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Trends in infections detected in women with cervicitis over a decade

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Objectives: There is a growing body of evidence that in the absence of *Chlamydia trachomatis* and/or *Neisseria gonorrhoeae, Mycoplasma genitalium* and bacterial vaginosis (BV) are associated with cervicitis. We aimed to describe infections detected among cervicitis cases over a decade and establish how commonly *M. genitalium* and BV were detected among non-chlamydial/non-gonococcal cases to inform testing and treatment practices.
Methods: We conducted a retrospective case-series to determine the number of cervicitis cases diagnosed with genital infections (*C. trachomatis*, *N. gonorrhoeae, M. genitalium* and BV) among women attending the largest public sexual health service in Australia from 2011 to 2021. We determined the proportion of cervicitis cases with one or more genital infections detected, and trends in testing and detection of each infection over time.
Results: Over a decade 813 cervicitis cases were diagnosed; 421 (52%, 95%CI: 48%–55%) had no infection detected; 226/729 (31%, 95%CI: 28%–35%) had BV, 163/809 (20%, 95%CI: 17%–23%) *C. trachomatis*, 48/747 (6%, 95%CI: 5%–8%) *M. genitalium*, and 13/793 (2%, 95%CI: 1%–3%) *N. gonorrhoeae*. Of the 665 (82%) cases tested for all four infections, 268 (40%) had one infection and 73 (11%) had >1 infection detected. Of the 517/665 (78%) non-chlamydial/non-gonococcal cases, 164 (32%) had BV and 16 (3%) had *M. genitalium* as the sole infections detected; a further 13 cases (3%) were co-infected with BV and *M. genitalium*. The proportion of cases tested for BV (90%) did not change overtime, but detection increased from 32% to 45% ($P_{trend} < 0.001$). The proportion of cases tested for *M. genitalium* increased from 84% in 2011 to 96% in 2019 ($P_{trend} = 0.006$), with *M. genitalium*-detection in cervicitis increasing from 3% to 7% ($P_{trend} = 0.046$).
Conclusions: In our study population, chlamydia or gonorrhoea were not detected in ~75% of cervicitis cases; 1 in 3 of these cases had BV and/or *M. genitalium*, and both increased in prevalence over time. These data highlight the need for clinicians to consider BV and *M. genitalium* when assessing and managing cervicitis.

KEYWORDS

cervicitis, sexually transmitted infections, *Mycoplasma genitalium*, bacterial vaginosis, *Chlamydia trachomatis*, *Neisseria gonorrhoeae*

Introduction

Cervicitis is defined by the presence of mucopurulent discharge and/or cervical friability at the endocervical os (1, 2). Cervicitis is associated with HIV transmission (3) and is a potential precursor of upper genital tract infection, resulting in pelvic inflammatory disease (PID) and obstetric sequelae (4, 5). Identification and effective treatment of cervicitis is important to relieve symptoms and prevent sequelae.

Chlamydia trachomatis and *Neisseria gonorrhoeae* have traditionally been considered the most common causes of cervicitis. Other etiologic pathogens less commonly attributed to cervicitis include *Trichomonas vaginalis* and Herpes Simplex Virus (HSV) (2, 6). In the absence of these pathogens, *Mycoplasma genitalium* and the common vaginal dysbiosis, bacterial vaginosis (BV), are emerging as other infections associated with cervicitis. *M. genitalium* is associated with cervicitis by meta-analysis [pooled odds ratio (OR) = 1.66, 95%CI: 1.35–2.04] (7), and in a recent case-control study of >1,300 women in Melbourne, Australia, *M. genitalium* was associated with mucopurulent cervicitis on examination (adjusted OR = 4.38, 95% CI: 1.69–11.33, $p = 0.002$) (8). Limited studies have also shown that BV is associated with cervicitis (9–11). A secondary analysis of the same Australian case-control study, which utilised samples from 65 STI-negative cases with cervicitis and 128 STI-negative asymptomatic women, found that STI-negative cervicitis cases were five times more likely to have BV compared to STI-negative asymptomatic controls (12). Cases were also more likely than controls to have a *Lactobacillus*-deficient non-optimal microbiota and an increased abundance of four BV-associated bacteria (*Gardnerella, Fannyhessea vaginae, Prevotella bivia, Dialister micraerophilus*) (12).

Despite this evidence, the relative contribution of *M. genitalium* and BV to the burden of cervicitis is poorly understood, leading to inconsistency in testing recommendations across international guidelines (2, 13–15). The majority of guidelines list chlamydia and gonorrhoea as the main causes of cervicitis and recommend routine testing, but these infections are detected in <30%–40% of cases (2, 16–18), leaving a high proportion of cases with no clear cause (Supplementary Table 1).

We aimed to describe the proportion of cervicitis cases with *C. trachomatis, N. gonorrhoeae, M. genitalium* and/or BV, and to determine how commonly *M. genitalium* and BV were detected among women with non-chlamydial, non-gonococcal cervicitis in order to inform contemporary testing and management practices.

