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Enhanced *Chlamydia trachomatis* and *Neisseria gonorrhoeae* Sexually Transmitted Infections and Associated Risk Factors in Fiji Following the Coronavirus Disease 2019 Pandemic

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Background. The coronavirus disease 2019 pandemic impact on sexually transmitted infections in countries practicing syndromic management remains unknown. We conducted cross-sectional surveys in Fiji to assess increases and risk factors for *Neisseria gonorrhoeae* (NG) and *Chlamydia trachomatis* (CT) infections pre- and postpandemic.

Methods. We enrolled women, men who have sex only with women (MSW), and men who have sex with men (MSM) aged 18–40 years, collected sociodemographic/behavioral data, and tested vaginal, urethral, and rectal samples using Xpert-CT/NG. Risk factors were evaluated using regression models.

Results. Of 1955 participants, 6.4% (95% confidence interval [CI], 5.4%–7.6%) had gonorrhea, increasing significantly postpandemic >2-fold among women aged 25–40 years and >4-fold among MSM, MSW, and men aged 18–24 and 25–40 years; 20.0% (95% CI, 18.3%–21.8%) had chlamydia, increasing significantly postpandemic among younger women and approximately 2- to 4-fold among MSW and younger and older men. Increases were driven by urethral/vaginal infections. Coinfections increased significantly postpandemic among older women. Postpandemic gonorrhea was associated with difficulty obtaining condoms (adjusted relative risk [aRR], 2.7 [95% CI, 1.0–8.0]) and ≥2 partners (aRR, 2.6 [95% CI, 1.0–7.1]) among younger women, and iTaukei ethnicity (aRR, 4.7 [95% CI, 1.4–16.5]) and heavy alcohol use (aRR, 7.1 [95% CI, 2.5–19.7]) among older women. Postpandemic chlamydia was associated with having a casual sex partner among younger (aRR, 1.7 [95% CI, 1.0–2.9]) and older (aRR, 1.9 [95% CI, 1.1–3.4]) women and with being unmarried (aRR, 1.7 [95% CI, 1.0–2.7]). iTaukei men had increased risk postpandemic for gonorrhea (aRR, 3.7 [95% CI, 1.3–10.6]) and chlamydia (aRR, 2.5 [95% CI, 1.3–4.9]). More than 50% of infected participants did not meet syndromic treatment criteria and would have remained untreated.

Conclusions. Postpandemic increases in gonorrhea and chlamydia—with risk factors varying by pathogen, gender, and age—require immediate interventions to reduce infection and transmission in Fiji.

Keywords. *Chlamydia trachomatis*; COVID-19 pandemic; Fiji; *Neisseria gonorrhoeae*; Pacific Islanders.

Chlamydia trachomatis (CT) and *Neisseria gonorrhoeae* (NG) are the most common bacterial sexually transmitted infections (STIs) worldwide [1]. The World Health Organization (WHO) estimated that in 2020 there were 82 and 130 million new cases, respectively, among those aged 15–49 years [1, 2]. Globally, the Western Pacific Region (WPR) has one of the highest estimated incidence rates for both STIs: 23 million gonorrhea cases and 51 million chlamydia cases annually [1–3].

The 22 Pacific Island countries and territories (PICTs) of the WPR are primarily low- and middle-income countries (LMICs) with limited resources for STI testing and surveillance. Consequently, PICTs follow WHO guidelines for syndromic management that rely on signs and symptoms as indicators of STIs [4]. Because 50%–70% of individuals with gonorrhea and up to 80% with chlamydia are asymptomatic [5–7], many

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infections go undiagnosed and untreated with potential for transmission and sequelae, including pelvic inflammatory disease, tubal factor infertility, preterm birth, and increased human immunodeficiency virus (HIV) risk [3, 8]. Furthermore, low diagnostic accuracy of syndromic management has led to the overuse of antibiotics, which contributes to NG antimicrobial resistance (AMR) [8–10]. While limited in number, rigorous epidemiologic studies from PICTs conducted before the coronavirus disease 2019 (COVID-19) pandemic documented a high prevalence of both STIs among women and men of all ages, ranging from 2%–37% for gonorrhea and 6%–53% for chlamydia (reviewed in [11]).

The impact of the COVID-19 pandemic on NG and CT infection and transmission in PICTs is unknown. While a few studies from the United States (US) and Europe have documented a postpandemic increase in STIs [12–15], no such studies have been conducted in PICTs. To address this gap and evaluate the impact of the pandemic on gonorrhea and chlamydia in PICTs, we tested sexually active women and men aged 18–40 years in Fiji for vaginal, urethral, and rectal NG and CT infections and collected data on STI risk factors before and after the pandemic. We hypothesized that disruptions in reproductive healthcare, clinic closures, reduced staffing, supply chain issues (eg, antibiotics, condoms), and behavioral changes could significantly increase both STIs postpandemic [13, 14].

