Published in final edited form as:

J Acquir Immune Defic Syndr. 2016 September 1; 73(1): 83–90. doi:10.1097/QAI.0000000000001022.

Barriers to Viral Suppression Among Female Sex Workers: Role of Structural and Intimate Partner Dynamics

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Abstract

Objective—Despite global evidence that sex workers (SWs) are disproportionately impacted by HIV, data on HIV treatment outcomes among SWs living with HIV remains sparse. This study examined the correlates of undetectable plasma viral load (pVL) among street- and off-street SWs living with HIV and on antiretroviral therapy (ART) in Metro Vancouver, Canada.

Methods—Analyses drew on data (2010–2014) from a longitudinal cohort of SWs (An Evaluation of Sex Workers Health Access) and confidential linkages with the Drug Treatment Program (DTP) data on ART dispensation and outcomes. Bivariate and multivariable generalized linear mixed effects models (GLMM) were used to identify longitudinal correlates of undetectable pVL (<50 copies/ml).

Results—Of the 72 SWs living with HIV who had ever used ART, 38.9% had an undetectable pVL at baseline. While 84.7% had undetectable pVL at least once over the study period, 18.1% exhibited sustained undetectable pVL. In multivariable GLMM analyses, 95% pharmacy refill adherence (Adjusted Odds Ratio (AOR)=4.21; 95% Confidence Interval (CI) 2.16–8.19), length of time since diagnosis (AOR=1.06; 95%CI 1.00–1.13) were positively correlated with undetectable pVL. Having an intimate male partner (AOR=0.35; 95%CI 0.16–0.78) and homelessness were negatively correlated with undetectable pVL (AOR=0.22; 95%CI 0.10–0.47).

Discussion/Conclusions—There is a need to more closely consider the social and structural contexts which shape SWs' experiences on ART and impact treatment outcomes, including the

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Conflicts of interest

The authors have no conflicts of interest to declare.

Contributions:

KS oversaw the study, had access to the data and takes full responsibility for the integrity of the analysis. PD and SG developed the initial analyses plan, in consultation with KS. SD and PN conducted the statistical analyses, PD wrote the first draft of the manuscript and integrated suggestions from all authors. All authors made significant contributions to the final manuscript.

gendered power dynamics within intimate partnerships. Future research on HIV care among SWs is urgently needed, alongside structural and community-led interventions to support SWs' access to and retention in care.

Keywords

HIV; sex worker; plasma viral load; antiretroviral therapy; gender dynamics

INTRODUCTION

Globally, sex workers (SWs) are disproportionately affected by HIV, with SWs having a global prevalence of 11.8% and much higher odds of living with HIV (pooled odds ratio of 13.5 (95% Confidence Interval: 10.0–18.1)) when compared to the general population of women of reproductive age.^{1,2} Despite bearing a high burden of HIV in many settings, SWs continue to experience low access to and retention in HIV services as a result of complex biomedical, social and structural factors including criminalization,^{1,3} stigma,⁴ violence and discrimination in health care settings.⁵ With a growing focus on the HIV cascade of care among other key populations, only a handful of studies have examined the treatment experiences and outcomes among SWs, with most focused on clinical and behavioural measures and little research on broader social and structural factors.^{6,7} At an individual and population level, suboptimal access and retention in care and poor HIV clinical outcomes (e.g., unsuppressed viral load) may impact women's morbidity, mortality and overall quality of life, including emotional and psychological health, sexual and reproductive health and economic productivity.⁸

While research on the HIV treatment experiences and outcomes among SWs are limited, key work on the barriers to adherence and pVL suppression among people living with HIV/AIDS have shed light on the important role that social and structural barriers play.^{9–11} For example, structural and interpersonal factors found to undermine ART adherence among people living with HIV include: intimate partner violence,^{9,12} HIV stigma,^{10,11,13} social support, trust and satisfaction with employer.¹³ Lack of stable, secure housing and has also been linked to reduced adherence and detectable viral loads.¹⁴

