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Patterns of Substance Use Among a Large Urban Cohort of HIV-Infected Men Who Have Sex With Men in Primary Care

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Abstract

The present study sought to identify characteristics of HIV-infected MSM that are associated with the use of specific substances and substance abuse in general. Participants were 503 HIV-infected MSM who were receiving primary care. A self-assessment and medical records were used to obtain information about past 3-month alcohol and drug use and abuse, and demographics, HIV-disease stage and treatment, sexual risk, and mental health. Associations of these four domains with substance use and abuse outcomes were examined using hierarchical block-stepwise multivariable logistic regression. Substance use and abuse in the sample was high. Transmission risk behavior was significantly associated with over half of the outcomes. The associations of demographic and HIV-disease stage and treatment variables varied by substance, and mental health problems contributed differentially to almost every outcome. These findings should be considered for designing, implementing, and evaluating substance use programming for HIV-infected MSM.

Keywords

HIV/AIDS; Men who have sex with men; Alcohol; Drugs; HIV clinic

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Introduction

HIV-infected men who have sex with men (MSM) are at an increased risk of using and abusing alcohol and other drugs [1–3]. Among this population, recreational substance use has been associated with multiple negative outcomes including increased sexually transmitted infection (STI) acquisition risk [4, 5], medication non-adherence [6], comorbid mental health problems, such as depression and anxiety [6], more rapid progression of disease [7, 8], and increased HIV transmission risk behavior [1, 3, 9–13]. These deleterious effects present several major causes for concern and consequent reasons for investigation and prevention.

While substance use data on HIV-infected MSM, especially with respect to sexual risk is well documented [1, 11–13], less is known about the patterns and correlates of use of specific substances and drug abuse in this population. What is known is that some specific substances used by HIV-infected MSM, including stimulants [1], methamphetamines, poppers, and cocaine [3], or use of three or more substance (i.e., poly substance use) [14], are associated with sexual risk taking. However, no study has sought to understand which characteristics of HIV-infected MSM in particular are associated with use of specific substances and drug abuse.

Given the noted associations of substance use and risky sexual behavior among HIV-infected MSM, and because MSM represent the largest number of new HIV infections (53%) and almost half of all Americans living with HIV (49%) [15], it is particularly important to examine patterns and correlates of substance use among this group. Prior work [13] has demonstrated that the patterns associated with alcohol and drug use among MSM are complex, and demographics, early life adverse events, mental health status, social and sexual practices, and connection to gay culture may be factors that influence whether a particular subgroup of MSM uses specific substances. Understanding these associations with use of different substances may have implications for substance use and sexual risk programming for HIV-infected MSM. Hence, the purpose of the present study was to identify characteristics of HIVinfected MSM who are at increased risk for use of specific substances and drug abuse.

Methods

Sample and Data

From 2004 to 2007, 503 HIV-infected MSM who received primary care at Fenway Health, the largest HIV-care center in New England, were recruited to participate in either of two secondary HIV-intervention studies aimed at reducing sexual transmission risk behavior. The data for this analysis were collected at the baseline enrollment/screening visit. Men who met inclusion criteria for this baseline/screening visit were infected with HIV, received primary HIV care at Fenway Health, were 18 years of age or older, and reported engaging in anal intercourse with another man within the past 6-months. Through audio computer-assisted self-interviewing (ACASI), the men completed a comprehensive screening assessment at baseline that included questions about demographics, substance use, sexual risk, HIV medication history, and mental health. Data from all of the men were included in the current study, regardless of their eventual participation in the interventions. This study was approved by The Fenway Health/Fenway Institute Institutional Review Board (IRB), and each participant completed an informed consent.

Measures

Outcome Variables

Alcohol Use: Men were asked how often they drank alcohol in the last 3-months using a frequency assessment question ranging from never to every day. Alcohol use was defined as reporting drinking alcohol at least once per week in the previous 3-months (dichotomous).

Excessive Alcohol Use: Participants were asked how many times they drank five or more drinks in a single day within the past 3 months. Men who reported participating in this behavior at least once per week were considered to engage in excessive alcohol use (dichotomous).

