Drug and Alcohol Dependence 197 (2019) 15–21

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Full length article

Associations between drug use patterns and viral load suppression among HIV-positive individuals who use support services in New York City

Matthew B. Feldman*, Kelsey L. Kepler, Mary K. Irvine, Jacinthe A. Thomas

New York City Department of Health and Mental Hygiene, Bureau of HIV/AIDS Prevention and Control, 42-09 28th Street, Queens, NY, 11101-4132, USA

ARTICLE INFO

Keywords:
Drug use
Patterns
HIV
Viral load suppression

ABSTRACT

Background: Drug use (DU) represents a significant barrier to maintaining physical health among people living with HIV (PLWH). Few studies, however, have examined the relationship between DU over time and HIV treatment outcomes. Such studies are needed because an individual's risk of poor health outcomes may vary with their DU behaviors. We examined associations between DU patterns over time and unsuppressed viral load (VL).

Methods: The sample included 7896 PLWH in New York City who completed ≥3 substance use assessments over a 24-month period. DU was defined as crystal methamphetamine, crack/cocaine, heroin, and/or recreational prescription medication use in the last three months. Four behavior patterns were constructed: (1) persistent use (DU reported on each assessment); (2) intermittent use-active (DU reported on the third, but not all previous assessments); (3) intermittent use-inactive (DU reported previously with no DU reported on the third assessment); (4) persistent non-use (no DU reported on any assessment). Unsuppressed VL (> 200 copies/mL) was assessed based on the last VL value in the New York City HIV Surveillance Registry in the 12 months following an individual's third DU assessment.

Results: Compared with persistent non-users, individuals with intermittent use-inactive (aOR = 1.24, 95% CI = 1.03–1.49), intermittent use-active (aOR = 1.68, 95% CI = 1.36–2.06), and persistent use (aOR = 2.21, 95% CI = 1.69–2.89) were significantly more likely to have unsuppressed VL.

Conclusions: While providers may be more likely to intervene with persistent or active drug users, our findings suggest the importance of addressing the risk of poor HIV treatment outcomes among those with any DU behavior.

1. Introduction

High rates of drug use (DU; e.g., crack, cocaine, heroin, methamphetamine, recreational prescription medication use) persist among people living with HIV (PLWH). In a sample of 3410 HIV-positive patients enrolled in the Veterans Aging Cohort Study, 22% reported the use of stimulants, opioids or injection drugs in the past year (Korthuis et al., 2012). There is also evidence that HIV-positive individuals are significantly more likely than HIV-negative individuals to use crack/cocaine (Cofrancesco et al., 2008; Pence et al., 2006; Shiau et al., 2017), heroin (Cofrancesco et al., 2008; Shiau et al., 2017), and amphetamines (Cofrancesco et al., 2008).

DU may present significant challenges to maintaining physical health among PLWH. Studies have consistently found that crystal meth (Ellis et al., 2003; Fairbairn et al., 2011; Feldman et al., 2015; King et al., 2009), crack/cocaine (Arnsten et al., 2002; Cofrancesco et al., 2008; Ladak et al., 2018), prescription opioid (Flores et al., 2018), and heroin use (Cofrancesco et al., 2008) are associated with unsuppressed viral load, a critical indicator of the clinical progression of HIV (HIV Surrogate Marker Collaborative Group, 2000) and the risk of onward transmission (Cohen et al., 2011). Substance use is also associated with antiretroviral therapy (ART) non-adherence, which is the primary cause of unsuppressed viral load (Lucas et al., 2002; Rosen et al., 2013). There is evidence that the effect of DU on indicators of HIV disease progression persists after controlling for non-adherence to ART, thus suggesting this association may be explained by an underlying bio-behavioral mechanism (Carrico, 2011).

A limited number of studies, however, have examined associations between DU patterns over time and HIV treatment outcomes. Lucas et al. (2006) found that the risk of developing new opportunistic infections during periods of abstinence among PLWH who used heroin or cocaine intermittently over time was similar to those who never used drugs. The risk of developing an opportunistic infection was significantly higher for persistent drug users and intermittent drug users

* Corresponding author.
E-mail address: mfeldman3@health.nyc.gov (M.B. Feldman).

https://doi.org/10.1016/j.drugalcdep.2018.12.015
Received 27 June 2018; Received in revised form 24 November 2018; Accepted 6 December 2018
Available online 15 January 2019
0376-8716/

during periods of active use compared to non-users. In a study of 1686 HIV-positive women in 6 US metropolitan areas, persistent and intermittent users in both active and abstinent phases had higher viral load levels compared to HIV-positive non-users (Cook et al., 2008).