A recent systematic review on the HIV treatment cascade among SWs identified only six studies that reported on the prevalence of undetectable pVL levels, all of which were conducted in low- and middle- income countries (LMICs).¹⁵ Two were a prospective cohort design,^{16–18} two were cross-sectional,^{6,19} and one was a peer-driven intervention.²⁰ Most of these studies focused on individual-correlates of undetectable pVL, including adherence,^{6,7,20} drug use¹⁷ and younger age.⁶ Additionally, Donastorg and colleagues reported a higher prevalence of undetectable pVL among single SWs in the Dominican Republic, underscoring the need for further research into how interpersonal factors, including relationship dynamics, affect ART treatment success.⁶

Despite well-established science and policy globally on the critical role of structural factors in shaping the HIV epidemic,¹ research on the social and structural determinants of achieving undetectable pVL levels in SWs is surprisingly sparse and largely drawn from a few low- and middle-income settings. We know from the HIV prevention literature that

structural determinants, including criminalization and policing of sex work,^{1,3} social exclusion,⁴ stigma, and discrimination from health care workers have been consistently linked to reduced access to health and social supports for SWs.^{1,2,5} Violence and abuse have also been consistently linked to enhanced HIV burden among SWs and reduced access to health care.^{1,21} At the same time, community empowerment, SW-led outreach, and access to indoor spaces have been shown to mitigate risks and promote access to care.²²

Given the complex structural factors and HIV burden among SWs, and increasing efforts globally to scale-up ART, we need to understand both barriers and facilitators to HIV care and successful treatment outcomes for sex workers that promote health, safety and rights-based approaches to care. Drawing on a longitudinal community-based research cohort, this analysis aimed to longitudinally examine individual, interpersonal and structural correlates of undetectable pVL (defined as plasma RNA viral load <50 copies/ml) among street- and off-street SWs living with HIV and on ART in BC, Canada. Since 2010, government-sponsored efforts to scale up access to HIV cascade and ART (as part of HIV treatment as prevention efforts), have led to substantial decreases in HIV prevalence and community pVL levels among the general population, as well as in people who inject drugs.^{23–25} However, the experiences of SWs and treatment outcomes within ART-based scale-up in BC remain poorly understood.

METHODS

An Evaluation of Sex Workers Health Access (AESHA)

This analysis drew on data from the AESHA cohort, (**An Evaluation of Sex Workers Health Access**) collected between January 2010 and February 2014. AESHA is a community-based longitudinal cohort of street- (e.g., parks, alleys, industrial settings) and off-street sex workers (e.g., SWs working in formal sex work establishments/ 'in-call' venues such as massage parlours; informal venue-based sex work such as bars, hotels, and SWs independent self-advertising through online or newspapers) across Metropolitan Vancouver. AESHA was built on long-standing community collaborations dating back to 2005,²⁶ and continues to be monitored by a community advisory board of over 15 sex work and community agencies. Participants eligible for the study were both cis-gender women (whose gender identity align with their biological sex at birth) and trans individuals, 14 and older who reported exchanging sex for money in the past month and provided informed consent. As previously described,²⁶ mapping and outreach together with sex workers continues to be used to identify street, indoor and online venues. Interviewers and outreach workers then used time-location methods²⁷ to recruit SWs during day and night-time outreach to sex work spaces identified in community mapping. Time-location methods use spaces where SWs congregate (rather than individuals) as the sampling unit, and are commonly used to sample hidden populations (e.g., sex workers, people who use drugs), that might not be captured using other methods. Time-location strategies have been recommended for SWs over other sampling methods such as respondent driven sampling,^{28,29} since SWs tend to have smaller social networks compared to other hidden populations.^{30,31} At baseline and every six-month follow-up, participants completed an interviewer-administered baseline questionnaire. All nursing, interview and outreach staff are either experiential (current/former sex workers) or

have substantial community support experience with sex workers and undergo extensive training in research, ethics and community guidelines on research with sex workers.^{26,32} The project nurses administer a pre-test counseling questionnaire and offered voluntary HIV/STI/HCV serology testing. Interview visits can take approximately one hour and services, referral, education and testing are offered/available to SWs, regardless of participation in the study. Participants received \$40 CAD remuneration at each visit for their time, expertise and travel. Ethical approval was granted through Providence Health Care's/ University of British Columbia's Research Ethics Board.

