Rising Chlamydia and Gonorrhoea Incidence and Associated Risk Factors Among Female Sex Workers in Australia: A Retrospective Cohort Study

Denton Callander, PhD,† Hamish McManus, PhD,* Rebecca Guy, PhD,* Margaret Hellard, PhD,‡ Catherine C. O'Connor, DrPH,*§¶ Christopher K. Fairley, PhD,||** Eric P.F. Chow, PhD,||** Anna McNulty, MM,†† David A. Lewis, DA, PhD,‡‡§§ Christopher Carmody, MB, BS,¶¶ Heather-Marie A. Schmidt, PhD,|||| Jules Kim,*** and Basil Donovan, MD*††*

Background: Female sex workers in Australia have achieved some of the lowest documented prevalences of human immunodeficiency virus (HIV) and other sexually transmissible infections globally but rates overall are increasing in Australia and warrant closer investigation.

Methods: We constructed a retrospective cohort using repeat testing data extracted from a network of 42 sexual health clinics. Poisson and Cox regression were used to determined trends in incidence and risk factors for HIV, chlamydia, gonorrhoea, and infectious syphilis among female sex workers.

Results: From 2009 to 2015, 18,475 women reporting sex work attended a participating service. The overall incidence of urogenital chlamydia was 7.7/100 person years (PY), declining by 38% from 2009 to 2013 before increasing by 43% to 2015 ($P < 0.001$); anorectal chlamydia incidence was 0.6/100 PY, and pharyngeal was 1.9/100 PY, which increased significantly during the study period ($P < 0.001$, both). For gonorrhoea, the urogenital incidence was 1.4/100 PY, anorectal incidence was 0.3/100 PY, $P < 0.001$), and 3.6/100 PY for pharyngeal; urogenital incidence doubled during the study period, anorectal increased fivefold, and pharyngeal more than tripled ($P < 0.001$, all). Incidence of infectious syphilis was 0.4/100 PY, which remained stable from 2009 to 2015 ($P = 0.09$). There were seven incident infections of HIV among female sex workers (0.1/100 PY). Inconsistent condom use with private partners, higher number of private partner numbers, recent injecting drug use, younger age, and country of birth variously predicted sexually transmissible infections among female sex workers.

Conclusions: Although infectious syphilis and HIV remain uncommon in female sex workers attending Australian sexual health clinics, the increasing incidence of gonorrhoea across anatomical sites and increasing chlamydia after a period of decline demands enhanced health promotion initiatives.

From the *The Kirby Institute, †Centre for Social Research in Health, UNSW Australia, Sydney, NSW; ‡Burnet Institute, Melbourne, VIC; §RPA Sexual Health Clinic, Community Health, Sydney Local Health District; ¶Central Clinical School, University of Sydney, Sydney, NSW; ||Melbourne Sexual Health Centre, Alfred Health; **Central Clinical School, Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, VIC; ††Sydney Sexual Health Centre, Sydney Hospital, Sydney; ‡‡Western Sydney Sexual Health Centre, Parramatta; §§Marie Bashir Institute for Infectious Diseases and Biosecurity & Sydney Medical School-Westmead, University of Sydney, Sydney; ¶¶Liverpool Sexual Health Centre, Liverpool; ||||New South Wales Ministry of Health; and ***Scarlet Alliance, Australian Sex Worker Association, Sydney, NSW, Australia

Source of Funding: The ACCESS Project received funding the departments of health in New South Wales, Victoria, the Northern Territory and the Australian Capital Territory. Funding for sex worker health surveillance was provided by the *BBV & STI Research, Intervention and Strategic Evaluation Program* at UNSW Australia.

Conflicts of Interest: None declared.

Acknowledgements: The authors acknowledge the contribution of the ACCESS Sexual Health Clinic Network Steering Committee members not co-authors of this article (Andrew Grulich, John Kaldor, David Wilson, Marlene Kong and Lucy Watchirs Smith). The authors also acknowledge the work of Bridget and Simon Dickson (CaraData), Afrizal (Melbourne Sexual Health Centre) and Heng Lu (Sydney Sexual Health Centre) in preparing and managing the extraction of clinical data. Finally, the authors acknowledge all clinics participating in ACCESS, including the site investigators who contributed data to this analysis: Eva Jackson, Darren Russell, Emanuel Vhalkis, Manoji Gunathilake, Alison Nikitas, Lewis Marshall, Maree O'Sullivan, Debbie Allen, Nathan Ryder, Katherine Brown, David Smith, Yoges Paramsothy, Cheryn Palmer, Stephen Davies, Arun Menon and Angela Parker.

Correspondence: Denton Callander, PhD, Wallace Wurth Building, UNSW Australia, Sydney NSW, 2052, Australia. E-mail: d.callander@unsw.edu.au.

Received for publication April 26, 2017, and accepted August 20, 2017.