Use of Specific Drugs: As part of the psychosocial assessment, men were asked if they had sniffed, snorted, smoked, swallowed, or injected any drugs within the past 3-months. If participants answered affirmatively, they were asked to identify their specific drugs of use from the following list: (1) marijuana, (2) crack, (3) cocaine, (4) heroin, (5) methamphetamine, (6) ketamine, (7) opiates such as Vicodin, Oxycontin, Dilaudid, Percocet, or Darvocet, (8) tranquilizers or barbiturates such as Valium, Xanax or GHB, (9) hallucinogens such as LSD or Ecstasy, or (10) inhalants such as glue, poppers, nitrous oxide (NO2). These answers were not mutually exclusive, so the participants were able to identify up to 10 substances. Additionally, a separate question was asked about specific crystal methamphetamine use within the past 3-months, which was combined with the methamphetamine use answer. Multiple drug use was defined as using three or more of these drugs within the past 3-months. Heroin use was not utilized as an outcome because only three individuals had reported using heroin. Each of the other substances (including multiple drug use) was modeled separately for the dichotomous outcome of substance use.

Drug Abuse: The drug abuse variable was created in the following way. Individuals who reported sniffing, snorting, smoking, swallowing, or injecting any drug were asked five questions related to drug abuse as part of the Patient Health Questionnaire [16]: if they had (1) used drugs even though a doctor suggested that they stop using them, (2) used drugs, were high from drugs, or hung over while they were working, going to school, or taking care of children or other responsibilities, (3) missed or were late for work, school, or other activities because they were taking drugs or hung over, (4) had a problem getting along with other people while they were taking drugs or hung over from drugs, and (5) driven a car after taking drugs. Drug abuse was defined as meeting any of these diagnostic criteria more than once within the past 6-months. These diagnostic questions were not asked in reference to a particular drug, so we were unable to assess drug abuse with specific drugs; the drug abuse assessment is therefore a general measure.

Drug Classes: In addition to the individual drugs, we examined two major classes of drugs, in order to further facilitate the comparison of significant associations across groups. Given the specific drugs queried about in the assessment, we grouped specific drugs into stimulants and depressants. These classes were based on the classification put forth by the Department of Justice's Drug Enforcement Administration (DEA) [17]. For drugs that could be grouped in more than one class (e.g., ketamine, opiates), we grouped them with the class that was most appropriately aligned with the effect that the drug has on the body. The stimulant class included crack, cocaine, and methamphetamine, and the depressant class included tranquilizers or barbiturates, ketamine, and opiates. A hallucinogen class was not utilized because this class would be encompassed by the stand-alone outcome of hallucinogens such as LSD or Ecstasy, which was already examined. Additionally, inhalants were not included in the class outcomes because the inhalant most used by MSM is poppers, which are not appropriately grouped into any particular class of drugs.

Independent Variables—We included a number of independent variables that were hypothesized to be significantly associated with substance use and drug abuse among HIV-infected MSM based on prior research [13, 18]. The independent variables were categorized into four domains: demographics, HIV-disease stage and treatment, sexual risk, and mental health.

Demographics: Demographic information included a continuous measure of age, and categorical measures of education (less than a college degree, college degree, graduate degree), annual income (≤$40,000, $40,001–$80,000, >$80,000), and race/ethnicity (white, African American/ Black, Latino/Hispanic, other). Additionally, men were asked if they were in a primary relationship with at least one male sex partner during the last 3-months, defined as someone they had lived with or seen a lot, and to whom they felt a special emotional commitment (dichotomous).

HIV-Disease Stage and Treatment: Results from the most recent blood tests within the 3-months prior to the baseline questionnaire assessing plasma HIV RNA and CD4 counts were used to assess HIV-disease stage, which were collected via review of an electronic medical record (Centricity EMR). These biological markers were measured at least quarterly as part of ongoing primary care, and participants provided consent to have the results of their tests used for study purposes. Plasma HIV RNA was dichotomized 75 or less or greater than 75 copies/ml, with the latter considered detectable, in accordance with the limit of detection of the assay used (bDNA). CD4 count was used as a continuous variable. Additionally, current anti-HIV medication use was assessed as part of the questionnaire (dichotomous).

