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Factors associated with HIV and syphilis infection among female sex workers in three cities in Papua New Guinea: findings from *Kauntim mi tu*, a biobehavioral survey

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Abstract. **Background:** In this paper, factors associated with HIV and syphilis infection in three cities in Papua New Guinea are explored. **Methods:** Respondent-driven sampling surveys among FSW in Port Moresby, Lae, and Mt. Hagen (2016–17) were conducted. FSW who were aged ≥ 12 years, who were born female, who spoke English or Tok Pisin and who had sold or exchanged vaginal sex in the past 6 months were eligible to participate. Participants were interviewed face-to-face and offered rapid HIV and syphilis testing. Survey logistic procedures were used to identify factors associated with HIV and syphilis infection, including modern contraception use, physical violence and having a casual male partner. Weighted data analysis was conducted. **Results:** Overall, 2901 FSW (Port Moresby, 673; Lae, 709; and Mt. Hagen, 709) were enrolled in the study. HIV prevalence was 15.2% in Port Moresby, 11.9% in Lae and 19.6% in Mt. Hagen. Factors associated with HIV varied by city; for example, use of modern contraception in Port Moresby, experiences of physical violence in Lae and ever having tested for HIV in Mt. Hagen. No one variable was associated with HIV in all cities. Prevalence of syphilis infection was 7.1%, 7.0%, and 3.0% in Port Moresby, Lae, and Mt. Hagen, respectively. Factors associated with syphilis infection also varied by city and were only significant in Lae. **Conclusion:** The different factors associated with HIV and syphilis infection in each city highlight the complex HIV and syphilis epidemics among FSW and the importance of conducting surveys in multiple locations and developing local interventions.

Additional keywords: condoms, key populations, Pacific, sexually transmitted infections, violence.

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Introduction

As of 2017, globally there were 37 million HIV positive people, with key populations and their sexual partners accounting for 47% of new HIV infections.¹ One key population is sex workers who receive money or goods in exchange for sexual services. HIV prevalence among female sex workers is up to 20-fold higher than that of the general population.^{2–4} Understanding the factors associated with HIV among this vulnerable group is imperative for developing effective interventions relevant to the

epidemic in Papua New Guinea. Papua New Guinea has the largest HIV epidemic in the Pacific region.⁵ With the increase in routine HIV test reporting from antenatal clinics and numerous biobehavioural surveys, the understanding of Papua New Guinea's HIV epidemic has greatly improved. Papua New Guinea has a concentrated epidemic, with HIV prevalence estimated at 0.9% among the general population aged 15–49 years.⁶ HIV and syphilis prevalence among female sex workers ranges from 2.7% and 3.8%, respectively, in the

Eastern Highlands Province to 19.0% and 24.2%, respectively, in Port Moresby,^{7,8} the country's capital. However, the biological and behavioural data on female sex workers in Papua New Guinea, where the practice is illegal, are outdated,⁹ and no data have been published for the second and third largest cities in the country (Lae and Mt. Hagen).

Improved evidence that Papua New Guinea's HIV epidemic is concentrated among key populations such as female sex workers led to important national policy changes, as well as funding for biobehavioural surveillance targeting female sex workers to ensure appropriate interventions are designed and implemented.¹⁰ To address the substantial data gap in up-to-date biobehavioural surveillance data, we conducted, for the first time, a multisite biobehavioural survey using respondent-driven sampling among female sex workers in Port Moresby, Lae and Mt. Hagen. Our findings show the prevalence and factors associated with HIV and syphilis infection among female sex workers in Papua New Guinea. Although much attention is afforded to HIV, syphilis infection remains a serious public health concern among female sex workers; syphilis can be transmitted to partners, clients and unborn children and can cause genital ulceration that has been shown to be associated with increased risk of the transmission and acquisition of HIV.^{11–13} In *Tok Pisin*, a lingua franca of Papua New Guinea, the study was called *Kauntim mi tu* (in English, 'count me too').

Methods

Study design and criteria

Kauntim mi tu was a respondent-driven sampling biobehavioural survey conducted in Port Moresby (June–October 2016), Lae (January–June 2017) and Mt. Hagen (August–December 2017). Respondent-driven sampling is a variant of snowball sampling that can be used to produce sampling weights, compensating for the non-random nature of recruitment.^{14–16} To participate in this survey, female sex workers had to be born a biological female, be aged ≥ 12 years, have sold or exchanged vaginal sex in the past 6 months, speak English or Tok Pisin and have a valid study coupon. The low age criterion reflects how early some girls in Papua New Guinea engage in transactional sex. Additionally, Papua New Guinea allows individuals aged ≥ 12 years to undergo HIV testing without consent of a guardian or parent.¹⁷

Recruitment

Respondent-driven sampling recruitment^{18,19} started with five seeds (well respected, networked female sex workers who initiated recruitment) in Port Moresby, four seeds in Lae and five seeds in Mt. Hagen. Three additional seeds were added in Lae (total seven), and one in Mt. Hagen (total six) to speed recruitment and reach underrepresented female sex worker social networks. Seeds were purposely selected to create diversity with respect to age, place of residence, region of origin, marital status, receipt of a unique object for sample size estimation and affiliation with a non-governmental or community-based organisation. The longest

recruitment chain in each city had 15, 12, and 9 waves, respectively.

Community consultation

We extensively consulted with female sex workers and Friends Frangipani, a local civil society organisation representing sex workers, at all phases of the biobehavioural survey. After data collection, findings were reported to female sex workers who then offered site-specific recommendations – see study reports for specific recommendations.

Reimbursement

In all locations, participants received 45 PNG kina (~US\$14) for their first visit to the survey site and 10 PNG kina (~US\$3) per successful recruit plus 5 PNG kina (~US\$1.50) for transportation at their second visit. This reimbursement rate was negotiated between the communities of female sex workers and researchers and approved by the ethics committees. All participants also were provided with condoms, lubricants and information on HIV and other sexually transmissible infections.

