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Gaps in HIV Testing and Treatment Among Female Sex Workers in Lae and Mt. Hagen, Papua New Guinea

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Abstract

We conducted biobehavioral surveys among female sex workers (FSW) in Lae and Mt. Hagen, Papua New Guinea (January–December 2017). Respondent-driven sampling was used to recruit FSW aged ≥ 12 years, who were assigned female sex at birth, who spoke English or Tok Pisin, and who sold or exchanged sex for money, goods, or services in the last 6 months. When adjusted for viral suppression, 48.9% of FSW Lae and 61.9% in Mt. Hagen were aware of their HIV positive status. Of these women, 95.3% in Lae and 98.9% in Mt. Hagen were on antiretroviral therapy, and of these, 83.5% in Lae and 87.0% in Mt. Hagen had suppressed viral load. Renewed efforts are needed to increase HIV testing among FSW and provide support to FSW on treatment in both cities to attain viral suppression.

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Author Contributions AJH and AKH designed the study and conceived of the manuscript. SGB and AJV led the biomarker component of the study. KC, DW, and AJH analyzed the data. AAK and BW supervised the study which was implemented by BW, RN, JG, SP, MK, PH, HA, RNB, JN, and SA. Technical support was provided by ND and JMK. AJH and KC contributed substantially to the writing of the manuscript, SC provided technical feedback on an early draft. All authors reviewed and approved the manuscript.

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Conflict of interest The authors declare that they have no competing interests.

Ethical Approval This survey was approved by the PNG National Department of Health's Medical Research Advisory Committee (MRAC), the Research Advisory Committee of the National AIDS Council Secretariat (RAC), the PNG Institute of Medical Research's Institutional Review Board (IRB), and the Human Research Ethics Committee at UNSW Sydney, Australia. 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 Kapul Champion, the peer led civil society for sexually diverse men and transgender people. Verbal informed consent was provided for all aspects of the study save for HIV testing, for which written informed consent was obtained per PNG national policy.

Keywords

Papua New Guinea; Female sex workers; 90-90-90; HIV; Respondent-driven sampling

Introduction

Early epidemiological modeling predicted that Papua New Guinea's HIV epidemic was similar to the epidemic in sub-Saharan Africa [1]. However, in the last decade, increased data from antenatal clinics have contributed to improved models of Papua New Guinea's HIV epidemic and disproven this prediction, with national HIV prevalence estimated at 0.9% among adults aged 15–49 years [2, 3]. Recent surveys among female sex workers (FSW), men who have sex with men (MSM), and transgender women (TGW) support the new characterization of Papua New Guinea's epidemic as concentrated, and have shown a substantial disparity in HIV prevalence between these groups and the general population. HIV prevalence among FSW was 15.2% in Port Moresby, 11.9% in Lae, and 19.6% in Mt. Hagen, the three largest cities in Papua New Guinea [4]. Among MSM/TGW, HIV prevalence was 8.5% in Port Moresby and 6.9% in Lae [5]. This disparity in HIV burden in Papua New Guinea among key populations compared to the general population reflects the experience of other countries [6, 7].

Though no population-based Joint United Nations Programme on HIV and AIDS (UNAIDS) 90-90-90 target results exist for FSW in other countries in Oceania, they do exist in a few sub-Saharan African countries, and progress toward these targets among FSW generally mirrors the progress among the general population though with lower coverage [8, 9]. In Cameroon, for example, of the 52% of HIV-positive FSW aware of their status, 81% were on antiretroviral therapy (ART) [10].

FSW in Papua New Guinea are particularly vulnerable to HIV and experience stigma, harassment, and violence and face barriers to HIV services [11–14]. The illegality of sex work in Papua New Guinea increases FSW vulnerability and hinders access to HIV services. Data are inadequate to determine national progress toward the 90-90-90 targets among FSW in Papua New Guinea, substantial gains are needed to reach these targets in Port Moresby, the capital, where only 39.0% of HIV-positive FSW knew their status, 79.6% of whom were on treatment, and 54.1% of whom had suppressed viral load. Among all HIV-positive FSW in Port Moresby, 35.4% had suppressed viral load [13].

To characterize progress toward the 90-90-90 targets among FSW in Papua New Guinea and to inform national and local HIV responses, we conducted biobehavioral surveys of FSW in Lae, Papua New Guinea's economic hub, and Mt. Hagen, the center of national resource extraction activities. The two cities are connected by highway and are the second and fourth largest in the country, respectively.

Methods

Data Collection

We used respondent-driven sampling to sample FSW in Lae (January–June 2017) and Mt. Hagen (August–December 2017), and we aimed to recruit 700 FSW in each city to measure HIV prevalence. Respondent-driven sampling is a variant of snowball sampling used to sample populations without a sampling frame [15–17] and can be used to produce sampling weights and approximate a random sample. Inclusion criteria were FSW who were aged ≥ 12 years; who were assigned female sex at birth; who spoke English or Tok Pisin; who sold or exchanged sex for money, goods, or services in the last 6 months; and who had a survey recruitment coupon. The minimum age for participation was set at 12 years with support from the National Department of Health in recognition of the young age at which girls start trading sex in Papua New Guinea.