Sexual Risk: As part of the comprehensive baseline assessment, participants were asked a series of questions regarding their sexual practices as consistent with other studies of HIV-uninfected MSM (e.g., Project EXPLORE) [9, 10]. Men who reported engaging in unprotected insertive or receptive anal intercourse with partners of HIV-negative or unknown status within the past 3-months were considered to have engaged in transmission risk behavior (TRB) (dichotomous). For a subset of the sample (i.e., participants in one of the intervention studies; $n = 201$), data on STIs were collected via serological testing for syphilis, and urines and rectal swabs for nucleic acid amplification tests (NAAT; gonorrhea and chlamydia) (BD ProbeTec) at baseline as part of study procedures, and for the rest of the sample, data on STI diagnosis were collected via electronic medical record extraction from the most current testing date within the year prior to the baseline assessment. As with the HIV biomarkers, participants consented to have their STI results used for study purposes.

Mental Health: Indicators pertaining to mental health included depression, anxiety disorder, attention deficit hyperactivity disorder, and childhood sexual abuse. Depression was assessed through the Depression Severity Scale of the Patient Health Questionnaire (PHQ) [16], a self-report instrument designed to detect common mental health disorders in the primary care setting through symptom severity and diagnostic assessments. This scale has shown excellent internal consistency (Chronbach's α 0.89) and test–retest reliability (r 0.84), as well as established criterion and construct validity [19]. For the current study, depression was measured as a categorical variable indicating no depression, screening in for Other Depressive Disorder, or screening in for Major Depressive Disorder.

Panic disorder and "other anxious syndrome" (similar to Generalized Anxiety Disorder) were assessed through the PHQ [16], which has demonstrated diagnostic accuracy (98% for panic disorder and 91% for any anxiety disorder), and criterion and construct validity [16]; the social phobia screening measure was the MINI-SPIN, a three item screening assessment that was derived from the Social Phobia Inventory (SPIN) [20, 21], which has a demonstrated diagnostic efficiency of 89.9% (sensitivity 88.7% and specificity 90.0%, at a

cutoff score of 6) [21]; and Post-Traumatic Stress Disorder (PTSD) was measured by the four-item SPAN [22]. The SPAN has been found to have a diagnostic accuracy of 88% (sensitivity 84%; specificity 91%) [22], where respondents are asked to rate items on a 5-point scale (ranging from "not at all" to "extremely") to indicate how distressing each of the symptoms had been during the past week. For the current study, anxiety was measured as a categorical dichotomous variable, if participants met screen-in criteria for panic disorder, other anxious syndrome, social phobia, or PTSD.

Screening in for attention deficit hyperactivity disorder (ADHD) was assessed with the ADHD Rating Scale [23], which has been shown to have strong psychometric properties, including internal consistency (Chronbach's α 0.86), inter-rater (73%), and test–retest reliability (0.82), and convergent and discriminant validity [24]. Accordingly, if a participant endorsed moderate or greater on either 6 attention or 6 hyperactive symptoms, they screened positive for ADHD.

To assess whether a participant had a history of childhood sexual abuse (CSA), men were asked two questions: (1) "when you were 12 years old or younger, did you have a sexual experience with a person who was at least five years older than you?"; and (2) "when you were between the ages of 13 and 16, did you ever have a sexual experience with someone who was 10 years older or more?" [25] If participants answered affirmatively to either of these questions, they were considered to have a history of CSA (dichotomous). This assessment is consistent with other large-scale studies of on CSA among MSM, such as Project EXPLORE! [26].

Data Analysis

To identify the characteristics of MSM associated with use of each substance, multiple drug use, and drug abuse, using SAS v. 9.1 we conducted block-stepwise multivariable logistic regression analyses, which were constructed in a similar fashion to prior research [13]. The four domains of independent variables described previously (demographics, HIV-disease stage and treatment, sexual risk, and mental health) were tested via a hierarchical structure for each outcome. Each outcome was modeled separately.