Research on the relationship between DU patterns and viral load suppression is particularly critical because these patterns may change over time (Lucas et al., 2002, 2006). The risk of unsuppressed viral load may, therefore, differ based on an individual's pattern of DU. The results of such studies could be useful in tailoring outreach and engagement strategies for PLWH with different patterns of DU. Further, prior studies on the association between DU patterns and unsuppressed viral load have been limited to heroin or crack/cocaine use. The aims for this study were: (1) to examine the prevalence of DU patterns in a sample of PLWH receiving support services in New York City; (2) to examine sociodemographic and clinical differences between PLWH by patterns of DU; and (3) to examine associations between DU patterns (both overall and by specific drug type) and unsuppressed viral load.

2. Methods

2.1. Data sources

The New York City Department of Health and Mental Hygiene (NYC DOHMH) collects data on PLWH who are receiving support services funded by Ryan White Part A (RWPA), which provides grant funding for medical and support services in areas throughout the U.S. that are most severely affected by HIV (Health Resources and Services Administration, n.d.). Client-level programmatic, demographic, psychosocial, clinical, and service utilization data were collected through the Electronic System for HIV/AIDS Reporting and Evaluation (eSHARE), a secure, web-based data system for contractually required reporting by organizations that are funded by the NYC DOHMH, including those funded by RWPA. The data in eSHARE are collected from clients when they enroll in any RWPA service (Intake Assessment), and then approximately every six months throughout their participation in that service (Reassessment), allowing for the analysis of client characteristics, behaviors, and outcomes over time.

The NYC HIV Surveillance Registry (the "Registry") was used as the data source for viral load lab values and the date of HIV diagnosis. New York State requires named reporting of all diagnoses of HIV and AIDS, all HIV-related illness, all positive HIV diagnostic tests, all viral load and CD4 cell count values, and all HIV genotypes (State of New York Laws Chapter 308, 2010). The collection of fully identified data (including client names) from NYC DOHMH-funded HIV care and treatment programs via eSHARE permits matching and de-duplication of programmatic data with the Registry. eSHARE data were merged with viral load and HIV diagnosis date data that were reported to the Registry as of 9/30/2016. This study was reviewed and approved by the NYC DOHMH Institutional Review Board.

2.2. Client population

The client population included 7896 PLWH who matched to the Registry and completed three or more eSHARE substance use assessments that met the following criteria: (1) the first assessment was an Intake from any RWPA service category (to ensure that all covariates were measured at the time of enrollment); (2) the assessments were at least 90 days apart from each other (to account for the 90-day recall period used to assess substance use); (3) the first assessment was dated no earlier than 1/2012 and the third assessment was dated no later than 9/2015 (to account for data availability and completeness in eSHARE and the Registry); and (4) the first and third assessments were no more than 24 months apart from each other (to allow for comparable DU observation periods across clients). For clients who had more than one qualifying set of three assessments, we prioritized sets that included an assessment from RWPA mental health or harm reduction programs because of the high level of substance use data completeness in reporting by these programs. Otherwise, the earliest qualifying assessment set was used.

2.3. Measures

Drug use patterns. Recent DU was defined as reporting crack/cocaine, heroin, crystal methamphetamine, and/or recreational prescription medication use in the past 3 months. Based on prior studies (Cook et al., 2008; Lucas et al., 2002), four patterns of use were constructed and a category was assigned based on a client's responses on three substance use assessments. These categories included: (1) persistent use (DU reported on each assessment); (2) intermittent use-active (DU reported on third assessment but not all previous ones); (3) intermittent use-inactive (DU reported previously with no DU reported on the third assessment; (4) persistent non-use (no DU reported on any assessment).

Unsuppressed viral load. Unsuppressed viral load was defined as an HIV-1 RNA $>$ 200 copies/mL), which is the threshold for virologic failure (CDC, 2011; Panel on Antiretroviral Guidelines for Adults and Adolescents, 2018). Viral suppression status was based on the last viral load value in the 12-month period following an individual's third qualifying substance use assessment. Individuals with no viral loads during the 12-month period were classified as virally unsuppressed.

Sociodemographic and clinical characteristics. Covariates for this study included gender (male vs. female or transgender), race/ethnicity (white vs. black or Hispanic/Latino or other), age ($<$ 30 vs. 30–49 or 50+), education level ($<$ vs. $\geq$ high school diploma/GED), country of birth (USA/US territory vs. other country), primary language (English vs. other), income ($\geq$ vs. $<$ 100% of the federal poverty level), housing status (stable vs. unstable), year diagnosed with HIV (1996 and earlier vs. 1997–2005 or 2006 and later), ART prescription status, viral suppression status ($>$ vs. $\leq$200 copies/mL) prior to the first substance use assessment, recent injection drug use (reporting injection as a method of administration for crack/cocaine, heroin, crystal methamphetamine, or recreational prescription drug use in the last three months on any of the three substance use assessments), and substance use service utilization (receiving $\geq$1 RWPA-funded alcohol or drug related counseling or health education service between the date of the first assessment and the date of the last viral load in the 12-month follow-up period or the third assessment if no viral load was available).

