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Original article

Gonococcal infections and risk factors for reinfection: a descriptive and case-case analysis of notifications in the Australian Capital Territory, 2017–2022

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Abstract

Background

In Australia, gonococcal infection notification rates are increasing with reinfections representing a substantial proportion of infections. Understanding the local epidemiology of gonococcal infections and reinfections and the risk factors for reinfection can assist with the design of targeted interventions. This study aimed to describe the epidemiology of gonococcal infections and reinfections between 2017 and 2022 in the Australian Capital Territory (ACT), and examine the risk factors for reinfection.

Methods

Data for gonococcal infections notified in the ACT between 2017 and 2022 were described. The epidemiological characteristics of individuals with a single infection and reinfection were compared using a case-case study design.

Results

There were 1,886 gonococcal infection notifications during the study period. Of these, 20.4% were reinfections (n = 385). Of 1,501 individuals, 1,254 (83.5%) had a single infection and 247 (16.5%) had a reinfection. Between 2017 and 2022, the annual gonococcal infection notification rate per 100,000 population increased from 59.98 to 80.14 and the proportion of reinfections from 4.0% to 26.8%. Compared with those with a single infection, individuals with a reinfection had significantly greater odds of being male, having a same-sex sexual exposure, using HIV pre-exposure prophylaxis at diagnosis, and having been diagnosed at a sexual health/family planning clinic. Individuals with a reinfection had significantly greater odds of being in the 25–34, 35–44 and 45–54 years age groups than the 14–24 years age group. The odds of anatomical site of first infection being only the rectum, only the throat, or at more than one site, compared with urogenital only, were significantly greater for those with a reinfection.

Conclusion

Gonococcal reinfections contribute substantially to gonococcal infection notifications in the ACT. Targeted interventions are needed to prevent gonococcal reinfections among at-risk groups, particularly men who have sex with men, people who use HIV pre-exposure prophylaxis, and individuals accessing sexual health/family planning services.

Keywords: sexually transmissible infection; gonococcal infection; reinfection; risk factor; notifications; Australian Capital Territory

Introduction

Worldwide, there were an estimated 82.3 million new gonococcal infections diagnosed among people aged 15–49 years during 2020, making it the second most commonly diagnosed bacterial sexually transmissible infection (STI).[1] Reducing transmission remains a global public health priority, owing to the emergence of antimicrobial-resistant lineages limiting effective treatment options.[1,2] Untreated, gonococcal infections can lead to adverse reproductive and perinatal outcomes and to enhanced transmission of human immunodeficiency virus (HIV).[1,3,4,5,6]

In Australia, laboratory-confirmed gonococcal infections are nationally notifiable.[7,8] Notification rates have risen over the past decade, peaking at 141.4 per 100,000 population per year in 2019 before declining to 109.4 in 2021 during the coronavirus disease 2019 (COVID-19) pandemic.[9] In the Australian Capital Territory (ACT), notification rates have followed a similar pattern to those in other Australian states and territories, increasing from 22.0 to 66.9 per 100,000 population per year from 2012 to 2021.[10] People aged 15–29 years; Aboriginal and/or Torres Strait Islander people; gay, bisexual, and other men who have sex with men (GBMSM); and sex workers are among priority populations who may be disproportionately affected.[11]

Testing is recommended for symptomatic and exposed body sites.[12] Three-monthly asymptomatic testing is recommended at all three sites (oropharyngeal, anorectal, and first pass urine) for men who have engaged in any type of sex with another man in the past three months.[12] Clinicians should also screen for STIs, including gonococcal infection, at commencement of HIV pre-exposure prophylaxis (PrEP) and every 90 days while PrEP is used.[12,13] After diagnosis, clinicians should provide education about preventing future infections and should initiate discussion about contact tracing for all partners for at least the past two months. Cases are followed up after one week and a test of cure performed for each site of infection (pharyngeal, anal and/or cervical) two weeks after treatment. Testing for reinfection is recommended at three months.[12]