A detailed description of survey methods has been published previously [13]. Briefly, consenting participants were interviewed by trained staff on topics including demographics, sexual history, stigma, violence, reproductive health, and health service utilization. The two-item Patient Health Questionnaire was used to screen for depression; a score of ≥ 3 indicated major depressive disorder [18]. Comprehensive awareness of HIV was based on the UNAIDS definition [19].

Following the interview, participants who provided written consent received HIV testing and counseling according to the national algorithm of Determine HIV-1/2 (Alere, Waltham, MA) with confirmation by Stat-Pak HIV-1/2 (Chembio, New York, NY). Those testing HIV-positive were then tested for HIV viral load using the GeneXpert HIV viral load assay (Cepheid, Sunnyvale, CA). Monthly quality control was conducted by using in-house dry tube samples and testing all HIV-positive and inconclusive samples with Geenius HIV-1/2 (Bio-Rad, Hercules, CA).

Participants testing HIV-positive received active linkage to HIV treatment services by a peer navigator. The survey team was trained to identify and refer all girls aged < 18 years to partner organizations that provide protective services to these populations.

The study was conducted in collaboration with the Papua New Guinea National Department of Health and National AIDS Council Secretariat and with support from the FSW civil society organization, Friends Frangipani. It 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 at UNSW Sydney. The protocol was reviewed in accordance with the Centers for Disease Control and Prevention (CDC) human research protection procedures and was determined to be research, but CDC investigators did not interact with human subjects or have access to identifiable data or specimens for research purposes.

Data Analysis

Except for where noted, this analysis was restricted to HIV-positive FSW to describe 90-90-90 target progress among this population. Suppressed HIV viral load was defined as < 1000 copies/mL. We conducted a sensitivity analysis to explore the impact of self-reporting on 90-90-90 estimates and present 90-90-90 progress in two ways: (1) where inclusion in a step is contingent upon self-reported response to the previous step and (2) where inclusion in a step is modified based on HIV viral load results, and participants with suppressed HIV viral load are classified as aware of their HIV status and receiving ART. All results presented in the tables are self-reported, except for HIV status and viral suppression.

Respondent-driven sample-adjusted population estimates are presented unless otherwise indicated. Weights were calculated in Respondent-driven Sampling Analyst (RDS-A) version 0.62 (Los Angeles, CA) using Gile's Successive Sampling estimator. RDS-A was used for univariate analysis. Survey logistic procedures were used in SAS version 9.4 (Carey, NC) to identify correlates of awareness of HIV positive status.

Results

We sampled 709 FSW in Lae (HIV-positive, 83) and 709 in Mt. Hagen (HIV-positive, 133). Self-reported awareness of HIV-positive status was 28.2% (95% confidence interval [CI]: 17.0–39.5) in Lae (Fig. 1a) and 43.9% (95% CI 34.2–53.7) in Mt. Hagen (Fig. 1b). Of those who were aware of their HIV-positive status, 91.9% (95% CI 79.7–100.0) in Lae and 86.3% (95% CI 77.0–95.6) in Mt. Hagen self-reported being on ART. Of these, 70.4% (95% CI 46.6–94.2) in Lae and 80.0% (95% CI 69.4–90.5) in Mt. Hagen had suppressed HIV viral load. Assuming that everyone with suppressed HIV viral load was also aware of their HIV status and on ART, 48.9% (95% CI 35.5–62.2) of FSW in Lae and 61.9% (95% CI 52.2–71.7) in Mt. Hagen were aware of their status. Under this assumption, the percentage of FSW aware of their HIV-positive status and receiving ART increased from the self-reported 91.9% to 95.3% (95% CI 88.2–100.0) in Lae and from 86.3 to 98.9% (95% CI 97.3–100.0) in Mt. Hagen. Viral suppression among those on ART also increased to 83.5% (95% CI 68.6–98.2) in Lae and 87.0% (95% CI 80.2–93.8) in Mt. Hagen.

Overall, among all FSW, regardless of HIV status, 7.2% (95% CI 4.9–9.5) in Lae and 9.6% (95% CI 7.1–12.1) in Mt. Hagen had viral load > 1000 copies/mL. Among HIV-positive FSW, 38.9% (95% CI 25.9–51.9) in Lae and 50.8% (95% CI 40.9–60.7) in Mt. Hagen had suppressed viral load.

Approximately one in ten FSW living with HIV in both Lae and Mt. Hagen were aged 15–24 years, and over half were aged 25–34 years (Table 1). Awareness of HIV-positive status was lowest among those aged 15–24 years (Lae, 12.1%; Mt. Hagen, 3.9%). Roughly equal proportions of FSW in both cities had never been married (Lae, 83.0%; Mt. Hagen, 78.9%) or traveled away from home six or more times in the last 6 months (Lae, 56.1%; Mt. Hagen, 52.4%). Sex work was the main source of income for a higher proportion of FSW with HIV in Lae (69.8%) than in Mt. Hagen (45.3%). Many FSW (Lae, 40.3%; Mt. Hagen, 28.8%) were ashamed of their work.