British Columbia Centre for Excellence in HIV/AIDS' Drug Treatment Program

Based on informed consent, questionnaire data for AESHA participants living with HIV was confidentially linked to administrative data from the British Columbia Centre for Excellence in HIV/AIDS' Drug Treatment Program (DTP), as previously described.³³ As previously noted,^{34,35} the provincially-funded DTP distributes ART across British Columbia and collects data on ART dispensation, clinical outcomes such as CD4 count and PVL for all ART patients in the province.

Independent variables—Guided by a structural determinants framework,³⁶ individual, interpersonal, workplace, and structural factors were included in the analysis. At baseline and each semi-annual follow-up, participants completed an extensive questionnaire that included individual, biological and behavioural factors. Time-fixed variables included age (at baseline), migrant status (defined as place of birth) and Indigenous ancestry (Indigenous peoples of Canada: First Nations, Métis and Inuit peoples). All other variables were time-updated at every semi annual follow-up, with events referring to the past 6 months. Individual/biological factors considered included: CD4 count per 100mm³ in the last 6 months (defined as the average CD4 count referring to the past six months), CD4 count at ART initiation, 95% pharmacy refill ART adherence (based on pharmacy refill data from the DTP), and duration since diagnosis (in months). Individual-level behavioural factors included self-reported injection drug use (e.g., heroin, cocaine, speedballs, street methadone) and self-reported non-injection drug use (e.g., crack cocaine, cocaine, crystal meth, inhalants). The survey also elicited data on interpersonal factors such as whether they had an intimate partner (non-commercial partner), inconsistent condom use by client (defined based on a response of 'always' versus 'usually', 'sometimes', 'occasionally' or 'never' to the question, 'in the last 6 months, how often has your client used a condom' for vaginal, anal or oral sex'). Work-related physical or sexual violence was also considered, based on whether participants reported any physical or sexual violence by a client or person posing as a client (e.g., sexual/physical assault, abducted/kidnapped, strangled, assaulted with a weapon, raped). Structural factors included homelessness (defined as having slept on the street overnight or longer) incarceration (spent time in jail/prison overnight or longer), sex work mobility (defined as working as a sex worker outside of Metro Vancouver) and accessing health services (defined as having used any health service in the last 6 months). Finally, workplace factors were based on sex workers' primary place of soliciting or servicing clients in the past 6 months and were coded as formal sex work establishments/ in-call venues (e.g., massage/beauty parlour, managed indoor spaces), informal indoor venues (e.g., client's place, hotel, own home) versus street/public places (e.g., street, park, public bathroom).

Outcome variable—The outcome, undetectable pVL, was obtained from DTP administrative data on viral outcomes, and was defined as having a median pVL of <50 copies/ml in the last six months. The outcome was updated at every 6 month follow-up.

Statistical analysis

Of the 744 AESHA participants enrolled between 2010 and 2014, 81 were living with HIV. The analytic sample was restricted to 72 SWs living with HIV who were on ART. Descriptive statistics included frequencies and proportions for categorical variables stratified by undetectable pVL levels and measures of central tendencies (i.e., median and interquartile range (IQR)) for continuous variables.