Data collection

After providing verbal informed consent, participants completed a face-to-face interview with a trained Papua New Guinean researcher. The questionnaire included: sociodemographics; sexual history; sexual behaviours (e.g. anal sex); sex work characteristics (e.g. number of male clients); current sexual practices (e.g. having a main or casual male partner); HIV knowledge; access to support services and peer outreach including number of months since last contact with a peer educator or outreach worker; social support from peers; stigma and discrimination; physical and sexual violence; condom use; experience of sexually transmissible infections; HIV testing; and HIV care and treatment. The two-item Patient Health Questionnaire (PHQ-2) was used to screen for depression.²⁰ Comprehensive HIV knowledge was based on the United Nations Joint Program for HIV/AIDS definition of correctly answering three questions and rejecting two myths regarding HIV.²¹ The questionnaire was administered in the language of the participants' choice (English or *Tok Pisin*). The questionnaire took ~1.5 h to complete. No personal identifiers were collected.

Sample collection and diagnostic methods

For HIV testing, all participants provided written informed consent, as per national testing guidelines. Consenting female sex workers were tested for HIV using the Papua New Guinea national HIV testing algorithm, Determine HIV-1/2 (Alere, Hannover, Germany), with confirmation by Stat-Pak HIV-1/2 (Chembio, New York, NY, USA). Participants with an indeterminate result were advised to test again in 3 months. Participants testing HIV positive underwent CD4 T-cell count and HIV viral load testing. The Chembio DPP Syphilis Screen & Confirm Assay was used to test consenting participants for syphilis (Chembio, Medford, NY, USA). This test detects treponemal antibodies and rapid plasma reagin titre greater than one-eighth. We

categorised participants by treponemal and by non-treponemal test results: syphilis infection (treponemal reactive, non-treponemal reactive ≥ 1); past syphilis (treponemal reactive, non-treponemal non-reactive); no syphilis (treponemal non-reactive, non-treponemal non-reactive).²²

The study was enrolled in the Royal College of Pathologists of Australasia Quality Assurance Program (RCPA QAP). Quality assurance testing for syphilis was performed four times per annum and six times per annum for HIV. Additional quality control for HIV testing was conducted by screening all HIV-positive and inconclusive samples with a third HIV test, Geenius HIV-1/2 (Bio-Rad, Mitry-Mory, Switzerland). This testing was conducted at the Institute of Medical Research's Sexual and Reproductive Health Laboratory (Goroka, Papua New Guinea).

Treatment and referral

Female sex workers with a HIV positive result were actively linked by a peer mentor to a HIV treatment site. Onsite, same-day treatment for syphilis commenced following the PNG National STI treatment Guidelines,²³ with a referral to a clinic to continue treatment. Study staff were trained to identify and refer sexually exploited girls aged <18 years to partner organisations experienced in providing psychosocial and protective services. Results of all tests were included in a referral letter given to participants.

Data analysis

Data were analysed using Respondent-Driven Sampling Analyst version 0.62 (RDS-A, Los Angeles, CA, USA) and SAS version 9.3 (Carey, NC, USA). Gile's Successive Sampling Estimator was used in RDS-A.²⁴ RDS weights are based mainly on the number of people in a person's social network.⁹ We determined the number of people in the network through a series of questions asking participants the number of women they have seen in the last 2 weeks who: (1) they know sold sex or exchanged sex for money, goods or services in the last 6 months; (2) live or work in the study city; (3) are aged ≥ 12 years; and (4) who they have seen in the last 4 weeks. Weighted χ^2 tests were calculated to determine if differences in descriptive statistics were statistically significant ($P < 0.05$). Odds ratios (OR) and 95% confidence intervals (CI) were calculated and a $P < 0.1$ was the threshold for inclusion in multivariate analysis. Variables with a $P > 0.05$ were sequentially removed from multivariable analysis through stepwise backward elimination until only significant variables ($P < 0.05$) remained.

Ethics

This study was approved by the Papua New Guinea National Department of Health's Medical Research Advisor Committee, the Research Advisory Committee of the National AIDS Council Secretariat, the Papua New Guinea Institute of Medical Research's Institutional Review Board and the Human Research Ethics Committee, UNSW Sydney. The protocol was reviewed according to the Centers for Disease Control and Prevention's (CDC) human research

protection procedures and was determined to be research, but CDC was not engaged. A letter of support was provided by Friends Frangipani, the civil society organisation in Papua New Guinea representing the needs and interests of sex workers.

Results

We enrolled 2091 female sex workers in the study (Port Moresby, 673; Lae, 709; and Mt. Hagen, 709). We distributed 1995 coupons in Port Moresby, 2235 in Lae and 2201 in Mt. Hagen.

Across all three cities, the median age^{25–27} of female sex workers was similar, and a majority (81.6–86.5%) had below a high school education or no formal education. Female sex workers had diverse religious affiliations in all three cities, a majority had been divorced, separated or widowed (68.6–74.5%), a majority had lived in their city for ≥ 5 years (68.4–81.1%) and many travelled away from home for more than 1 month at a time in the last 6 months (14.4–25.0%). Sex work was the main form of income for 62.8–76.8% of female sex workers in all three cities. Approximately half of female sex workers across the three cities lived on <500 PNG kina per month (~US\$149). Depression was much higher in Mt. Hagen (53.2%) than in Port Moresby (22.0%) or Lae (36.6%). A minority (26.5–37.7%) of female sex workers in all three cities were using a modern contraceptive method. Physical violence in the last 12 months (26.0% in Port Moresby, 20.2% in Lae and 18.2% in Mt. Hagen) was marginally more common than sexual violence in the same period (15.2% in Port Moresby, 14.5% in Lae and 15.2% in Mt. Hagen; Table 1).

The majority (64.6–77.0%) of female sex workers in all three cities experienced their sexual debut between 15 and 19 years of age. Most (52.6–65.5%) had ever had anal sex and had diverse ages for both first having sold or exchanged sex, as well as the numbers of years they have been selling sex. A minority (7.9–17.6%) of female sex workers in all three cities used the Internet or mobile apps to meet clients in the last 6 months. More female sex workers in Port Moresby had a main male sexual partner and a casual male partner (54.9% and 21.5%, respectively) in the last 6 months than did female sex workers in Lae (46.4% and 17.4%, respectively) and Mt. Hagen (39.6% and 19.3%, respectively). In Mt. Hagen, 41.6% of female sex workers had 10 or more clients in the past 6 months, compared with 34.0% in Lae and 18.9% in Port Moresby (Table 2).