Though most FSW had been selling sex for ≥ 5 years, there was no difference in awareness of HIV-positive status by duration of sex work (Table 2). More FSW who had spoken to a peer educator or outreach worker in the last 12 months were aware of their HIV-positive status (Lae, 39.1%; Mt. Hagen, 65.9%) than those who had not (Lae, 14.7%; Mt. Hagen, 31.2%). More FSW in Lae received free condoms in the last 12 months (78.2%) than in Mt. Hagen (48.0%). However, only 33.2% of those who received condoms in Lae were aware of their status compared to 65.4% in Mt. Hagen. Approximately two-thirds of FSW did not use a condom during the last sexual encounter, and of these, 17.8% in Lae and 35.5% in Mt. Hagen were aware of their status.

In multivariable analysis, in Lae, the odds of awareness of HIV-positive status were higher among FSW who did not have syphilis, gonorrhea, or chlamydia (adjusted odds ratio [aOR] 4.7 [95% CI 1.2–18.6]) and among those who used a condom during the last sexual encounter (aOR 7.5 [95% CI 1.9–29.7]; Table 3). In Mt. Hagen, FSW who had never been married (aOR 4.3, 95% CI 1.1–16.1) and those who received free condoms in the last 12 months (aOR 3.8 [95% CI 1.2–11.9]) had higher odds of being aware of their HIV-positive status (Table 4).

Discussion

In Lae and Mt. Hagen, we found high ART coverage among FSW who have been diagnosed with HIV and good viral suppression among those on ART. That some FSW on treatment had unsuppressed viral load suggests a need for enhanced adherence counseling and a faster transition to fixed-dose tenofovir/lamivudine/dolutegravir.

Nonetheless, the least progress was made in the most critical element of the treatment cascade, the first step of diagnosis. In Lae, 28.2% of HIV-positive FSW and in Mt. Hagen, 43.9% had been diagnosed Our findings mirror those from FSW and MSM/TGW in Port Moresby, as well as other countries [8, 13]. Even in our sensitivity analysis, awareness of HIV-positive status was still low (Lae, 48.9%; Mt. Hagen, 61.9%), possibly reflecting persistent HIV-associated stigma. That so few HIV-positive FSW were aware of their HIV status threatens efforts to reach sufficient population viral suppression to bring about epidemic control and highlights the utility of expanding HIV case finding efforts through new case finding approaches such as social network strategies, self-testing, and index testing [20, 21].

Though FSW aged 15–24 years account for 38.6% of FSW in Lae and 45.5% in Mt. Hagen, they account for 8.1% of HIV-positive FSW in Lae and 12.3% in Mt. Hagen [4]. In Mt. Hagen, FSW in this age group are significantly less likely to be aware of their HIV-positive status than older FSW, and, given the vulnerabilities young key populations face, the same may be true in Lae [22].

We found that awareness of HIV-positive status was higher among FSW in Lae who did not have syphilis, gonorrhea, or chlamydia as well as among those who used a condom during the last sexual encounter, which may suggest that FSW in Lae who have been diagnosed with HIV are changing their behaviors and using condoms more often. The increased

condom use among these women may in turn explain why those who did not have a sexually transmitted infection also had a higher odds of being aware of their HIV status.

This survey was conducted at the same time as publication of the results from HIV Prevention Trials Network 052 and at the beginning of the Undetectable = Untransmittable era (U = U, the consensus that people with undetectable viral load are unable to transmit HIV) [23, 24]. However, it is unlikely that FSW in Papua New Guinea would have been aware of this information. Even if some were aware of this information, viral load testing was not available at the survey sites during data collection, and FSW would not have known if they had suppressed viral load before survey participation. It is thus possible that FSW who knew they had HIV were using condoms to prevent HIV transmission to their partners. While it is possible that FSW with symptoms of sexually transmitted infections sought treatment and were offered HIV testing at the same time, this is unlikely because healthcare-seeking behavior among FSW in these cities is low and because sexually transmitted infection symptoms often do not manifest in women [25–28].

Of FSW who had interacted with a peer educator or outreach worker in the last 12 months, 39.1% in Lae and 65.9% in Mt. Hagen were aware of their HIV-positive status, indicating a missed opportunity for peer educators and outreach workers to provide HIV testing, peer-mediated self-testing, or referrals for testing. In Mt. Hagen, those who received free condoms were more likely to be aware of their HIV-positive status. Nonetheless, of the 48.0% of HIV-positive FSW in Mt. Hagen received free condoms in the last 12 months, 65.4% were aware of their HIV status. This finding suggests that those who distribute condoms can also be engaged to encourage HIV testing.

Our findings are limited by our ability to characterize progress toward the 90-90-90 targets and to conduct multivariable analyses given our limited sample size. This highlights the importance of moving from powering biobehavioral surveys for HIV prevalence to powering for viral suppression [29]. Because interviews were conducted face-to-face, the data are susceptible to response bias. Our sensitivity analysis of progress toward the 90-90-90 targets helped address some of this potential bias and revealed higher coverage for each target. As treatment coverage is relatively low in Papua New Guinea, we do not believe that the increase in viral suppression in this adjusted analysis is due to elite controllers (i.e., people who have suppressed viral load without being on ART [30, 31]. The only explanation for these people being virally suppressed is that these individuals had received an HIV diagnosis and were on ART. The higher coverage revealed through the sensitivity analysis suggest the potential benefit of conducting such a sensitivity analysis and adjusting the first two 90 s based on viral suppression, testing for the presence of antiretroviral medications, or conducting self-administered interviews [32, 33]. Finally, as associations between CD4 count and awareness of HIV-positive status may be confounded by ART eligibility at time of diagnosis and during the study period, CD4 count at time of diagnosis, CD4 count at time of ART initiation, and duration of ART use, we did not include it in our analysis.