First, we sought to identify the significant independent variables within each domain. Accordingly, bivariate logistic regression models were run for each outcome within the four domains, starting with demographics, then adding HIV-disease stage and treatment, then sexual risk, and finally mental health. Because a substantial proportion of the sample reported multiple drug use, each model for the specific drug outcomes (including the bivariate and all multivariable models) adjusted for a multiple drug use dummy variable, which did not include the drug that was being modeled. Within each domain, variables that were statistically significant in the bivariate models ($p < 0.05$) were incorporated into a multivariable model that only included other variables within the same domain. When plasma RNA was significant in the bivariate models and retained in further models, we controlled for CD4 count.

A final multivariable model for each outcome variable was constructed as follows. Variables that were significant ($p < 0.05$) in the multivariable model in the first domain (demographics) started as the base. Variables that were significant in the multivariable model of the next domain (HIV-disease stage and treatment) were added in the next block. Variables that at least approached significance ($p < 0.10$) were retained within this multivariable model. This cutoff was chosen for this one step to increase the likelihood that important variables from the initial domain blocks got a fair chance of being included in the final multivariable models that represented all of the domains. This process was repeated for the next two domains (sexual risk and then mental health), where significant variables ($p <$

0.05) from the multivariable models within each domain were added to the previously constructed model, until the final multivariable logistic regression model represented all domains, with significance determined by $p < 0.05$. Because the hierarchical procedure was utilized to filter out non-significant covariates at each step, the final models for each outcome did not necessarily include independent variables from each domain.

Consistent with Stall and colleagues [13], we chose to order the domains in the hierarchical process because we wanted to characterize the sample in a distinct way that could inform future interventions for HIV-infected substance using MSM. It is well documented that sexual risk and mental health are highly associated with substance use among HIV-infected individuals generally, and MSM specifically. As such, in our analyses we anticipated that measures of sexual risk and mental health would likely remain statistically significant once carried over in the model building process, and wanted key demographics associated with each substance to have a primary opportunity to be carried over to the final multivariable model.

Results

The average age of the sample was 41.9 (SD 8.3). The majority of the sample identified as White (75.1%; which is consistent with HIV-infected MSM living in the state of Massachusetts [27]), were college educated (51.7%), and had an annual income of less than $40,000 a year (57.3%). The frequency of substance use and abuse in the sample was high: 49.1% reported alcohol use, 19.9% reported excessive alcohol use, 52.3% reported any drug use, 19.9% reported multiple drug use (3 or more drugs) and 29.0% reported drug abuse. The most commonly used drugs were marijuana (33.8%), inhalants (26.6%), methamphetamine (including crystal meth) (20.7%), and cocaine (17.1%), and the prevalence of use was less than 10% for each of the other drugs. Of those who met criteria for drug abuse ($n = 145$), 60.0% were using marijuana, 56.6% were using inhalants, 44.8% were using methamphetamine, 42.8% were using cocaine, and less than 30% were using any of the other drugs. Further descriptions of the sample have been reported elsewhere [28].

Block-Stepwise Logistic Regression Models

In the final block-stepwise multivariable logistic regression models, the following characterizes the HIV-infected MSM in the sample who used each substance, met criteria for multiple drug use and drug abuse, and who used drugs within the two classes (separately). The adjusted bivariate models and final multivariable regression models for the specific drug outcomes, multiple drug use, and drug abuse outcomes as well as the two drug class outcomes are presented in Tables 1 and 2 respectively.

Alcohol and Excessive Alcohol Use

Alcohol: Participants who were currently taking anti-HIV medication [Adjusted Odds Ratio (AOR 0.62; 95% Confidence Interval (CI) 0.42–0.93; *p-value* (*p*) 0.01] had a reduced odds of using alcohol on a weekly basis. Study participants who had a higher annual income (greater than $80,000 compared to those with an annual income of less than or equal to $40,000) (AOR 2.08; CI 1.19–3.62; $p < 0.01$) had an associated increased likelihood of drinking alcohol on a weekly basis.