DOI: 10.1097/OLQ.0000000000000714

In many parts of the world, female sex workers are at increased risk of human immunodeficiency virus (HIV) and other sexually transmissible infections (STIs). A review of HIV prevalence in low- and medium-income countries reported the rate of infection to be over 13 times that among nonsex worker women of reproductive age.[1] Although some previous research has identified a number of factors associated with increased infection risk among female sex workers, such as pressure from clients to forgo condoms[2] and multiple private (ie, noncommercial) partners,[3] the risks to sexual health faced by sex workers are also influenced by experiences of violence, the stigma and discrimination they face, and the legal and policy environments in which they operate.[4] Indeed, research has consistently linked the criminalization of sex work to poorer health outcomes.[5,6]

In 2012, the *Global Network of Sex Work Projects* partnered with the *World Health Organisation* to recommend global decriminalisation, condom use, and improved service access as keys to managing and preventing HIV and other STIs.[7] In Australia, tailored service delivery, partnerships between affected communities, research and government, and evidence-based treatment and prevention policy have helped achieve what are some of the lowest HIV and infection rates among female sex workers globally.[8] It is, therefore, of concern that recent reports in Australia suggest increasing STI diagnoses among female sex workers.[9,10] It is important to investigate such observations closely and make recommendations for public health responses. Using data from a national surveillance network of sexual health clinics in Australia, we undertook a retrospective cohort analysis of HIV and STI incidence among female sex workers, with a focus on determining trends and risk factors.

MATERIALS AND METHODS

Study Design

Using routine consultation data from Australian sexual health clinics, we constructed a retrospective cohort of female sex workers from January 1, 2009, to December 31, 2015.

Setting

Data were collected from 42 publicly funded sexual health clinics in urban, regional, and remote locations participating in the *Australian Collaboration for Coordinated Enhanced Sentinel Surveillance of Sexually Transmissible Infections and Blood Borne Viruses (*ACCESS).[11] Clinics were located in New South Wales, Victoria, Queensland, Western Australia, Queensland, and the Northern Territory and were based in major cities (38%), regional areas (55%), and remote parts of the country (7%). Many of these clinics used triage protocols to target sex workers, other priority populations, and those with STI-related symptoms. Several clinics also operated outreach targeting sex work populations, such as those that work in brothels. Care and treatment at these clinics was provided free of charge; patients were not required to have either public or private medical insurance nor produce any identifying documents.

Sexual health diagnostic testing at participating clinics involved testing for *Chlamydia trachomatis* (chlamydia) and *Neisseria gonorrhoeae* (gonorrhoea) via nucleic acid amplification tests (NAATs). Although the majority of laboratories serving participating clinics transitioned from culture-based testing to NAATs before the study period, it was introduced for 12 of the 42 clinics at various points from 2009 and 2015. *Treponema pallidum* (syphilis) was assessed with an initial test for antibodies (via enzyme immunoassay or immunoglobin G test) and, as necessary, subsequent rapid plasma reagin tests, whereas HIV (for individuals not known to be positive) was assessed using fourth-generation antibody/antigen tests and confirmed by Western blots.

Among female sex workers, Australian clinical guidelines recommend a vaginal swab for chlamydia and gonorrhoea, a rectal swab for chlamydia and gonorrhoea if anal sex was reported, a pharyngeal swab for gonorrhoea if oral sex was reported, and serology for syphilis and HIV as well as hepatitis B among those not previously vaccinated.[12] These guidelines recommend regular, asymptomatic screening for female sex workers, which is mandated by law in Victoria, Queensland, and the Australian Capital Territory.

Participating clinics routinely collected behavioral details associated with infection risk for the 12-month period before a consultation. Information collected included location of sex work, number of private sexual partners, condom use for vaginal or anal sex with private and paid partners, and injecting drug use. Although practices for collecting sex work details varied both between and within participating sites, patients were typically asked if they had sold sex in the previous 12 months.

Data Sources and Variables

Using customised extraction scripts, data from participating clinics were retrospectively extracted annually and compiled into a centralized database. The following details were extracted per patient consult: date, clinic, patient age, home postcode, gender, indigenous status, country of birth, HIV status, pathology requests and results, and clinical diagnoses. Behavioral information on recent sex work, private sexual partner numbers, condom use with private partners, and injecting drug use were also extracted. Although details on condom use with paid partners and number of sex work clients per week were extracted also, this information was recorded for only a very small number of participants. No identifying details were extracted with patients identified used an anonymous numerical code. Although it is possible that some patients could have used an alias (a potential issue for sex workers in particular[13]), as long as an alias was consistent, it was possible to identify patients over time.

Cohort Participants

Sex workers were identified on the basis of being recorded as having engaged in sex work in the 12 months before a consultation or if they attended for a specialized sex worker consultation. Patients were categorized as a sex worker for the 12 months before a consultation or until more recent behavioral information identified them as no longer involved with sex work. If, however, a patient reported sex work again at a later visit, they were returned to the cohort. In this way, patients could move in and out of the cohort over time. Female sex workers were included in our cohort if they attended a participating service during the study period, were identified as female, were 16 years or older, and had more than 1 test in the study period. Patients were excluded from our analysis if they had only 1 visit during the study period or if information on sex work was missing from their record.