Condom use at last sexual encounter was low in all three cities, ranging from 27.1% to 37.2%. Low proportions of female sex workers received free condoms in the last 12 months in Port Moresby (59.7%), Lae (51.9%) and Mt. Hagen (42.8%). Half (50.9%) of all female sex workers in Mt. Hagen had never met with a peer educator compared with 30.6% in Port Moresby and 31.0% in Lae (Table 2).

Fewer female sex workers in Port Moresby (40.0% and 54.3%, respectively) than in Lae (62.9% and 70.2%, respectively) or Mt. Hagen (72.6% and 74.4%, respectively) could count on a peer to accompany them to the doctor or a hospital or count on a peer to let them borrow money if they

Table 1. Characteristics of female sex workers in Port Moresby, Lae and Mt. Hagen (2016–17)
CI, confidence interval; IQR, interquartile range

	Port Moresby			Lae			Mt. Hagen			<i>P</i> -value
	Valid <i>n</i>	Sample proportion %	Population proportion % (95% CI)	Valid <i>n</i>	Sample proportion %	Population proportion % (95% CI)	Valid <i>n</i>	Sample proportion %	Population proportion % (95% CI)	
Age (years)	633			609			554			<0.001
12–19	77	12.2	14.4 (10.9–18.0)	73	12.0	11.9 (8.9–15.0)	65	11.7	13.1 (9.8–16.4)	
20–24	173	27.3	28.9 (24.4–33.3)	166	27.3	26.7 (22.4–30.9)	173	31.2	32.4 (27.9–36.9)	
25–29	119	18.8	17.5 (13.9–21.1)	127	20.9	20.2 (16.4–24.0)	135	24.4	23.0 (19.1–26.9)	
30–34	94	14.8	15.0 (11.5–18.5)	105	17.2	19.5 (15.6–23.4)	83	15.0	15.1 (11.7–18.6)	
≥35	170	26.9	24.2 (20.1–28.2)	138	22.7	21.7 (17.8–25.6)	98	17.7	16.4 (13.0–19.8)	
Sample median (IQR)		27 (21–36)			29 (23–38)			28 (22–41)		
Education	672			708			709			<0.001
No formal education	163	24.3	23.6 (19.6–27.5)	256	36.2	35.6 (31.4–39.9)	284	40.1	39.9 (35.8–44.0)	
Primary	391	58.2	61.5 (57.0–66.1)	349	49.3	50.9 (46.5–55.3)	295	41.6	41.7 (37.5–45.8)	
High school or other	118	17.6	14.9 (11.6–18.1)	103	14.5	13.5 (10.5–16.4)	130	18.3	18.4 (15.1–21.7)	
Religious affiliation	673			705			708			<0.001
Seventh Day Adventist	235	34.9	36.6 (32.0–41.2)	207	29.4	28.7 (24.7–32.7)	130	18.4	19.2 (15.8–22.6)	
Mainstream Church (Catholic, Lutheran and United Church)	208	30.9	31.1 (26.7–35.6)	292	41.4	42.0 (37.6–46.4)	313	44.2	43.3 (39.1–47.4)	
Pentecostal (Revival/Four Square, other Christian)	172	25.6	23.9 (20.0–27.8)	166	23.5	22.7 (19.0–26.3)	188	26.6	26.6 (22.9–30.3)	
Other (No religious affiliation, other non-Christian, other Protestant)	58	8.6	8.3 (5.7–10.8)	40	5.7	6.6 (4.2–8.9)	77	10.9	10.9 (8.3–13.5)	
Marital status	673			708			709			<0.001
Never married	115	17.1	18.2 (14.4–21.9)	137	19.4	19.5 (16.0–23.0)	142	20.0	21.5 (18.0–25.1)	
Married	93	13.8	13.2 (10.1–16.4)	75	10.6	10.5 (7.8–13.2)	26	3.7	4.0 (2.2–5.7)	
Divorced, separated or widowed	465	69.1	68.6 (64.2–73.0)	496	70.1	70.0 (65.9–74.0)	541	76.3	74.5 (70.7–78.3)	
Residence in city (years)	670			708			709			<0.001
<5	119	17.8	18.9 (15.1–22.7)	210	29.7	31.6 (27.4–35.8)	161	22.7	25.8 (22.0–29.6)	
≥5	551	82.2	81.1 (77.3–84.9)	498	70.3	68.4 (64.2–72.6)	548	77.3	74.2 (70.4–78.0)	
Away from home for >1 month at a time in last 6 months	650			667			594			<0.001
Yes	91	14.0	14.4 (11.0–17.8)	164	24.6	25.0 (21.0–29.0)	151	25.4	23.7 (20.0–27.5)	
Sex work as main source of income	671			701			686			<0.001
Yes	467	69.6	66.5 (61.9–71.1)	458	65.3	62.8 (58.4–67.1)	535	78.0	76.8 (73.1–80.4)	
Average monthly income (kina)	578			589			556			<0.001
<200 (~US\$63)	76	13.1	14.5 (10.8–18.2)	67	11.4	11.0 (8.0–14.0)	68	12.2	13.0 (9.7–16.3)	
200–499	237	41.0	41.9 (36.8–46.9)	264	44.8	47.2 (42.3–52.0)	216	38.8	38.4 (33.8–43.0)	
500–999	145	25.1	24.9 (20.5–29.4)	146	24.8	25.4 (21.2–29.6)	184	33.1	32.3 (27.8–36.7)	
≥1000	120	20.8	18.7 (14.9–22.6)	112	19.0	16.4 (13.1–19.8)	88	15.8	16.3 (12.8–19.9)	
Screened positive for depression	671			708			709			<0.001
Yes	148	22.1	22.0 (18.0–25.9)	252	35.6	36.6 (32.3–40.9)	369	52.0	53.2 (49.0–57.4)	
Using modern contraceptive method	466			446			430			<0.001
Yes	171	36.7	37.7 (32.2–43.2)	131	29.4	30.9 (25.6–36.1)	121	28.1	26.5 (21.9–31.2)	
Physical violence, last 12 months	669			702			697			<0.001
Yes	187	28.0	26.0 (21.9–30.1)	146	20.8	20.2 (16.6–23.7)	125	17.9	18.2 (14.9–21.4)	
Sexual violence, last 12 months	664			694			701			0.683
Yes	109	16.4	15.2 (11.9–18.6)	112	16.1	14.5 (11.5–17.5)	115	16.4	15.2 (12.2–18.2)	