Excessive Alcohol Use: Compared to men in the sample with less than a college degree, men with a college degree (AOR 0.54; CI 0.32–0.94; *p* 0.03) had a decreased odds of excessive alcohol use, and compared to men in the sample who identified as white, men who identified as Black (AOR 2.02; CI 1.05–3.91; *p* 0.04) and had a detectable viral load (AOR 1.66; CI 1.03–2.67; *p* 0.04) had a greater associated likelihood of excessive alcohol use.

Specific Drugs

Marijuana: HIV-infected MSM who engaged in TRB (AOR 1.63; CI 1.05–2.51; p 0.03) and had a history of childhood sexual abuse (AOR 1.54; CI 1.02–2.34; p 0.04) had an increased odds for using marijuana.

Inhalants: Compared to participants who identified as white, participants who identified as Black (AOR 0.36; CI 0.15–0.86; p 0.02) or Hispanic/Latino (AOR 0.38; CI 0.14–0.99; p 0.04) had a reduced odds of using inhalants. Men who had a graduate degree compared to those with less than a college education (AOR 2.11; CI 1.14–3.91; p 0.02), had engaged in TRB (AOR 3.38; CI 2.11–5.42; $p < 0.001$), and had a prior positive STI (AOR 3.38; CI 1.37–8.31; $p < 0.01$) had an associated increased likelihood of inhalant use.

Methamphetamine: Men in the sample who reported engaging in TRB (AOR 4.05; CI 2.38–6.88; $p < 0.001$) and screened positive for an STI (AOR 3.27; CI 1.34–8.02; $p < 0.01$) had a greater odds of using methamphetamine.

Cocaine: The only variable significantly associated with cocaine use was depression. As such, compared to participants who did not screen in for a depressive disorder, participants who screened in for a major depressive disorder had an associated increased likelihood of using cocaine (AOR 2.02; CI 1.06–3.83; p 0.03).

Tranquilizers or Barbiturates: HIV-infected MSM in the sample who met screen-in criteria for ADHD (AOR 2.67; CI 1.18–6.05; p 0.02) had an associated increased likelihood of using tranquilizers or barbiturates.

Hallucinogens (Such as LSD or Ecstasy): Study participants who had a primary partner (AOR 2.32; CI 1.13–6.07; p 0.02) and screened in for an anxiety disorder (AOR 3.06; CI 1.25–7.49; p 0.01) had an associated increased likelihood of using hallucinogens.

Crack: Compared to participants who reported a lower annual income (less than $40,000), those reporting an annual income of between $40,001 and $80,000 (AOR 0.12; CI 0.03–0.51; $p < 0.01$) and those reporting an annual income of greater than $80,000 (AOR 0.12; CI 0.02–0.94; p 0.04) had a reduced odds of using crack. Compared to participants who identified as white, participants who identified as Black (AOR 2.68; CI 1.01–7.18; p 0.04) had an associated increased likelihood of reported crack use.

Opiates: The only variable that was significant with regard to an associated increased risk of opiate use was reporting childhood sexual abuse (AOR 2.10; CI 1.01–4.41; p 0.04).

Ketamine: HIV-infected MSM who engaged in TRB (AOR 3.19; CI 1.25–8.16; p 0.02) and screened positive for an STI (AOR 4.14; 1.26–13.58; p 0.02) had an associated increased likelihood of using ketamine.

Multiple Drugs and Drug Abuse

Multiple Drugs: Participants who had a detectable viral load (AOR 1.73; CI 1.04–2.86; p 0.02), had reported engaging in TRB (AOR 3.98; CI 2.45–6.48; $p < 0.001$), and screened-in for ADHD (AOR 2.93; CI 1.52–5.65; $p < 0.01$) had an associated increased likelihood of engaging in multiple drug use.