Methods

This retrospective case-series incorporated women with cervicitis who attended Melbourne Sexual Health Centre (MSHC) from 1st March 2011 to 1st March 2021. Ethical approval was provided by the Alfred Hospital Ethics Committee (ID: 718/20).

Women presenting with vaginal, pelvic and/or abdominal symptoms underwent a speculum and bimanual examination, STI testing, and microscopy of vaginal secretions. Cervicitis was defined as the presence of mucopurulent discharge at the cervical os and/or cervical ectopy or a friable cervix with easily induced bleeding (13). Clinical signs, symptoms, diagnoses, and test results were documented.

Testing for genital infections

The details of laboratory testing performed for all STIs and BV are as previously reported (19–21), with extended information supplied in Supplementary Material—*Extended Methodology*. Briefly, *C. trachomatis* was universally screened for. Before March 2015, *N. gonorrhoeae* was tested for in symptomatic women, sex workers, and sexual contacts, and subsequently, attendees were universally screened for *N. gonorrhoeae*. Indications for *M. genitalium* testing included cervicitis, pelvic pain, post-coital bleeding, test-of-cure, and sexual contact of infection. Throughout the study period, vaginal microscopy (Gram stain and wet preparation) was performed in all women presenting with abnormal vaginal discharge, itch, vaginal malodour, pelvic pain, cervicitis, and post-coital bleeding. BV was assessed and diagnosed using a combination of both Amsel and Nugent criteria (22, 23). Selective testing for *T. vaginalis* and genital HSV occurred among cervicitis cases based on the presence of relevant clinical signs and indications (19, 24).

Data extraction

Epidemiological and clinical data were extracted for all individuals >18 years with a diagnosis of "cervicitis" documented. File review captured additional relevant data from an adjacent clinical visit within 4 weeks of the cervicitis diagnosis (i.e., if a case had chlamydia in the week preceding the cervicitis diagnosis, this recent infection was attributed to the case). Among those with >1 cervicitis diagnosis within 6 months ($n = 16$), either the first cervicitis diagnosis or the diagnosis with the most complete data was included. For the purposes of this study, each 12-month period incorporated March of 1 year to March of the subsequent year (i.e., "2011" comprises data from 1st March 2011 to 1st March 2012).

Statistical analysis

All proportions, 95% confidence intervals (CIs; using exact binomial method), and statistical analyses were conducted using Stata (v14, StataCorp LP, College Station, TX, USA).

We extracted the number of cervicitis cases, and calculated the number tested for, and the proportion with, *C. trachomatis, N. gonorrhoeae, M. genitalium*, BV, *T. vaginalis* and/or HSV. Utilising recently published data from our service for *C. trachomatis* and *N. gonorrhoeae* (25), supplemented with additional data for *M. genitalium* and BV, we next calculated the proportion of first-time MSHC attendees tested for, and with each genital infection (including BV), during an equivalent period. This approach enabled an estimate of the annual change in cervicitis diagnoses to be

generated, however was limited, as not all women were examined for cervicitis. Due to differing indications for testing/screening, and because asymptomatic cervicitis cases were potentially missed, the two groups were not statistically compared.

The following analyses were restricted to visits prior to 1st March 2020 (i.e., includes 2011–2019, as defined above), after which there was a significant impact of COVID-19 lockdowns on MSHC attendance (26). Poisson regression was used to examine changes in the number of first-time MSHC attendees and cervicitis cases over time, and the chi-square trend test applied to establish trends in the proportion of attendees diagnosed with cervicitis (excluding repeat visits in the same year to ensure that recurrent/persistent infections did not influence estimates). Trends in the proportion tested for each infection and positive for each infection were then assessed separately among cervicitis cases and the MSHC population (25).

Results

A total of 840 cervicitis diagnoses were recorded over the study period; 27 cases were excluded as individuals were ≤18 years of age ($n = 11$) or they had a repeat cervicitis diagnosis *within* 6 months ($n = 16$). The remaining 813 cases were from 805 attendees with at least one diagnosis of cervicitis >6 months apart. None of the identified cases were women living with HIV.

Testing patterns and genital infections among cervicitis cases

Table 1 outlines the number of cervicitis cases tested for each genital infection and the proportion with each infection. Of the

TABLE 1 Detection of *Chlamydia trachomatis, Neisseria gonorrhoeae, Mycoplasma genitalium*, bacterial vaginosis, *trichomonas vaginalis* and herpes simplex virus among women with cervicitis 2011–2020, and among all women attending for their first visit to MSHC 2011–2019.