A generalized linear mixed effects model (GLMM) with a logit link was used to measure the independent associations of *a priori* known confounders with undetectable viral load over the four-year follow-up period (2010–2014). A GLMM approach using random intercepts was chosen to model subject-level effects across time. Bivariate GLMM analyses were run to determine factors associated with achieving an undetectable pVL and variables that retained a p-value of <0.05 in bivariate analysis were considered for inclusion in the multivariable analysis. As in previous studies,^{33,37,38} a backward approach was used to construct the final GLMM multivariable model, which used a combination of sequential removal of variables, starting with the highest p-value, and an assessment of the Akaike's Information Criterion (AIC). The final model exhibiting the lowest AIC value was considered to have the best overall fit with the outcome, undetectable viral load. This model-building procedure has been justified elsewhere.³⁹ A sensitivity analysis was conducted, to examine the influence of individual, interpersonal and structural factors in the presence and absence of adherence in the model. SAS software version 9.4 was used for all statistical analyses (SAS Institute Inc., Cary, North Carolina, USA). All p-values are two-sided.

RESULTS

At baseline, 38.9% of the 72 SWs included in the analysis had an undetectable pVL. The median pVL among women with detectable pVL was 1,774 copies/ml (IQR: 117–28,862 copies/ml). Among the 72 participants, there were 388 observations in total over the four-year follow-up period, and 184 (54.4%) events with undetectable pVL. The median number of study visits was 5 (Interquartile Range (IQR): 3–7 visits). Over the course of the study, 84.7% achieved undetectable pVL levels at least once between 2010 and 2014, though only 18.1% had a consistently sustained undetectable pVL during this period. At baseline, less than half (59.7%) of SWs had 95% adherence to ART (based on pharmacy refill), and these women were more likely to have an undetectable pVL at baseline (78.6% vs. 21.4%) than those who did not achieve 95% adherence (Table 1). The majority (63.9%) of participants living with HIV in the study were of Indigenous ancestry, reflecting the Canadian epidemic which disproportionately affects Indigenous people and the overrepresentation of Indigenous women engaged in sex work.^{40–42} and almost all (98.6%) were born in Canada. While many participants used illicit injection drugs (66.7%) and non-injection drugs (90.3%), drug use was not significantly associated (at $p < 0.05$) with undetectable pVL levels in bivariate analyses.

In longitudinal bivariate analysis using GLMM, ART pharmacy-refill adherence (95% OR=5.51; 95%CI 3.01–10.1) and time since HIV diagnosis (OR=1.08; 95%CI 1.02–1.16) were individual factors positively correlated with undetectable pVL in the last 6 months. Homelessness (AOR=0.23; 95%CI 0.11–0.46), having an intimate partner (OR=0.43; 95%CI 0.22–0.87), and spending time in jail or prison (OR=0.30; 95%CI 0.11–0.79) were structural and interpersonal factors negatively associated with undetectable pVL. In multivariable GLMM analysis, 95% pharmacy-refill ART adherence (AOR=4.21; 95%CI 2.16–8.18), being single (versus having an intimate male partner) (AOR=0.35; 95%CI 0.16–0.78), stable housing (versus homelessness) (AOR=0.22; 95%CI 0.10–0.47) and length of time since diagnosis (AOR=1.06; 95%CI 1.00–1.13) were positively correlated with having an undetectable pVL. A second model excluding adherence yielded comparable results (Table 2).

DISCUSSION

In the context of ART scale-up efforts globally, these findings draw significant concern of sub-optimal HIV treatment among SWs living with HIV. While 84.7% of women SWs had an undetectable pVL at least once over the four-year study period (2010–2014), less than one-fifth (18.1%) were able to consistently sustain these undetectable levels. The prevalence of undetectable pVL in this study is lower compared to reports elsewhere.^{6,17,43} However, the lower cut-off values for pVL suppression used in other studies^{16,17,19,20} or higher levels of adherence⁶ may account for these differences. The relatively lower levels of adherence in our sample may contribute to the lower prevalence of pVL suppression. Studies in other settings have reported poorer ART outcomes among SWs compared to individuals not involved in sex work,⁴⁴ possibly due to higher rates of HIV-super infection or acquired HIV-1 resistant strains.¹⁷ While the rate of drug-resistance among Vancouver-based SWs is unknown, a previous study among people who use drugs in Vancouver reported an incidence of 1.8 (0.7–4.0) per 100 person-years per annum.⁴⁵ The positive association between duration since HIV diagnosis and undetectable pVL likely reflects having more time to initiate ART and find ways to integrate treatment into women's lives, or may reflect late or delayed initiation of ART. For example this may allow women time to process one's HIV diagnosis, access peer and social support, better understand how to navigate the HIV care system, develop personal strategies to adhere to treatment and manage side-effects, and identify treatment supports necessary to achieve undetectable pVL levels.