Biobehavioral surveys play an important role in informing the epidemic response. Our findings reveal the potential benefits of reenergizing HIV testing efforts among FSW in both Lae and Mt. Hagen and integrating HIV testing in other healthcare services for FSW.

Optimized testing modalities such as social network strategies and community-based peer-supported self-testing could also increase the awareness of HIV status among HIV-positive FSW [20, 34]. Our findings also show that though treatment retention may be high, viral suppression is not, indicating a need for differentiated services and adherence support to increase viral suppression and, if needed, to switch those with unsuppressed viral load to second-line treatment regimens [35].

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Availability of Data and Material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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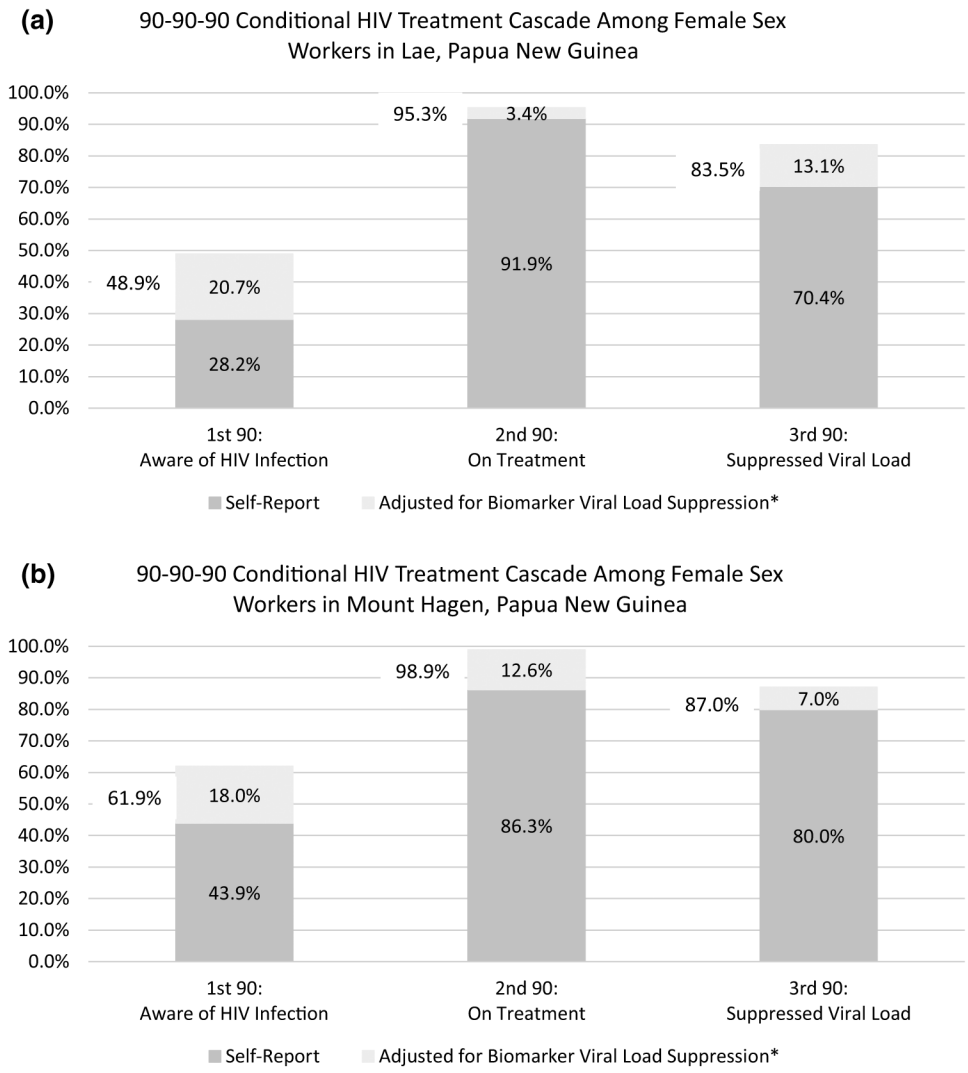

Fig. 1.

a * Reflects testing all HIV-positive specimens for viral load regardless of self-reported awareness or treatment status. Self-reported results from individuals with suppressed viral load were recoded as “aware” and “aware and on treatment.” **b** *Reflects testing all HIV-positive specimens for viral load regardless of self-reported awareness or treatment status. Self-reported results from individuals with suppressed viral load were recoded as “aware” and “aware and on treatment.”