	No. of women with cervicitis who were tested for, and diagnosed with, each infection *n, N*	% of cervicitis cases with each infection % (95% CI)	No. of all female attendees tested for, and diagnosed with, each infection at their first visit to MSHC *n/N*	% of all female attendees with each infection at their first visit to MSHC % (95% CI)
C. trachomatis				
Negative	646, 809	79.85 (76.9–82.6)	30,809/33,833	91.06 (90.8–91.4)
Positive	163, 809	20.15 (17.4–23.1)	3,024/33,833	8.94 (8.6–9.3)
Not tested[a]	4/813	0.49 (0.1–1.3)	2,314/36,147	6.40 (6.5–6.7)
N. gonorrhoeae				
Negative	780/793	98.36 (97.2–99.1)	22,139/22,398	98.84 (98.7–99.0)
Positive	13/793	1.64 (0.9–2.8)	259/22,398	1.16 (1.0–1.3)
Not tested[a]	20/813	2.46 (1.5–3.8)	13,749/36,147	38.03 (37.5–38.5)[b]
M. genitalium				
Negative	699/747	93.57 (91.6–95.2)	4,232/4,728	89.51 (88.7–90.4)
Positive	48/747	6.43 (4.8–8.4)	496/4,728	10.49 (9.6–11.4)
Not tested[a]	66/813	8.12 (6.3–10.2)	31,436/36,147	86.97 (86.6–87.3)
Bacterial vaginosis				
Negative	503/729	69.00 (65.5–72.3)	8,783/12,128	72.42 (71.6–73.2)
Positive	226/729	31.00 (27.7–34.5)	3,345/12,128	27.58 (26.8–28.4)
Not tested[a]	84/813	10.33 (8.3–12.6)	24,036/36,147	66.50 (66.0–67.0)
T. vaginalis				
Negative	129/135	95.56 (90.6–98.4)	8,539/8,589	99.42 (99.2–99.6)
Positive	6/135	4.44 (1.6–9.4)	50/8,589	0.58 (0.4–0.8)
Not tested[a]	678/813	83.39 (80.7–85.9)	27,558/36,147	76.24 (75.8–76.7)
Herpes simplex virus				
Negative	64/88	72.72 (62.2–81.7)	34,973/36,147	96.75 (96.6–96.9)
Positive	24/88	27.27 (18.3–37.8)	1,174/36,147	0.03 (3.1–3.4)
HSV-1	13/24		–	–
HSV-2	7/24		–	–
Untyped	4/24		–	–
Not tested[a]	725/813	89.18 (86.8–91.2)	–	–

N.B. Cells have been left empty (–) if data was unavailable or because testing was specific to those presenting with clinically relevant symptoms and/or signs. There was no infectious cause detected in 421 women diagnosed with cervicitis.

[a]"Not tested" data reflect the number of women who were not tested, and the proportion not tested, firstly for women with cervicitis and secondly, for women attending for their first visit at MSHC.

[b]The large proportion not tested reflects the period prior to March 2015, when indications for *N. gonorrhoeae* testing only included cervicitis, pelvic inflammatory disease (PID), post-coital bleeding, test-of-cure, sex worker, and sexual contact of *N. gonorrhoeae* infection. During this period, *N. gonorrhoeae* testing involved culture (swabs plated at the bedside onto a modified Thayer-Martin medium) and a cervical smear that was Gram stained and underwent immediate microscopy. From March 2015, all women were *universally screened* for *N. gonorrhoeae* using the multiplex AC2-assay (Hologic, combined with chlamydia).

813 cases, 421 (51.8%, 95%CI:48.3%–55.3%) had no infections identified; two of the 421 did not have a *C. trachomatis* test documented, 19 did not have a *N. gonorrhoeae* test documented, 64 did not have an *M. genitalium* test documented and 55 did not have Amsel and/or Nugent criteria documented (i.e., no BV result documented). Of those with an infection identified, 392 (48.2%, 95%CI: 44.7%–51.7%) had at least one infection detected; 90.3% of whom had one infection, and 9.7% ≥2 infections detected.

Of the 809/813 (99.5%, 95%CI: 98.7%–99.9%) cervicitis cases tested for *C. trachomatis,* 163 (20.1%, 95%CI: 17.4%–23.1%) had *C. trachomatis.* Of the 793/813 cases (97.5%, 95%CI: 96.2%–98.5%) tested for *N. gonorrhoeae,* only 13 (1.6%, 95%CI: 0.9%–2.8%) had *N. gonorrhoeae* detected. Of the 747/813 (91.9%, 95% CI: 89.8%–93.7%) cervicitis cases tested for *M. genitalium*, 48 (6.4%, 95%CI: 4.8%–8.4%) had *M. genitalium* detected. 729 (89.7%, 95%CI: 87.4%–91.7%) cases were assessed for BV, and 226 (31.0%, 95%CI: 27.7%–34.5%) had BV diagnosed.

Select testing for *T. vaginalis* and HSV was based on clinical indications (as per clinical guidelines). Of the 135/813 (16.6% 95%CI: 14.1%–19.3%) cases selectively tested for *T. vaginalis*, six (4.4%, 95%CI: 1.6%–9.4%) had *T. vaginalis* detected. Additionally, 88/813 (10.8%, 95%CI: 8.8%–13.2%) cervicitis cases were selectively tested for HSV; 24 (27.3%, 95%CI: 18.3%–37.8%) had HSV detected.