asked. Approximately half (53.7–55.9%) of female sex workers in Port Moresby, Lae and Mt. Hagen had a symptom of a sexually transmissible infection in the past 12 months. Between 56.1% and 68.2% of female sex workers had ever tested for HIV across all three cities. In all cities, comprehensive HIV knowledge was low (20.5–35.6%; data not shown; Table 2).

HIV results

HIV prevalence was 15.2% (95% CI: 11.7–18.8) in Port Moresby, 11.9% (95% CI: 9.0–14.8) in Lae and 19.6% (95% CI: 16.1–23.0) in Mt. Hagen. Among female sex workers in Port Moresby, factors associated with HIV in multivariate

analysis included not using modern contraceptive methods (e.g. intrauterine devices, tubal ligation, Depo and other injectables and the oral pill; aOR, 2.7; 95% CI: 1.2–5.9) and an inability to count on another female sex worker to accompany her to the doctor or hospital (aOR, 2.3; 95% CI: 1.0–5.1; Table 3). In Lae, factors associated with HIV included having experienced physical violence in the last 12 months (aOR, 2.5; 95% CI: 1.2–4.9), not having used the Internet or mobile applications to meet clients in the last 6 months (aOR, 7.2; 95% CI: 1.9–27.4), not having a main male sexual partner in the last 6 months (aOR, 2.4; 95% CI: 1.3–4.6), an inability to count on another female sex worker to lend money (aOR, 2.2; 95% CI: 1.2–4.0) and having been given free condoms in the last 12 months (aOR, 3.2; 95% CI: 1.7–6.0; Table 4). In Mt.

Table 2. Sexual behaviours, sex work characteristics, HIV services and laboratory-confirmed HIV and syphilis infection results among female sex workers in Port Moresby, Lae and Mt. Hagen (2016–17)
CI, confidence interval; STI, sexually transmissible infection

	Port Moresby			Lae			Mt. Hagen			<i>P</i> -value
	Valid <i>n</i>	Sample proportion %	Population proportion % (95% CI)	Valid <i>n</i>	Sample proportion %	Population proportion % (95% CI)	Valid <i>n</i>	Sample proportion %	Population proportion % (95% CI)	
Age of sexual debut (years)	634			578			525			<0.001
10–14	103	16.2	14.5 (11.3–17.6)	154	26.6	26.5 (22.1–30.9)	100	19.0	18.5 (14.9–22.2)	
15–19	469	74.0	77.0 (73.2–80.9)	374	64.7	64.6 (59.8–69.3)	370	70.5	69.5 (64.9–74.0)	
≥20	62	9.8	8.5 (6.0–11.0)	50	8.7	8.9 (6.1–11.7)	55	10.5	12.0 (8.7–15.4)	
Ever had anal sex	672			706			709			<0.001
Yes	357	53.1	52.6 (47.8–57.3)	453	64.2	62.5 (58.1–66.8)	472	66.6	65.5 (61.5–69.5)	
Age first sold or exchanged sex (years)	626			605			529			<0.001
10–14	32	5.1	4.9 (2.9–7.0)	50	8.3	7.4 (5.0–9.9)	26	4.9	5.6 (3.3–7.9)	
15–19	208	33.2	35.1 (30.4–39.8)	213	35.2	32.6 (28.2–37.0)	209	39.5	39.0 (34.3–43.8)	
20–24	172	27.5	26.5 (22.2–30.8)	148	24.5	25.7 (21.5–29.9)	161	30.4	31.0 (26.5–35.5)	
25–29	99	15.8	15.5 (11.9–19.2)	109	18.0	19.4 (15.5–23.3)	84	15.9	15.6 (12.1–19.1)	
30–34	66	10.5	11.7 (8.5–15.0)	50	8.3	8.0 (5.4–10.6)	32	6.0	6.4 (4.0–8.9)	
≥35	49	7.8	6.2 (4.3–8.2)	35	5.8	6.9 (4.3–9.5)	17	3.2	2.3 (1.2–3.5)	
Years selling sex	671			688			638			<0.001
<1	61	9.1	9.4 (6.7–12.2)	42	6.1	6.5 (4.3–8.8)	34	5.3	6.2 (4.0–8.5)	
1–2	189	28.2	30.4 (26.0–34.9)	154	22.4	23.7 (19.8–27.6)	158	24.8	26.0 (22.1–29.9)	
3–4	134	20.0	21.5 (17.5–25.4)	165	24.0	26.2 (22.1–30.2)	166	26.0	25.8 (21.9–29.7)	
5–9	150	22.4	20.1 (16.4–23.8)	194	28.2	28.1 (24.1–32.1)	198	31.0	30.6 (26.5–34.6)	
≥10	137	20.4	18.6 (15.0–22.2)	133	19.3	15.5 (12.5–18.4)	82	12.9	11.4 (8.7–14.1)	
Used Internet or mobile apps to meet clients in last 6 months	672			708			709			<0.001
Yes	60	8.9	7.9 (5.5–10.4)	85	12.0	10.8 (8.2–13.4)	133	18.8	17.6 (14.5–20.7)	
Had a main male partner in last 6 months	671			707			707			<0.001
Yes	371	55.3	54.9 (50.1–59.6)	311	44.0	46.4 (42.0–50.8)	260	36.8	39.6 (35.4–43.8)	
Had a casual male partner in last 6 months	672			708			709			<0.001
Yes	144	21.4	21.5 (17.7–25.4)	124	17.5	17.4 (14.0–20.8)	138	19.5	19.3 (15.9–22.6)	
Number of male clients who gave money, last 6 months	665			703			702			<0.001
1–2	197	29.6	32.1 (27.5–36.6)	151	21.5	22.7 (18.9–26.5)	74	10.5	12.1 (9.2–15.1)	
3–4	183	27.5	29.1 (24.7–33.4)	134	19.1	20.3 (16.7–23.9)	132	18.8	20.8 (17.2–24.3)	
5–9	140	21.1	20.0 (16.3–23.6)	162	23.0	23.0 (19.3–26.8)	174	24.8	25.5 (21.8–29.2)	
≥10	145	21.8	18.9 (15.3–22.5)	256	36.4	34.0 (29.8–38.1)	322	45.9	41.6 (37.5–45.7)	
Used condom for last sex act	671			708			705			<0.001
Yes	258	38.5	37.2 (32.6–41.7)	245	34.6	32.1 (28.0–36.2)	204	28.9	27.1 (23.5–30.8)	
Ever had contact with peer educator or outreach worker	668			674			678			<0.001
Yes	466	69.8	69.4 (65.0–73.8)	494	73.3	69.0 (64.7–73.4)	353	52.1	49.1 (44.8–53.4)	
Can count on other sex workers to accompany her to the doctor or hospital if she asked them	651			692			678			<0.001
Yes	269	41.3	40.0 (35.3–44.7)	444	64.2	62.9 (58.5–67.3)	496	73.2	72.6 (68.8–76.5)	
Can count on other sex workers to let her borrow money if she asked them	667			695			692			<0.001
Yes	358	53.7	54.3 (49.6–59.0)	473	68.1	70.2 (66.2–74.3)	517	74.7	74.4 (70.6–78.1)	
Given free condoms in last 12 months	670			704			707			<0.001
Yes	408	60.9	59.7 (55.0–64.3)	394	56.0	51.9 (47.4–56.3)	325	46.0	42.8 (38.7–47.0)	
Experienced at least one self-reported STI symptom in the last 12 months	669			702			699			0.281
Yes	365	54.6	55.9 (51.2–60.6)	396	56.4	55.1 (50.7–59.5)	379	54.2	53.7 (49.5–58.0)	
Ever tested for HIV	672			706			708			<0.001
Yes	479	71.3	68.2 (63.7–72.7)	418	59.2	56.1 (51.6–60.5)	439	62.0	60.0 (55.8–64.1)	
HIV infection	663			704			709			<0.001
Yes	94	14.2	15.2 (11.7–18.8)	83	11.8	11.9 (9.0–14.8)	133	18.8	19.6 (16.1–23.0)	
Syphilis infection	666			709			709			<0.001
Yes	41	6.2	7.1 (4.6–9.6)	43	6.1	7.0 (4.6–9.3)	26	3.7	3.0 (1.8–4.3)	

