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No Evidence of Increased Sexual Risk Behaviour after Initiating Antiretroviral Therapy among People who Inject Drugs

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Abstract

Objective—Although antiretroviral therapy (ART) dramatically reduces viral load and improves survival among HIV-infected injection drug users (IDU), several short-term studies have raised concerns that ART initiation may result in increases in sexual risk behaviour among IDU.

Design—We used data from a long-running cohort of HIV-positive IDU to examine whether ART initiation was associated with increases in several measures of sexual risk behaviour. The date of ART initiation was determined through a validated linkage to a centralized ART dispensation pharmacy.

Methods—We used generalized linear mixed-effects modeling to examine whether sexual activity, unprotected intercourse, and multiple sexual partnerships were more likely in the 12 month period following ART initiation.

Results—Among 457 individuals who were ART naïve at baseline, the median age was 34 (interquartile range [IQR]: 28–41) and 202 (44.2%) were female. Between May 1996 and April 2008, 260 (56.7%) participants initiated ART. In multivariate analyses, ART initiation was not associated with sexual activity (adjusted Odds Ratio [AOR] = 0.87, 95%CI: 0.60–1.25), unprotected intercourse (AOR = 0.82, 95%CI: 0.51–1.31), or multiple sexual partnerships (AOR = 0.93, 95%CI: 0.61–1.40).

Conclusions—In this study of HIV-positive IDU, we failed to detect an increase in sexual risk behaviour during the period following ART initiation. In light of this evidence, and given the

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known positive effect of ART on survival and its potential role in reducing HIV transmission, concerns regarding potential increases in sexual risk-taking should not undermine the delivery of ART to IDU.

Keywords

injection drug use; antiretroviral therapy; sexual risk; HIV; AIDS

INTRODUCTION

Antiretroviral therapy (ART) effectively suppresses viral load and dramatically reduces morbidity and mortality among persons living with HIV [1–3]. The apparent ability of ART to reduce HIV transmission among serodiscordant couples has also led to the increasingly well-recognized notion that the expansion of access to ART may also be an effective HIV prevention strategy [4,5]. However, some have argued that expanded access to ART may result in increased HIV risk behaviour as a result of diminished concerns about HIV transmission among treated persons [6,7]. For example, some studies involving men who have sex with men (MSM) [8] and injection drug users (IDU) [9] have suggested that individuals who believe receiving ART protects against transmitting HIV are more likely to engage in unprotected intercourse and other HIV risk behaviours. Other studies among MSM have shown that initiating ART and immunologic response to treatment are associated with a return to high-risk sexual behaviours [10,11], which may contribute to HIV transmission [12].

Although international guidelines state that HIV-positive IDU should have equitable and universal access to ART [13], the worldwide coverage of HIV prevention and treatment services for IDU remains poor [14]. In addition to the widely held view the IDU are poor candidates for ART due to ongoing drug dependence and other co-morbidities [13], concerns have been raised that IDU may resume high-risk behaviours following the initiation of HIV therapy [15]. Previous studies investigating the relationship between ART initiation and increases in risk behaviour among IDU are equivocal [16–18]. Although a European study showed significant decreases in risk behaviour following the commencement of HIV therapy [18], studies conducted in the United States have demonstrated marginal increases in sexual risk behaviour, particularly following successful immunologic response to therapy [16,17]. However, these studies were limited by relatively short follow-up periods (e.g., two years), and inconsistent adjustment for potential confounding variables (e.g., relationship status). Some studies have also relied on self-reported ART use, which has been shown to be a less than ideal measure of medication use among IDU [19]. Finally, studies conducted in settings where ART is not freely available may suffer from a selection bias due to financial barriers to accessing HIV care and treatment. We conducted this study using data from a long-running prospective cohort study of ART naïve HIV-positive IDU to address the limitations of prior studies and to examine whether ART initiation was associated with increases in sexual risk behaviour in a setting where ART is freely available to eligible individuals.