We next looked at mono- and co-infections among cases tested for *C. trachomatis, N. gonorrhoeae, M. genitalium* and BV and determined the proportion of non-chlamydial, non-gonococcal cervicitis with *M. genitalium* and/or BV. Of the $N = 665$ (81.8%) cervicitis cases tested for all four of these infections, 268 (40.3%) had a single infection detected, and 73 (11.0%) had more than one infection detected, Figure 1. *C. trachomatis* or *N. gonorrhoeae* accounted for 22.3% ($n = 148$) of infection in cases of cervicitis. The most common co-infection among these cases was *C. trachomatis* with BV ($n = 43/73$; 58.9% of coinfections). Of 517 cases (77.7%) with non-chlamydial, non-gonococcal cervicitis, BV and/or *M. genitalium* was the sole infection detected in 193/517 (37.3%) of cases; BV was the only infection detected in 164/517 (31.7%) cervicitis cases, and *M. genitalium* was the sole infection detected in 16/517 (3.1%) cervicitis cases. Thirteen cases (2.5%) were co-infected with BV and *M. genitalium*.

Trends in cervicitis and genital infections

The following analyses were restricted to a woman's first-ever cervicitis diagnosis or visit to MSHC during 2011–2019, as described above.

The number of unique MSHC attendees significantly increased over time ($p < 0.001$), from 6,475 in 2011 to 11,323 in 2019, and the number of cervicitis cases increased from 60 in 2015 to 98 in 2019 ($p = 0.006$), Figure 2a. The cases of cervicitis as a proportion of MSHC attendees was low and ranged from 0.9% to 1.1% and remained stable over time ($P_{trend} = 0.080$), Figure 2b.

We next calculated the trends in the proportion of MSHC attendees from 2011 to 2019 who (i) were tested for and (ii) tested positive for each of the four genital infections (Figure 2c),

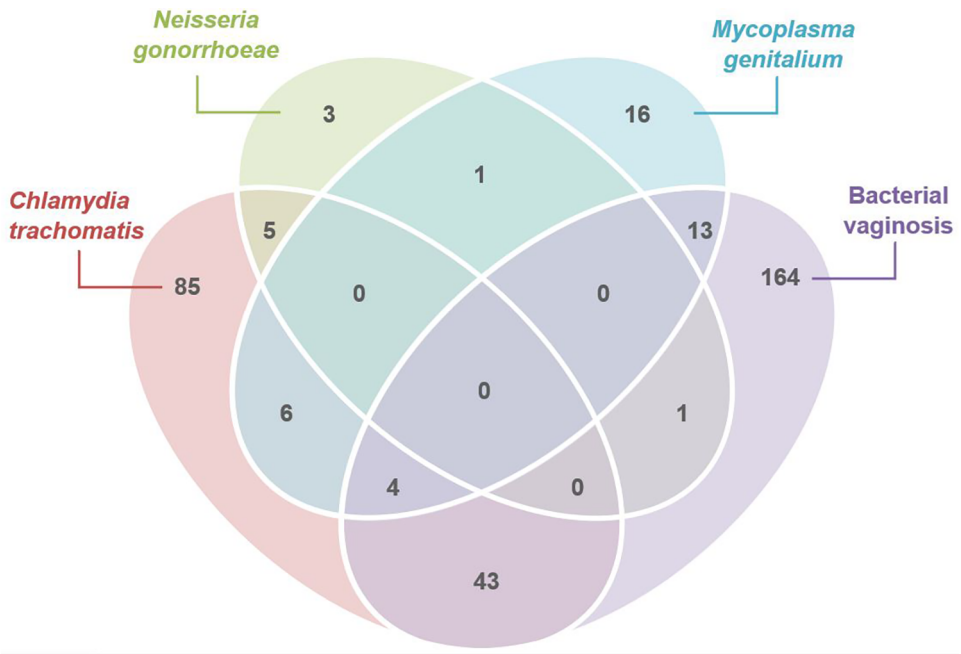

FIGURE 1
Venn diagram illustrating the number of women with cervicitis attending MSHC who were tested for *C. trachomatis, M. genitalium, N. gonorrhoeae* and bacterial vaginosis (BV) ($N = 665$), and who had either mono-infections detected ($n = 268$), or who were co-infected ($n = 73$) with one or more infections (2011–2020). Of those without *C. trachomatis* or *N. gonorrhoeae* ($n = 517$), 193 women with cervicitis had either *M. genitalium* ($n = 16$), bacterial vaginosis ($n = 164$) or both *M. genitalium* and BV detected ($n = 13$).