METHODS

Study Design and Population

We conducted a repeated, cross-sectional, bio-behavioral study, enrolling women, men who have sex only with women (MSW), and men who have sex with men (MSM) prepandemic (February 2018–March 2020) and postpandemic (February 2022–December 2023) in the Central Division of Viti Levu, Fiji, which serves approximately one-half of the Fijian population. Participants were consecutively consented as a convenience sample and screened at 6 Ministry of Health and Medical Services (MHMS) Health Centers and 2 university clinics serving a wide range of low- to high-risk populations. As described previously [16], inclusion criteria were age 18–40 years, sexually active, nonpregnant, and willing to provide samples for STI testing. Those with untreated syphilis, HIV, cancer, or antibiotic treatment (within the prior month) were excluded. The same questionnaires and recruitment and STI testing protocols were used pre- and postpandemic. Different participants were enrolled at each time point.

Ethical Considerations

The study was approved by the University of California, San Francisco institutional review board and Fijian MHMS ethics committees in accordance with the Declaration of Helsinki. Each participant provided written informed consent. Participant study forms and samples were assigned a unique identification number to ensure anonymity and confidentiality.

Data Collection

Sociodemographic and behavioral data were collected as previously described [16]. In brief, self-administered questionnaires were adapted from the Family Health International HIV/AIDS/STD Behavioral Surveillance Study for Adults [17], the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) Questionnaire [18, 19], and Sexual Coercion in Intimate Relationships Scale [18, 19], respectively. Traditional data on risk factors for gonorrhea and chlamydia were collected.

As previously described [16], trained study clinicians collected data on patient STI symptoms, conducted urogenitoanal examinations to identify signs of STIs, and collected vaginal and rectal samples from women and rectal and urethral samples from men. Samples were tested for CT and NG using the Xpert CT/NG Assay (Cepheid, Sunnyvale, California). All supplies were provided by the study. Participants with gonorrhea and/or chlamydia were treated per Fiji MHMS guidelines. Study data were entered into a REDCap database (Research Electronic Data Capture; REDCap Consortium, Nashville, Tennessee).

Data Analysis

Univariate summaries, including proportions and frequency tables, examined participant sociodemographics and behaviors pre- and postpandemic. A 1-sided Fisher exact test was used to test the hypothesis that the proportion of gonorrhea and/or chlamydia cases increased postpandemic. Bivariate associations between risk factors and gonorrhea and/or chlamydia were analyzed by pre- and postpandemic periods. Missing values were presented but not imputed.

Multivariable Poisson regression models with robust error variance [20] were used to explore independent risk factors for gonorrhea and for chlamydia pre- and postpandemic. Variables were included in the regression model based on their significance from prior literature and bivariate analyses to account for cohort-specific variations. Covariate effects are presented as adjusted relative risks (aRRs) with approximate 95% confidence intervals (CIs). Possible interactions between risk factors and pre-/postpandemic periods were examined by comparing overlap of CIs and formal significance testing for product terms in a regression model for combined data. Results are presented overall and stratified by gender and, where possible, age group and male sexual orientation to facilitate comparisons to published literature. Analyses were performed using Stata software, version 18 (StataCorp, College Station, Texas).

RESULTS

Participant Characteristics

Overall, 1955 participants (1690 women; 265 men) completed surveys and were tested for NG and CT. Participants (1343 prepandemic; 612 postpandemic) presented for regular check-ups, contraception, family planning, reproductive health counseling, infertility, or STI testing. The MHMS reported 1 pandemic clinic closure and approximately 40%–50% reduction in staff.

Overall, the median age was 29 years (interquartile range [IQR], 25–34 years) for women and 26 years (IQR, 22–31 years) for men. Approximately half of the participants (54.2% of women; 55.8% of men) were iTaukei. Overall, participant characteristics pre- and postpandemic were generally similar (Supplementary Table 1). Some notable exceptions for women included employment and relationship status, ≥2 lifetime sex partners, obstacles to obtaining condoms, and anal sex. For men, these included age group, employment status, obstacles to obtaining condoms, and having a regular partner who has sex with others.

NG Infections Increased Significantly Postpandemic Among Older Women and All Men, Driven by Increases in Vaginal and Urethral Infections

Of 1955 participants overall, 126 (6.4% [95% CI, 5.4%–7.6%]) had gonorrhea, doubling from 4.5% (61/1343 [95% CI, 3.5%–5.8%]) prepandemic to 10.6% (65/612 [95% CI, 8.3%–13.3%]) postpandemic ($P = .001$) (Figure 1; Table 1, see footnote). Gonorrhea increased significantly among most participant groups postpandemic: >2-fold among women aged 25–40 years (from 2.4% to 5.8%; $P = .001$) and >4-fold among men aged 18–24 years (4.5% to 21.3%; $P = .003$), men aged 25–40 years (3.3% to 16.5%; $P = .006$), MSM (5.3% to 25.0%; $P = .04$), and MSW (3.7% to 16.4%, $P = .001$) (Figure 1; Tables 1 and 2).

Among women aged 25–40 years, there was a 2-fold increase postpandemic in vaginal gonorrhea (2.4% to 5.2%; $P = .006$), with a similar but nonsignificant increase in rectal gonorrhea (Table 1). Younger women had nonsignificant postpandemic increases at both sites.

There was a >3-fold increase postpandemic in urethral gonorrhea among men aged 18–24 years (4.9% to 17.0%; $P = .02$), men aged 25–40 years (4.3% to 15.1%; $P = .03$), and MSW (3.8% to 16.2%; $P = .002$) with a nonsignificant increase among MSM (Tables 1 and 2). Rectal gonorrhea increased among all male groups, but not significantly.