Statistical Methods

The overall and annual incidences of chlamydia, gonorrhoea, infectious syphilis, and HIV were calculated using repeat testing methods.[14] Incident infections of chlamydia, gonorrhoea, and HIV were identified as those for which a negative test was followed by a positive test, whereas incident infectious syphilis was identified as a negative test followed by a recorded clinical diagnosis of primary, secondary, or early latent (<2 years) syphilis, per Australia's national case definition.[15] The date of infection was estimated to be the midpoint between a positive test or clinical diagnosis and the most recent negative result. Time at risk was defined as the cumulative time between each patient's first negative test and last test (negative or positive) or clinical diagnosis during the observation period, which was extended into 2008 and 2016 to avoid underestimating time at risk on either end of the study period. Figure 1 outlines our methods of assessing time at risk among clinic attendees including key exclusion criteria. Given the time needed for treatment and that it takes between 3 and 4 weeks for bacterial clearance of chlamydia posttreatment,[16] patients were not considered at risk for 1 month after identifying STI other than HIV. For HIV, time at risk ceased at the first positive result; HIV incidence calculations excluded those already known to be HIV positive.

The incidence rate was calculated per 100 person years (PY) of risk assuming a Poisson distribution of infection numbers per person per period to account for multiple potential infections. Rates were calculated overall and by year; annual trends were quantified using Poisson regression analyses with year fit as an independent continuous variable. Because this method for calculating incidence relied on repeat testing, we also calculated the mean number of tests per patient per calendar year and included that variable in the Poisson analyses to control for the potential for testing patterns to impact incidence trends. Mean was used over median because it is more sensitive to changes in testing patterns. Patients were considered loss-to-follow-up if the time until the next test event exceeded 15 months, which excluded patients who tested less frequently (eg, once every 2 years) but was deemed an appropriate limit for this population given the previously reported high frequency of HIV and STI testing among male and female sex workers in Australia.[10]

We assessed the association between risk factor variables and each STI (at any anatomical site) among female sex workers

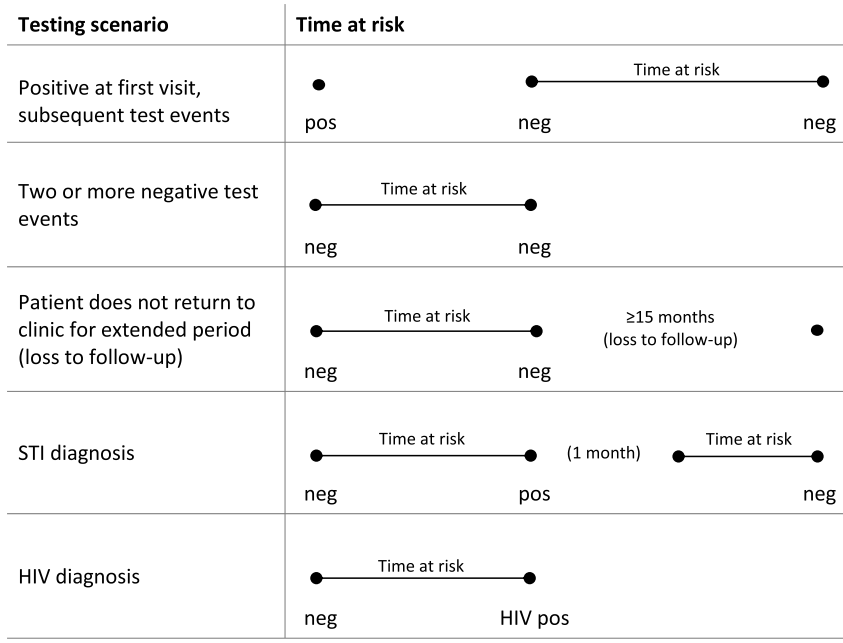

Figure 1. Testing scenarios and time at risk for calculating the incidence of HIV and other STIs via repeat diagnostic testing.

using multivariate Cox proportional hazards models. The following demographic and behavioral variables were used to stratify incidence rates and included in models based on previously identified associations in Australian surveillance data[9]: age (split at the median value for female sex workers: <29 vs ≥29 years old), indigenous status (Indigenous Australians vs non-Indigenous), home neighborhood (urban vs nonurban),[17] reported STI symptoms or contact (yes/no), and in the 12 months before a consultation: number of private sexual partners (split at the median for female sex workers: <2 vs ≥2 partners), condom use for vaginal and/or anal sex with private partners (always vs sometimes/never), and the use of injecting drugs (yes/no). Models were stratified by clinic to account for potential violation of the proportional hazards assumption.

We assessed temporal changes in demographic and behavioral characteristics using nonparametric tests for trend. To account for the impact of NAATs on changing incidence, trend analyses for chlamydia and gonorrhoea incidence were also conducted just among the subsample of clinics for which they were used during the entirety of the study period. Stata Version 14 was used for all analyses.[18]

Ethical Review and Oversight

St Vincent's Hospital provided lead ethical oversight for the ACCESS project (08/51). Ethical reviews were also conducted by the AIDS Council of New South Wales and the Victorian AIDS Council, which represented the interests of sex workers.