Table 3. Factors associated with testing positive for HIV and syphilis infection among female sex workers in Port Moresby, Papua New Guinea (2016)

OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; Ref, reference

Characteristic	<i>n</i>	Bivariate OR (95% CI) HIV infection	<i>P</i> value	Multivariate a OR (95% CI)	<i>P</i> -value
Sex work as main source of income	661		0.086		
Yes		Ref			
No		1.6 (0.9–2.9)			
Screened positive for depression	661		0.001		
Yes		2.2 (1.2–4.1)			
No		Ref			
Using modern contraceptive method	463		0.008		0.013
Yes		Ref		Ref	
No		2.9 (1.3–6.2)		2.7 (1.2–5.9)	
Sexual violence in last 12 months	654		0.009		
Yes		Ref			
No		2.8 (1.3–6.1)			
Can count on other sex workers to accompany her to the doctor or hospital if she asked them	641		0.001		0.039
Yes		Ref		Ref	
No		2.7 (1.5–5.0)		2.3 (1.0–5.1)	
		Active syphilis infection			
Ever had anal sex	665		0.084		
Yes		Ref		Ref	0.127
No		2.0 (0.9–4.2)		1.8 (0.8–3.9)	
Can count on other sex workers to let her borrow money if she asked them	660		0.070		
Yes		Ref		Ref	0.094
No		2.0 (0.9–4.3)		1.9 (0.9–4.1)	

Hagen, the only factor associated with HIV was having ever tested for HIV (aOR, 2.1; 95% CI: 1.2–3.5; Table 5).

Syphilis infection results

Prevalence of syphilis infection was 7.1% (95% CI: 4.6–9.6) in Port Moresby, 7.0% (95% CI: 4.6–9.3) in Lae and 3.0% (95% CI: 1.8–4.3) in Mt. Hagen. Among female sex workers in Port Moresby (Table 3) and Mt. Hagen (Table 5), there were no statistically significant factors associated with syphilis in the multivariable analysis; appropriately powering our analysis for the low prevalence of syphilis infection with an increased target sample size may have resulted in significant *P*-values for these factors. Nonetheless, these models still yield valuable information. Although our findings were not statistically significant, we still should consider the plausibility of the covariates.²⁸ In Port Moresby, the inability to count on another female sex worker to lend money had an aOR of 1.9 with a 95% CI that was almost above 1 (0.9–4.1; Table 3). In Lae, two potential factors associated with syphilis infection were having had a casual male partner for <6 months (aOR, 2.4; 95% CI: 1.1–5.2) and reporting having had no sexually transmissible infection symptoms in the past 12 months (aOR, 2.1; 95% CI: 1.0–4.4; Table 4). In Mt. Hagen, no factors for syphilis had 95% CI that were close to excluding the value of 1 (Table 5).