Risk Factors for NG Differed Significantly for Women and Men and by Age Group Postpandemic

Bivariate analyses of risk factors for gonorrhea among all women and by age group are shown in Supplementary Tables 2 and 3, respectively. In multivariable age-adjusted models among women (Table 3), significant independent risk factors for gonorrhea for pre- and postpandemic periods were iTaukei ethnicity, a nonmonoganous partner, and heavy alcohol use. Significant independent risk factors for the postpandemic period only were obstacles to obtaining condoms (aRR, 2.0 [95% CI, 1.1–3.8]) and tobacco use in the past month (aRR, 1.9 [95% CI, 1.0–3.6]).

In multivariable age-stratified models (Table 4), independent risk factors for gonorrhea for younger women were obstacles to obtaining condoms (aRR, 2.7 [95% CI, 1.0–8.0]) and ≥2 sex partners in the last year (aRR, 2.6 [95% CI, 1.0–7.1]) in the postpandemic period only. For older women, significant independent risk factors for gonorrhea for pre- and postpandemic periods were being unmarried and having a nonmonoganous partner, while those for the postpandemic period only were iTaukei ethnicity (aRR, 4.7 [95% CI, 1.4–16.5]) and ≥3 alcoholic drinks per day (aRR, 7.1 [95% CI, 2.5–19.7]). When testing for interactions, only obstacles to obtaining condoms for younger women and heavy alcohol use among older women remained significant in the postpandemic period ($P = .02$ and $P = .05$, respectively).

Bivariate analyses of risk factors for gonorrhea among men are shown in Supplementary Table 4. In multivariable age-adjusted models, the only independent risk factor for men postpandemic was iTaukei ethnicity (aRR, 3.7 [95% CI, 1.3–10.6]), while being unmarried and having anal sex increased the risk for gonorrhea postpandemic, but not significantly (Table 3). There was no evidence of interaction by pre- and postpandemic periods. There was insufficient power to stratify by age or sexual orientation.

CT Infections Increased Significantly Postpandemic Among Younger Women and All Men of Both Age Groups

Of 1955 participants overall, 391 (20.0% [95% CI, 18.3%–21.8%]) had chlamydia, increasing from 18.2% (244/1343 [95% CI, 16.1%–20.3%]) to 24.0% (147/612 [95% CI, 20.7%–27.6%]; $P = .003$) (Figure 1; Table 1, see footnote). Postpandemic, chlamydia increased significantly among younger women (from 26.9% to 35.2%; $P = .04$), 2-fold among younger men (13.6% to 25.5%; $P = .05$), >4-fold among older men (6.6% to 28.6%; $P < .001$), and 3-fold among MSW (11.1% to 30.0%; $P < .001$) (Figure 1; Tables 1 and 2).

Increases in men with chlamydia were driven mainly by urethral infections among older men (6.4% to 24.4%; $P = .005$) and MSW (12.2% to 27.6%; $P = .004$). Although there were increases in vaginal infections for both age groups, these were not significant, nor were postpandemic changes observed in rectal infections for either men or women.

Risk Factors for CT Differed for Men and Women

Bivariate analyses of risk factors for chlamydia among women pre- and postpandemic are shown in Supplementary Tables 2 and 5. In multivariable age-adjusted models, significant independent risk factors for chlamydia for pre- and for postpandemic periods were being younger and iTaukei ethnicity (Supplementary Table 6). Significant independent risk factors