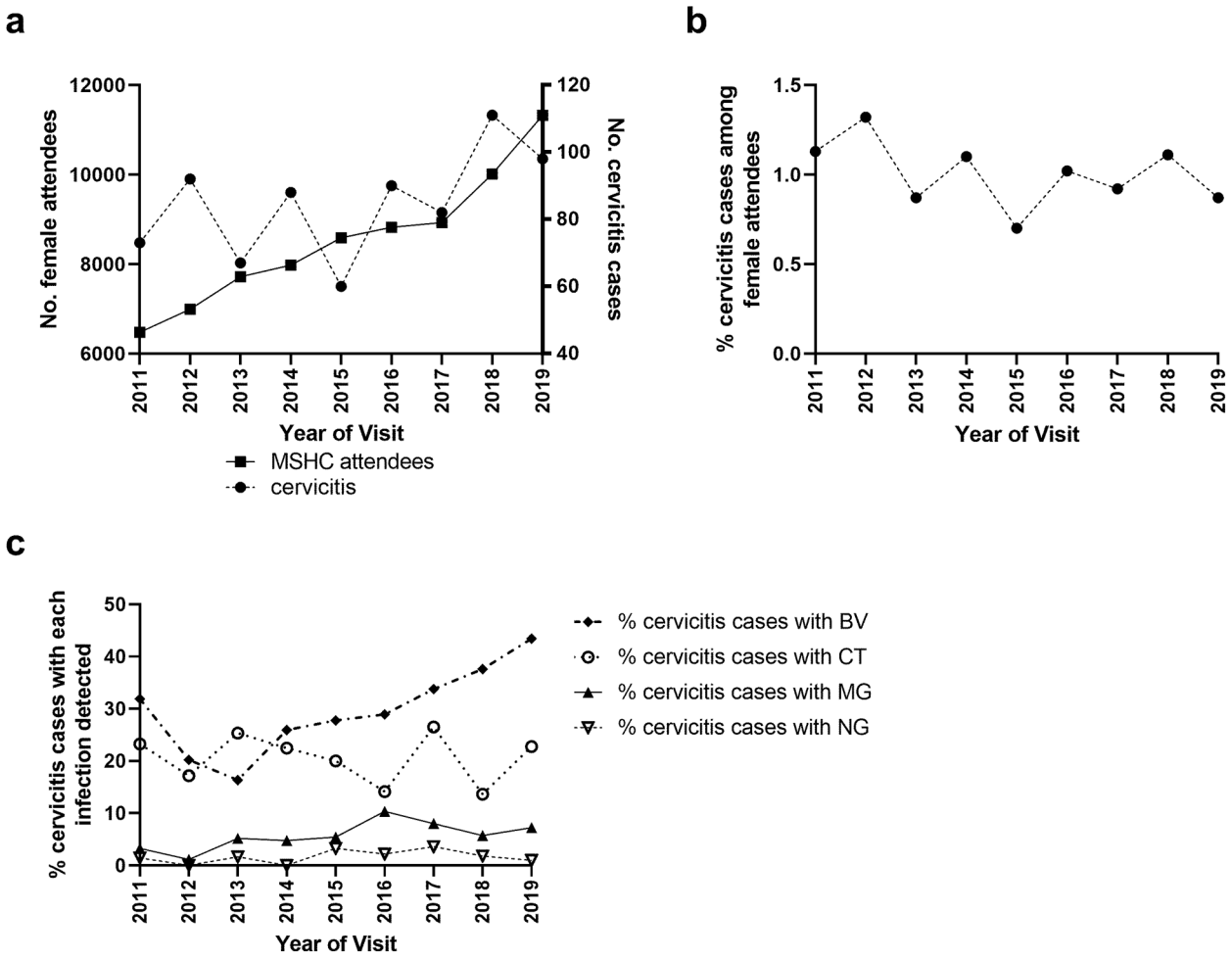

FIGURE 2
Distribution of (a) the number of women attending MSHC for the first-time and the number of cervicitis cases over time (2011–2019) and (b) the proportion of unique women who had a cervicitis diagnosis overtime. The number of first-ever cervicitis diagnoses of women attending the service was divided by the total number of unique attendees per annum. (c) The proportion of cervicitis cases diagnosed with each of the four infections (*C. trachomatis* [CT], *N. gonorrhoeae* [NG], *M. genitalium* [MG] and bacterial vaginosis [BV]) per annum. Only the first cervicitis diagnosis for each woman was included within temporal analyses.

and then repeated these analyses for cervicitis cases over the same period. The proportion of MSHC attendees who were tested for *C. trachomatis* was high and increased from 91% in 2011 to 94% in 2019 ($P_{trend} < 0.001$), with no change in positivity over time ($P_{trend} = 0.168$; Supplementary Figure 1). Among cervicitis cases, *C. trachomatis* testing was consistently high (range = 98%–100%; $P_{trend} = 0.705$), and *C. trachomatis* positivity in cervicitis cases also did not change over time (range = 14%–25%, $P_{trend} = 0.467$). The proportion of all attendees tested for *N. gonorrhoeae* increased from 49% in 2011 to 95% in 2019 ($P_{trend} < 0.001$), corresponding to a change from selective testing to universal screening in March 2015. However, the proportion of all attendees who tested positive for *N. gonorrhoeae* did not change over time (range = 1%–2%, $P_{trend} = 0.140$; Supplementary Figure 1). Among cervicitis cases, the proportion tested for *N. gonorrhoeae* increased from 96% in 2011 to 100% in 2019 ($P_{trend} < 0.001$), but again positivity in cervicitis cases was stable (range = 0%–4%, $P_{trend} = 0.367$).