Although evidence on the contribution of reinfections to total gonococcal infections is limited, reinfections have been shown to represent a substantial proportion: approximately 18% in defined study populations.[14,15] Definitions of 'reinfection' after treatment for a prior infection reported in the literature range from two weeks to two months.[14,16,17,18,19] The lack of a universally agreed definition prohibits accurate estimation of the true burden of reinfection and presents a barrier to identifying the risk factors, as findings from research studies may not be comparable. Relatively few studies have investigated the risk factors for gonococcal reinfections. International evidence suggests people of male sex, young adults, GBMSM, those with a previous history of STI, and those co-infected with another STI at diagnosis of initial gonococcal infection, may be at increased risk of gonococcal reinfection.[14,16,18,20] Lower socioeconomic status (SES), engaging in sex work, inconsistent condom use, having had more than one sexual partner in the past six months, or having a partner who had another partner in the recent past, have also been shown to increase the risk.[14–16,18,20] Recent Australian studies are lacking; however, a 2020 study in Adelaide, South Australia, identified GBMSM, people living in low SES areas, and older age groups as having a higher risk of reinfection.[15] Understanding the local epidemiology of gonococcal infections and reinfections, and risk factors for reinfection, can help with the design of effective interventions to reduce the disease burden. This study aimed to describe the epidemiology of gonococcal infections and reinfections in the ACT between 2017 and 2022 and examine the risk factors for reinfection during this period.

Methods

Study design and population

In the ACT, laboratory-confirmed gonococcal infections are notified to the ACT Health Directorate. Public health officers (PHO) conduct routine case follow-up through interviews with clinical staff and/or the case to collect enhanced surveillance data, which is entered into the ACT notifiable diseases databases. Where a positive result is received within 28 days of a previous gonococcal infection notification for the same individual, PHO investigate (in consultation with the clinician) whether the notification represents a persistent or new infection. Infections deemed new, such as where there was a negative test for that anatomical site in the intervening period, are classified as confirmed.

A retrospective cross-sectional study was undertaken to describe the epidemiology of gonococcal infection notifications in the ACT. The study population included ACT residents with a gonococcal infection notification with specimen collection between 1 January 2017 and 31 December 2022.

Sex at diagnosis was used for analyses, as data for gender were not available for the entire study period. A reinfection was defined as a subsequent notification for an individual who had a prior gonococcal infection notification during 2017–2022.

A case-case study design was used to investigate the risk factors for reinfection. Cases of interest were defined as individuals with more than one notification during the study period (Reinfection group). Cases with a single notification during the study period served as comparison cases (Single Infection group). To reduce misclassification bias, individuals with an additional gonococcal infection notified during 2014–2016 were excluded from comparisons between the Single Infection and Reinfection groups. Prior to 2014, the gonococcal infection notification rate in the ACT was low (< 30 per 100,000 population), so notifications for this period were not explored.[10]

Data sources

Demographic and clinical data were exported from ACT notifiable diseases databases. Enhanced data fields included self-reported sexual exposure type for this infection (opposite sex, same sex, both sexes, or unknown) and sex worker status during the past 12 months. Data for use of PrEP at diagnosis were available for notifications from October 2018. For the Reinfection group, epidemiological data from the first infection during the study period (or first infection at which data were available) were used for comparisons with the Single Infection group. Notifications for individuals aged less than 14 years were excluded due to very low numbers and to prevent re-identification. Duplicate entries and notifications with a postcode outside the ACT were also excluded.

Statistical analyses

Analyses were undertaken with Microsoft Excel (2016) and Stata (Version 17). Counts and proportions were used to describe epidemiological characteristics. To prevent potential re-identification, where numbers for a variable were low (n < 5) or where the number of notifications in a category could be easily added to reveal the number of notifications for a subgroup, categories were combined or the exact numbers concealed using '< n'. Trends were described in the number and rate (per 100,000 population per year) of gonococcal infection and reinfection notifications during the study period. Annual population rates were calculated using Australian Bureau of Statistics mid-year ACT estimated resident population data.[21]

To identify risk factors for reinfection, epidemiological data for the Reinfection and Single Infection groups were compared univariately. Odds ratios (OR) and 95% confidence intervals (95% CI) were calculated to identify factors associated with reinfection. *P* values < 0.05 were considered statistically significant. Pearson's Chi-squared test was used for categorical variables and Mann-Whitney U test was used for median age. Records with indeterminate/non-binary sex, anatomical site of infection of 'other', and unknown or not reported Aboriginal and/or Torres Strait Islander status, sexual exposure type, PrEP use, and sex worker status, were excluded from comparisons based on these variables.