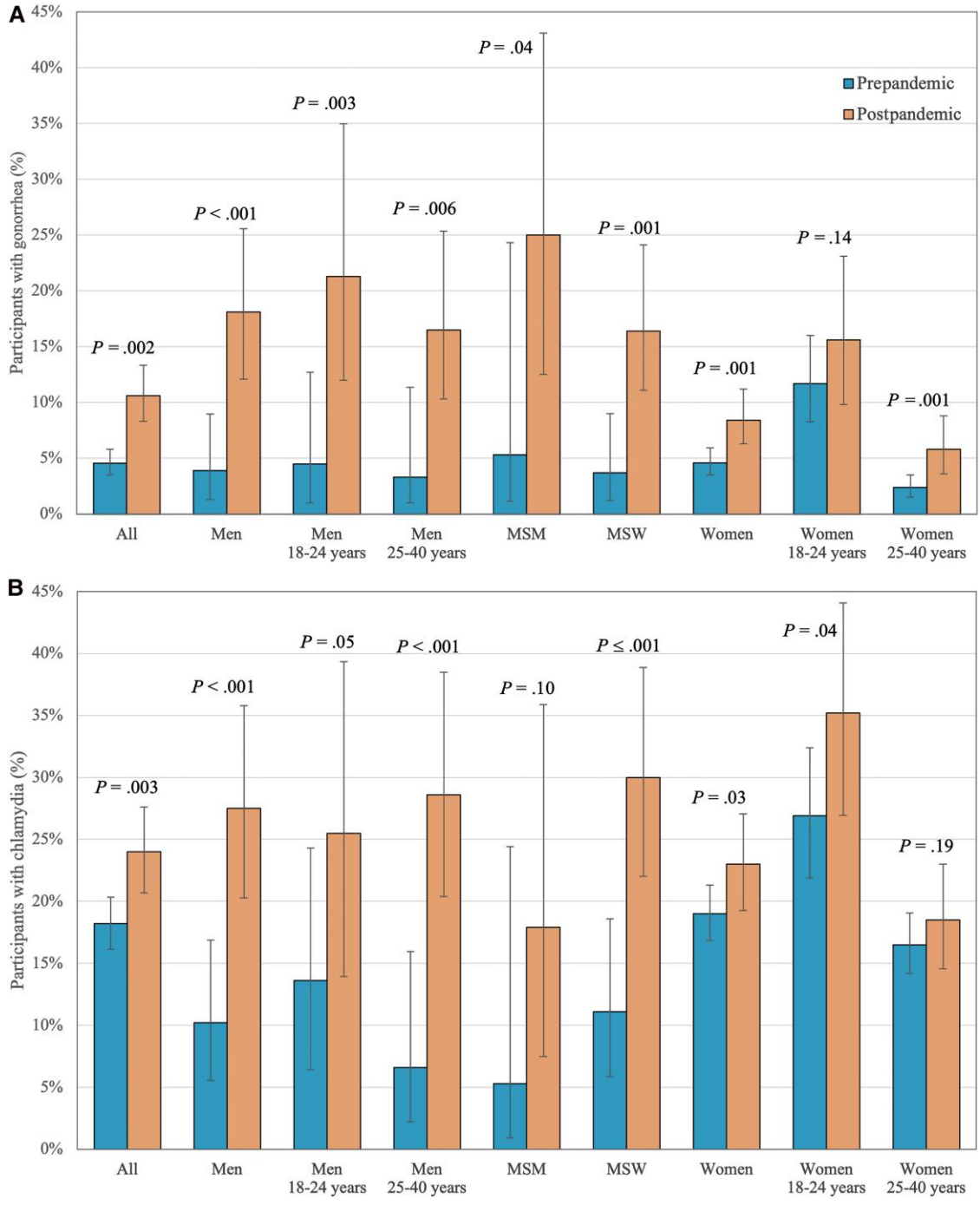

Figure 1. Percentage of participants with *Neisseria gonorrhoeae* (*A*) and *Chlamydia trachomatis* (*B*) infection before (February 2018 to March 2020) and after (February 2022 to December 2023) the coronavirus disease 2019 pandemic. *P* values were calculated using the 1-sided Fisher exact test to test the hypothesis that the proportion of gonorrhea and/or chlamydia cases increased following the pandemic. Error bars represent 95% confidence intervals. Women and men were categorized by age groups (18–24 and 25–40 years). Men were also categorized by sexual orientation: men who have sex with men (MSM) and men who have sex only with women (MSW).

for the postpandemic period only were being unmarried (aRR, 1.6 [95% CI, 1.6–2.5]) and having sex with a casual partner (aRR, 1.9 [95% CI, 1.3–2.7]). There was no evidence of interaction by pre- and postpandemic periods.

In the age-stratified models (Supplementary Table 7), significant independent risk factors for pre- and postpandemic periods were iTaukei ethnicity for both younger and older women. For the postpandemic period only, the independent risk factors were having sex with a casual partner for both younger

Table 1. Chlamydial and Gonorrheal Cases Among Women and Men in Fiji, Comparing Pre– and Post–Coronavirus Disease 2019 Pandemic Periods, Overall and by Age Group and Anatomic Site

Women (n = 1690)	Prepandemic	Postpandemic	*P* Value	Men (n = 265)	Prepandemic	Postpandemic	*P* Value
Neisseria gonorrhoeae				*Neisseria gonorrhoeae*			
Any site				Any site			
All	4.6 (56/1216)	8.4 (40/474)	**.001**	All	3.9 (5/127)	18.1 (25/138)	**<.001**
18–24 y	11.7 (34/290)	15.6 (20/128)	.14	18–24 y	4.5 (3/66)	21.3 (10/47)	**.003**
25–40 y	2.4 (22/926)	5.8 (20/346)	**.001**	25–40 y	3.3 (2/61)	16.5 (15/91)	**.006**
Vaginal				Urethral[b]			
All	4.5 (55/1216)	7.0 (33/474)	**.02**	All	4.6 (5/108)	15.8 (21/133)	**.003**
18–24 y	11.4 (33/290)	11.7 (15/128)	.47	18–24 y	4.9 (3/61)	17.0 (8/47)	**.02**
25–40 y	2.4 (22/926)	5.2 (18/346)	**.006**	25–40 y	4.3 (2/47)	15.1 (13/86)	**.03**
Rectal[a]				Rectal[a]			
All	5.8 (7/120)	7.8 (36/462)	.23	All	0 (0/12)	9.0 (12/134)	.14
18–24 y	12.8 (5/39)	15.1 (19/126)	.36	18–24 y	0 (0/5)	10.9 (5/46)	.21
25–40 y	2.5 (2/81)	5.1 (17/336)	.15	25–40 y	0 (0/7)	8.0 (7/88)	.21
Chlamydia trachomatis				*Chlamydia trachomatis*			
Any site				Any site			
All	19.0 (231/1216)	23.0 (109/474)	**.03**	All	10.2 (13/127)	27.5 (38/138)	**<.001**
18–24 y	26.9 (78/290)	35.2 (45/128)	**.04**	18–24 y	13.6 (9/66)	25.5 (12/47)	**.05**
25–40 y	16.5 (153/926)	18.5 (64/346)	.19	25–40 y	6.6 (4/61)	28.6 (26/91)	**<.001**
Vaginal				Urethral[b]			
All	18.3 (222/1216)	19.8 (94/474)	.35	All	10.2 (11/108)	24.1 (32/133)	**.003**
18–24 y	25.9 (75/290)	29.7 (38/128)	.21	18–24 y	13.1 (8/61)	23.4 (11/47)	.08
25–40 y	15.9 (147/926)	16.2 (56/346)	.44	25–40 y	6.4 (3/47)	24.4 (21/86)	**.005**
Rectal[a]				Rectal[a]			
All	24.2 (29/120)	18.4 (85/462)	.92	All	16.7 (2/12)	7.5 (10/134)	.87
18–24 y	28.2 (11/39)	31.0 (39/126)	.37	18–24 y	20.0 (1/5)	6.5 (3/46)	.86
25–40 y	22.2 (18/81)	13.7 (46/336)	.97	25–40 y	14.3 (1/7)	8.0 (7/88)	.36