RESULTS

From 2009 to 2015, a total of 130,377 female patients attended participating clinics; our sample consisted of the 18,475 (14%) women who reported sex work at least once during that period. Demographic, clinical, and behavioral characteristics of our sample are outlined in Table 1. Most of the female sex workers in our sample were born overseas, a proportion that increased slightly over time (51% in 2009 to 53% in 2015, $P < 0.001$). Most participants (90%) lived in an urban area. Compared with the women who attended these services but did not report sex work, our sample was slightly older, more likely to be born overseas, and more likely to live in an urban area. This cohort, however, was demographically similar to previous samples of female sex workers in Australia.[19,20]

The proportion of female sex workers reporting 2 or more private sexual partners increased from 37% in 2009 to 47% in

TABLE 1. Characteristics of Female Sex Worker Patients at Their First Consultation in an Australian Sexual Health Clinic (n = 18,475), 2009–2015

	Sex Workers*
Demographic characteristics	
Age range	16–91 y
Median age (interquartile range)	29 y (24–37 y)
Country/region of birth	
Australia or New Zealand	8771 (48%)
Asia	7397 (40%)
Africa	206 (1%)
Oceania	77 (<1%)
North or South America	545 (3%)
Europe	1479 (8%)
Lives in an urban neighbourhood	15,406 (90%)
Indigenous Australian	363 (2%)
Clinical factors	
Symptomatic presentation	6277 (34%)
STI diagnosis in previous 2 y	2876 (16%)
Known HIV infection	150 (0.8%)
Behavioral risk factors[†]	
Injecting drug use	846 (5%)
≥2 private sexual partners[‡]	5563 (46%)
Inconsistent condom use (private partners)[§]	4484 (80%)

*Women who reported sex work at least once during the study period.

[†]In the 12 months before each patient's first consultation during the study period.

[‡]Private partner numbers collected for 12,027 (65%) of participants at their first visit.

[§]Self-reported condom use for vaginal or anal sex; consistent defined as "always" using a condom; condom use details collected for 5618 (30%) of participants at their first visit.

TABLE 2. Overall Incidence Rates (per 100 PY) of Chlamydia, Gonorrhoea and Infectious Syphilis Among Female Sex Workers Attending Australian Sexual Health Clinic, 2009–2015