Discussion

Kauntim mi tu is the first biobehavioural survey among female sex workers in Papua New Guinea since 2010⁷ and the first to include female sex workers in the country's second and third largest cities. HIV prevalence among female sex workers in Port Moresby (15.2%) is lower than the previous study where 19.0% were infected.⁷ The HIV prevalence in Mt. Hagen (19.6%) is higher than the average prevalence among female sex workers in other low-income and middle-income countries with similarly low background epidemics among the general population, such as Brazil and Vietnam, in which the average HIV prevalence among female sex workers is 11.8%.²⁹ Moreover, the HIV prevalence in Mt. Hagen is now the same as the HIV prevalence among female sex workers was in 2010 in the national capital.⁷ HIV prevalence in Lae is similar to rates in Brazil and Vietnam. Syphilis infection was highest in Port Moresby and Lae, but syphilis infection was not associated with HIV in any of the three cities. To our knowledge, our study is the first to provide multisite data for female sex workers in the three major cities in Papua New Guinea and offers new and important understandings of the HIV epidemic.

In all three cities, we identified several different factors associated with HIV among female sex workers. This variation supports the importance of granular data collection

Table 4. Factors associated with testing positive for HIV and syphilis infection among female sex workers in Lae, Papua New Guinea (2017)
OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; Ref, reference; STI, sexually transmissible infection

Characteristic	<i>n</i>	Bivariate OR (95% CI)	<i>P</i> value	Multivariate aOR (95% CI)	<i>P</i> value
HIV infection					
Sex work as main source of income	696		0.013		
Yes		2.4 (1.2–4.7)			
No		Ref			
Physical violence in last 12 months	697		0.009	2.5 (1.2–4.9)	0.012
Yes		2.3 (1.2–4.2)			
No		Ref		Ref	
Ever had anal sex	701		0.055		
Yes		1.8 (1.0–3.4)			
No		Ref			
Years selling sex	684		0.073		
<1		Ref			
1–2		0.4 (0.1–1.2)			
3–4		0.5 (0.1–1.4)			
5–9		0.8 (0.3–2.6)			
≥10		1.1 (0.3–3.4)			
Used internet or mobile apps to meet clients in last 6 months	703		0.005		0.004
Yes		Ref		Ref	
No		4.8 (1.6–14.5)		7.2 (1.9–27.4)	
Had a main male partner in last 6 months	702		0.014		0.006
Yes		Ref		Ref	
No		2.1 (1.2–3.7)		2.4 (1.3–4.6)	
Ever had contact with peer educator or outreach worker	669		0.073		0.073
Yes		1.9 (0.9–3.9)		1.9 (0.9–4.0)	
No		Ref		Ref	
Can count on other sex workers to let her borrow money if she asked them	690		0.018		0.013
Yes		Ref		Ref	
No		2.0 (1.1–3.5)		2.2 (1.2–4.0)	
Given free condoms in last 12 months	699		<0.001		<0.001
Yes		3.9 (2.0–7.3)		3.2 (1.7–6.0)	
No		Ref		Ref	
Syphilis infection					
Residence in city (years)	708		0.095		
<5		Ref			
≥5		2.5 (0.9–7.0)			
Had a casual male partner in last 6 months	708		0.047		0.035
Yes		2.2 (1.0–5.0)		2.4 (1.1–5.2)	
No		Ref		Ref	
Experienced at least one self-reported STI symptom in the last 12 months	702		0.061		0.044
Yes		Ref		Ref	
No		2.0 (1.0–4.2)		2.1 (1.0–4.4)	

in different cities, as well as focused interventions that can respond to local issues in collaboration with civil society organisations and community members.^{25–27}

In Port Moresby, female sex workers who were not using modern contraceptive methods had higher odds of HIV infection compared with women who were using such methods. This suggests that women not using modern contraceptive methods may be trying to get pregnant and are at increased risk for HIV acquisition. HIV infection was also associated with an inability to rely on peers to assist female sex workers to see a doctor or attend a health facility or hospital. This suggests an opportunity for social support interventions through community-based organisations to

promote social capital and support among female sex workers.²⁷

In Lae, HIV infection was associated with an inability to rely on peers to borrow money, further revealing weak social bonds between sex workers. Increased odds of HIV infection among female sex workers who had received condoms in the last 12 months suggests that these women may have been given condoms due to their increased risk of HIV infection or because they were aware of their HIV status and were given condoms at a HIV treatment facility.

As only 60.0% of women in Mt. Hagen had ever been tested for HIV, and a history of testing for HIV was associated with HIV, it is possible that many female sex workers only access

Table 5. Factors associated with testing positive for HIV and syphilis infection among female sex workers in Mt. Hagen, Papua New Guinea (2017)
OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; Ref, reference

Characteristic	<i>n</i>	Bivariate OR (95% CI)	<i>P</i> value	Multivariate aOR (95% CI)	<i>P</i> value
HIV infection					
Can count on other sex workers to let her borrow money if she asked them	692		0.075		0.106
Yes		Ref		Ref	
No		1.6 (1.0–2.5)		1.5 (0.9–2.5)	
Ever tested for HIV	707		0.003		0.006
Yes		2.2 (1.3–3.6)		2.1 (1.2–3.5)	
No		Ref		Ref	
Syphilis infection					
Number of male clients who gave money in last 6 months	702		0.049		0.089
1–2		0.3 (0.1–1.4)		0.4 (0.1–1.9)	
3–4		0.4 (0.1–2.0)		0.4 (0.1–2.1)	
5–9		0.2 (0.1–0.7)		0.2 (0.0–0.8)	
≥10		Ref		Ref	
Used condom at last sex act	705		0.055		
Yes		2.3 (1.0–5.4)			
No		Ref			
Can count on other sex workers to accompany her to the doctor or hospital if she asked them	678		0.056		0.146
Yes		3.0 (1.0–9.3)		2.4 (0.7–7.8)	
No		Ref		Ref	

HIV testing when they already have symptoms of HIV or when they fear they have been exposed to HIV. This finding suggests a need to expand testing services through new mediums, such as social network strategies and facilitated self-testing.