2.4. Data analysis

Chi-square and Fisher's exact tests were used to examine how sociodemographic and clinical characteristics differed between clients by patterns of DU. Bivariate analyses of the relationship between each of the variables and unsuppressed viral load were conducted using logistic regression to estimate odds ratios. A multivariate logistic regression model was used to identify the variables independently associated with unsuppressed viral load. A separate multivariate analysis was conducted for overall DU and then for each specific drug type (cocaine/crack, heroin, crystal meth, recreational prescription medications). For drug-specific models, covariates also included any use (reported on any of the assessments) of any of the other drugs. Variables statistically significant ($p < 0.05$) in the bivariate analyses were included in the multivariate models. These results are shown as adjusted odds ratios (aOR) with their corresponding 95% confidence intervals (CIs). Data were analyzed using SAS statistical software version 9.3 (SAS Institute Inc., Cary, NC, USA).

3. Results

Most individuals in the sample were male (61%), non-Hispanic black (57%), 30–49 years old (46%), and born in the United States or a US territory (76%). The majority of individuals were living below 100%

Table 1
Client sociodemographic, behavioral, and clinical characteristics.

	n (%)
Gender	
Male	4825 (61.1%)
Female	2838 (35.9%)
Transgender	233 (3.0%)
Race/ethnicity	
White	538 (6.8%)
Black	4520 (57.3%)
Hispanic	2601 (33.0%)
Other	224 (2.8%)
Age	
< 30	911 (11.5%)
30–49	3615 (45.8%)
50+	3370 (42.7%)
Education level[a]	
< High school/GED	3230 (43.1%)
≥High school/GED	4271 (56.9%)
Country of birth[a]	
USA/US territory	5983 (76.0%)
Other country	1885 (24.0%)
Primary language[a]	
English	6217 (79.0%)
Other	1652 (21.0%)
Income[a]	
≥100% FPL	1205 (17.4%)
< 100% FPL	5710 (82.6%)
Housing status[a,b]	
Stable	5535 (71.9%)
Unstable	2159 (28.1%)
Year of HIV diagnosis[c]	
1996 and earlier	2308 (29.2%)
1997–2005	3260 (41.3%)
2006 or later	2328 (29.5%)
ART prescription status[a]	
Prescribed ART	6374 (81.7%)
Not prescribed ART	1425 (18.3%)
Viral suppression status[c,d]	
Suppressed (≤200 copies/mL)	3922 (49.7%)
Unsuppressed (> 200 copies/mL)	3974 (50.3%)
Substance use service utilization	
None	5221 (66.1%)
One or more service	2675 (33.9%)
Crystal meth use	
Recent	222 (2.8%)
Lifetime	651 (8.3%)
Heroin use	
Recent	522 (6.7%)
Lifetime	1751 (22.3%)
Crack/cocaine use	
Recent	1594 (20.2%)
Lifetime	3614 (45.8%)
Recreational prescription drug use	
Recent	279 (3.57%)
Lifetime	717 (9.2%)
Polysubstance use	
Recent	529 (6.8%)
Lifetime	1937 (24.7%)
Injection drug use	
Recent[e]	295 (3.7%)
Lifetime[f]	1513 (20.1%)

GED, general equivalency diploma; FPL, federal poverty level; ART, antiretroviral therapy.

[a] Based on data from the first of the three assessments.

[b] Unstable housing was defined as being incarcerated or homeless or living in an emergency shelter, single room occupancy hotel or other hotel/motel, transitional supportive housing program, someone else's home with an expected stay of less than 6 months, or an institution (i.e., jail, in-patient facility) for 90 days or less if the client was homeless immediately prior to institutionalization.

[c] Data are based on information reported to the New York City HIV Surveillance Registry as of 9/2016.

[d] Based on the most recent viral load value in the 6 months prior to the first assessment.

[e] Reporting injection as a method of administration for crack/cocaine, heroin, crystal methamphetamine, or recreational prescription drug use in the last three months on any of the three substance use assessments.

[f] Reporting injection as the method of administration for any lifetime drug use.

of the federal poverty level (83%), and 28% were unstably housed. Of the specific drug types, crack/cocaine was most frequently reported for both lifetime (46%) and recent use (20%; Table 1).

Compared to persistent non-users, drug users were more likely to be transgender, between 30 and 49 years old, educated at less than the high school level, born in the US or a US territory, primarily English speaking, living below the federal poverty level, unstably housed, and receiving RWPA harm reduction services. Higher proportions of intermittent drug users who were not using drugs at the third assessment were non-Hispanic black, whereas a higher proportion of intermittent drug users who were actively using at the last assessment were non-Hispanic white (Table 2).