Consistent with previous studies,^{6,7} SWs with greater adherence had increased odds of having undetectable pVL. While adherence was strongly linked to undetectable pVL, structural and interpersonal factors including homelessness and having an intimate partner remained statistically significantly associated with undetectable pVL, even after adjusting for adherence. A number of potential pathways could explain the independent effect of these social and structural factors, independent of adherence. This includes the effect of treatment interruption or gaps; recent data document frequent interruptions in ART (63 events of ART gaps of 6 months or longer) among SWs over a 2.5 year follow-up period.³³ Another pathway is the potential lack of uptake and retention in HIV services, due to instability or fear related to homelessness or intimate partner violence.⁴⁶ A lack of HIV care may deprive SWs of social support and treatment for co-morbidities (e.g., mental health) that are key to

achieving undetectable viral loads.⁴⁶ The finding that having an intimate partner reduced odds of pVL suppression echoes findings from a recent study among SWs in the Dominican Republic.⁶ This finding suggests that criminalization of HIV disclosure and gendered power dynamics (e.g., fear of violence due to HIV serostatus disclosure) within intimate relationships could result in hiding of medications, treatment interruptions, poor uptake and retention in HIV care, hamper treatment adherence and optimal clinical outcomes. While research on the effects of criminalization of HIV and relationship dynamics on ART outcomes is scant, there is evidence among women in the general population to suggest a link between recent intimate partner violence (IPV) and detectable pVLs.^{6,9,47} Among ART naïve women living with HIV in South Africa, emotional violence from one's intimate partner was significantly associated with declines in CD4 and CD8 cells, even after adjusting for substance use.⁴⁸ The mechanism linking IPV to immunity and HIV disease progression remain understudied/unclear, though some research suggests intimate partner violence may reduce cellular and humoral immunity, elevate cortisol and dehydroepiandrosterone (DHEA) levels (sometimes mediated by PTSD),^{49,50} and decrease T cell function.⁵¹

Our findings corroborate the well-documented link between homelessness and poor treatment outcomes.^{52,53} A recent systematic review of 152 studies on housing status and health outcomes among People Living With HIV/AIDS (PLWHA) found overwhelming evidence for the link between housing instability (and homelessness) with reduced HIV/health care access and utilization, low adherence, poor clinical outcomes (CD4 counts and plasma viral load) as well other poor health outcomes (e.g., mental health, HCV infection, tuberculosis, quality of life).¹⁴ Homelessness is a particularly prevalent structural barrier among street-based SWs in our sample (43.3%), 60 with a previous study documenting homeless SWs to be younger, experience higher rates of sexual intimate partner violence, service clients in public spaces and have intensive, daily crack use. These numerous and overlapping vulnerabilities, alongside others such as food insecurity,⁵⁴ concomitant depression^{15,55} undoubtedly undermine SWs' human right to access, uptake and remain in HIV treatment and care, and together, have a strong potential to undermine the treatment success, health and well-being of SWs living with HIV.⁵⁴ Homelessness may also be a proxy of reduced stability required for proper ART adherence,⁵⁶ such as having a safe and confidential place to store and ingest medications.⁵⁴