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Table 1

Characteristics of HIV-positive female sex workers (FSW) at each stage of the conditional 90-90-90 cascade in Lae and Mt. Hagen, Papua New Guinea, 2017

	Lae				Mt. Hagen			
	HIV positive*	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****	**HIV positive***	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****
	N = 83	**N = 28**	**N = 26**	**N = 19**	**N = 133**	**N = 65**	**N = 54**	**N = 38**
	n (%; 95% CI)	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**
Age (years)								
13–24	10 (8.1; 2.8–13.4)	1 (12.1; 0.0–34.7)	_***	_***	11 (12.3; 4.6–20.0)	1 (3.9; 0.0–11.7)	_***	_***
25–34	41 (53.5; 39.8–67.2)	16 (31.1; 14.6–47.6)	15 (95.0; 84.6–100.0)	10 (70.8; 43.5–98.2)	59 (53.9; 42.8–65.1)	27 (41.2; 26.8–55.5)	23 (91.6; 83.0–100.0)	16 (76.2; 57.9–94.6)
≥ 35	25 (38.4; 24.7–52.0)	10 (32.6; 11.2–53.9)	9 (86.0; 58.7–100.0)	7 (62.2; 16.0–100.0)	33 (33.7; 23.1–4.4)	23 (65.5; 46.5–84.5)	21 (95.2; 88.1–100.0)	17 (89.3; 77.8–100.0)
Highest level of education completed								
No formal education	37 (43.8; 30.8–56.9)	9 (16.8; 4.5–29.1)	8 (90.0; 69.7–100.0)	6 (66.8; 25.2–100.0)	54 (44.3; 34.5–54.1)	26 (44.5; 29.2–59.8)	20 (78.7; 60.5–97.0)	14 (82.8; 67.9–97.7)
Primary	39 (46.7; 33.7–59.2)	16 (35.4; 18.1–52.8)	15 (90.6; 72.1–100.0)	12 (87.4; 71.4–100.0)	55 (35.1; 26.1–44.1)	27 (43.9; 28.9–58.9)	23 (90.7; 81.2–100.0)	15 (69.5; 49.1–89.9)
High school or higher	7 (9.5; 1.1–17.8)	3 (45.8; 0.0–93.3)	3 (100.0; 76.9–100.0)	1 (17.0; 0.0–55.8)	24 (20.6; 12.3–28.9)	12 (42.8; 20.0–65.6)	11 (95.7; 86.9–100.0)	9 (92.2; 80.3–100.0)
Ever married								
Yes	20 (17.0; 8.5–25.5)	6 (22.9; 4.0–41.8)	6 (100.0; 74.9–100.0)	4 (73.8; 37.3–100.0)	26 (21.1; 12.7–29.5)	9 (22.0; 5.1–38.9)	7 (85.9; 65.3–100.0)	4 (67.6; 29.0–100.0)
No	63 (83.0; 74.5–91.5)	22 (29.3; 16.4–42.3)	20 (90.6; 76.5–100.0)	15 (69.8; 42.7–96.9)	107 (78.9; 70.5–87.3)	56 (49.8; 38.8–60.8)	47 (86.4; 76.2–96.5)	34 (81.4; 70.6–92.3)
Number times away from home, last 6 months								
0 times	10 (12.2; 3.6–20.8)	4 (34.9; 1.2–68.6)	4 (100.0; 74.8–100.0)	3 (59.9; 0.6–100.0)	20 (17.6; 9.8–25.5)	13 (60.2; 35.7–84.7)	10 (83.1; 62.2–100.0)	8 (87.7; 70.0–100.0)
1–5 times	19 (31.7; 18.0–45.3)	3 (15.9; 0.0–36.2)	2 (83.8; 47.2–100.0)	2 (100.0; 74.6–100.0)	32 (30.0; 20.0^0.0)	12 (29.2; 12.0–464)	11 (95.0; 84.9–100.0)	8 (82.9; 62.4–100.0)
≥ 6	47 (56.1; 42.2–70.0)	19 (34.5; 18.5–50.6)	19 (100.0; 93.1–100.0)	13 (65.0; 35.6–94.5)	58 (52.4; 41.7–63.1)	29 (51.7; 36.8–66.7)	24 (85.5; 70.5–100.0)	16 (76.2; 58.8–93.6)
Sex work as main source of income								
Yes	56 (69.8; 58.0–81.5)	20 (30.5; 16.2–44.7)	18 (89.2; 73.1–100.0)	12 (61.4; 31.3–91.6)	66 (45.3; 35.6–55.1)	31 (38.3; 25.1–51.5)	27 (90.0; 80.0–100.0)	16 (65.2; 45.2–85.3)