In the sample, 75% were persistent non-users. Among those who reported any DU, the most common pattern was intermittent use-inactive (12%, n = 919). In a multivariate model controlling for sociodemographic and clinical characteristics, individuals with intermittent use-inactive (aOR = 1.24, 95% CI = 1.03–1.49), intermittent use-active (aOR = 1.68, 95% CI = 1.36–2.06), and persistent use (aOR = 2.21, 95% CI = 1.69–2.89) were significantly more likely than persistent non-users to have unsuppressed viral load (Table 3).

In the drug-specific multivariate model for cocaine/crack (n = 2252), individuals with intermittent use-active (aOR = 1.73, 95% CI = 1.37–2.18) and persistent use (aOR = 1.92, 95% CI = 1.40–2.64) were significantly more likely than persistent non-users to have unsuppressed viral load. There were no significant relationships between unsuppressed viral load and crystal meth, heroin or recreational prescription DU patterns (Table 3).

4. Discussion

We found that three patterns of DU (intermittent use-inactive, intermittent use-active, and persistent use) were independently associated with unsuppressed viral load in a sample of PLWH receiving RWPA-funded support services. Of these patterns, persistent use was the most strongly associated with unsuppressed viral load. Importantly, we also found that both categories of intermittent use were associated with unsuppressed viral load, which underscores that even occasional DU may be associated with negative health outcomes. These findings are consistent with prior research that has examined associations between longitudinal patterns of DU and HIV treatment outcomes among PLWH (Cook et al., 2008; Lucas et al., 2006).

When we restricted our analysis of DU patterns by drug type, we found that some cocaine/crack use patterns were associated with unsuppressed viral load. Previous studies have found longitudinal relationships between cocaine/crack use and clinical indicators of disease progression (Baum et al., 2009; Cook et al., 2008). The binge consumption pattern is common among cocaine/crack users and can lead to the suspension of taking medication during periods of seeking, using, and recovery from using (Harzke and Williams, 2009). Indeed, studies have found that cocaine/crack use is associated with poor ART adherence (Hinkin et al., 2007; Rosen et al., 2013). There is also evidence that the use of crack/cocaine may influence HIV disease progression, independent of ART adherence (Carrico, 2011). More research is needed to better understand how the use of different types of drugs over time impacts HIV treatment outcomes. These studies should focus on prescription opioid use, which represents a growing epidemic both in the general population (Han et al., 2017) and among PLWH (Robinson-Papp et al., 2012; Turner et al., 2016).

The findings of this study have implications for substance use services for PLWH, particularly for individuals who have more intermittent DU patterns. There is evidence that engaging occasional or

Table 2
Comparison of client sociodemographic, behavioral, and clinical characteristics by drug use pattern.

	Persistent non-use	Intermittent use with abstinence at third assessment	Intermittent with active use at third assessment	Persistent use	p[a]
Total	5920 (75.0%)	919 (11.6%)	684 (8.7%)	373 (4.7%)	
Gender					
Male	3534 (59.7%)	617 (67.1%)	450 (65.8%)	224 (60.1%)	< .0001
Female	2245 (37.9%)	259 (28.2%)	205 (28.2%)	129 (34.6%)	
Transgender	141 (2.4%)	43 (4.7%)	29 (4.2%)	20 (5.5%)	
Race/ethnicity					
White	380 (6.4%)	63 (6.9%)	70 (10.2%)	25 (6.7%)	< .0001
Black	3318 (56.2%)	559 (60.9%)	411 (60.1%)	232 (62.2%)	
Hispanic	2018 (34.2%)	284 (30.9%)	192 (28.1%)	107 (28.7%)	
Other	192 (3.3%)	12 (1.3%)	11 (1.6%)	9 (2.4%)	
Age					
< 30	759 (12.8%)	60 (6.5%)	67 (9.8%)	25 (6.7%)	< .0001
30–49	2587 (43.7%)	458 (49.8%)	359 (52.5%)	211 (56.6%)	
50+	2574 (43.5%)	401 (43.6%)	258 (37.7%)	137 (36.7%)	
Education level[b]					
< High school/GED	2362 (42.1%)	399 (45.4%)	305 (46.6%)	164 (46.5%)	0.028
Country of birth[b]					
USA/US territory	4176 (70.8%)	835 (91.2%)	634 (92.8%)	338 (92.1%)	< .0001
Primary language[b]					
English	4489 (76.0%)	804 (87.7%)	602 (88.4%)	322 (87.7%)	< .0001
Income[b]					
< 100% FPL	4166 (80.6%)	717 (86.8%)	534 (90.4%)	293 (88.5%)	< .0001
Housing status[b,c]					
Unstable	1316 (22.8%)	379 (42.3%)	299 (45.3%)	165 (45.5%)	< .0001
Year of HIV diagnosis[d]					
1996 and earlier	1642 (27.7%)	278 (30.3%)	265 (38.7%)	123 (33.0%)	< .0001
1997–2005	2414 (40.8%)	423 (46.0%)	261 (38.2%)	162 (43.4%)	
2006 or later	1864 (31.5%)	218 (23.7%)	158 (23.1%)	88 (23.6%)	
ART prescription status[b]					
Prescribed ART	4823 (82.6%)	724 (79.2%)	540 (80.00%)	287 (78.0%)	0.010
Viral suppression status[d,e]					
Unsuppressed (> 200 copies/mL)	2724 (46.0%)	574 (62.5%)	429 (62.7%)	247 (66.2%)	< .0001
Recent injection drug use[f]					
	0 (0%)	99 (10.9%)	106 (15.7%)	90 (24.7%)	< .001
Substance use service utilization[g]					
None	4364 (73.7%)	419 (45.6%)	279 (40.79%)	159 (42.6%)	< .0001
One or more service	1556 (26.3%)	500 (54.4%)	405 (59.21%)	214 (57.4%)	