Ethics

The protocol for the study was approved by the ACT Health Human Research Ethics Committee (HREC) Low-Risk Sub-Committee and acknowledged by the Australian National University HREC.

Results

Descriptive analysis

After exclusions (n = 13), a total of 1,886 gonococcal infection notifications were included in the study for 1,501 unique individuals. For all notifications, data completeness (with 'unknown' responses considered missing) was 100% for age, sex, diagnosing clinical facility, and anatomical site of infection and > 95.0% for Aboriginal and/or Torres Strait Islander status, sexual exposure type, and sex worker status. Data completeness, among 1,385 notifications from October 2018 onwards, was > 95.0% for use of PrEP.

There were 1,485 notifications (78.7%) for males, 391 (20.7%) for females and 10 (0.5%) for individuals with indeterminate/non-binary sex. The median age was 30 years (range: 14–75; interquartile range [IQR]: 13). Table 1 shows the number and percentage of notifications within each variable category, by sex.

Males with a same-sex or both-sexes sexual exposure represented 59.9% of all notifications (n = 1,130) and > 99.0% (n = 475) where PrEP was used at diagnosis. The majority of those diagnosed at a sexual health/family planning clinic (78.7%, n = 926) were also males with a same-sex or both-sexes sexual exposure. For site of infection, approximately half of notifications (n = 967) included a urogenital infection; 40.0% included throat; and 33.0% included rectum (Table 1).

Table 1: Case characteristics of gonococcal infection notifications in the ACT, by demographic, behavioural, and clinical variables, 2017–2022