These findings highlight the detrimental role of social and structural barriers on SWs' HIV care experiences and outcomes; outcomes which often result in a cascade of negative impacts on patients' overall wellbeing and quality of life. Our results underscore the need for structural and community-led interventions that address social and structural factors, including the evaluation of the impact of peer/SW-outreach and support (e.g., HIV+ peer navigators) access to more integrated health and housing models that support women and SWs living with HIV. Given that access to safe, secure and non-judgmental housing is a basic human right and essential to health, wellbeing, human dignity as well as range of human rights (e.g., adequate standard of living, liberty and security of the person, freedom from discrimination), and established gendered-barriers to safe, non-exploitative housing for women SWs in this setting,^{37,57} there remains an urgent need to increase access to successful models of safe and secure women-centred and sex worker-tailored housing.⁵⁸ A

number of randomized controlled trial housing intervention studies have demonstrated increased odds in intact immunity (CD4 T-cell counts ≥ 200 and undetectable pVL).^{56,59} This includes immediate housing and intensive case management for PLWHA,⁵⁶ as well as immediate rental assistance for PLWHA experiencing housing instability.⁵⁹ These models embrace a 'housing first' approach, where housing and support services are immediately provided for homeless/unstably housed PLWHA; regardless of one's previous history or risk patterns (e.g., drug use).¹⁴ Understanding the role of access to low-barrier, women-centred housing initiatives remain critical; however research also suggests that integrated care and housing for WLWH need to be tempered by rights to privacy and confidentiality.^{57,60} Given that homeless SWs in our setting are more likely to work on the street, be young, use drugs and experience elevated levels of sexual violence,³⁷ housing interventions need to include gender-sensitive and trauma-informed HIV care. There is an urgent need to explore innovative approaches to improve ART access, including evaluation of the ethical issues for SWs of targeted ART scale-up strategies.⁶¹ Growing research has highlighted the critical role of removal of legal barriers (e.g., decriminalization of sex work) and scaling-up of community-empowerment and SW-led services as necessary to access the health and social supports for sex workers and WHO/UNAIDS best practices.^{22,62–64} Finally, to inform effective SW-tailored and gender-based HIV programming, future research together with SWs is needed better understand the experiences with HIV treatment among sex workers and gendered role of intimate partnerships in shaping treatment outcomes among SWs.

Strengths and Limitations

This study has a number of limitations. Given the hidden, stigmatized and criminalized nature of sex work in Canada, attaining a representative sample can be challenging. However, community-based research with sex workers and time-location sampling methods were used to help mitigate this, which have been widely used in SW research.³⁶ Given the limited numbers of SWs living with HIV in our cohort, the sample size for this analysis was small. Despite the small sample size, prospective design of this study allowed for multiple observations for each participant over time, thus increasing the number of observation points available for this analysis. Finally, although our HIV treatment measures (e.g., ART adherence; outcome variable, undetectable pVL) were obtained from provincial administrative data, other independent variables relied on self-report as with other observational data and therefore may be subject to social desirability bias. However, we have no reason to believe that the variables that emerged significant in this analysis (having an intimate partner, homelessness) would be differentially reported by virally suppressed or not suppressed SWs. Further, given this study employs highly trained experiential interview and nursing staff (sex workers) and individuals with substantial sex work support experience and strong rapport with the community and combined decades of experience with this population, this likely minimizes such biases. A number of individual and structural factors previously linked to undetectable viral loads in the general population were significant here and should be considered in future, large studies, including: mental health, food insecurity, poverty, alcohol use and intimate partner violence.

Conclusions

As global efforts to scale-up ART continue to grow, and gaps in research on the experiences of SWs living with HIV remain, this study provides insight into HIV care outcomes among SWs in the context of a province-wide programme to HIV services. The findings highlight major gaps with less than one-fifth of women have sustained pVL suppression suggesting a key population being left behind in HIV scale-up efforts. Alongside a critical need for more community-based research on barriers and facilitators to HIV care for sex workers, including gender dynamics with intimate partners, these findings point to the role of structural and gender-sensitive community-led interventions to promote access to safe, secure health and housing for women SWs living with HIV.