GED, general equivalency diploma; FPL, federal poverty level; ART, antiretroviral therapy.

[a] p-value from chi-square test.

[b] Based on data from the first of the three assessments.

[c] Unstable housing was defined as being incarcerated or homeless or living in an emergency shelter, single room occupancy hotel or other hotel/motel, transitional supportive housing program, someone else's home with an expected stay of less than 6 months, or an institution (i.e., jail, in-patient facility) for 90 days or less if the client was homeless immediately prior to institutionalization.

[d] Data are based on information reported to the New York City HIV Surveillance Registry as of 9/2016.

[e] Based on the most recent viral load value in the 6 months prior to the first assessment.

[f] Reporting injection as a method of administration for crack/cocaine, heroin, crystal methamphetamine, or recreational prescription drug use in the last three months on any of the three substance use assessments.

[g] Receiving ≥1 RWPA-funded alcohol or drug related counseling or health education service between the date of the first assessment and the date of the last viral load in the 12-month follow-up period or the third assessment if no viral load was available.

"recreational" drug users in substance use treatment is challenging because they are less likely to believe that there is a serious problem that needs to be addressed. For example, a study of drug users in Los Angeles County found that higher levels of DU severity and motivation/readiness were associated with acceptance of referrals to drug treatment (Boyle et al., 2000). There is also evidence that high levels of DU severity are associated with starting treatment (Weisner et al., 2001). Harm reduction services, therefore, represent a critical service for PLWH (Campbell et al., 2013). Future studies should examine the impact of strategies to effectively engage and provide support to PLWH who are intermittent drug users, particularly on maintaining ART adherence and viral suppression.

The findings of this study should be considered in the context of several limitations. The HIV-positive individuals in the analysis included only those who received services funded through a RWPA federal grant to the New York eligible metropolitan area. The results are, therefore, not necessarily generalizable to other PLWH in NYC or other areas. There were also limitations related to the data used in the analysis. First, these data were cross-sectional, so observed associations should not be inferred as evidence of causality. Second, DU data were self-reported, and thus subject to social desirability bias, which would result in the under-ascertainment of DU. While biological tests could offer valuable information to validate self-reported DU, the windows of detection can be limited to very recent use (i.e., within a few days; Dolan et al., 2004). Further, RWPA-funded substance use services, as defined by the HIV Health and Human Services Planning Council of New York, primarily use a harm reduction approach, which does not generally include drug testing and rather focuses on developing a therapeutic alliance that allows the client to be open about their DU (Vakharia and Little, 2017). Finally, there were important covariates for which we were not able to control, including the presence of a mental health and/or substance use diagnosis and ART adherence, which is an important factor in evaluating whether there is an association between substance use and HIV disease progression that is independent of non-adherence. Also, while we were able to assess the utilization of substance use services, we were only able to include those

Table 3
Associations between type of drug use pattern and unsuppressed viral load (VL > 200 copies per Milliliter).