	Lae				Mt. Hagen			
	HIV positive*	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****	**HIV positive***	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****
	N = 83	**N = 28**	**N = 26**	**N = 19**	**N = 133**	**N = 65**	**N = 54**	**N = 38**
	n (%; 95% CI)	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**
No	27 (30.2; 18.5–42.0)	8 (23.1; 6.3–39.9)	8 (100.0; 84.3–100.0)	7 (94.7; 83.4–100.0)	66 (54.7; 44.9–64.4)	33 (48.2; 34.3–62.1)	26 (83.7; 69.6–97.7)	22 (92.1; 83.6–100.0)
Screened positive for depression								
Yes	22 (28.6; 16.5–40.8)	8 (30.6; 8.0–53.3)	8 (100.0; 87.1–100.0)	6 (59.1; 11.6–100.0)	68 (56.5; 46.9–66.2)	31 (41.1; 28.0–54.3)	26 (84.3; 69.1–99.4)	18 (76.8; 60.2–93.3)
No	61 (71.4; 59.2–83.5)	20 (27.3; 14.4–40.1)	18 (88.2; 70.9–100.0)	13 (76.2; 53.3–99.0)	65 (43.5; 33.8–53.1)	34 (47.6; 33.0–62.1)	28 (88.6; 79.0–98.2)	20 (83.4; 70.9–95.9)
Tested positive for syphilis, gonorrhea, or chlamydia								
Yes	48 (54.9; 41.7–68.0)	11 (16.8; 6.3–27.3)	10 (92.0; 75.8–100.0)	8 (82.1; 57.1–100.0)	63 (45.9; 36.1–55.7)	31 (43.3; 28.9–57.7)	25 (88.3; 78.5–98.2)	14 (71.2; 52.7–89.6)
No	35 (45.1; 32.0–58.3)	17 (42.1; 22.2–62.1)	16 (91.9; 75.5–100.0)	11 (64.7; 32.6–96.9)	70 (54.1; 44.3–63.9)	34 (44.5; 31.2–57.8)	29 (84.6; 69.9–99.4)	24 (87.5; 75.9–99.2)
Ashamed to be FSW								
Yes	31 (40.3; 27.3–53.3)	8 (24.4; 7.8–41.1)	7 (83.6; 52.6–100.0)	5 (72.1; 34.1–100.0)	37 (28.8; 19.8–37.7)	14 (31.3; 15.1–47.6)	11 (79.7; 56.9–100.0)	6 (69.1; 41.1–97.0)
No	49 (59.7; 46.7–72.7)	20 (32.9; 17.1–48.8)	19 (96.1; 87.9–100.0)	14 (69.7; 39.9–99.5)	92 (71.2; 62.3–80.2)	49 (50.0; 38.0–62.0)	42 (88.7; 78.6–98.8)	32 (83.2; 72.1–94.4)
Disclosed sex work to anyone[b]								
Yes	62 (76.5; 65.9–87.1)	26 (35.0; 20.9–49.1)	24 (91.5; 78.6–100.0)	17 (68.6; 43.7–93.6)	79 (56.1; 46.3–65.9)	46 (55.4; 42.5–68.3)	40 (86.6; 74.7–98.5)	27 (76.6; 63.1–90.1)
No	21 (23.5; 12.9–34.1)	2 (6.3; 0.0–15.2)	2 (100.0; 53.1–100.0)	2 (100.0; 53.1–100.0)	54 (43.9; 34.1–53.7)	19 (29.3; 15.7–42.8)	14 (85.5; 71.9–99.2)	11 (88.2; 74.0–100.0)
Minimum distance traveled to closest ART facility (km)								
0– < 0.5	30 (35.7; 23.0–48.3)	12 (32.8; 14.0–51.5)	10 (78.6; 49.6–100.0)	6 (59.2; 23.3–95.0)	51 (40.3; 30.5–50.1)	30 (49.8; 33.7–65.9)	26 (92.7; 85.2–100.0)	18 (76.8; 59.9–93.7)
0.5– < 100C	30 (42.4; 28.8–55.9)	8 (17.0; 4.1–29.9)	8 (100.0; 83.5–100.0)	6 (80.3; 52.5–100.0)	38 (28.5; 19.6–37.4)	17 (36.3; 19.4–53.3)	14 (82.7; 63.0–100.0)	8 (71.7; 48.1–95.3)
≥ 1000	17 (22.0; 10.9–33.0)	6 (35.4; 7.1–63.6)	6 (100.0; 84.5–100.0)	5 (58.6; 1.2–100.0)	40 (31.2; 21.9–0.5)	17 (46.5; 28.3–64.7)	14 (83.2; 61.6–100.0)	12 (90.8; 77.4–100.0)
Physical violence, last 12 months								
Yes	28 (33.6; 21.1–4-6.1)	8 (29.6; 8.5–50.8)	7 (84.4; 54.2–100.0)	5 (77.2; 40.5–100.0)	29 (20.2; 12.4–27.9)	14 (38.9; 18.6–59.1)	12 (91.7; 79.6–100.0)	6 (65.0; 36.3–93.7)

	Lae				Mt. Hagen			
	HIV positive*	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****	**HIV positive***	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****
	N = 83	**N = 28**	**N = 26**	**N = 19**	**N = 133**	**N = 65**	**N = 54**	**N = 38**
	n (%; 95% CI)	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**
No	55 (66.4; 53.9–78.9)	20 (27.5; 14.5–40.6)	19 (96.0; 87.6–100.0)	14 (67.1; 37.7–96.5)	104 (79.8; 72.1–87.6)	51 (45.2; 34.1–56.3)	42 (85.1; 74.2–96.1)	32 (83.5; 72.4–94.5)
Sexual violence, last 12 months								
Yes	19 (21.6; 1.9–32.4)	4 (27.2; 0.5–53.9)	3 (73.6; 23.8–100.0)	3 (100.0; 76.9–100.0)	30 (19.6; 12.2–27.1)	17 (45.7; 25.0–66.4)	14 (88.7; 75.5–100.0)	6 (53.1; 22.4–83.7)
No	64 (78.4; 67.6–89.1)	24 (28.5; 16.2–40.8)	23 (96.7; 89.8–100.0)	16 (64.5; 38.3–90.7)	103 (80.4; 72.9–87.8)	48 (43.5; 32.4–67.6)	40 (85.7; 74.5–96.9)	32 (87.1; 77.5–96.8)