Physical violence was only associated with HIV infection in Lae. We found that although sexual violence was associated with HIV infection in bivariate analyses in one site (Port Moresby), it was no longer statistically significant once included in the multivariate analysis, and was eliminated from the final multivariate model for this site (Table 3). Reducing sexual violence is important, but specific sexual violence-reduction programs may not reduce the risk of HIV infection among female sex workers in Papua New Guinea. Survivors of sexual violence should receive proper care, treatment and post-exposure prophylaxis. Our findings are supported by similar results in other contexts, even those with high HIV prevalence, where sexual violence has been reported to have a negligible effect on HIV prevalence^{30,31} and is not associated with HIV infection,^{30,32} including at the population level.³³ Future studies are needed to focus specifically on the effects of violence on HIV infection.

As with HIV, the factors associated with syphilis infection in the three cities varied. Because sexually transmissible infections can contribute to both the transmission and acquisition of HIV,^{11–13} female sex workers should routinely receive both HIV testing and testing and treatment for syphilis. Potential factors associated with syphilis infection included having more paying clients in Mt. Hagen and having a casual partner in Lae, which suggests that supplying condoms to female sex workers in these cities could prevent transmission not only of HIV but sexually transmissible infections such as syphilis. Additionally, the

correlation between lack of sexually transmissible infection symptoms (e.g. discharge or ulcer) and syphilis infection in Lae suggests that syndromic management of sexually transmissible infections alone is insufficient and that more testing for sexually transmissible infections is needed in Papua New Guinea.

Our findings are limited by the cross-sectional nature of our survey and by potential bias because the survey was administered face-to-face. Using audio-computer-assisted self-interviews, a method used in the earlier 2010 female sex worker biobehavioural survey in Port Moresby, rather than face-to-face interviews, may have helped decrease this bias.⁶ It is also important to note that we calculated the sample sizes to power for HIV prevalence. Because syphilis prevalence was lower than HIV prevalence, we were unable to determine statistically significant factors associated with syphilis infection.

The differences in factors associated with HIV and syphilis infection from *Kauntim mi tu* provide valuable information for HIV and sexually transmissible infection programming and resource allocation. Our findings can help health service providers find new approaches to reach female sex workers in Papua New Guinea and bolster peer outreach, testing and treatment across the country.

Kauntim mi tu highlights the complexity of transactional sex and HIV risk in Papua New Guinea. As with all biobehavioural evidence, our findings reflect social structures, including the legal environment. The illegality of sex work and other structural barriers negatively affect the framing and delivery of public health services to prevent HIV among female sex workers.^{4,34–39} To reduce new HIV infections among female sex workers and care for those already living with HIV, public health programs in Papua

New Guinea should consider addressing structural barriers, including health systems, the law, socioeconomic factors, long-standing cultures of violence and inequalities in power.^{4,34–39}

Conflicts of interest

The authors declare that they have no conflicts of interest.

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References

- 1 The Joint United Nations Programme on HIV and AIDS, editor. 2017 Global HIV Statistics. Geneva: UNAIDS; 2018.
- 2 Ngugi EN, Roth E, Mastin T, Nderitu MG, Yasmin S. Female sex workers in Africa: epidemiology overview, data gaps, ways forward. *SAHARA J* 2012; 9: 148–53. doi:10.1080/17290376.2012.743825
- 3 Kerrigan D, Wirtz A, Baral S, Decker M, Murray L, Poteat T, *et al.* The global HIV epidemics among sex workers. Washington DC, USA: World Bank; 2013.
- 4 Shannon K, Crago AL, Baral SD, Bekker LG, Kerrigan D, Decker MR, *et al.* The global response and unmet actions for HIV and sex workers. *Lancet* 2018; 392: 698–710. doi:10.1016/S0140-6736(18)31439-9
- 5 National AIDS Council Secretariate, editor. National HIV and AIDS Strategy 2011–2015. Port Moresby: National Department of Health; 2010.
- 6 World Health Organization. Country profiles on HIV: Papua New Guinea. 2018. Available online at: <http://www.wpro.who.int/hiv/data/countries/png/en/> [verified 13 September 2018].
- 7 Kelly A, Kupul M, Man WYN, Nosi S, Lote N, Rawstone P, *et al.* Askim na Save (Ask and understand): people who sell and/or exchange sex in Port Moresby. Key Quantitative Findings. Sydney, Australia: Papua New Guinea Institute of Medical Research and the University of New South Wales; 2011.
- 8 Maibani G, Ryan C, Lote N, Edward G, Ralai A, Gare J, *et al.* Papua New Guinea - Australia Sexual Health Improvement Program. Report on the Baseline Survey. Goroka: PNG Institute of Medical Research; 2011.
- 9 World Health Organization, CDC, UNAIDS, FHI 360. Biobehavioral survey guidelines for Populations at Risk for HIV. Geneva: World Health Organization; 2017.
- 10 Kelly-Hanku A. Past. Present. Future. Response(s) to HIV in Papua New Guinea. Australasian HIV/AIDS Conference; 2016 Nov 14–16; Adelaide, Australia, 2016.
- 11 Cohen M. Sexually transmitted diseases enhance HIV transmission: no longer a hypothesis. *Lancet* 1998; 351: 5–7. doi:10.1016/S0140-6736(98)90002-2
- 12 Freeman EE, Weiss HA, Glynn JR, Cross PL, Whitworth JA, Hayes RJ. Herpes simplex virus 2 infection increases HIV acquisition in men and women: systematic review and meta-analysis of longitudinal studies. *AIDS* 2006; 20: 73–83. doi:10.1097/01.aids.0000198081.09337.a7
- 13 Zetola NM, Klausner JD. Syphilis and HIV infection: an update. *Clin Infect Dis* 2007; 44: 1222–8. doi:10.1086/513427
- 14 Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden populations. *Soc Probl* 1997; 44: 174–99. doi:10.2307/3096941
- 15 Heckathorn DD. Snowball versus respondent-driven sampling. *Sociol Methodol* 2011; 41: 355–66. doi:10.1111/j.1467-9531.2011.01244.x
- 16 Malekinejad M, Johnston LG, Kendall C, Kerr LR, Rifkin MR, Rutherford GW. Using respondent-driven sampling methodology for HIV biological and behavioral surveillance in international settings: a systematic review. *AIDS Behav* 2008; 12: S105–30. doi:10.1007/s10461-008-9421-1
- 17 Government of Papua New Guinea. The HIV and AIDS Management and Prevention Act. Port Moresby: Government of Papua New Guinea; 2003.
- 18 Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden populations. *Soc Probl* 1997; 44: 174–99. doi:10.2307/3096941
- 19 Johnston LG, Hakim AJ, D'ittrich S, Burnett J, Kim E, White RG. A systematic review of published respondent-driven sampling surveys collecting behavioral and biologic data. *AIDS Behav* 2016; 20: 1754–76. doi:10.1007/s10461-016-1346-5
- 20 Kroenke K Sr, Williams JB. The Patient Health Questionnaire-2: validity of a two-item depression screener. *Med Care* 2003; 41: 1284–92. doi:10.1097/01.MLR.0000093487.78664.3C
- 21 The Joint United Nations Programme on HIV and AIDS. Global AIDS response progress reporting 2014: construction of core indicators for monitoring the 2011 United Nations political declaration on HIV and AIDS. Geneva: UNAIDS; 2014.
- 22 Causer LM, Kaldor JM, Conway DP, Leslie DE, Denham I, Karapanagiotidis T, *et al.* An evaluation of a novel dual treponemal/nontreponemal point-of-care test for syphilis as a tool to distinguish active from past treated infection. *Clin Infect Dis* 2015; 61: 184–91. doi:10.1093/cid/civ243
- 23 National Department of Health PNG. Standard treatment guidelines for adults. Port Moresby: National Department of Health PNG; 2012.
- 24 Gile KJ. Improved inference for respondent-driven sampling data with application to HIV prevalence estimation. *J Am Stat Assoc* 2011; 106: 135–46. doi:10.1198/jasa.2011.ap09475
- 25 Schwartländer B, Stover J, Hallett T, Atun R, Avila C, Gouws E, *et al.* Towards an improved investment approach for an effective response to HIV/AIDS. *Lancet* 2011; 377: 2031–41. doi:10.1016/S0140-6736(11)60702-2
- 26 Berkman A, Garcia J, Muñoz-Laboy M, Paiva V, Parker R. A critical analysis of the Brazilian response to HIV/AIDS: lessons learned for controlling and mitigating the epidemic in developing countries. *Am J Public Health* 2005; 95: 1162–72. doi:10.2105/AJPH.2004.054593
- 27 Campbell C, Scott K, Nhamo M, Nyamukapa C, Madanhire C, Skovdal M, *et al.* Social capital and HIV Competent Communities: the role of community groups in managing HIV/AIDS in rural Zimbabwe. *AIDS Care* 2013; 25: S114–22. doi:10.1080/09540121.2012.748170
- 28 Wasserstein RL, Schirm AL, Lazar NA. Editorial: moving to a world beyond “p<0.05”. *Am Stat* 2019; 73: 1–9. doi:10.1080/00031305.2019.1583913