Data are presented as % (no./No.) unless otherwise indicated. *P* values were calculated using 1-sided Fisher exact test to test the hypothesis that the proportion of gonorrhea and/or chlamydia cases increased following the pandemic; 126 (96 females + 30 males; 6.4%) had gonorrhea: 4.5% (61/1343; 56 females + 5 males) prepandemic to 10.6% (65/612; 40 females + 25 males) postpandemic ($P = .001$); 391 (340 females + 51 males) had chlamydia: 18.2% (244/1343; 231 females + 13 males) prepandemic to 24.0% (147/612; 109 females + 38 males) postpandemic ($P = .003$). *P* values in bold indicate statistical significance.

[a]Testing started 24 October 2019 for women and men.

[b]Testing started 8 May 2018 for urethral infections in men.

(aRR, 1.7 [95% CI, 1.0–2.9]) and older (aRR, 1.9 [95% CI, 1.1–3.4]) women, in addition to being unmarried for older women (aRR, 1.7 [95% CI, 1.0–2.7]).

Bivariate analyses of risk factors for chlamydia among men pre- and postpandemic are shown in Supplementary Table 4. In the multivariable age-adjusted models, iTaukei ethnicity (aRR, 2.5 [95% CI, 1.3–4.9]) was the only independent risk factor for chlamydia postpandemic (Supplementary Table 6). There was no evidence of interaction by pre- and postpandemic periods. There was insufficient power to stratify analyses by age or sexual orientation among men.

The Proportion of Older Women Coinfected With Gonorrhea and Chlamydia Significantly Increased Postpandemic

Overall, 21.9% (93/424 [95% CI, 18.1%–26.2%]) of women and men were coinfected. Coinfection increased from 17.1% (44/257) prepandemic to 26.9% (45/167) postpandemic ($P = .02$). Among women, 20.8% (75/361) were coinfected, nearly doubling among older women (11.5% [18/157] to 20.0% [14/70]; $P = .04$) but with only a modest increase among younger women (30.2% [26/86] to 35.4% [17/48]; $P = .54$). Among men, 28.6% (18/63) were coinfected with no significant increase postpandemic (28.6% [4/14] to 28.6% [14/49]; $P = 1.0$).

Based on Syndromic Management, Most Participants With Gonorrhea and/or Chlamydia Would Have Gone Untreated, and Most Who Would Have Received Treatment Were Uninfected

Overall, 40.6% (39/96) of women with gonorrhea and 45.3% (154/340) with chlamydia were asymptomatic while, for men, 40.0% (12/30) with gonorrhea and 62.8% (32/51) with chlamydia were asymptomatic, defined as having no signs or symptoms consistent with STIs [4]. The proportions of asymptomatic infections were similar pre- and postpandemic for women and men.

Among participants with gonorrhea and/or chlamydia (n = 424), 76.7% (277/361) of women, 60.0% (6/10) of MSM, and 52.8% (28/53) of MSW did not meet syndromic management criteria for treatment. These proportions did not differ significantly pre- and postpandemic. Among those who did meet the criteria, 65.5% (215/328) tested negative for NG and/or

Table 2. Chlamydial and Gonorrheal Cases Among Men Who Have Sex With Men and Men Who Have Sex Only With Women in Fiji, Comparing Pre– With Post–Coronavirus Disease 2019 Pandemic Periods, Overall and by Anatomic Site