METHODS

Study Population

Data for these analyses were derived from the AIDS Care Cohort to Evaluate Exposure to Survival Services (ACCESS), a community-recruited open prospective cohort of HIV-positive injection drug users in Vancouver, Canada. The study methodology has been described in detail elsewhere [20,21]. In brief, recruitment began in May 1996 and occurred through extensive street-based outreach and word of mouth. Participants were eligible for

the study if they were 18 years of age or older, resided in the greater Vancouver region, tested HIV-positive upon entry, had injected an illegal drug during the previous month, and provided informed consent. HIV infection was detected using ELISA and positive test results were confirmed using Western blot. At baseline and at each semi-annual follow-up, participants completed a lengthy interviewer-administered questionnaire that elicits information regarding sociodemographic characteristics, drug use patterns, sexual behaviours (including all outcomes assessed in this study), and other relevant exposures. The present analysis is based on data for participants who completed a baseline and at least one follow-up interview between May 1996 and April 2008 and who were naïve to ART upon entry into the cohort. This study was approved by the University of British Columbia/ Providence Health Care Research Ethics Board.

Clinical Variables and Exposure to ART

Our setting is somewhat unique in that antiretroviral drugs have been centrally distributed at no cost to eligible individuals since 1986 [2]. All eligible HIV positive patients residing in British Columbia receive antiretroviral therapy from the HIV/AIDS Drug Treatment Program, a province-wide dispensation program and laboratory for HIV/AIDS clinical monitoring. ACCESS cohort data are linked in a confidential manner to the information collected by this program. Thus, all CD4⁺ cell count and HIV RNA level measurements conducted throughout the study period are available from this database. CD4⁺ cell counts are determined by flow cytometry and plasma HIV RNA levels were measured using the Roche Amplicor Monitor assay (Roche Molecular Systems, Mississauga, Canada). Program data also include a complete prospective profile of ART use, including the exact date of therapy initiation.

Outcome Variables

We examined the following sexual behaviours reported at baseline and at each subsequent interview. We defined “any sexual activity” as engaging in voluntary sexual activity (i.e., oral, vaginal, or anal intercourse) with any same or opposite sex regular partner, casual partner, or sex trade client. Although sexual intercourse is not a risk factor for HIV transmission per se, sexually active participants represent a group at risk of engaging in high-risk behaviour. Participants were also asked to indicate whether they had engaged in any vaginal or anal intercourse without using a condom. Finally, we also examined the number of sex partners reported by participants, and dichotomised this variable as greater than one (i.e., “multiple sex partners”) versus less than or equal to one. All outcome variables refer to the six months prior to each semi-annual visit.

Exposure Variables

The objective of this study was to examine whether ART initiation was associated with increases in sexual activity or risk behaviours among HIV-positive IDU. Therefore, the primary independent variable of interest was “initiate ART”, operationalised as an indicator variable representing the first follow-up interview between six and 12 months following the commencement of therapy. All other visits were coded as zero, as were all visits for individuals who never initiated therapy throughout the study period. The date of ART initiation was determined through a confidential database linkage as described above. To be conservative, follow-up interviews occurring within six months of initiating therapy were not considered an ART initiation visit as behaviours assessed would have included periods of both very early ART treatment and no treatment.

We also examined variables that have been observed in other studies of HIV-positive IDU to be associated with sexual behaviours [16–18]. Variables that were considered as potential confounders included: age at baseline (per year older), sex (female versus male), ethnicity

(Aboriginal ancestry versus other), current relationship status (partnered [i.e., married, common law, regular partner] versus single or casually dating), homelessness (yes versus no), sex trade work (yes versus no), non-injection crack use ($\geq$ daily versus $<$ daily), injection heroin use ($\geq$ daily versus $<$ daily), injection cocaine use ($\geq$ daily versus $<$ daily), syringe sharing (yes versus no), use of addiction treatment (yes versus no), current enrolment in a methadone maintenance therapy (MMT) program (yes versus no), CD4⁺ count (per 100 cells per mL), HIV-1 RNA plasma viral load (per log₁₀ copies per mL). Unless otherwise indicated, all behaviours refer to the six months prior to the date of the interview. The year of interview was also included as a potential confounder as we recognized that perceptions of ART, side effects of treatment, and prevalence of risk behaviour may have changed over the study period. To further investigate possible changes in the impact of ART initiation over time, we tested for interaction effects between calendar year and the “initiate ART” period.