- 29 Baral SBC, Muessig K, Poteat T, Wirtz AL, Decker MR, Sherman SG, *et al.* Burden of HIV among female sex workers in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet Infect Dis* 2012; 12: 538–49. doi:10.1016/S1473-3099(12)70066-X
- 30 Anema A, Joffres MR, Mills E, Spiegel PB. Widespread rape does not directly appear to increase the overall HIV prevalence in conflict-affected countries: so now what? *Emerg Themes Epidemiol* 2008; 5: 11. doi:10.1186/1742-7622-5-11
- 31 Supervie V, Halima Y, Blower S. Assessing the impact of mass rape on the incidence of HIV in conflict-affected countries. *AIDS* 2010; 24: 2841–7. doi:10.1097/QAD.0b013e32833fed78
- 32 Decker MR, Wirtz AL, Baral SD, Peryshkina A, Mogilnyi V, Weber RA, *et al.* Injection drug use, sexual risk, violence, and STI/HIV among Moscow FSWs. *Sex Transm Infect* 2012; 88: 278–83. doi:10.1136/sextrans-2011-050171
- 33 Watts CH, Foss AM, Hossain M, Zimmerman C, von Simson R, Klot J. Sexual violence and conflict in Africa: prevalence and potential impact on HIV incidence. *Sex Transm Infect* 2010; 86: iii93–9. doi:10.1136/sti.2010.044610
- 34 Shannon K, Kerr T, Allinott S, Chettiar J, Shoveller J, Tyndall MW. Social and structural violence and power relations in mitigating HIV risk of drug-using women in survival sex work. *Soc Sci Med* 2008; 66: 911–21. doi:10.1016/j.socscimed.2007.11.008
- 35 Bhattacharjee P, Isac S, McClarty LM, Mohan HL, Maddur S, Jagannath SB, *et al.* Strategies for reducing police arrest in the context of an HIV prevention programme for female sex workers: evidence from structural interventions in Karnataka, South India. *J Int AIDS Soc* 2016; 19: 20856. doi:10.7448/IAS.19.4.20856
- 36 Shannon K, Goldenberg SM, Deering KN, Strathdee SA. HIV infection among female sex workers in concentrated and high prevalence epidemics: why a structural determinants framework is needed. *Curr Opin HIV AIDS* 2014; 9: 174–82. doi:10.1097/COH.0000000000000042
- 37 Awungafac G, Delvaux T, Vuylsteke B. Systematic review of sex work interventions in sub-Saharan Africa: examining combination prevention approaches. *Trop Med Int Health* 2017; 22: 971–93. doi:10.1111/tmi.12890
- 38 Gupta GR, Parkhurst JO, Ogden JA, Aggleton P, Mahal A. Structural approaches to HIV prevention. *Lancet* 2008; 372: 764–75. doi:10.1016/S0140-6736(08)60887-9
- 39 Shannon K, Strathdee SA, Goldenberg SM, Duff P, Mwangi P, Rusakova M, *et al.* Global epidemiology of HIV among female sex workers: influence of structural determinants. *Lancet* 2015; 385: 55–71. doi:10.1016/S0140-6736(14)60931-4