The proportion of all attendees tested for *M. genitalium* significantly increased from 6% in 2011 to 16% in 2019 ($P_{trend} < 0.001$, Figure 3a), and positivity also increased from 6% in 2011 to 15% in 2019 ($P_{trend} < 0.001$), Figure 3b. Among women with cervicitis, the proportion tested for *M. genitalium* increased from 84% in 2011 to 96% in 2019 ($P_{trend} = 0.006$), and positivity increased from 3% in 2011 to 7% in 2019 ($P_{trend} = 0.046$). The proportion of women attending MSHC tested for BV at their first visit decreased slightly but significantly from 33% in 2011 to 31% in 2019 ($P_{trend} < 0.001$, Figure 3c), however the proportion with BV detected increased from 23% in 2011 to 31% in 2019 ($P_{trend} < 0.001$), Figure 3d. Although testing for BV in cervicitis was high (average = 89%) and ranged from 82% to 98% in 2019, it did not significantly change over time ($P_{trend} = 0.359$), however,

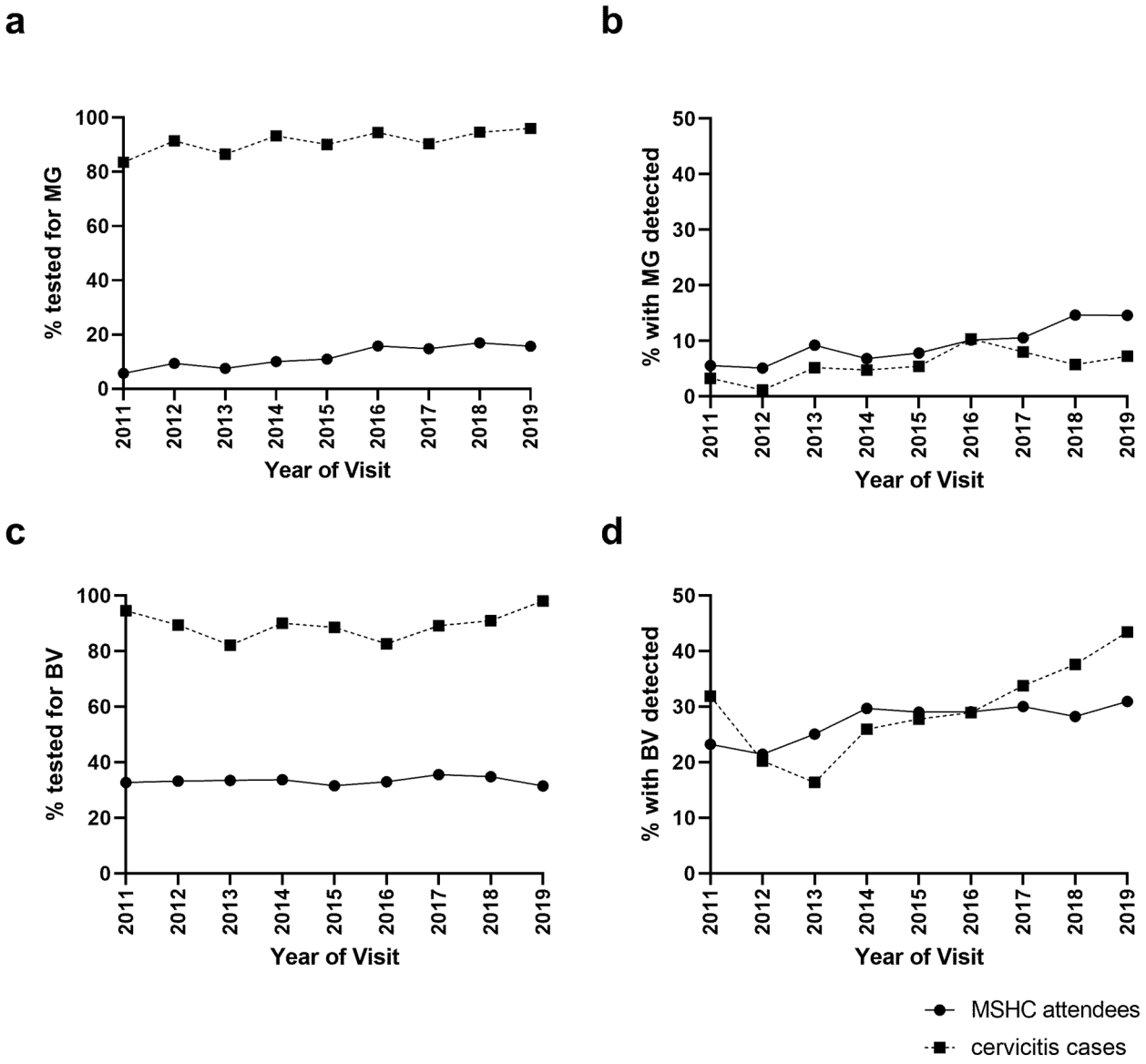

FIGURE 3
Mycoplasma genitalium (MG) and bacterial vaginosis (BV) testing and positivity among women with cervicitis and all women attending MSHC overtime. The proportion of cervicitis cases or all MSHC first-ever attendees who were **(a)** tested for *M. genitalium,* **(b)** had *M. genitalium* detected, **(c)** tested for BV or **(d)** had BV detected at MSHC between 2011 and 2019 was calculated.

BV positivity in cervicitis cases significantly increased from 32% in 2011 to 45% in 2019 ($P_{trend} < 0.001$).

Discussion

This retrospective study examined infections detected among women with cervicitis attending the largest public sexual health centre in Australia over a decade. This study was not designed to determine causality but to establish the proportion of cervicitis cases with *C. trachomatis*, *N. gonorrhoeae, M. genitalium* and/or BV, and to estimate how commonly *M. genitalium* and BV were detected among women with non-chlamydial, non-gonococcal cervicitis. As expected, a substantial proportion of cervicitis cases tested positive for *C. trachomatis*, with no significant change in the proportion of cases attributable to *C. trachomatis* over time. In contrast, *N. gonorrhoeae* was rarely detected among cervicitis cases. Collectively these two infections were only detected in 22% of cases tested for all four genital infections. In women with non-chlamydial non-gonococcal cervicitis, BV and *M. genitalium* were diagnosed in a third of cases, with BV the most common sole diagnosis made. Furthermore, despite no increase in testing, the number of BV diagnoses among cervicitis cases significantly increased throughout the study period. *M. genitalium* was the third most common infection found in cervicitis cases, and *M. genitalium* detection among cases and the clinic population both significantly increased over time