Statistical Analysis

We first examined whether those who initiated ART differed from those who did not initiate with respect to sociodemographic characteristics and baseline clinical factors. The Pearson χ^2 test was used to test for differences between categorical variables and the Wilcoxon rank sum test was used for continuous variables. We then performed a series of bivariate analyses using generalized linear mixed-effects modeling (GLMM). These longitudinal models allow for the analysis of both between-subject and within-subject variations in responses over time (i.e., individuals are assumed to have their own subject-specific trajectories) [22]. Therefore, this modeling strategy permitted us to examine whether an individual’s likelihood of engaging in sexual behaviour following ART initiation was significantly less or greater than his/her underlying propensity for engaging in these activities. To determine the independent association between initiating ART and sexual behaviour, we fit a series of multivariate models including all variables significant in bivariate analyses at an *a priori* defined cut-off of $p < 0.10$. As has been suggested by other authors [23], we chose a more liberal criterion for the inclusion of covariates than the traditional cut-off of $p < 0.05$ to ensure that all potentially confounding measured variables were included.

To further investigate the potential relationships between ART initiation, immunologic response to therapy, and return to engagement in sexual activity/risk behaviour, we conducted a series of sensitivity analyses. Firstly, we hypothesized that individuals initiating ART with a CD4 measurement > 200 cells/mm³ would be more likely to engage in sexual behaviour than individuals initiating ART with a CD4 count below 200 cells/mm³. To test this hypothesis, we created a categorical indicator variable consisting of four mutually exclusive levels: “initiate ART” period with CD4 ≥ 200 cells/mm³, “initiate ART” period with CD4 < 200 cells/mm³, all other periods with CD4 ≥ 200 cells/mm³, and all other periods with CD4 < 200 cells/mm³ (referent). We calculated the bivariate associations between this variable and each sexual behaviour outcome. Secondly, to determine whether successful response to ART was associated with increases in sexual risk behaviour, we conducted a paired analysis among individuals with a CD4 measurement < 200 cells/mm³ prior to ART initiation and a second measurement with a CD4 count ≥ 200 cells/mm³ after the commencement of therapy. We then compared self-reported sexual behaviour during these two time periods using McNemar’s exact test for matched data.

We also recognized that by examining an *a priori* defined “initiate ART” period (i.e., between six and twelve months following the commencement of therapy), we may have failed to identify longer term changes in sexual activity and risk. Therefore, we determined the proportion of participants reporting each outcome in the four follow-ups (i.e., two years) after the initiation of ART, and examined changes over time using the Mantel trend test [24].

All statistical analyses were conducted using SAS (version 9.1) and all *p*-values are two-sided.

RESULTS

Between May 1996 and April 2008, 457 antiretroviral-naïve HIV-positive participants were enrolled in the study and completed at least one follow-up interview. The median duration of follow-up was 52 months (IQR: 16 – 100). Over the study period, 260 (56.9%) initiated ART. Of those, 197 (75.8%) completed an interview between six and 12 months following the date of ART initiation. The 63 participants who did not complete an interview between six and 12 months following the commencement of therapy and thus did not contribute behavioural data during the “initiate ART” period did not differ with respect to age ($p = 0.972$), sex ($p = 0.643$), ethnicity ($p = 0.101$), or baseline involvement in any sexual activity ($p = 0.615$), unprotected sex ($p = 0.960$), or multiple sexual partnership ($p = 0.878$). The majority of individuals initiated ART prior to 1999 (median = 1998, IQR: 1997 – 2002). Among those who initiated ART, the median number of follow-ups prior to and following initiation was 3 (IQR: 1 – 6) and 7 (IQR: 3 – 14), respectively. The median number of follow-ups among those who were never exposed to ART over the study period was 3 (IQR: 2 – 8).

At baseline, the median age of the sample was 34.2 (IQR: 27.7 – 40.8), 202 (44.2%) were female, and 178 (68.5%) were of Aboriginal ancestry. The sociodemographic characteristics of those who initiated ART over follow-up did not significantly differ compared to those who remained antiretroviral-naïve (see Table 1). As expected, among ART initiates, the median baseline CD4 count was significantly lower (350 cells/mm³ vs. 490 cells/mm³, $p < 0.001$) and the baseline median HIV-1 RNA viral load was significantly higher (56,000 copies/mL vs. 30,000 copies/mL, $p < 0.001$). At baseline, 331 (72.4%) reported sexual intercourse during the past six months, 158 (34.6%) reported recent unprotected vaginal or anal intercourse with a sex partner or client, and the median number of sex partners reported was 1 (IQR: 1 – 2).