	Men Who Have Sex With Men (n = 47)				Men Who Have Sex Only With Women Only (n = 218)			
Anatomic Site	Total	Prepandemic	Postpandemic	*P* Value[a]	Total	Prepandemic	Postpandemic	*P* Value[a]
Neisseria gonorrhoeae								
Any site	17.0 (8/47)	5.3 (1/19)	25.0 (7/28)	**.04**	10.1 (22/218)	3.7 (4/108)	16.4 (18/110)	**.001**
Urethral[b]	10.9 (5/46)	5.6 (1/18)	14.3 (4/28)	.18	10.8 (21/195)	3.8 (4/90)	16.2 (17/105)	**.002**
Rectal[c]	14.3 (4/28)	0 (0/1)	14.8 (4/27)	1.0	6.8 (8/118)	0 (0/11)	7.5 (8/107)	.17
Chlamydia trachomatis								
Any site	12.8 (6/47)	5.3 (1/19)	17.9 (5/28)	.10	20.6 (45/218)	11.1 (12/108)	30.0 (33/110)	**<.001**
Urethral[b]	6.5 (3/46)	0 (0/18)	10.7 (3/28)	.08	20.5 (40/195)	12.2 (11/90)	27.6 (29/105)	**.004**
Rectal[c]	17.9 (5/28)	100 (1/1)	14.8 (4/27)	.18	6.7 (8/119)	16.7 (2/12)	5.6 (6/107)	.93

Data are presented as % (no./No.) unless otherwise indicated. *P* values in bold indicate statistical significance.

[a] *P* value calculated using 1-sided Fisher exact test to test the hypothesis that the proportion of gonorrhea and/or chlamydia cases increased following the pandemic.

[b] Testing started 8 May 2018.

[c] Testing started 24 October 2019.

CT: 57.5% (42/73) of younger women, 72.3% (138/191) of older women, 66.6% (8/12) of MSM, and 51.9% (27/52) of MSW. These proportions did not differ significantly between the pre- and postpandemic periods.

DISCUSSION

This is the first study in LMICs and PICTs to document a significant increase in gonorrhea and chlamydia among women, MSW, and MSM following the COVID-19 pandemic. Urethral and, to a lesser extent, vaginal infections were likely drivers of these postpandemic increases, although we lacked sufficient numbers to draw conclusions regarding rectal infections. The proportion of participants with gonorrhea was approximately 6 and 16 times greater than the WHO global estimates for women and men, respectively, while chlamydia was approximately 5 and 7 times greater, respectively [3]. Our data suggest unchecked STI transmission and possible NG AMR. Targeted STI testing (including NG susceptibility testing) treatment, and prevention strategies are urgently needed to decrease transmission and sequelae and reduce the risk for HIV [21, 22], especially in light of the recent surge in HIV/AIDS in Fiji [23].

While older women in this study had a significant increase in gonorrhea postpandemic, younger women did not. This latter result may be explained in part by the already high prevalence of gonorrhea prepandemic (11.4%), suggesting a saturation among sexual networks that creates a bottleneck, preventing appreciable ongoing increases. Bottlenecks can be influenced by pathogen strain(s)/subtype(s) and host inflammatory responses, as has been shown for HIV infection [24–26]. The modest increase in postpandemic chlamydia may similarly be explained (19% to 23%). STI coinfection increases postpandemic support this hypothesis in that each pathogen increases the risk for the other [27], driving coinfection to a saturation threshold. The significant increase in both STIs among MSW may have contributed to these findings. MSM had significant postpandemic increases in gonorrhea only. While our findings are consistent with recent European and US publications that reported increases in chlamydia and gonorrhea postpandemic among women and men [12, 15], the increases in Fiji were appreciably higher.

We tested multiple anatomic sites to identify potential sources of transmission. Vaginal gonorrhea and both urethral gonorrhea and chlamydia increased significantly postpandemic among women and men, respectively, which likely influenced bidirectional transmission. However, rectal infections varied by age group for men and women, and for MSW and MSM without significant differences postpandemic. The relatively low number of rectal samples in our study, however, limited the conclusions that could be drawn. Prospective studies with larger sample sizes are needed to fully understand intra- and interhost rectal and urogenital transmission dynamics for both STIs.

Women and men of iTaukei ethnicity, an ethnic group that comprises over half of Fiji's population, were significantly more likely to have gonorrhea and chlamydia than Indo-Fijian or other ethnicities before and after the pandemic. This finding is consistent with our prior publication [16]. The growing prevalence of these infections among women and men in the present study indicates the need for equitable allocation of scarce healthcare resources for this vulnerable population.

We identified independent behavioral risk factors for gonorrhea and chlamydia that are consistent with the literature [3, 8, 28–30]. However, several differed by pathogen, gender, and age group in the postpandemic period. For example, younger women had a higher risk of gonorrhea postpandemic if they faced obstacles to obtaining condoms and had ≥2 sex partners, while older women had a higher risk if they were iTaukei and reported heavy alcohol use. Women in both age groups with chlamydia postpandemic were at increased risk if they reported

Table 3. Multivariable Models for Characteristics and Risk Behaviors Associated With *Neisseria gonorrhoeae* at Any Anatomic Site Among Women and Men, Stratified by Pre– and Post–Coronavirus Disease 2019 Pandemic Periods