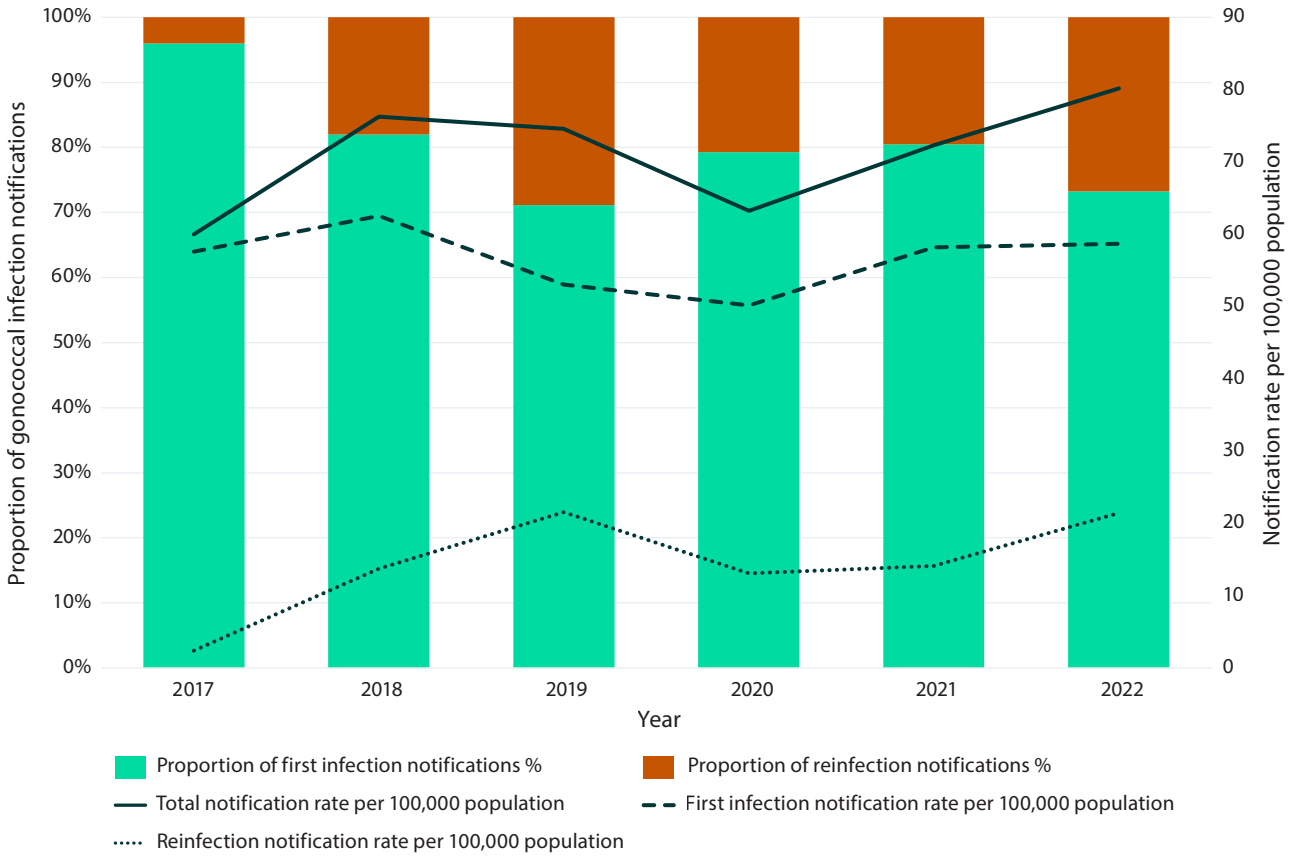
Variable	Variable category	Number (%)[a]	
		Males	Females
Age at onset (years)	14–24	319 (21.5)	155 (39.6)
	25–34	649 (43.7)	152 (38.9)
	35–44	306 (20.6)	56 (14.3)
	45–54	136 (9.2)	22 (5.6)
	55 and over	75 (5.1)	6 (1.5)
Aboriginal and/or Torres Strait Islander status	Neither Aboriginal nor Torres Strait Islander	1,375 (92.6)	323 (82.6)
	Aboriginal and/or Torres Strait Islander	46 (3.1)	41 (10.5)
	Unknown/not reported/inadequately described	64 (4.3)	27 (6.9)
Sexual exposure type	Same sex	1,072 (72.2)	< 5 (< 1.3)
	Opposite sex	325 (21.9)	363 (92.8)
	Both sexes	58 (3.9)	16 (4.1)
	Unknown/not reported	30 (2.0)	< 10 (< 2.6)
HIV PrEP at diagnosis[b]	No	555 (51.9)	299 (94.6)
	Yes	475 (44.4)	< 5 (< 1.6)
	Unknown	39 (3.6)	< 20 (< 6.3)
Sex worker	No	1,426 (96.0)	337 (86.2)
	Yes	8 (0.5)	34 (8.7)
	Unknown/not reported	51 (3.4)	20 (5.1)
Diagnosing clinical facility	Sexual health/family planning clinic	1,046 (70.5)	131 (33.5)
	General practice	373 (25.1)	181 (46.3)
	Hospital	25 (1.7)	43 (11.0)
	Other	41 (2.8)	36 (9.2)
Anatomical site of infection[c]	Urogenital only	473 (31.9)	277 (70.7)
	Throat only	385 (26.0)	37 (9.4)
	Rectum only	294 (19.8)	6 (1.5)
	Rectum and throat	181 (12.2)	< 5 (< 1.3)
	Urogenital and throat	48 (3.2)	33 (8.4)
	Urogenital and rectum	59 (4.0)	14 (3.6)
	Urogenital, rectum and throat	43 (2.9)	20 (5.1)

a Excludes sex of indeterminate/non-binary (n = 10).

b For 1,385 notifications from October 2018 to December 2022.

c Excludes 'other' (n < 5).

Figure 1: Proportions of gonococcal notifications for reinfections and first infections, by year of specimen collection and ACT notification rates per 100,000 population for first gonococcal infections, gonococcal reinfections, and total gonococcal infections, 2017–2022



Reinfections

There were 385 notifications classified as reinfections, amounting to 20.4% of total notifications. Of 1,501 unique individuals, one gonococcal infection was notified for 1,254 individuals (83.5%) and more than one for 247 individuals (16.5%). Of those with one infection notified during the study period, 37 were excluded as they had at least one notification reported during 2014–2016, resulting in 1,217 individuals in the Single Infection group. Of the 247 individuals in the Reinfection group, 169 (68.4%) had two infections, 42 (17.0%) had three infections, 21 (8.5%) had four infections, 10 (4.0%) had five infections, and five (2.0%) had six or more infections.