	Any drug use[a]			*Crack/cocaine use*[b]			*Heroin use*[c]			*Crystal meth use*[d]			*Recreational prescription drug use*[e]		
	n (%)	OR (95% CI)	AOR (95% CI)	n (%)	OR (95% CI)	AOR (95% CI)	n (%)	OR (95% CI)	AOR (95% CI)	n (%)	OR (95% CI)	AOR (95% CI)	n (%)	OR (95% CI)	AOR (95% CI)
Drug use pattern															
Persistent non-use	1450 (24.5%)	ref.	ref.	1571 (25.0%)	ref.	ref.	2000 (27.3%)	ref.	ref.	2163 (28.4%)	ref.	ref.	2111 (28.0%)	ref.	ref.
Intermittent use, abstinent at 3rd assessment	337 (36.7%)	1.79 (1.54-2.07)	**1.24 (1.03-1.49)**	310 (39.3%)	1.95 (1.67-2.27)	1.21 (0.99-1.48)	112 (42.3%)	1.95 (1.53-2.50)	1.17 (0.83-1.64)	25 (26.0%)	0.89 (0.56-1.40)	0.65 (0.38-1.11)	65 (39.9%)	1.70 (1.24-2.34)	1.12 (0.75-1.67)
Intermittent use, active use at 3rd assessment	292 (42.7%)	2.30 (1.95-2.70)	**1.68 (1.36-2.06)**	238 (45.5%)	2.51 (2.10-3.01)	**1.73 (1.37-2.18)**	88 (45.8%)	2.25 (1.69-3.00)	1.41 (0.94-2.12)	36 (36.7%)	1.46 (0.967-2.21)	1.18 (0.73-1.91)	40 (40.4%)	1.74 (1.16-2.61)	1.35 (0.82-2.22)
Persistent use	184 (49.3%)	3.00 (2.43-3.71)	**2.21 (1.69-2.89)**	133 (50.4%)	3.05 (2.38-3.91)	**1.92 (1.40-2.64)**	28 (48.3%)	2.48 (1.48-4.16)	1.83 (0.92-3.64)	10 (37.0%)	1.48 (0.677-3.24)	1.48 (0.38-3.85)	2 (22.2%)	0.733 (0.152-3.53)	0.45 (0.09-2.39)

The significance for 1.24 (1.03–1.49) = p < n.05. The significance for the remainder of the bold values is p < .01.
ART, antiretroviral therapy; VLS, viral load suppression.

[a] Model adjusted for baseline ART status, baseline VLS, year of diagnosis, gender, race/ethnicity, age group, education, primary language, country of birth, income, housing status, recent injection drug use, and substance use service utilization.

[b] Model adjusted for baseline VLS, year of diagnosis, gender, race/ethnicity, age group, education, primary language, country of birth, income, housing status, recent meth use, recent heroin use, recent recreational prescription drug use, recent injection drug use, and substance use service utilization.

[c] Model adjusted for baseline VLS, year of diagnosis, gender, race/ethnicity, age group, education, country of birth, income, housing status, recent crack/cocaine use, recent recreational prescription drug use, recent injection drug use, and substance use service utilization.

[d] Model adjusted for baseline ART status, baseline VLS, year of diagnosis, gender, race/ethnicity, age group, education, primary language, country of birth, housing status, recent crack/cocaine use, recent heroin use, recent recreational prescription drug use, recent injection drug use, and substance use service utilization.

[e] Model adjusted for baseline VLS, year of diagnosis, gender, race/ethnicity, age group, education, country of birth, income, housing status, recent crack/cocaine use, recent crystal meth use, recent heroin use, recent injection drug use, and substance use service utilization.

funded by RWPA (e.g., alcohol and drug counseling). RWPA is a payer of last resort and does not fund services that are reimbursable by Medicaid in New York State, such as medication assisted treatments, which were, therefore, not accounted for in this analysis. It is important to note that RWPA may pay for these treatments in states that have a less robust Medicaid program than the New York State Medicaid program.

There may have also been a limitation related to the use of different time frames for observing DU patterns (6–24 months) and viral load suppression (12 months). While we ask providers to complete reassessments with clients every six months throughout their participation in a RWPA service, they sometimes complete them after the due date. It is, therefore, difficult to establish a standardized substance use observation period without excluding a large number of clients from the sample. Despite the lack of a standardized substance use observation period, all clients had a 12-month viral load observation period. The rationale for using this length is that all PLWH—including those who are consistently virally suppressed—should receive at least one viral load lab result each year, which, therefore, provides the opportunity for nearly all clients in our sample to have at least one viral load value on which their viral suppression status can be based. This study was further strengthened by the use of the Registry, which is considered to be the most comprehensive source of longitudinal HIV-related laboratory data on individuals diagnosed with HIV and/or receiving HIV care in NYC.

DU remains a significant barrier to the health of PLWH, and therefore merits continued investigation, particularly to inform the provision of effective substance use and harm reduction services. While providers may be more likely to intervene with individuals who report consistent DU, the results of this study suggest the importance of increasing awareness of the risk for poor HIV treatment outcomes among people who occasionally use drugs. Similarly, services that meet the needs of both persistent and intermittent drug users living with HIV should be available to support the achievement of optimal physical health.

Role of funding source

This work was supported through a grant from the Health Resources and Services Administration [HRSA; H89HA00015] to the New York City Department of Health and Mental Hygiene. HRSA had no further role in study design, the collection, analysis and interpretation of the data, the writing of the report, or in the decision to submit the paper for publication.