	Women (n = 1690)				Men (n = 265)			
	Prepandemic (n = 1216)		Postpandemic (n = 474)		Prepandemic (n = 127)		Postpandemic (n = 138)	
Characteristic	aRR (95% CI)	*P* Value	aRR (95% CI)	*P* Value	aRR (95% CI)	*P* Value	aRR (95% CI)	*P* Value
Age group, y								
18–24	2.2 (1.2–4.1)	**.01**	1.3 (.7–2.5)	.40	0.5 (.1–2.4)	.35	1.2 (.6–2.4)	.63
25–40	ref		ref		ref		ref	
Sexual orientation								
MSM	…		…		0.5 (.1–4.6)	0.51	0.5 (.2–1.2)	.13
MSW	…		…		ref		ref	
Ethnicity								
iTaukei Fijian	2.9 (1.5–5.8)	**.002**	2.4 (1.1–5.4)	**.03**	…[b]		3.7 (1.3–10.6)	**.02**
Other[a]	ref		ref		ref		ref	
Education level								
Secondary or less	1.2 (.7–1.9)	.65	1.0 (.5–1.9)	.98	…[b]		0.6 (.3–1.3)	.21
University or more	ref		ref		ref		ref	
Relationship status								
Not married	3.7 (1.7–7.8)	**<.001**	2.5 (.9–6.6)	.07	…[b]		5.6 (.9–34.7)	.07
Married	ref		ref		ref		ref	
Sex with casual partner								
Yes	1.1 (.6–2.0)	.78	1.3 (.6–2.7)	.43	2.4 (.4–14.9)	.33	0.8 (.4–1.6)	.46
No	ref		ref		ref		ref	
Obstacles to obtaining condoms								
Yes	0.6 (.3–1.3)	.19	2.0 (1.1–3.8)	**.03**	0.4 (.1–2.8)	.34	0.9 (.5–1.9)	.84
No	ref		ref		ref		ref	
No. of sex partners, past year								
≥2	1.2 (.7–2.1)	.51	1.5 (.8–3.0)	.24	2.8 (.4–19.0)	.29	1.9 (.8–4.5)	.12
0–1	ref		ref		ref		ref	
Regular partner has sex with others								
Yes	2.9 (1.7–4.8)	**<.001**	1.8 (1.1–3.2)	**.04**	4.8 (.5–44.2)	.17	1.5 (.8–3.2)	.23
No	ref		ref		ref		ref	
Anal sex, ever								
Yes	0.8 (.4–1.4)	.41	0.7 (.3–1.2)	.20	0.2 (.1–3.0)	.28	2.3 (.9–5.8)	.08
No	ref		ref		ref		ref	
Alcohol use								
≥3 drinks/day	1.7 (1.0–2.9)	**.05**	2.3 (1.3–4.2)	**.006**	2.2 (.3–16.2)	.43	0.9 (.4–2.0)	.82
<3 drinks/day	ref		ref		ref		ref	
Tobacco use, past month								
Yes	1.3 (.8–2.4)	.31	1.9 (1.0–3.6)	**.05**	1.7 (.2–16.7)	.64	2.1 (.9–5.6)	.10
No	ref		ref		ref		ref	
Sexual coercion[c], past month								
Yes	1.0 (.6–1.8)	.98	1.3 (.8–2.4)	.31	7.9 (1.1–54.7)	**.04**	1.1 (.5–2.5)	.84
No	ref		ref		ref		ref	

Abbreviations: aRR, adjusted relative risk; CI, confidence interval; MSM, men who have sex with men; MSW, men who have only sex with women. *P* values in bold indicate statistical significance.

[a]"Other" includes Chinese, Asian, European, White, and Pacific Islanders who are not iTaukei.

[b]In the prepandemic period, all men with *Neisseria gonorrhoeae* were of iTaukei ethnicity, not married, and had more than a university education and therefore were not included in the prepandemic model.

[c]"Yes" defined as Sexual Coercion Score ≥1.

sex with a casual partner. Following the pandemic, iTaukei ethnicity was a risk factor for both gonorrhea and chlamydia for men. The heterogeneity of these results underscores the importance of identifying risk factors for defined risk groups as these differences can inform the design of targeted interventions to reduce infection and transmission.

Obstacles to obtaining condoms increased significantly postpandemic overall for both women and men but was associated with an increased risk of gonorrhea only among younger women following the pandemic. This likely reflects supply chain issues during the pandemic that have persisted to date. Barrier contraceptives are an important means to preventing STIs

Table 4. Multivariable Models for Characteristics and Risk Behaviors Associated With *Neisseria gonorrhoeae* at Any Anatomic Site Among Women Aged 18–24 Years and 25–40 Years, Stratified by Pre– and Post–Coronavirus Disease 2019 Pandemic Periods