Trends

Between 2017 and 2019, the proportion of notifications which were reinfections increased from 4.0% to 28.9%, before reducing in 2020 and 2021 and increasing again to 26.8% in 2022 (Figure 1). The overall rate of gonococcal infection notifications per 100,000 population per year increased from 59.98 in 2017 to 80.14 in 2022, with a dip in 2020 before increasing again in 2021 and 2022. The rate of reinfections per 100,000 population, which increased from 2.40 in 2017 to 21.46 in 2022, also saw a dip in 2020 and 2021.

Prior to 2020, the rate of first infections was declining while both the rate and proportion of reinfections increased between 2017 and 2019 (Figure 1). Although the rate of both first infections and reinfections decreased in 2020, there was a greater increase in the rate of reinfections than first infections between 2021 and 2022.

Case-case analysis

The median age at first infection for the Reinfection and Single Infection groups were 30 years (range: 16–61; IQR: 13) and 28 years (range: 14–75; IQR: 53), respectively (p = 0.050). Univariate analysis showed that compared with the Single Infection group, the Reinfection group had significantly greater odds of being male, having a same-sex (compared with opposite-sex) sexual exposure, having used PrEP at diagnosis, and having been diagnosed at a sexual health/family planning clinic (compared with a general practice). Based on age at first infection, the Reinfection group had significantly greater odds of being in the 25–34, 35–44, and 45–54 years age groups than the 14–24 years age group (Table 2). The odds of anatomical site of first infection being only the rectum, only the throat, or at more than one site (compared with urogenital only) were significantly greater for the Reinfection group. No statistically significant differences were found between the two groups for Aboriginal and/or Torres Strait Islander status or sex worker status (Table 2).

Table 2: Number and proportion of individuals with a gonococcal infection notification in the ACT allocated to the 'Reinfection' and 'Single Infection' groups, by epidemiological characteristics, with univariate analyses of association, 2017–2022

Variable	Variable category	Reinfection (%)	Single Infection (%)	Unadjusted OR (95% CI)[a]	*p* value (χ^2)
Age (years)	14–24	51 (20.6)	373 (30.6)	Ref.	—
	25–34	115 (46.6)	487 (40.0)	1.73 (1.21–2.47)	0.003
	35–44	49 (19.8)	209 (17.2)	1.71 (1.12–2.63)	0.013
	45–54	23 (9.3)	96 (7.9)	1.75 (1.02–3.02)	0.041
	55 and over	9 (3.6)	52 (4.3)	1.27 (0.59–2.73)	0.546
Sex[b]	Female	23 (9.3)	341 (28.2)	Ref.	—
	Male	223 (90.7)	868 (71.8)	3.81 (2.42–5.99)	< 0.001
Aboriginal and/or Torres Strait Islander status[c]	Neither Aboriginal nor Torres Strait Islander	231 (95.5)	1080 (94.7)	Ref.	—
	Aboriginal and/or Torres Strait Islander	11 (4.5)	61 (5.3)	0.84 (0.44–1.63)	0.611
Sexual exposure type[d]	Opposite sex	43 (17.6)	590 (49.8)	Ref.	—
	Same sex	194 (79.5)	535 (45.1)	4.98 (3.46–7.15)	< 0.001
	Both sexes	7 (2.9)	60 (5.1)	1.60 (0.69–3.72)	0.270
HIV PrEP at diagnosis[e]	No	94 (43.5)	685 (78.1)	Ref.	—
	Yes	122 (56.5)	192 (21.9)	4.60 (3.33–6.43)	< 0.001