Acknowledgments

Sources of funding:

This research was supported by operating grants from the US National Institutes of Health (R01DA028648) and Canadian Institutes of Health Research (CIHR) (HHP-98835), and MacAIDS. PD is supported by the CIHR and Michael Smith Foundation for Health Research (MSFHR) Postdoctoral Fellowship Awards. JSM is supported by an Avante Garde award from US NIH (DP1DA026182). KD is supported by CIHR and MSFHR. KS is partially supported by a Canada Research Chair in Global Sexual Health and HIV/AIDS and Michael Smith Foundation for Health Research. SG is partially supported by the US NIH (R01DA028648) and CIHR. JM is supported with grants paid to his host institution by the British Columbia Ministry of Health and by the US National Institutes of Health (R01DA036307). He has also received limited unrestricted funding, paid to his institution, from Abbvie, Bristol-Myers Squibb, Gilead Sciences, Janssen, Merck, and ViiV Healthcare.

We thank all those who contributed their time and expertise to this project, particularly participants, AESHA community advisory board members and partner agencies. We wish to acknowledge Chrissy Taylor, Jennifer Morris, Tina Ok, Rachel Nicoletto, Julia Homer, Emily Leake, Rachel Croy, Emily Groundwater, Meenakshi Mannoe, Silvia Machat, Jasmine McEachern, Brittany Udall, Chris Rzepa, Jungfei Zhang, Xin (Eleanor) Li, Krista Butler, Peter Vann, Sarah Allan and Jill Chettiar for their research and administrative support.

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Table 1

Baseline sample characteristics and bivariate odds ratios (OR) with 95% Confidence Intervals (CI) for individual, interpersonal and structural factors associated with undetectable pVL (<50 copies/ml) among 72 sex workers living with HIV who had ever used ART

Characteristic	Undetectable pVL* 28 (38.9%)	Detectable pVL* 46 (63.9%)	p - value
<i>Individual/Biological factors</i>			
Age, per year older (median (IQR) 35.0 (29.0–43.0))	40 (34–47)	32 (28–40)	0.004
Indigenous ancestry-Yes	17 (60.7)	30 (65.2)	0.655
Indigenous ancestry-No	11 (39.3)	16 (34.8)	-
CD4 per 100mm ³ (median (IQR)) *	4.7 (3.10–5.90)	3.2 (1.50–4.55)	0.002
CD4 at ART initiation: <250 per mm ³	13 (46.4)	14 (31.8)	-
250– 499 mm ³	13 (46.4)	24 (54.6)	0.297
500 mm ³	2 (7.14)	5 (11.4)	0.361
Pharmacy-refill ART adherence 95% *	22 (78.6)	21 (47.7)	0.008
Pharmacy-refill ART adherence <95% *	6 (21.4)	23 (52.3)	-
Time since HIV diagnosis	10.6 (6.5–14.3)	4.41 (1.07–10.4)	0.011
<i>Im/migrant Status</i>			
Born in Canada	27 (96.4)	44 (100.0)	-
Im/migrant to Canada	1 (3.6)	0 (0.0)	-
Non-injection drug use- Yes *	25 (89.3)	40 (90.9)	0.774
Non-injection drug use- No *	3 (10.7)	4 (9.1)	-
Injection drug use- Yes *	18 (64.3)	30 (68.2)	0.733
Injection drug use- No *	10 (35.7)	14 (31.8)	-
<i>Interpersonal factors</i>			
Have an intimate partner- Yes *	4 (10.7)	18 (39.1)	0.017
Have an intimate partner- No *	23 (89.3)	26 (60.9)	-
Physical/sexual violence by client- Yes *	5 (17.9)	8 (18.2)	0.920
Physical/sexual violence by client-No *	23 (82.1)	36 (81.8)	-
Inconsistent condom use by client	5 (17.9)	7 (15.2)	0.991
Consistent condom use by	23 (82.1)	39 (84.8)	