	Age 18–24 y (n = 418)				Age 25–40 y (n = 1272)			
	Prepandemic (n = 290)		Postpandemic (n = 128)		Prepandemic (n = 926)		Postpandemic (n = 346)	
Women	aRR (95% CI)	*P* Value	aRR (95% CI)	*P* Value	aRR (95% CI)	*P* Value	aRR (95% CI)	*P* Value
Ethnicity								
iTaukei Fijian	5.4 (1.7–16.7)	**.003**	1.7 (.6–4.7)	.33	1.7 (.7–4.2)	.28	4.7 (1.4–16.5)	**.01**
Other[a]	ref		ref		ref		ref	
Education level								
Secondary or less	1.2 (.6–2.5)	.55	0.6 (.1–1.6)	.20	1.0 (.4–2.3)	.92	2.1 (.9–5.5)	.10
University or more	ref		ref		ref		ref	
Relationship status								
Not married	1.8 (.7–4.3)	.19	1.1 (.1–9.5)	.94	5.5 (2.1–14.5)	**<.001**	3.0 (1.0–9.4)	**.05**
Married	ref		ref		ref		ref	
Sex with casual partner								
Yes	0.9 (.5–1.8)	.78	1.2 (.4–7.1)	.74	1.4 (.5–4.5)	.53	1.5 (.6–3.6)	.37
No	ref		ref		ref		ref	
Obstacles to obtaining condoms								
Yes	0.4 (.2–1.3)	.13	2.7 (1.0–8.0)	**.05**	0.9 (.3–2.7)	.85	1.4 (.6–3.3)	.49
No	ref		ref		ref		ref	
No. of sex partners, past y								
≥2	1.3 (.7–2.6)	.43	2.6 (1.0–7.1)	**.05**	1.1 (.4–3.1)	.88	1.0 (.3–2.8)	.98
0–1	ref		ref		ref		ref	
Regular partner has sex with others								
Yes	3.5 (1.8–7.0)	**<.001**	1.8 (.7–9.4)	.14	2.3 (1.0–5.3)	**.05**	3.6 (1.6–7.9)	**.002**
No	ref		ref		ref		ref	
Anal sex, ever								
Yes	1.1 (.5–2.2)	.82	0.4 (.5–2.0)	.11	0.5 (.1–1.9)	.32	1.4 (.6–3.4)	.42
No	ref		ref		ref		ref	
Alcohol use								
≥3 drinks/day	1.6 (.9–3.1)	.13	1.4 (.4–5.1)	.48	1.7 (.7–4.3)	.23	7.1 (2.5–19.7)	**<.001**
<3 drinks/day	ref		ref		ref		ref	
Tobacco use, past month								
Yes	1.3 (.6–1.7)	.47	2.1 (.8–9.5)	.12	1.4 (.5–3.5)	.53	1.0 (.4–2.5)	.99
No	ref		ref		ref		ref	
Sexual coercion[b], past month								
Yes	0.7 (.3–1.4)	.29	1.0 (.3–5.2)	.95	1.6 (.6–4.1)	.31	1.6 (.8–3.5)	.19
No	ref		ref		ref		ref	

Abbreviations: aRR, adjusted relative risk; CI, confidence interval. *P* values in bold indicate statistical significance.

[a]"Other" includes Chinese, Asian, European, White, and Pacific Islanders that are not iTaukei.

[b]"Yes" defined as Sexual Coercion Score ≥1.

[31], and the lack of available condoms, in addition to the decrease in clinic staffing during and following the pandemic, may have increased risk for those who use them. MHMS clinicians also reported that participants often defied pandemic curfews, seeking sexual hook-ups via social networking apps, a behavior known to increase STI risk [32].

Fiji and other PICTs follow syndromic management of STIs. However, three-quarters of women and half of men with 1 or both STIs in this study did not meet syndromic treatment criteria, which would have resulted in significant undertreatment. In contrast, >50% who met the criteria were uninfected, which would have led to substantial overtreatment. These findings are consistent with many studies that have found similar discrepancies when syndromic management was compared with the results of sensitive diagnostics [9–11, 16, 33]. Overtreatment promotes antibiotic resistance, especially in LMICs where different antibiotic options are often limited [8, 9]. Reports of NG AMR and highly resistant strains or "superbugs" in neighboring New Zealand and Australia suggest that similar strains may also be present in Fiji and other PICTs [9, 34, 35]. This represents a regional and global threat, which will likely worsen with continued overtreatment of uninfected individuals [36], warranting a reevaluation of syndromic management.

Our study has limitations. The cross-sectional design does not allow us to assess causality of risk factors. While we enrolled

women and men in the most populated region of the archipelago, our study was limited by those who chose to attend MHMS and university clinics, which may reduce the generalizability of our results. We also had relatively fewer male participants and rectal samples, reducing our statistical power for multivariable subgroup analyses. Additionally, it was not possible within the scope of this study to perform antibiotic susceptibility testing for NG. Nonetheless, our findings are likely relevant to other PICTs and Pacific Islander populations in the Pacific Rim, including Hawaii and the US mainland where Fijians comprise the highest proportion of ethnic Pacific Islanders and are known to have significant health disparities [37]. These results hold practical implications for STI prevention and care in Fiji and similar settings in PICTs.

Prospective epidemiologic studies are urgently needed in Fiji and other PICTs to understand who is at greatest risk for gonorrhea and chlamydia, identify modifiable risk factors, and design and test evidence-based interventions to ensure equitable prevention and treatment of these infections. Susceptibility testing is essential to understanding NG AMR patterns in PICTs and developing effective treatment regimens [38]. Efforts to improve STI screening with point-of-care tests that follow REASSURED criteria (real-time connectivity, ease of specimen collection, affordable, sensitive, specific, user-friendly, rapid, equipment-free, delivered to users) [39] and include NG AMR detection are crucial for control. Innovative advances in vaccines and treatments for multidrug-resistant gonorrhea must be developed [40]. Addressing this public health crisis in Fiji, especially in light of postpandemic surges in global travel and HIV infections in PICTs [23], will help reduce the spread of STIs and NG AMR throughout the region and globally [8, 9, 38].

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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Patient consent. Each participant provided written informed consent. The study was approved by the University of California, San Francisco institutional review board and the Fijian Ministry of Health and Medical Sciences ethics committees in accordance with the Declaration of Helsinki.

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