	Chlamydia				Gonorrhoea				
	Any Anatomical Site	Urogenital	Anorectal	Pharyngeal	Any Anatomical Site	Urogenital	Anorectal	Pharyngeal	Infectious Syphilis
Injecting drug use *·									
No	9.8 (9.4–10.2)	7.7 (7.4–8.1)	0.5 (0.3–0.7)	1.9 (1.7–2.3)	4.4 (4.1–4.8)	1.3 (1.2–1.5)	0.3 (0.2–0.5)	3.6 (3.2–4.0)	0.4 (0.3–0.5)
Yes	8.0 (6.2–10.2)	5.9 (4.4–7.9)	10.2 (3.8–27.1)	—	6.7 (4.4–10.2)	2.1 (1.3–3.3)	2.6 (0.4–18.3)	4.6 (2.4–8.8)	1.6 (0.8–3.2)
Private sexual partners* ·									
<2 partners	6.8 (6.3–7.4)	5.8 (5.3–6.3)	0.2 (0.1–0.5)	1.2 (0.9–1.5)	4.3 (3.8–4.9)	1.0 (0.8–1.2)	0.1 (0.0–0.3)	3.5 (3.0–4.0)	0.3 (0.2–0.5)
≥2 partners	13.0 (12.1–14.0)	10.7 (9.9–11.6)	0.8 (0.4–1.4)	2.6 (2.0–3.3)	4.5 (3.8–5.3)	1.4 (1.1–1.8)	0.5 (0.2–1.0)	3.8 (3.0–4.7)	0.7 (0.5–1.0)
Condom use *†·									
Always	8.4 (6.9–10.3)	7.0 (5.7–8.8)	0.4 (0.1–1.3)		3.5 (2.5–4.8)	1.0 (0.6–1.8)	—		—
Sometimes/never	14.7 (13.6–15.8)	12.8 (11.8–13.9)	0.1 (0.1–0.3)		5.1 (4.5–5.9)	2.1 (1.7–2.5)	0.2 (0.1–0.4)		0.8 (0.6–1.2)
Symptoms or contact									
No	9.1 (8.6–9.6)	7.2 (6.8–7.7)	0.6 (0.4–1.0)	2.1 (1.7–2.4)	4.0 (3.6–4.5)	1.1 (1.0–1.3)	0.3 (0.1–0.5)	3.4 (3.0–3.9)	0.5 (0.3–0.6)
Yes	11.1 (10.4–12.0)	8.7 (8.0–9.5)	0.5 (0.3–0.9)	1.5 (1.1–2.0)	5.6 (4.9–6.4)	1.9 (1.6–2.2)	0.5 (0.3–0.9)	4.3 (3.6–5.2)	0.4 (0.2–0.6)
Age									
≥29 y	7.1 (6.7–7.6)	5.4 (5.0–5.8)	0.4 (0.2–0.7)	1.6 (1.3–2.0)	4.4 (4.0–4.9)	1.3 (1.1–1.5)	0.3 (0.2–0.6)	3.5 (3.1–4.0)	0.4 (0.3–0.5)
<29 y	13.8 (13.0–14.6)	11.3 (10.6–12.0)	0.9 (0.6–1.4)	2.4 (1.9–3.0)	4.6 (4.0–5.3)	1.5 (1.2–1.8)	0.4 (0.2–0.7)	3.8 (3.2–4.6)	0.5 (0.4–0.8)
Indigenous status									
Nonindigenous	9.6 (9.2–10.1)	7.6 (7.3–8.0)	0.6 (0.4–0.8)	1.9 (1.6–2.2)	2.7 (0.9–8.3)	1.4 (1.2–1.5)	0.3 (0.2–0.5)	3.6 (3.2–4.0)	0.4 (0.3–0.5)
Indigenous	17.7 (13.1–23.8)	10.6 (7.2–15.5)	13.4 (1.3–94.9)	2.1 (0.3–15.1)	4.5 (4.2–4.9)	0.4 (0.1–3.0)	12.7 (1.8–89.9)	6.2 (2.0–19.3)	1.2 (0.3–4.7)
Home neighborhood									
Nonurban	10.2 (8.8–11.8)	7.0 (5.8–8.3)	4.3 (1.6–11.5)	2.2 (1.1–4.2)	1.7 (1.0–3.1)	0.4 (0.2–0.8)	—	1.7 (0.8–3.6)	—
Urban	9.9 (9.5–10.4)	7.9 (7.5–8.3)	0.5 (0.3–0.7)	2.0 (1.7–2.3)	4.7 (4.3–5.1)	1.5 (1.3–1.7)	0.4 (0.2–0.6)	3.8 (3.4–4.3)	0.5 (0.4–0.6)
Country of birth									
Australia/New Zealand	9.2 (8.6–9.8)	6.7 (6.2–7.2)	0.1 (0.1–0.3)	1.3 (1.0–1.9)	4.8 (4.4–5.3)	1.2 (1.0–1.4)	0.1 (0.0–0.2)	2.8 (2.2–3.5)	0.4 (0.3–0.6)
Other	10.2 (9.7–10.8)	8.5 (8.0–9.0)	3.4 (2.3–5.1)	2.2 (1.8–2.5)	3.9 (3.3–4.5)	1.5 (1.3–1.7)	2.0 (1.2–3.4)	4.0 (3.5–4.6)	0.5 (0.3–0.6)

* Behavioral variable relate to the 12 months before a consultation.

† Condom use pertains to private (ie, nonpaying) partners and vaginal or anal sex only and was, therefore, excluded from analyses of pharyngeal infection.

2015 ($P < 0.001$), whereas those reporting at least 1 episode of not using a condom during anal or vaginal sex with private partners decreased from 84% to 80% ($P = 0.004$). During the study period, the proportion of female sex workers who reported injecting drug use in the past year decreased slightly, from 6% in 2009 to 4% in 2015 ($P < 0.001$).

Testing for HIV and Other STIs

Overall, 54% of sex workers had 2 or more tests for urogenital chlamydia with 96% of the attendees in 2009 tested and 98% of the 2015 attendees tested ($P < 0.001$). The average number of urogenital tests per person per year decreased slightly from 2.2 per person in 2009 to 1.8 in 2015 ($P < 0.001$). Fifteen percent of our sample were tested 2 or more times for anorectal infections; 26% of the attendees in 2009 and 31% in 2015 were tested ($P < 0.001$), and test frequency increased slightly from an average of 0.4 tests per person in 2009 to 0.5 in 2015 ($P < 0.001$). Regarding pharyngeal tests, 26% of female sex workers had at least 2 tests during the study period with uptake increasing from 38% of attendees in 2009 to 47% in 2015 ($P < 0.001$). The average number of pharyngeal tests rose slightly from 0.6 to 0.7 during that period ($P < 0.001$).

For syphilis and HIV, 38% of our sample were tested 2 or more times during the study period and uptake increased from 77% of sex workers tested in 2009 to 86% tested in 2015 ($P < 0.001$). Syphilis test frequency also increased during that period from an average of 1.0 tests per person in 2009 to 1.2 in 2015 ($P < 0.001$).

Chlamydia Incidence

Table 2 details the overall incidence rates stratified by demographic and behavioral factors. Overall, there were 2053 incident cases of chlamydia (at any anatomical site) over 21,113 years of follow-up among female sex workers (9.7/100 PY; 95% confidence interval [CI], 9.3–10.2). As described, multiple chlamydia diagnoses at a visit were collapsed into a single case but we looked also at multisite infections. Of cases of incident chlamydia, 4.3% involved multisite infections, which increased from zero such cases in 2009 to 1% in 2010 and 10% in 2015 ($P < 0.001$). By far, the most common coinfection was chlamydia of the urethra and pharynx, accounting for 78% of all coinfections.