Contributors

M. Feldman conceived and designed the study and led the writing of the manuscript. K. Kepler conducted the statistical analyses. M. Irvine and J. Thomas assisted in the conceptualization of the study. All authors contributed to and have approved the final manuscript.

Conflict of interest

No conflict declared.

Acknowledgments

We would like to thank Sarah Braunstein and the HIV Epidemiology and Field Services Program for providing the Registry data, and the New York Eligible Metropolitan Area Ryan White providers for reporting client assessment and services data to the NYC DOHMH.

References

Arnsten, J.H., Demas, P.A., Grant, R.W., Gourevitch, M.N., Farzadegan, H., Howard, A.A., Schoenbaum, E.E., 2002. Impact of active drug use on antiretroviral therapy adherence and viral suppression in HIV-infected drug users. J. Gen. Intern. Med. 17, 377–381.

Baum, M.K., Rafie, C., Lai, S., Sales, S., Page, B., Campa, A., 2009. Crack-cocaine use accelerates HIV disease progression in a cohort of HIV-positive drug users. J. Acquir. Immune Defic. Syndr. 50, 93–99.

Boyle, K., Polinsky, M.L., Hser, Y.I., 2000. Resistance to drug abuse treatment: a comparison of drug users who accept or decline treatment referral assessment. J. Drug Issues 30, 555–574.

Campbell, A.N.C., Tross, S., Calsyn, D.A., 2013. Substance use disorders and HIV/AIDS prevention and treatment intervention: research and practice considerations. Soc. Work Public Health 28, 333–348.

Carrico, A.W., 2011. Substance use and HIV disease progression in the HAART era: implications for the primary prevention of HIV. Life Sci. 88, 940–947.

Centers for Disease Control and Prevention, 2011. Guidance on Community Viral Load: A Family of Measures, Definitions, and Method for Calculation. Centers for Disease Control and Prevention, Atlanta, GA. https://stacks.cdc.gov/view/cdc/28147.

Cofrancesco, J., Scherzer, R., Tien, P.C., Gibert, C.L., Southwell, H., Sidney, S., Dobs, A., Grunfeld, C., 2008. For the study of fat redistribution, metabolic change in HIV infection (FRAM), 2008. Illicit drug use and HIV treatment outcomes in a US cohort. AIDS 22, 357–365.

Cohen, M.S., Chen, Y.Q., McCauley, M., Gamble, T., Hosseinipour, M.C., Kumarasamy, N., Hakim, J.G., Kumwenda, J., Grinsztejn, B., Pilotto, J.H., Godbole, S.V., Mehen-dale, S., Chariyalertsak, S., Santos, B.R., Mayer, K.H., Hoffman, I.F., Eshleman, S.H., Piwowar-Manning, E., Wang, L., Makhema, J., Mills, L.A., de Bruyn, G., Sanne, I., Eron, J., Gallant, J., Havlir, D., 2011. Prevention of HIV-1 infection with early antiretroviral therapy. N. Engl. J. Med. 365, 493–505.

Cook, J.A., Burke-Miller, J.K., Cohen, M.H., Cook, R.L., Vlahov, D., Wilson, T.E., Golub, E.T., Schwartz, R.M., Howard, A.A., Ponath, C., Plankey, M.W., Levine, A.M., Grey, D.D., 2008. Crack cocaine, disease progression, and mortality in a multicenter cohort of HIV-1 positive women. AIDS 22, 1355–1363.

Dolan, K., Rouen, D., Kimber, J., 2004. An overview of the use of urine, hair, sweat and saliva to detect drug use. Drug Alcohol Rev. 23, 213–217.

Ellis, R.J., Childers, M.E., Cherner, M., Lazzaretto, D., Letendre, S., Grant, I., 2003. Increased human immunodeficiency virus loads in active methamphetamine users are explained by reduced effectiveness of antiretroviral therapy. J. Infect. Dis. 188, 1820–1826.

Fairbairn, N., Kerr, T., Milloy, M.J., Zhang, R., Montaner, J., Wood, E., 2011. Crystal methamphetamine injection predicts slower HIV RNA suppression among injection drug users. Addict. Behav. 36, 762–763.

Feldman, M.B., Thomas, J.A., Alexy, E.R., Irvine, M.K., 2015. Crystal methamphetamine use and HIV medical outcomes among HIV-infected men who have sex with men accessing Ryan White services in New York. Drug Alcohol Depend. 147, 266–271.

Flores, J., Liang, Y., Ketchum, N.S., Turner, B.J., Bullock, D., Villarreal, R., Potter, J.S., Taylor, B.S., 2018. Prescription opioid use is associated with virologic failure in people living with HIV. AIDS Behav. 22, 1323–1328.

Han, B., Compton, W.M., Blanco, C., Crane, E., Lee, J., Jones, C.M., 2017. Prescription opioid use, misuse, and use disorders in US adults: 2015 National Survey on Drug Use and Health. Ann. Intern. Med. 167, 293–301.