Any Sexual Activity

Among participants who completed an interview between six and twelve months after the initiation of ART, 101 (51.3%) reported having sexual activity. In a bivariate GLMM analysis, participants were no more likely to report sexual activity in the period following ART initiation than in other follow-ups (odds ratio [OR] = 1.02, 95%CI: 0.71 – 1.46, $p = 0.921$). Other factors associated with sexual activity are shown in Table 2. In a multivariate model adjusting for sociodemographic characteristics and other variables, ART initiation remained non-significant (adjusted odds ratio [AOR] = 0.87, 95%CI: 0.60 – 1.25, $p = 0.453$). Female sex, partnered relationship status, daily cocaine use, and higher CD4 count were positively associated with sexual activity in the final multivariate model, while older age, current enrolment in MMT, and year of interview were inversely associated with this outcome (see Table 2).

Unprotected Intercourse

Within six to twelve months following ART initiation, 33 (16.8%) reported engaging in unprotected vaginal or anal intercourse with a client or sex partner. Table 3 shows the GLMM bivariate and multivariate analyses of engaging in unprotected intercourse over the follow-up period. The period following ART initiation was not associated with an increase or decrease in the likelihood of unprotected intercourse in either bivariate (OR = 0.79, 95%CI: 0.49 – 1.26, $p = 0.324$) or multivariate (AOR = 0.82, 95%CI: 0.51 – 1.31, $p = 0.402$) analyses. Factors significantly associated with unprotected intercourse in multivariate

analysis were partnered relationship status, sex trade work, syringe sharing, and CD4 count (Table 3).

Multiple Sex Partners

Of those participants who initiated ART, 53 (26.9%) reported having multiple sex partners or clients during the six to twelve month period following the commencement of therapy. Even after extensive adjustment for potential confounders, ART initiation was not associated with having multiple sex partners (AOR = 0.93, 95%CI: 0.61 – 1.40, $p = 0.712$). Female sex, daily crack use, daily cocaine use, and syringe sharing were positively associated with having multiple sex partners in multivariate analysis, while older age, partnered relationship status, current enrolment in MMT, and year of interview were protective for this outcome (see Table 4). In all models, we observed no interaction between calendar year and ART initiation period (all $p > 0.10$).

Sensitivity Analyses

To evaluate whether participants initiating ART with a CD4 count ≥ 200 cells/mm³ were at an increased risk of engaging in sexual behaviour, we constructed a categorical indicator variable and examined the bivariate associations with each outcome. Relative to the non-“initiate ART” periods in which CD4 counts were < 200 cells/mm³, sexual activity was more common during both the non-“initiate ART” periods (OR = 1.94, 95%CI: 1.56 – 2.41, $p < 0.001$) and “initiate ART” period (OR = 1.76, 95%CI: 1.13 – 2.76, $p = 0.013$) when CD4 counts were greater than 200 cells/mm³. In contrast, unprotected sexual intercourse was only associated with the non-“initiate ART”, CD4 ≥ 200 cells/mm³ periods (OR = 1.50, 95%CI: 1.13 – 1.98, $p = 0.005$) (i.e., “initiate ART” period and having a CD4 measurement ≥ 200 cells/mm³ was not significant [$p = 0.966$]). Similarly, having multiple sex partners was not associated with initiating ART and having a CD4 count ≥ 200 cells/mm³ ($p = 0.752$).

To further investigate the impact of immunological response to therapy on sexual behaviour, we conducted a sub-analysis consisting of individuals with a CD4 measurement < 200 cells/mm³ prior to initiation and a subsequent measurement ≥ 200 cells/mm³ after the commencement of therapy. Among these participants, 12 (19.1%) reported unprotected intercourse during the pre-initiation period compared to 11 (17.5%) following ART initiation (McNemar’s test $p = 1.000$). Multiple sex partners were reported by 17 (27.0%) participants and 10 (15.9%) during the pre- and post-initiation periods, respectively (McNemar’s test $p = 0.144$).

As a final sensitivity analysis, we examined longer term changes in sexual activity following ART initiation by calculating the proportion of individuals reporting each outcome during the four follow-up visits subsequent to the commencement of therapy. As shown in Figure 1, there were no detectable trends in any sexual activity ($p = 0.636$), unprotected intercourse ($p = 0.271$), or multiple sexual partners ($p = 0.380$) over the two year period following ART initiation.