Drug Abuse: Compared to participants who identified as white, participants who identified as Hispanic/Latino (AOR 0.27; CI 0.09–0.82; p 0.02) had a reduced odds of abusing drugs. Men who had detectable plasma RNA (AOR 1.73; CI 1.06–2.81; p 0.03), engaged in TRB

(AOR 3.90; CI 2.46–6.20; $p < 0.001$), screened in for major depression (AOR 2.60; CI 1.28–5.30; $p < 0.01$), and screened in for ADHD (AOR 2.90; CI 1.42–5.95; $p < 0.01$) had an associated increased likelihood of abusing drugs.

Drug Classes

Stimulant Class: Men with detectable plasma RNA (AOR 1.70; CI 1.08–2.69; p 0.02), engaged in TRB (AOR 2.54; CI 1.63–3.94; $p < 0.001$) and screened in for major depression (AOR 2.09; CI 1.12–3.90; p 0.02) had an associated increased likelihood of using stimulant class drugs.

Depressant Class: Compared to participants in the sample who identified as white, participants who identified as Black (AOR 0.23; CI 0.06–0.85; p 0.03) had an associated reduced likelihood of using depressant drugs, whereas men with detectable plasma RNA (AOR 2.20; CI 1.21–4.00; p 0.01) and met screen-in criteria for ADHD (AOR 2.28; CI 1.08–4.79; p 0.03) had an associated increased risk of using depressant drugs.

Discussion

In the current study of 503 HIV-infected MSM, we examined the risk of substance use with many different substances, multiple drug use, and drug abuse in relation to demographics, HIV-disease stage and treatment, sexual risk, and mental health. Notably, the most prominent risk factor associated with substance use among over half of the different substance categories, including multiple drug use, drug abuse, and the stimulant drug class, was engaging in HIV transmission risk behavior. The risk of substance use associated with engaging in TRB ranged from a 63% (marijuana) to a three-fold (methamphetamine) increase among the men in the sample, after controlling for demographics, HIV-disease stage and treatment variables, STIs, and mental health problems, as well as multiple drug use for the specific drugs. Additionally, having screened positive for an STI was significantly associated with an increased risk of inhalant, methamphetamine, and ketamine use, ranging from a two-fold to a three-fold increase. These finding are consistent with what is known about the association between sexual risk taking, sexually transmitted infections, and substance use and abuse among MSM [1, 11].

The risks associated with the demographic characteristics varied by substance. For example, level of education was associated with both an increased and decreased risk of substance use and abuse, depending on the specific substance. Compared to men in the sample with less than a college degree, those with a college degree had a significantly lower likelihood of excessive alcohol use, whereas those with a graduate degree had a significantly higher likelihood of inhalant use. Similar patterns emerged with race/ethnicity as men who identified as Black were at an increased risk for excessive alcohol use and for using crack compared to men who identified as white. However, men who identified as Black had a decreased risk of inhalant use (as did men who identified as Hispanic) and use of depressant class drugs compared to their white-identified counterparts.

The risk for substance use associated with income level also varied across different substances, as compared to the lowest income group, those in the highest income bracket (> $80,000) had an increased likelihood of alcohol use whereas compared to men in the lowest income group, those in the mid ($40,001–$80,000) and highest income brackets were significantly less likely to use crack. Having a primary partner was only associated with hallucinogen use, as participants who reported being in a primary relationship with at least one male sex partner during the last 3-months had an increased likelihood of hallucinogen use.

With respect to the HIV-disease stage and treatment variables, men who had a detectable viral load (HIV RNA greater than 75) were more likely to report excessive alcohol use, multiple drug use, drug abuse, and use of stimulant, as well as depressant class drugs, and current anti-HIV medication use was associated with a decreased likelihood of weekly alcohol use.

Finally, while the different mental health indicators (depression, anxiety, ADHD, and childhood sexual abuse) were consistently associated with an increased risk of substance use and abuse, each mental health problem was associated with a unique set of substances. Men with any anxiety disorder were more likely to use hallucinogenic drugs (LSD or Ecstasy), whereas participants with ADHD had an increased risk of using tranquilizers or barbiturates, depressant class drugs, multiple drugs, and having problems with drug abuse. Major depressive syndrome was significantly associated with cocaine use and drug abuse, as well as stimulant class drugs, and a reported history of childhood sexual abuse was associated with marijuana and opiate use.