Variable	Variable category	Reinfection (%)	Single Infection (%)	Unadjusted OR (95% CI)[a]	*p* value (χ^2)
Sex worker[f]	No	235 (97.9)	1,134 (97.3)	Ref.	—
	Yes	5 (2.1)	32 (2.7)	0.75 (0.29–1.96)	0.560
Diagnosing clinical facility[g]	General practice	40 (16.6)	463 (40.2)	Ref.	—
	Sexual health/family planning clinic	193 (80.1)	635 (55.2)	3.52 (2.43–5.08)	< 0.001
	Hospital	8 (3.3)	53 (4.6)	1.75 (0.78–3.94)	0.173
Anatomical site of infection[h]	Urogenital only	66 (26.7)	597 (49.3)	Ref.	—
	Rectum only	47 (19.0)	159 (13.1)	2.67 (1.76–4.06)	< 0.001
	Throat only	67 (27.1)	248 (20.5)	2.44 (1.68–3.56)	< 0.001
	Two or more sites	67 (27.1)	208 (17.2)	2.91 (1.99–4.23)	< 0.001

a OR: odds ratio; 95% CI: 95% confidence interval; Ref.: category is assigned as OR reference.

b Excludes indeterminate/non-binary (n < 10) due to low numbers.

c Excludes unknown, not stated or inadequately described (n=81). Records with Aboriginal and/or Torres Strait Islander status of Aboriginal, Torres Strait Islander, and both Aboriginal and Torres Strait Islander have been combined to prevent reidentification.

d Excludes unknown/not reported (n = 35).

e For Reinfection group, reflects the first infection with data available for use of PrEP at diagnosis. Excludes unknown (n = 44).

f Excludes unknown/not reported (n = 58).

g Excludes 'other' (n = 72).

h Excludes 'other' (n < 5).

Discussion

Reinfections contribute substantially to gonococcal infection notifications in the ACT. More than one-fifth of the notifications in our study were for reinfections. The notification rates, both for reinfections and for gonococcal infections overall, appear to be increasing in the ACT. These findings emphasise the need for the timely development of interventions aimed at identified at-risk groups, informed by further studies to better understand the reasons behind the observed trends.

More than three-quarters of gonococcal infection notifications over the study period were for males. A higher proportion of notifications for females were in younger age groups, with 39.6% of notifications for females in the 14–24 years age group, compared with 21.5% for males. Females had a higher proportion of notifications for Aboriginal and/or Torres Strait Islander people—10.5% compared with 3.1% for males. This is consistent with another study which found a higher female-to-male ratio and higher notification rates in females in the younger (15–19 years) age groups among Aboriginal and/or Torres Strait Islander people.[22] Although just over one half of notifications were for urogenital infections, around 40% involved the throat and around one third involved the rectum. This supports the need for testing of these sites where recommended by clinical guidelines.[12]

In our study, over 20% of notifications were reinfections, slightly higher than the proportions reported in other studies, which may reflect both testing practices and behaviours in the ACT.[14,15] More than two thirds of those in the Reinfection group had only two infections, with the number of individuals with each subsequent number of infections approximately halving from three infections onwards. This supports previous findings that reinfections were

concentrated among a small subset of individuals.[23] Future studies, particularly qualitative studies, are needed to better understand the reasons why current prevention initiatives may be ineffective for preventing subsequent infections among some individuals.

Examination of trends suggests an increase in both the proportion and rate of gonococcal reinfections contributed to the increase in overall gonococcal infection notifications seen in the ACT since the relaxation of COVID-19-related restrictions in 2021. In 2022, the ACT recorded its highest ever gonococcal infection notification rate, with a greater increase in reinfections than first infections between 2021 and 2022. This suggests that the pattern of increasing gonococcal infections and reinfections seen between 2017 and 2019, which was interrupted by the COVID-19 pandemic, may have recommenced in 2022 following the relaxation of restrictions in Australia. Future studies examining the impact of COVID-19 lockdowns and other public health and social measures on reinfection rates may assist in better understanding these patterns.