DISCUSSION

In this twelve year-long study of HIV-positive IDU, ART initiation was not associated with increases in sexual activity or risk behaviour. Given these findings, concerns regarding potential increases in or resumption of sexual risk behaviour among IDU following the initiation of HIV therapy appear to be unfounded in this setting.

Although previous research has shown that successful immunologic response to ART may lead to a resumption of engagement in sexual risk behaviour [10,16], we failed to observe this phenomenon in a series of sub-analyses among participants initiating ART.

Furthermore, although commencing therapy with CD4 count ≥ 200 cells/mm³ was associated with engagement in sexual activity, we did not detect an increased risk of unprotected intercourse or reporting multiple sexual partners. Longer-term sexual behaviour patterns following ART initiation were also stable in this cohort. Nonetheless, physicians that prescribe ART should be aware that although increases risk behaviour in the period directly following ART initiation may be unlikely, patients who exhibit improvements in health and social functioning should be provided with risk reduction education and counseling. Health professionals should also recognize the broader determinants of risk behaviour among IDU populations (including for example the role of social networks, homelessness, incarceration, and other economic inequities [25–27]) and facilitate the engagement of patients initiating ART with other health and social services to address health disparities.

The present study has a number of limitations that should be noted. Firstly, as this study was observational, access to antiretroviral therapy was not random but influenced by a number of factors outside of our control, including for example physicians' beliefs regarding the prescription of ART to individuals with ongoing drug use [28]. Although it is therefore possible that selection bias may have affected our results, we note that the longitudinal model used in these analyses compared individual trajectories over time (as opposed to differences between those who received and did not receive ART). Furthermore, since ART is freely available in our setting, socioeconomic barriers to accessing therapy would not have influenced our results [20]. Secondly, although ART initiation was determined through a confidential linkage to a centralized dispensation database, all other behavioural data were self-reported. Although it is possible that stigmatized behaviours such as unprotected intercourse may have been underreported, we have no reason to believe that socially desirable reporting would have been more common during the visit following ART initiation. Thus, underreporting of these behaviours would have biased our results towards the null. Thirdly, we were unable to assess changes in behaviour that occurred within six months of ART initiation due to the semi-annual design of the study. We were also unable to examine the potential role that individuals' perceptions regarding the ability of ART to reduce HIV transmissibility may have on return to engagement in risk behaviour following initiation. Finally, since ACCESS is not a random sample, we are unable to generalize our findings to the entire IDU population in Vancouver or to other settings; however, prior reports have indicated that this cohort's sociodemographics are similar to other samples of IDU in Canada [29].

Targeting IDU populations in efforts to expand ART is increasingly recognized as a promising strategy to control HIV transmission and should be a key public health priority given the known impacts of ART in improving morbidity and mortality [30,31]. Concerns regarding the expansion of access to ART for IDU populations due to fears of increased HIV risk behaviour in the period following ART initiation are unsupported by the results presented in this study. Given these findings and the known benefits of ART among individuals with a history of injection drug use [32], we recommend the immediate implementation and evaluation of novel programmes to reduce barriers to HIV care and increase uptake of ART among IDU.

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Figure 1. Sexual activity and sexual risk behaviour in the 24 months following ART* initiation among a cohort of HIV positive injection drug users ($n = 260$)

Notes: * ART = antiretroviral therapy; p -values shown represent the results of the Mantel trend test as described in [24] ($p > 0.05$ suggest no association between time since ART initiation and each outcome).

Table 1

Baseline factors associated with ART* initiation among a cohort of HIV positive injection drug users in Vancouver, 1996–2008 ($n = 457$).

Characteristic	Initiated ART* N (%) <i>n</i> = 260	Did Not Initiate ART* N (%) <i>n</i> = 197	Odds Ratio(95% CI)	<i>p</i> – value
Age (median, IQR)	34 (28–40)	36 (28–41)	0.99 (0.97–1.01)	0.460
Sex				
Female	118 (45.4)	84 (42.6)		
Male	142 (54.6)	113 (57.4)	1.12 (0.77–1.62)	0.558
Aboriginal ethnicity				
Yes	105 (40.4)	73 (37.1)		
No	155 (59.6)	124 (62.9)	1.15 (0.79–1.68)	0.470
Baseline CD4 Count (median, IQR)	350 (250–530)	490 (310–640)		
Baseline log ₁₀ (Viral Load)(median, IQR)	4.7 (4.2–5.1)	4.5 (3.9–4.9)	0.84 (0.76–0.92)	<0.001
			1.70 (1.27–2.29)	<0.001

Notes:

* ART = antiretroviral therapy;

Table 2

Factors associated with recent[†] self-reported sexual activity among a prospective cohort of HIV positive injection drug users, 1996–2008.