The overall incidence rate for urogenital chlamydia was 7.7/100 PY (95% CI, 7.3–8.1), which decreased from 9.6/100 PY in 2009 to 6.0/100 PY in 2013 ($P < 0.001$) and then increased to 8.6/100 PY in 2015 ($P < 0.001$). In a subanalysis of just those clinics for whom NAAT testing was available during the entire study period, the same pattern of chlamydia incidence was observed ($P < 0.001$, both). The overall incident rate for anorectal chlamydia was 0.6/100 PY (95% CI, 0.4–0.8), which annually increased from no incident infections in 2009 to 0.3/100 PY in 2010 to 1.3/100 PY in 2015 ($P < 0.001$). The overall rate of infection for pharyngeal chlamydia was 1.9/100 PY (95% CI, 1.6–2.2), which

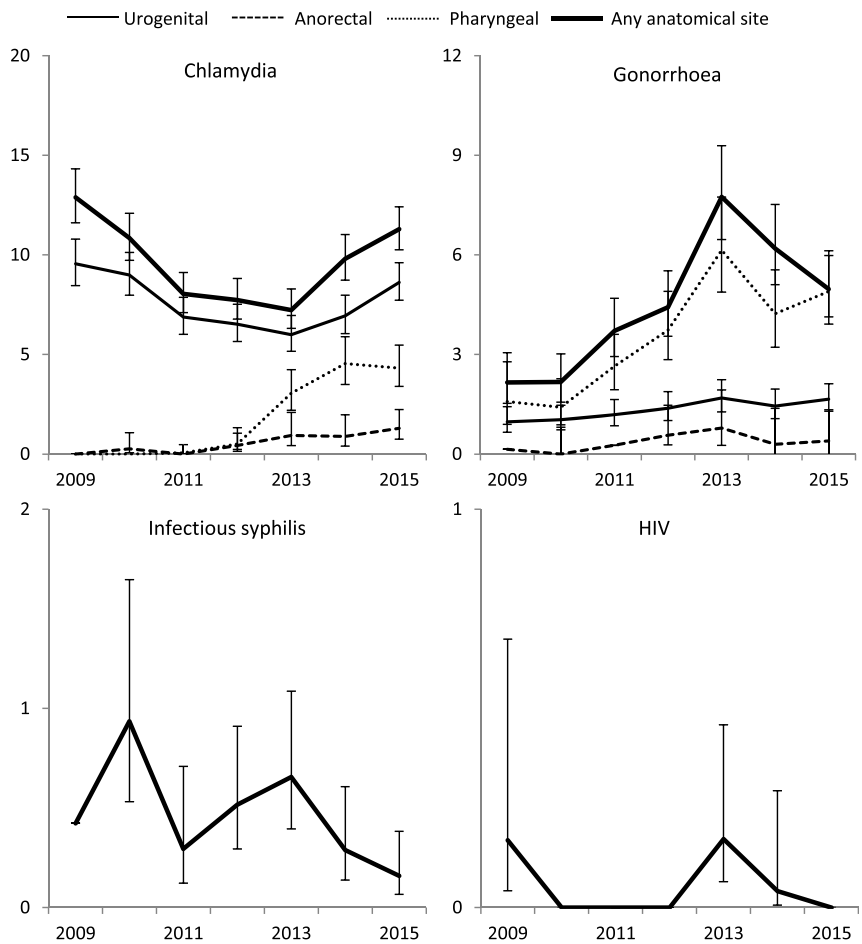

Figure 2. Incidence (per 100 PY) of HIV and other STIs among female sex workers attending Australian sexual health clinics, 2009–2015.

increased from zero in 2009 or 2010 to 0.1/100 PY in 2011 and 4.3/100 PY in 2015 ($P < 0.001$). These changes were evident even after accounting for trends in testing. Annual incidence rates by anatomical site are depicted in Figure 2.

After controlling for symptomatic patients and those with reported STI contact, among female sex workers, the following factors were independently associated with increased risk of chlamydia at any anatomical site: having two or more private sexual partners, using condoms inconsistently with private partners, being younger, and being born in a country other than Australia or New Zealand. Table 3 details the results of the univariate and multivariate analyses.

Gonorrhoea Incidence

Across all anatomical sites, there were 951 incident infections of gonorrhoea over 21,113 years of follow-up, an incident rate of 4.5/100 PY (95% CI, 4.1–4.9). Of these, 14% were multisite infections, which increased from 13% of incident cases in 2009 to 31% in 2015 ($P < 0.001$). In total, 84% of gonorrhoea coinfections were of the urethra and pharynx.