The use of PrEP at diagnosis and same-sex sexual exposure demonstrated the strongest association with reinfection on univariate analysis (unadjusted ORs: 4.60; 95% CI: 3.33–6.43 and 4.98; 95% CI: 3.46–7.15, respectively). Previous studies have identified individuals taking PrEP and GBMSM as groups at increased risk of reinfection.[15,18,23,24,25] Another study found commencing PrEP was associated with an increase in gonococcal infection incidence.[29] In Australia, prescription of PrEP is indicated for GBMSM who engage in condomless sex with casual partners so these variables are highly correlated. However, these findings emphasise the need for tailored health promotion and educational initiatives to reduce gonococcal infections and reinfections among these groups. These groups should be considered for priority access to pharmacological interventions to prevent transmission, such as antibiotic prophylaxis or vaccination. Although data for whether the case was symptomatic or asymptomatic were outside the scope of this study, regular asymptomatic STI screening is recommended for GBMSM, at commencement of PrEP, and every 90 days while PrEP is used, increasing the likelihood of diagnosis.[13] Therefore, individuals taking PrEP may be both at inherently greater risk of gonococcal reinfections and more likely to have their infections identified through regular testing.[12] The ACT has the highest rate of PrEP use per 100,000 population of any Australian state or territory, potentially contributing to the substantial proportion of gonococcal reinfections seen in this study.[26] These interactions with health services present an opportunity for the implementation of interventions aimed at reducing future gonococcal infections.

Diagnosis at a sexual health/family planning clinic was associated with increased odds of reinfection (unadjusted OR: 3.52; 95% CI: 2.43–5.08). The majority those diagnosed in sexual health/family planning clinics were males with a same-sex or both-sexes sexual exposure, suggesting these variables were highly correlated. However, these findings confirm the critical role of sexual health/family planning clinics in managing gonococcal reinfections. These settings provide an important potential avenue for the delivery of interventions to prevent subsequent infections in their clients. Sufficient resources must be allocated to clinics to enable their development. To prevent reinfection, novel prevention strategies are needed to reduce condomless sex and multiple partners among those with a previous gonococcal infection. These may include health promotion strategies, such as embedded STI education and testing advice in dating apps, and counselling or educational techniques which aim to change risk perception around STIs.

The strengths of this study include the use of a case-case study design, with those with a notification in the three years prior to the study period excluded from the Single Infection group to reduce misclassification bias. Data were collected by experienced PHO using established processes and completeness was high with only a very small number of notifications excluded from the study.

As this study used data from notifications, asymptomatic or otherwise undiagnosed infections may not have been captured. However, regular testing among priority groups, as recommended by clinical guidelines, may have reduced the effect of this limitation. Although STI testing and treatment in the ACT is informed by clinical guidelines, it was not possible to determine whether these guidelines were followed in every case. Movement of people in and out of the ACT within the study period also presents a limitation to identifying all repeat infections, as individuals within the Single Infection group may have had an infection notified outside the ACT.

Due to the retrospective study design, it was not possible to track changes in epidemiological variables for individuals in the Reinfection group. Data for the first infection were used for comparisons with the Single Infection group. However, for some individuals, the status of some variables may have changed for subsequent infections, potentially affecting our estimates. Data for sexual exposure type and sex worker status relied on self-reported responses and may have been subject to under-reporting due to concerns around stigma and privacy.

In this study, univariate analysis sought to examine the relationships between each variable and risk of reinfection. However, the complex inter-relationships between some variables presented limitations to undertaking multivariable analyses. As the vast majority of individuals using PrEP at diagnosis were males with a same-sex sexual exposure, these variables were highly correlated. Additionally, the small number of females with a same-sex sexual exposure prevented examination of males and females separately. Therefore, the finding of same-sex sexual exposure as a risk factor for reinfection likely reflects male same-sex sexual exposure. Available data for sexual exposure type related to the specific infection notified, rather than to the individual's broader sexual history. This prevented comparison of GBMSM with males who were not GBMSM, as those who reported an opposite-sex sexual exposure for a given infection could not be reliably excluded from the GBMSM group.

Conclusion

This study shows that the contribution of reinfections to overall gonococcal infection notifications in the ACT is substantial and increasing. People who use PrEP, have a same-sex sexual exposure, and use sexual health/family planning clinics, had the highest odds of gonococcal reinfections. The development of appropriately targeted new interventions to reduce gonococcal infections and reinfections, particularly among these groups, is required. This may include specific health promotion activities, novel methods in education and counselling, and prioritisation of these groups for future pharmacological interventions. Further studies are needed to understand why current prevention initiatives may be ineffective for some individuals, to support the development of effective interventions.

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