Characteristic	Unadjusted OR(95% CI) (n = 457)	p - value	Adjusted OR (95% CI) (n = 380) [¶]	p - value
Initiate ART ^{a,‡} (yes vs. no)	1.02 (0.71–1.46)	0.921	0.87 (0.60–1.25)	0.453
Age (per year older)	0.95 (0.93–0.97)	<0.001	0.96 (0.94–0.98)	<0.001
Sex (female vs. male)	3.03 (2.06–4.46)	<0.001	2.08 (1.43–3.01)	<0.001
Ethnicity (Aboriginal vs. other)	1.44 (0.96–2.15)	0.076	1.06 (0.73–1.54)	0.757
Relationship status (partnered [*] vs. single)	5.25 (4.10–6.72)	<0.001	4.72 (3.69–6.03)	<0.001
Homeless [‡] (yes vs. no)	0.93 (0.74–1.16)	0.501		
Crack use [‡] (≥ daily vs. < daily)	1.03 (0.84–1.25)	0.809		
Heroin use [‡] (≥ daily vs. < daily)	1.30 (1.06–1.61)	0.014	0.83 (0.66–1.05)	0.126
Cocaine use [‡] (≥ daily vs. < daily)	1.97 (1.62–2.39)	<0.001	1.58 (1.27–1.96)	<0.001
Syringe sharing [‡] (yes vs. no)	2.24 (1.74–2.87)	<0.001	1.30 (0.99–1.70)	0.064
Addiction treatment [‡] (yes vs. no)	0.95 (0.79–1.14)	0.545		
Currently enrolled in MMT ^b (yes vs. no)	0.56 (0.45–0.70)	<0.001	0.67 (0.53–0.84)	<0.001
CD4 count (per 100 cells per mL)	1.18 (1.12–1.24)	<0.001	1.08(1.03–1.14)	0.002
Viral load (per log ₁₀ copies per mL)	1.07 (0.99–1.16)	0.071	0.93 (0.85–1.01)	0.093
Year of interview (per year greater)	0.85(0.83–0.87)	<0.001	0.87(0.85–0.90)	<0.001

Notes

^a ART = antiretroviral therapy;

[‡] refers to activities in the past 6 months;

[‡] indicator variable representing the first follow-up interview between 6 months and 12 months following initiation of ART;

^{*} partnered includes legally married, common law, or having a regular sex partner;

^b MMT = methadone maintenance therapy; sex trade work is not included as a variable since by definition all individuals reporting sex trade work are sexually active;

[¶] participants with no CD4 or HIV RNA plasma measurements were excluded from the multivariate model.

Table 3

Factors associated with recent[†] unprotected vaginal or anal intercourse among a prospective cohort of HIV positive injection drug users, 1996–2008.