Harzke, A.J., Williams, M.L., 2009. Binge use of crack cocaine and sexual risk behaviors among African-American, HIV-positive users. AIDS Behav. 13, 1106–1118.

Hinkin, C.H., Barclay, T.R., Castellon, S.A., Levine, A.J., Durvasula, R.S., Marion, S.D., Myers, H.F., Longshore, D., 2007. Drug use and medication adherence among HIV-1 infected individuals. AIDS Behav. 11, 185–194.

HIV Surrogate Marker Collaborative Group, 2000. Human immunodeficiency virus type 1 RNA level and CD4 count as prognostic markers and surrogate endpoints: a meta-analysis. AIDS Res. Hum. Retroviruses 16, 1123–1133.

King, W.D., Larkins, S., Hucks-Ortiz, C., Wang, P.C., Gorbach, P.M., Veniegas, R., Shoptaw, S., 2009. Factors associated with HIV viral load in a respondent driven sample in Los Angeles. AIDS Behav. 13, 145–153.

Korthuis, P.T., Fiellin, D.A., McGinnis, K.A., Skanderson, M., Justice, A.C., Gordon, A.J., Doebler, D.A., Asch, S.M., Fiellin, L.E., Bryant, K., Gibert, C.L., Crystal, S., Goetz, M.B., Rimland, D., Rodriguez-Barradas, M.C., Kraemer, K.L., 2012. Unhealthy alcohol and illicit drug use are associated with decreased quality of HIV care. J. Acquir. Immune Defic. Syndr. 61, 171–178.

Ladak, F., Socias, E., Nolan, S., Dong, H., Kerr, T., Wood, E., Montaner, J., Milloy, M.-J., 2018. Substance use patterns and HIV-1 RNA viral load rebound among HIV-positive illicit drug users in a Canadian setting. Antivir. Ther [E-pub. ahead of print].

Lucas, G.M., Gebo, K.A., Chaisson, R.E., Moore, R.D., 2002. Longitudinal assessment of the effects of drug and alcohol abuse on HIV-1 treatment outcomes in an urban clinic. AIDS 16, 767–774.

Lucas, G.M., Griswold, M., Gebo, K.A., Keruly, J., Chaisson, R.E., Moore, R.D., 2006. Illicit drug use and HIV-1 disease progression: a longitudinal study in the era of highly active antiretroviral therapy. Am. J. Epidemiol. 163, 412–420.

Panel on Antiretroviral Guidelines for Adults and Adolescents, 2018. Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents Living With HIV. Available at:. Department of Health and Human Services. http://aidsinfo.nih.gov/contentfiles/lvguidelines/AdultandAdolescentGL.pdf.

Pence, B.W., Miller, W.C., Whetten, K., Eron, J.J., Gaynes, B.N., 2006. Prevalence of DSM-IV- defined mood, anxiety, and substance use disorders in an HIV clinic in the Southeastern United States. J. Acquir. Immune Defic. Syndr. 42, 298–306.

Robinson-Papp, J., Elliott, K., Simpson, D.M., Morgello, S., for the Manhattan HIV Brain Bank, Manhattan, 2012. Problematic prescription opioid use in an HIV-infected cohort: the importance of universal toxicology testing. J. Acquir. Immune Defic. Syndr. 61, 187–193.

Rosen, M.I., Black, A.C., Arnsten, J.H., Goggin, K., Remien, R.H., Simoni, J.M., Golin,

C.E., Bangsberg, D.R., Liu, H., 2013. Association between use of specific drugs and antiretroviral adherence: findings from MACH 14. AIDS Behav. 17, 142–147.
Shiau, S., Arpadi, S.M., Yin, M.T., Martins, S.S., 2017. Patterns of drug use and HIV infection among adults in a nationally representative sample. Addict. Behav. 68, 39–44.
State of New York Laws Chapter 308, 2010. HIV Testing and Counseling, Amendment to New York State Public Health Law Article 21, Amendment of Part 63 of Title 10, Codes, Rules, and Regulations of the State of New York (HIV/AIDS Testing, Reporting and Confidentiality of HIV-Related Information).
Turner, A.N., Maierhofer, C., Funderburg, N.T., Snyder, B., Small, K., Clark, J., Bazan, J.A., Kwiek, N.C., Kwiek, J.J., 2016. High levels of self-reported prescription opioid use by HIV-positive individuals. AIDS Care 28, 1559–1565.
Vakharia, S.P., Little, J., 2017. Starting where the client is: harm reduction guidelines for clinical social work practice. Clin. Soc. Work J. 45, 65–76.
Weisner, C., Mertens, J., Tam, T., Moore, C., 2001. Factors affecting the initiation of substance abuse treatment in managed care. Addiction 96, 705–716.