For urogenital infections, the overall incident rate was 1.4/100 PY (95% CI, 1.2–1.5), which after controlling for test frequency remained stable over time at 1.0/100 PY in 2009 and 1.7/100 PY in 2015 ($P = 0.1$). In our analysis of those clinics for whom NAAT testing was available during the entire study period, gonorrhoea incidence increased during the study period ($P < 0.001$). There were 18 incident infections of rectal gonorrhoea detected over 5210 years of follow-up (0.3/100 PY, 95% CI, 0.2–0.6), which when controlling for test frequency increased from 0.2/100 PY in 2009 and 0.4/100 PY in 2015 ($P = 0.03$). Overall, there were 321 incidents of pharyngeal gonorrhoea among female sex workers over 8847 years, an incident rate of 3.6/100 PY (95% CI, 3.3–4.1). From 2009 to 2015, the incidence of pharyngeal gonorrhoea increased from 1.6/100 to 4.9/100 PY ($P < 0.001$) even after accounting for increased testing frequency. Annual incidence of gonorrhoea overall and by anatomical site is shown in Figure 2. In the multivariate analysis, when controlling for symptomatic presentation and those with reported STI contact, recent injecting drug use, and being born in Australia or New Zealand were associated with an increased risk of gonorrhoea among female sex workers (Table 3).

Chlamydia and Gonorrhoea Co-infection

The incidence of chlamydia and gonorrhoea coinfection at any anatomical site was 0.2/100 PY overall (95% CI, 0.1–0.3), representing 2% of all incident infections of either chlamydia or gonorrhoea. Over time, coinfection incidence increased slightly from 0.1/100 PY in 2009 to 0.2/100 PY in 2015 ($P = 0.04$).

Infectious Syphilis and HIV Incidence

Table 2 details the overall incidence of infectious syphilis, stratified by demographic and behavioral factors. The incidence rate of infectious syphilis among female sex workers was 0.4/100 PY (95% CI, 0.3–0.6), representing 61 infections over 14,328 years. After accounting for testing patterns, the incidence of infectious syphilis was stable over time (0.4/100 PY in 2009 and 0.1/100 PY in 2015, $P = 0.09$; Fig. 2). In the multivariate analysis, when controlling for symptomatic presentation and those with reported STI

TABLE 3. Univariate and Multivariate (Cox regression) Analyses of Factors Associated With Incident Infections of Chlamydia, Gonorrhoea, and Infectious Syphilis, 2009–2015

	Any Anatomical Site		
Variable (Reference Group)	**Chlamydia**	**Gonorrhoea**	**Infectious Syphilis**
Injecting drug use [no injecting drug use]*.			
Unadjusted HR (95% CI)	0.8 (0.6–1.0)	1.3 (0.9–1.8)	4.0 (1.9–8.3)
Adjusted HR (95% CI)	0.5 (0.2–1.3)	3.4 (1.2–8.0)†	10.2 (4.1–25.7)‡
≥2 private sexual partners (<2 partners)*.			
Unadjusted HR (95% CI)	1.9 (1.7–2.1)‡	1.0 (0.9–1.3)	2.6 (1.4–4.9)†
Adjusted HR (95% CI)	1.9 (1.6–2.2)‡	1.2 (0.9–1.5)	2.2 (1.1–4.4)†
Sometimes/never used condoms (always)*§.			
Unadjusted HR (95% CI)	1.7 (1.4–2.2)‡	1.4 (1.0–2.0)	¶
Adjusted HR (95% CI)	2.0 (1.5–2.5)‡	1.4 (1.0–2.0)	¶.
Symptomatic or contact (no symptoms/contact)			
Unadjusted HR (95% CI)	1.3 (1.1–1.4)‡	1.4 (1.2–1.6)‡	0.8 (0.4–1.3)
Adjusted HR (95% CI)	0.9 (0.8–1.1)	1.3 (1.0–1.6)†	0.4 (0.2–0.9)†
<29 y (≥29 y)			
Unadjusted HR (95% CI)	1.9 (1.8–2.1)‡	1.1 (0.9–1.3)	1.4 (0.9–2.4)
Adjusted HR (95% CI)	1.4 (1.2–1.7)‡	1.0 (0.8–1.3)	1.3 (0.7–2.4)
Indigenous (nonindigenous)			
Unadjusted HR (95% CI)	1.8 (1.3–2.4)‡	1.2 (0.6–2.4)	2.9 (0.7–11.6)
Adjusted HR (95% CI)	2.3 (0.8–6.7)	<0.1 (0.0–0.1)	<0.1 (0.0–0.1)
Nonurban neighbourhood (urban)			
Unadjusted HR (95% CI)	1.0 (0.8–1.1)	3.4 (2.1–5.7)‡	¶.
Adjusted HR (95% CI)	0.8 (0.5–1.4)	1.0 (0.3–3.2)	¶.
Born in Australia (born overseas)			
Unadjusted HR (95% CI)	1.1 (1.0–1.2)†	1.5 (1.2–1.7)‡	1.1 (0.7–1.9)
Adjusted HR (95% CI)	1.6 (1.3–2.0)‡	1.3 (0.8–1.7)	2.2 (1.0–4.8)†

*Behavioral variables relate to the 12 months before a consultation.
† $P < 0.05$.
‡ $P < 0.001$.
§ Condom use pertains to anal and/or vaginal sex with private (ie, nonpaying) partners.
¶ No reference group; excluded from multivariate analysis.
HR, hazard ratio.

contact, recent injecting drug use, having 2 or more private partners, and being born in Australia or New Zealand were associated with increased risk of incident infectious syphilis (Table 3).