Characteristic	Unadjusted OR(95% CI) (n = 457)	p - value	Adjusted OR (95% CI) (n = 380) [¶]	p - value
Initiate ART^{a,†} (yes vs. no)	0.79 (0.49–1.26)	0.324	0.82(0.51–1.31)	0.402
Age (per year older)	0.97 (0.94–0.99)	0.025	1.00 (0.98–1.02)	0.844
Sex (female vs. male)	2.64 (1.68–4.16)	<0.001	1.48(1.00–2.19)	0.052
Ethnicity (Aboriginal vs. other)	1.71 (1.08–2.71)	0.024	1.43(0.98–2.08)	0.067
Relationship status (partnered [*] vs. single)	7.15 (5.60–9.12)	<0.001	6.00(4.71–7.64)	<0.001
Homeless[‡] (yes vs. no)	1.04 (0.79–1.37)	0.774		
Sex trade work[‡] (yes vs. no)	1.87 (1.40–2.51)	<0.001	1.72(1.24–2.37)	<0.001
Crack use[‡] (≥ daily vs. < daily)	1.05 (0.82–1.34)	0.697		
Heroin use[‡] (≥ daily vs. < daily)	1.18 (0.91–1.52)	0.204		
Cocaine use[‡] (≥ daily vs. < daily)	1.42 (1.13–1.78)	0.002	1.20(0.93–1.54)	0.164
Syringe sharing[‡] (yes vs. no)	3.11 (2.37–4.09)	<0.001	2.38(1.78–3.19)	<0.001
Addiction treatment[‡] (yes vs. no)	1.06 (0.85–1.33)	0.617		
Currently enrolled in MMT^b (yes vs. no)	0.80 (0.61–1.04)	0.089	0.89 (0.68–1.16)	0.377
CD4 count (per 100 cells per mL)	1.34 (1.07–1.21)	<0.001	1.09(1.04–1.15)	0.001
Viral load (per log ₁₀ copies per mL)	0.99 (0.90–1.09)	0.895		
Year of interview (per year greater)	0.93 (0.90–0.95)	<0.001	0.98(0.94–1.01)	0.188

Notes:

^a ART = antiretroviral therapy;

[†] refers to activities in the past 6 months;

[‡] indicator variable representing the first follow-up interview between 6 months and 12 months following initiation of ART;

^{*} partnered includes legally married, common law, or having a regular sex partner;

^b MMT = methadone maintenance therapy; sex trade work is not included as a variable since by definition all individuals reporting sex trade work are sexually active;

[¶] participants with no CD4 or HIV RNA plasma measurements were excluded from the multivariate model.

Table 4

Factors associated with multiple sex partners among a prospective cohort of HIV positive injection drug users, 1996–2008.

Characteristic	Unadjusted OR (95% CI) (n = 457)	p - value	Adjusted OR (95% CI) (n = 380) [¶]	p - value
Initiate ART ^{a†} (yes vs. no)	1.00 (0.66–1.51)	0.990	0.93(0.61–1.40)	0.712
Age (per year older)	0.93 (0.90–0.95)	<0.001	0.95(0.93–0.97)	<0.001
Sex (female vs. male)	4.29 (2.71–6.77)	<0.001	3.55(2.30–5.46)	<0.001
Ethnicity (Aboriginal vs. other)	1.12 (0.70–1.80)	0.640	0.78(0.51–1.21)	0.264
Relationship status (partnered [*] vs. single)	0.43 (0.33–0.56)	<0.001	0.43(0.33–0.57)	<0.001
Homeless [‡] (yes vs. no)	1.23 (0.96–1.57)	0.104		
Crack use [‡] (≥ daily vs. < daily)	1.35 (1.08–1.68)	0.009	1.60(1.26–2.04)	<0.001
Heroin use [‡] (≥ daily vs. < daily)	2.43 (1.93–3.06)	<0.001	1.27(0.98–1.63)	0.068
Cocaine use [‡] (≥ daily vs. < daily)	3.07 (2.48–3.80)	<0.001	1.68(1.32–2.13)	<0.001
Syringe sharing [‡] (yes vs. no)	3.15 (2.40–4.13)	<0.001	1.84(1.38–2.46)	<0.001
Addiction treatment [‡] (yes vs. no)	0.95 (0.77–1.17)	0.619		
Currently enrolled in MMT ^b (yes vs. no)	0.44 (0.34–0.57)	<0.001	0.62(0.48–0.81)	<0.001
CD4 count (per 100 cells per mL)	1.13 (1.07–1.20)	<0.001	1.05 (0.99–1.12)	0.080
Viral load (per log ₁₀ copies per mL)	1.22 (1.11–1.34)	<0.001	1.01(0.91–1.12)	0.845
Year of interview (per year greater)	0.88 (0.86–0.90)	<0.001	0.88(0.85–0.92)	<0.001

Notes:

^a ART = antiretroviral therapy;

[‡] refers to activities in the past 6 months;

[‡] indicator variable representing the first follow-up interview between 6 months and 12 months following initiation of ART;

^{*} partnered includes legally married, common law, or having a regular sex partner;

^b MMT = methadone maintenance therapy; sex trade work is not included as a variable since by definition all individuals reporting sex trade work are sexually active;

[¶] participants with no CD4 or HIV RNA plasma measurements were excluded from the multivariate model.