from 3%–7% to 6%–15%, respectively. Although these data cannot establish causation, this study supports recent findings on the association between both BV (and BV-associated bacteria) and *M. genitalium* in case-control studies and informs contemporary clinical practice.

There are a limited number of studies that investigate the relationship between BV/BV-associated bacteria and cervicitis (9–12, 27, 28). The most recent evidence is from a case-control study of 65 STI-negative cases with cervicitis and 128 STI-negative asymptomatic women attending for STI-screening at MSHC. Cases with STI-negative cervicitis were 5 times more likely to have BV than STI-negative asymptomatic controls and in vaginal microbiota analyses, there was an increased abundance of specific BV-associated bacteria in cases compared to controls (12). This evidence builds on prior studies showing an association between BV (and BV-associated bacteria) and cervicitis. One US study reported that 67/423 (15%) BV cases had cervicitis, and of these, most (87%) had no other pathogen detected (11). In a small Seattle cohort, of which 14/210 had cervicitis, the BV-associated species, *Mageeibacillus indolicus*, was significantly associated with cervicitis, although this finding was not replicated among the comparator Kenyan cohort (28). Among a Chinese cohort, using qPCR *Prevotella* was more abundant in BV-positive cervicitis cases vs. people without cervicitis or BV (27). Emerging evidence also suggests that BV-associated bacteria account for a significant proportion of PID cases. One large prospective study of 2,956 women found BV was associated with incident PID, after adjusting for concurrent STIs (29). Two recent reviews reported that <50% of women with PID had chlamydial or gonococcal infections, while *M. genitalium* and detection of BV/BV-associated bacteria (*Sneathia* spp., *Atopobium vaginae, Megasphaera* spp.) accounted for a substantial fraction of PID cases (30, 31). In support of this, the addition of metronidazole to empiric PID treatment improved clinical outcomes for people with PID (32). Furthermore, the addition of metronidazole to cervicitis treatment improved cervicitis resolution, and people with BV were more likely to experience resolution (10). Clearly, there is a need for prospective research to improve our understanding of causal relationships between BV or specific BV-associated bacteria and the genital syndromes of cervicitis and PID, although current evidence supports consideration of BV in diagnostic recommendations.