From 2009 to 2015, there were 7 incident infections of HIV among female sex workers over 14,408 years, and incident rate of 0.1/100 PY (95% CI, 0.0–0.1). Because of the small number of infections overall, we did not conduct further stratifications, time trend, or multivariate analyses.

DISCUSSION

The incidence of chlamydia and gonorrhoea has increased over time among female sex workers attending Australian sexual health clinics, whereas infectious syphilis and HIV remain uncommon. A range of demographic and behavioral factors were associated with incident infections among sex workers, including inconsistent condom use with private partner, higher private partner numbers, country of birth, younger age, and use of injecting drugs.

The rates of HIV and STIs among female sex workers attending sexual health clinics in Australia were comparable to earlier estimates for female sex workers in Australia[3] and other parts of the world including the United Kingdom,[21] and China[22] (although chlamydia and gonorrhoea were less common than in another Chinese study[23]). Compared with a study from 2011, chlamydia incidence among female sex workers in our sample was slightly higher than nonsex working women in Australia.[24] Our findings also affirm that HIV among female sex workers in Australia is among the lowest anywhere in the world.[25]

During the study period, anorectal chlamydia increased by 382%, urogenital gonorrhoea increased by 71%, and anorectal gonorrhoea increased by 171%. Large relative increases were observed also for infections of the pharynx, which for chlamydia rose from no infection in 2009 to an incidence rate of 4.1/100 PY in 2015 and for gonorrhoea increased by over 200%. Notably, these increases remained relevant even after accounting for testing patterns. The increase in pharyngeal infection incidence likely reflects a decline in condom use during oral sex with paid partners among female sex workers noted in previous research.[26] The transference of pharyngeal infections to other anatomical sites via private partner(s) could partially explain the overall increase in gonorrhoea observed among sex workers and the increase in chlamydia from 2013 to 2015 after a period of decline, especially alongside what other research has reported as high rates of condom use for commercial encounters of vaginal and anal sex.[8,20] Further, we observed a reasonable amount of pharyngeal and urogenital coinfection for both chlamydia and gonorrhoea. It is also worth noting the slight increase in private partner numbers over time among female sex workers in our sample, which could have played a part in the rising incidence of these infections. Although some behavioral data on risk was collected by clinics, the changing epidemiology of these infections requires more detailed behavioral research to be undertaken, particularly on sexual practices with paid partners.

Consistent with previous epidemiological research, risk factors for incident chlamydia among female sex workers included being younger,[9] having more private partners,[3] and being born overseas.[27] Chlamydia is the most prolific STI among women in Australia, and these risks are the same as those relevant to all women (sex working or otherwise). Gonorrhoea and infectious syphilis, however, are not common among women and have largely been concentrated among gay and bisexual men and in remote Australian communities.[9] For female sex workers, injecting drug use was a predictor of both of these infections even though it is not a possible infection route for gonorrhoea. Research has previously linked injecting and other drug use to an increased risk of STIs among sex workers,[28] and it could be that it is a proximal marker for sexual networks or particular practices among the minority of women in our sample reporting this behavior. Given that sex work and drug use can intersect and overlap through client requests, drug addiction, and other factors[29] a more detailed understanding of this issue and how it relates to sex work and infection risk in Australia is warranted.

There are some inherent limitations in using clinical data to calculate incidence. First, our method of calculating incidence relied on repeat testing among individuals, which may introduce a bias by excluding those who test only once or test infrequently. This may be less relevant among sex workers because previous studies have found very high rates of testing uptake and frequency among female sex workers in Australia.[10,20] Second, clinical samples may not be representative of the general population. Again, this may be less of an issue for female sex workers because previous surveys have found that the majority attend these publicly funded clinics for their sexual health needs.[20] Third, the use of clinical data also meant that any analysis was limited to what was available in each clinic's database and could not, therefore, account for some potentially relevant details, such as condom use with and numbers of paying partners. Finally, it is possible that some chlamydia and gonorrhoea infections cleared spontaneously before they were identified[30,31] but given our loss-to-follow-up period and that the average time between tests among our sample was less than a year, the number of infections missed was likely modest.

This study reveals a changing epidemiology of chlamydia and gonorrhoea among female sex workers. Although Australia has demonstrative successes in maintaining the sexual health of sex workers, in light of the rising transmission of chlamydia and gonorrhoea, efforts to maintain these successes must be reviewed, reinforced, and renewed. The promotion of pharyngeal testing to both clinicians and sex workers is needed. Further, education efforts should also focus on alerting sex workers to the potential of infection transference between anatomical sites, including the need for a new condom when moving between anal, vaginal, and oral sex.

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