      |                   |             |                       |   |
| Single     | 164      | 96 (58.5)         | Reference   | Reference             | - |
| Divorced   | 57       | 32 (56.1)         | 0.9 (0.5-1.7) | 1.0 (0.5-1.9)         | 0.94 |
| Married - monogamous | 742     | 381 (51.3)        | 0.7 (0.5-1.1) | 0.8 (0.6-1.2)         | 0.26 |
| Married - polygamous | 294     | 181 (61.6)        | 1.1 (0.8-1.7) | 1.4 (0.9-2.1)         | 0.13 |
| Parity     |          |                   |             |                       |   |
| No child   | 574      | 331 (57.7)        | Reference   | Reference             | - |
| 1-3 children | 534     | 296 (55.4)        | 0.9 (0.7-1.1) | 0.9 (0.8-1.3)         | 0.96 |
| >3 children | 149      | 63 (42.4)         | 0.5 (0.4-0.8) | 0.6 (0.4-0.9)         | 0.03 |

Hosmer-Lemeshow goodness-of-fit test: Chi (8 df)=5.34; P=0.72. AUC=0.65; test for multicollinearity using VIF=1.53. AIC=1674; BIC=1762. AUC: Area under the curve, VIF: Variance inflation factor, BIC: Bayesian information criterion, OR: Odds ratio, CI: Confidence interval, T. vaginalis: Trichomonas vaginalis.
care.\cite{25} Other predisposing factors comprise use of oral contraceptives, trading sex, smoking, single marital status, and low socioeconomic class.\cite{28} However, the study did not investigate the distribution of some of these factors among the study participants.

On the other hand, a proportion of 3% of women with vaginal discharge were co-infected by \textit{T. vaginalis} and \textit{Mycoplasma}, and the study revealed that patients infected by \textit{T. vaginalis} were more likely to carry \textit{Mycoplasma} compared to noninfected patients. The symbiotic relationship between \textit{T. vaginalis} and \textit{Mycoplasma} has been described in several studies,\cite{11,27} and it is established that \textit{T. vaginalis} can act as a niche and vector for the transmission of \textit{M. hominis}.\cite{29} \textit{T. vaginalis} has been identified as a potential carrier for \textit{M. hominis},\cite{29} and \textit{Mycoplasmas} hosted by \textit{T. vaginalis} have the privilege to evade host immune response and enhance \textit{T. vaginalis} virulence.\cite{27} This clinically significant symbiosis between these two obligate human microorganisms suggests systematic screening of \textit{Mycoplasma} among patients with \textit{T. vaginalis} infection for better optimization of STI treatment practices.

The study revealed an overall prevalence of \textit{M. hominis} at 57.4% and a prevalence of \textit{U. urealyticum} at 54.9%. \textit{Mycoplasma} and \textit{Ureaplasma} infections were more frequent among the youngest women (<35 years). \textit{Mycoplasmas} are thus frequently isolated microorganisms from the genital tract of women,\cite{30} but various prevalence rates of \textit{Mycoplasma} and \textit{Ureaplasma} infections have been reported. A study conducted in Cameroon revealed a prevalence of \textit{Mycoplasma} at 48%,\cite{31} and the \textit{Mycoplasma} prevalence was evaluated at 42.8% in a study conducted in Korea.\cite{32} Higher prevalence (80%) was reported in South Africa\cite{33} and Papua New Guinea (70% for \textit{M. hominis} and 78% for \textit{U. urealyticum}).\cite{34} These variations in the frequency of \textit{Mycoplasmas} could be explained by the variability of diagnostic methods across studies, but other factors such as method of sample collection (urine, cervical swab, and vaginal discharge), socioeconomic factors, as well as sexual behavior could impact on infection rate variability.\cite{35} In this study, \textit{M. hominis} and \textit{U. urealyticum} were more prevalent among women below the age of 45 years. Indeed, STI in that age group may be more prevalent due to the fact that it is a sexually active and reproductive age group, which may be a predisposing factor for infection.\cite{10,35}
In this study, the presence of Mycoplasmas resulted in significant biological modifications such as increased excretion of white blood cells within the vaginal swabs. Moreover, Mycoplasma infection was associated with significant modification of the vaginal flora, and participants with abnormal vaginal flora (Type III and IV) were more likely to be infected by Mycoplasma and/or Ureaplasma. Indeed, Mycoplasma infections of the female urogenital tract are commonly associated with bacterial vaginosis, pelvic inflammatory disease, and cervicitis, which may result in increased secretion of white blood cells.57,38

Although the study provided relevant evidence on the association between T. vaginalis and M. hominis, it has some limitations. Co-infection with Trichomonas and Mycoplasma in many cases may result in reduced susceptibility to antimicrobial agents, thus complicating the infection eradication process.37,39 In this study, laboratory investigations did not include antimicrobial susceptibility testing, and a follow-up assessment was not performed after treatment. Additional investigations would contribute to a better understanding of the effect of the co-infection on response to treatment under routine practices. In the current study, T. vaginalis detection was only based on wet mount smear microscopic examination as part of a routine standard practice, but no additional investigations such as culture or PCR were done. This may have lowered parasite detection rate.

CONCLUSION

T. vaginalis and Mycoplasmas are two closely associated pathogens in the urogenital tract of women, providing a symbiotic relationship between these microorganisms. This significant symbiotic action may require systematic screening of Mycoplasma among patients infected by T. vaginalis for optimal management of STI among women. Infection by these pathogens is often associated with bacterial vaginosis and can result in increased excretion of white blood cells.

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Conflicts of interest

There are no conflicts of interest.

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