As the third most common infection detected, *M. genitalium* positivity among cervicitis cases was 6% overall and increased over time, although this may reflect increased testing. Throughout the study period two different PCR assays were used with similar sensitivity, but lower sensitivity than a transcription-mediated amplification (TMA) assay (33). As *M. genitalium* is often a low load infection it is possible that positivity may have been under-reported, but even based on an additional 25%–30% of infections being detected by TMA, this would not increase the overall proportion of cases to more than 8%. A recent study at our service showed *M. genitalium* to be associated with a four-fold increased odds of cervicitis (8), in line with other publications (7, 34). Importantly however, *M. genitalium* was often co-detected with other infections, especially BV. BV may enhance an individual's risk of *M. genitalium* infection (35), although the importance of co-infections to an individual's susceptibility to cervicitis remains unknown.

Over the study period, *C. trachomatis* remained a significant contributor to cervicitis; it was detected in 1 in 5 cervicitis cases, which is within the previously reported range (11%–50%) (1, 36, 37), but greater than a similar Sydney-based population (6%) (38). Although the number of attendees to MSHC increased over time, the proportion of cervicitis cases with *C. trachomatis* was stable. This finding may be explained by a relative decrease in the contribution of *C. trachomatis* to cervicitis in comparison to other emerging infections, which has also been reported in relation to PID (30, 31). The low prevalence of *N. gonorrhoeae* was expected and is in line with prevalence in urban Australian populations (39). It is possible that increased screening for chlamydia and gonorrhoea, and practices such as expedited treatment, have reduced the risk of women developing more severe symptoms/syndromes including cervicitis. It is important to note that in some populations, *N. gonorrhoeae* positivity is higher and may have a greater contribution to cervicitis, highlighting the need for contemporary local data to inform regional guidelines.

We detected at least one of the four bacterial infections in half of cervicitis cases, which aligns with previous studies (1, 11, 36). While it is possible that a small number of the cervicitis cases without an infection identified had *T. vaginalis* or HSV, our limited data supports their selective testing based on clinical indications for our population. However, guidelines should consider regional risk data as these infections have higher prevalence estimates in other populations. Recent PID studies have reported three broad groups of aetiological organisms; established STIs (*N. gonorrhoeae, C. trachomatis, M. genitalium, T. vaginalis*), BV-associated bacteria (*A. vaginae*, *Sneathia*, *Megasphaera*), and organisms usually associated with the gastrointestinal or respiratory tracts (i.e., *Bacteroides, Escherichia coli, Streptococcus, Haemophilus influenzae*) (31). While PID is a distinct syndrome involving endometrial and upper genital tract infection, cervical infection commonly precedes PID, and it is logical to conclude that the spectrum of organisms involved is similar. The recent microbiota studies of women with cervicitis (12) and PID (30, 31) provide insights into likely infectious aetiologies, and prospective studies using whole metagenome sequencing will provide deeper and broader knowledge of the spectrum of infectious causes of cervicitis.

This study was conducted at the largest public Australian sexual health centre and accessed comprehensive clinical and meta-data. As this retrospective audit was of symptomatic cervicitis cases, these findings may not be generalisable to asymptomatic cases. However, the clinical importance of asymptomatic cervicitis is not clear. Longitudinal prospective studies that include asymptomatic women are challenging but may be needed to further interrogate causality. Additionally, our findings may not apply to other sites with differing population prevalence of infections.

Conclusion

In this study, BV and/or *M. genitalium* were detected in a third of non-chlamydial and non-gonococcal cervicitis cases, and BV was often the sole diagnosis made. *M. genitalium* was detected as the sole infection in 3% of cervicitis cases, and two-thirds of all cases with *M. genitalum* were co-infected with another infection. How co-infections/polymicrobial infections contribute to cervicitis requires further investigation. These findings build on recent case-control studies showing an association between BV (and BV-associated bacteria) and cervicitis and *M. genitalium* and cervicitis. Though prospective studies are needed to inform causality, these are challenging to undertake and unlikely to be rapidly forthcoming, as they require substantial funding and time. In the meantime, although chlamydia and gonorrhoea account for <30% of infections in cervicitis, testing remains universally recommended by global guidelines. In contrast, despite published data supporting an association, recommendations for testing for *M. genitalium,* and particularly BV, are inconsistent and uncommon outside of specialist sexual health services, potentially leading to delays in appropriate treatment and persistence of infection. Given that >60% of cases of cervicitis are not caused by *C. trachomatis* or *N. gonorrhoeae* in the majority of studies it is time to consider assessing women for BV and *M. genitalium* on presentation with cervicitis, as current empiric treatment may be inadequate.

Data availability statement

The dataset presented in this article is not readily available because data cannot be made publicly available in order to protect patient privacy as per the approved ethics requirement. Requests to access a identified dataset should be directed to LV, lenka.vodstrcil@monash.edu.

Ethics statement

The studies involving humans were approved by Alfred Health Human Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

LV: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. EP: Data curation, Methodology, Validation, Visualization, Writing – review & editing. TN: Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. CF: Resources, Supervision, Writing – review & editing. EC: Data curation, Formal Analysis, Writing – review & editing. TP: Data curation, Writing – review & editing. CB: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frph.2025.1539186/full#supplementary-material

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