Some variables contained missing values and responses may not add up to the number of participants

CI confidence interval, *ART* antiretroviral therapy

[a] Self-reported

[b] Includes immediate and extended family members, spouse or partner, friends who do not sell sex, health care providers, and others

* Column percentage

** Row percentage

*** Results suppressed due to small cell size

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Table 2

Sex work characteristics, sexual behaviors, and HIV services among HIV-positive female sex workers at each stage of the conditional 90-90-90 cascade in Lae and Mt. Hagen, Papua New Guinea, 2017

	Lae				Mt. Hagen			
	HIV positive*	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****	**HIV positive***	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****
	(N = 83)	**(N = 28)**	**(N = 26)**	**(N = 19)**	**(N = 133)**	**(N = 65)**	**(N = 54)**	**(N = 38)**
	n (%; 95% CI)	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**
Years selling sex								
≤ 2	20 (23.6; 12.4–34.7)	2 (9.5; 0.0–23.5)	2 (100.0; 62.9–100.0)	0 (0.0)	35 (32.5; 22.9–12.2)	11 (30.5; 13.6–7.4)	8 (68.8; 36.9–100.0)	5 (66.5; 31.6–100.0)
3–4	20 (18.7; 9.6–27.8)	6 (24.7; 4.9–44.4)	5 (83.7; 52.4–100.0)	4 (82.8; 49.3–100.0)	27 (22.7; 13.9–31.6)	12 (38.2; 16.4–60.1)	10 (91.8; 79.5–100.0)	6 (79.0; 55.2–100.0)
≥ 5	42 (57.7; 44.9–70.6)	20 (37.8; 20.6–55.1)	19 (92.8; 78.3–100.0)	15 (75.8; 48.0–100.0)	64 (44.7; 34.8–54.6)	38 (55.3; 41.2–69.4)	33 (91.8; 84.3–99.3)	25 (84.1; 72.5–95.8)
Has someone who facilitates meeting clients								
Yes	38 (51.4; 38.3–64.6)	11 (28.7; 11.2–6.1)	10 (89.3; 68.0–100.0)	4 (43.6; 3.8–83.4)	53 (40.6; 30.9–50.3)	28 (50.9; 35.2–66.7)	24 (86.9; 71.5–100.0)	18 (80.8; 64.7–97.0)
No	44 (48.6; 35.4–61.7)	17 (28.7; 14.2–13.2)	16 (94.6; 83.6–100.0)	15 (97.2; 91.2–100.0)	78 (59.4; 49.7–69.1)	36 (39.1; 26.8–51.5)	30 (87.1; 76.1–98.1)	20 (79.2; 65.4–93.1)
Spoke with peer educator or outreach worker, last 12 months								
Yes	46 (55.4; 42.0–68.7)	19 (39.1; 21.8–56.3)	18 (92.6; 77.8–100.0)	13 (65.9; 36.2–95.6)	58 (36.6; 27.3–15.9)	39 (65.9; 51.9–79.9)	33 (89.8; 81.3–98.4)	23 (78.8; 64.7–93.0)
No	34 (44.6; 31.3–58.0)	8 (14.7; 3.4–26.1)	7 (88.5; 65.4–100.0)	5 (82.1; 54.8–100.0)	69 (63.4; 54.1–72.7)	24 (31.2; 19.0–43.4)	19 (80.3; 61.7–98.9)	13 (78.3; 60.2–96.5)
Given free condoms, last 12 months								
Yes	65 (78.2; 67.7–88.7)	26 (33.2; 19.6–46.7)	25 (94.0; 82.0–100.0)	18 (68.5; 43.7–93.3)	74 (48.0; 38.2–57.7)	48 (65.4; 52.9–77.9)	40 (89.6; 81.9–97.2)	29 (83.3; 72.4–94.2)
No	18 (21.8; 11.3–32.3)	2 (10.5; 0.0–25.6)	1 (67.8; 3.2–100.0)	1 (100.0; 54.4–100.0)	59 (52.0; 42.3–61.8)	17 (24.2; 12.3–36.0)	14 (78.2; 53.4–100.0)	9 (70.6; 45.3–95.8)
Number of male clients who gave money, last 6 months								
< 5	27 (33.7; 21.4–46.1)	7 (22.4; 5.8–39.0)	6 (79.5; 42.4–100.0)	6 (100.0; 82.2–100.0)	37 (31.9; 22.6–11.3)	16 (38.1; 20.6–55.5)	14 (89.2; 73.6–100.0)	11 (86.9; 71.0–100.0)
≥ 5	56 (66.3; 53.9–78.6)	21 (31.2; 16.7–15.7)	20 (96.4; 89.0–100.0)	13 (61.5; 32.6–90.4)	95 (68.1; 56.7–77.4)	48 (46.0; 34.2–57.8)	39 (84.8; 73.2–96.5)	26 (76.5; 62.9–90.2)
Used condoms with all male clients, last 6 months								