Characteristic	Undetectable pVL [*] 28 (38.9%)	Detectable pVL [*] 46 (63.9%)	p - value
client			
Structural factors			
<i>Sex work mobility</i>			
Engaged in sex work outside Vancouver [*]	0 (0.0)	2 (4.5)	-
Did not engage in sex work outside Vancouver [*]	28 (100.0)	42 (95.5)	
Homelessness – Yes [*]	7 (25.0)	17 (38.6)	0.226
Homelessness – No [*]	21 (75.0)	27 (61.4)	-
Incarcerated – Yes [*]	4 (14.3)	7 (17.1)	0.226
Incarcerated – No [*]	24 (85.7)	34 (82.9)	-
Accessed health care services [*]	26 (92.9)	41 (93.2)	0.957
Did not access health care services [*]	2 (7.14)	3 (6.8)	-
Workplace factors			
Place of servicing clients[†]			
Street/outdoors/public spaces [*]	13 (46.4)	19 (47.5)	-
Informal indoor venue [*]	13 (46.4)	17 (42.5)	0.829
Formal in-call/SW establishment [*]	2 (7.1)	4 (10.0)	0.738

^{*} in the last 6 months

[†] Informal indoor venues include out-call, clients homes, hotels and home-based. Formal in-call/SW establishments include massage parlours, health enhancement centres and micro-brothels.

Table 2

Longitudinal Bivariate Odds Ratios (OR) and Adjusted Odds Ratios (AOR) using Generalized Linear Mixed Effects Model (GLMM) for correlates of undetectable pVL (<50 copies/ml) among 72 sex workers who had ever used ART Metropolitan Vancouver, Canada, 2010–2014

Variable	Bivariate correlates of undetectable viral load	Model 1: Correlates of undetectable viral load (excluding adherence)	Model 2: Correlates of undetectable viral load (including adherence)
	OR (95%CI)	AOR (95%CI)	AOR (95%CI)
<i>Individual/Biological Factors</i>			
Age, per year older	1.04 (1.00–1.09)	–	–
Aboriginal ancestry	0.58 (0.26–1.28)	–	–
CD4 per 100mm ³	1.87 (1.44–2.44)	–	–
Pharmacy-refill ART adherence 95%	5.51 (3.01–10.1)	–	4.21 (2.16 – 8.19)
Length of time since HIV diagnosis, per year	1.09 (1.02–1.16)	1.07 (1.00 – 1.14)	1.06 (1.00 – 1.13)
Non-injection drug use *	0.80 (0.33–1.94)	–	–
Injection drug use *	0.98 (0.53–1.83)	–	–
<i>Interpersonal factors</i>			
Have an intimate partner *	0.43 (0.22–0.87)	0.39 (0.17 – 0.86)	0.35 (0.16 – 0.78)
Physical/sexual violence by client *	0.50 (0.20–1.23)	–	–
<i>Structural and workplace factors</i>			
Homelessness *	0.23 (0.11–0.46)	0.20 (0.09 – 0.43)	0.22 (0.10 – 0.47)
Incarcerated *	0.30 (0.11–0.79)	0.45 (0.16 – 1.29)	0.51 (0.18 – 1.45)
Accessed health care services *	3.75 (0.86–16.4)	–	–
Im/migrant status: Born in Canada	0.24 (0.01–7.13)	–	–
Engaged in sex work outside of Metro Vancouver	1.19 (0.12–12.1)	–	–
Serviced clients in informal indoor venues vs. outdoor/public spaces *†	0.88 (0.44–1.73)	–	–
Serviced clients in formal/in-call SW establishments vs. outdoor/public spaces *†	0.14 (0.02–1.04)	–	–

*
in the last six months

† Informal indoor venues include out-call, clients homes, hotels, home-based. Formal in-call/SW establishments include massage parlours, health enhancement centres, and micro-brothels.