	Lae				Mt. Hagen			
	HIV positive*	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****	**HIV positive***	**HIV-positive aware[a],****	**On ART[a],****	**Suppressed viral load****
	(N = 83)	**(N = 28)**	**(N = 26)**	**(N = 19)**	**(N = 133)**	**(N = 65)**	**(N = 54)**	**(N = 38)**
	n (%; 95% CI)	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**	**n (%; 95% CI)**
Yes	20 (21.6; 10.8–32.4)	8 (33.6; 7.0–60.2)	8 (100.0; 84.7–100.0)	7 (94.9; 83.5–100.0)	30 (19.8; 12.4–27.2)	20 (71.8; 54.7–88.9)	19 (93.9; 82.1–100.0)	13 (77.7; 58.6–96.7)
No	62 (78.4; 67.6–89.2)	20 (27.1; 14.7–39.4)	18 (89.1; 73.0–100.0)	12 (61.0; 32.0–90.0)	102 (80.2; 72.8–87.6)	44 (36.5; 25.8–17.1)	34 (82.2; 69.5–94.9)	24 (80.6; 67.6–93.6)
Used condom at last sex act								
Yes	39 (37.2; 25.3–19.2)	18 (45.8; 27.0–64.5)	17 (95.7; 86.7–100.0)	12 (80.4; 61.6–99.3)	49 (32.7; 23.8–41.6)	31 (60.7; 44.9–76.5)	25 (86.1; 74.2–98.1)	18 (78.4; 61.4–95.3)
No	44 (62.8; 50.8–74.7)	10 (17.8; 5.3–30.4)	9 (86.2; 59.3–100.0)	7 (53.4; 9.5–97.3)	83 (67.3; 58.4–76.2)	33 (35.5; 23.7–17.4)	29 (87.7; 73.9–100.0)	20 (81.3; 68.2–94.5)

Some variables contained missing values and responses may not add up to the number of participants

CI confidence interval, *ART* antiretroviral therapy

* Column percentage

** Row percentage

Table 3

Multivariable analysis of variables significantly associated with awareness of HIV-positive status among female sex workers in Lae, Papua New Guinea, 2017

Variable	Lae			
	OR (95% CI)	p value	aOR (95% CI)	p value
Tested positive for syphilis, gonorrhea, or chlamydia		0.0249		0.0295
Yes	Ref		Ref	
No	3.6 (1.2–11.0)		4.7 (1.2–18.6)	
Used condom at last sex act		0.0209		0.0048
Yes	3.9 (1.2–12.2)		7.5 (1.9–29.7)	
No	Ref		Ref	
Spoke with peer educator or outreach worker, last 12 months		0.0003		0.1319
Yes	3.7 (1.2–11.9)		2.8 (0.7–11.0)	
No	Ref		Ref	
Given free condoms, last 12 months		0.1012		0.3622
Yes	4.2 (0.8–24.0)		2.2 (0.49–13.0)	
No	Ref		Ref	

OR odds ratio, *aOR* adjusted odds ratio, *CI* confidence interval

Table 4

Variables significant in multivariable analysis by awareness of HIV-positive status among female sex workers in Mt. Hagen, Papua New Guinea, 2016

Variable	Lae			
	OR (95% CI)	p value	aOR (95% CI)	p value
Ever married		0.0230		0.0335
Yes	Ref		Ref	
No	3.5 (1.2–10.4)		4.3 (1.1–16.1)	
Ashamed to be FSW		0.0857		0.0967
Yes	0.5 (0.2–1.1)		0.4 (0.1–1.2)	
No	Ref		Ref	
Disclosed sex work to anyone		0.0108		0.7083
Yes	3.0 (1.3–6.9)		1.2 (0.4–3.8)	
No	Ref		Ref	
Years selling sex		0.1004		0.7897
≤ 2 years	Ref		Ref	
3–4 years	1.4 (0.4–4.8)		0.8 (0.2–3.3)	
≥ 5 years	2.8 (1.1–7.9)		1.1 (0.3–4.4)	
Used condoms with all male clients, last 6 months		0.0028		0.1362
Yes	4.4 (1.7–11.7)		2.47 (0.8–8.2)	
No	Ref		Ref	
Used condom at last sex act		0.0172		0.3975
Yes	2.8 (1.2–6.5)		1.7 (0.5–5.8)	
No	Ref		Ref	
Spoke with peer educator or outreach worker, last 12 months		0.0009		0.5613
Yes	4.3 (1.8–10.0)		1.5 (0.4–5.3)	
No	Ref		Ref	
Given free condoms, last 12 months		<0.0001		0.0238
Yes	5.9 (2.5–13.9)		3.8 (1.2–11.9)	
No	Ref		Ref	

OR odds ratio, *aOR* adjusted odds ratio, *CI* confidence interval