The current study has some important limitations. First, the data were cross-sectional, so we were unable to establish temporal ordering between the risk factors and substance use outcomes. This is an especially important consideration with respect to the relationships between substance use and sexual risk and mental health. For example, regarding sexual risk, the literature has elucidated that sexual risk is often a result of substance use and not necessarily the other way around; however, risk behaviors do cluster together, so it is entirely feasible that HIVinfected MSM who engage in TRB use substances outside of the context of sexual behavior (i.e., substance use may not be directly tied to sexual activity). This relationship could also be differential by specific drug (e.g., the relationship between TRB and marijuana use compared to the use of other drugs), which warrants further examination. In addition, while the literature is unclear about the temporal ordering between certain mental health problems and substance use, where depression and/or anxiety can precede or follow substance use [29], other problems such as childhood sexual abuse and ADHD have had more consistent research indicating a temporal ordering where these problems precede substance use [30–33].

Second, the past three-month drug use outcome measures do not include any indicators of frequency, thus limiting the ability to identify other drugs men in the sample were using simultaneously. While controlling for multiple drug use in each analysis at least somewhat addresses this limitation, a stronger analysis would model most frequently used drugs, which would temper the challenges posed by the fact that MSM often use many different kinds of drugs even over periods of time as long as three months. This type of analysis was not possible with the current data.

Third, the sample was predominantly white and urban, and received care at Fenway Health, which limits the generalizability of these findings. Fourth, the substance use and sexual risk measures were collected via self-report, which could result in bias associated with social desirability; however, the audio computer-assisted interview method employed has been shown to be effective in increasing reporting of private and undesirable behaviors [34, 35]. Fifth, drug abuse and screening in for mental health diagnoses were assessed via symptom-based questionnaires and do not represent actual DSM-IV diagnoses; however, the PHQ is a commonly used symptom-based instrument approximating DSM-IV diagnoses with good psychometric properties [16]. Finally, the way in which drug use was measured, use of one specific drug is not mutually exclusive with use of another specific drug. For example, among those who used marijuana in the sample, 47.1% used at least one other drug, and 47.6% used at least 2 other drugs. However, all of the analyses of each specific drug include

an indicator for multiple drug use, which helps control for confounding associated with the use of other drugs.

Conclusions

These limitations notwithstanding, to the best of our knowledge, this is the first study to characterize which MSM are at increased risk for substance use and abuse among an exclusively HIV-infected cohort. The results of this study identify that important correlates of the use of several specific drugs, as well as multiple drug use and drug abuse, include engaging in sexual behavior that puts men at risk for transmitting HIV to their partners and/or acquiring sexually transmitted infections (i.e., TRB), having a less controlled virus (i.e., detectable viral load), and having mental health problems. HIV-infected MSM with these characteristics appear to be most in need of programmatic intervention with respect to substance use and abuse, and as such, these factors need to be considered when designing, implementing, and evaluating substance use and sexual risk programming for this population.

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Table 1

Adjusted bivariate and block-stepwise multivariable logistic regression models examining associations of demographics, HIV disease stage and treatment, sexual risk, and mental health indicators with alcohol use, excessive alcohol use, use of specific drugs (in order of prevalence), multiple drug use, and drug abuse

	Alcohol		Excessive alcohol use		Marijuana	
	Adjusted bivariate[a]	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Demographics						
Age	0.99 (0.97, 1.01)		0.98 (0.95, 1.00)~		1.01 (0.98, 1.03)	
Education						
<College degree	1.00		1.00	1.00	1.00	
College degree	1.10 (0.72, 1.62)		0.49 (0.30, 0.82)**	0.54 (0.32, 0.94)*	0.89 (0.57, 1.39)	
Graduate degree	1.06 (0.65, 1.74)		0.57 (0.30, 1.08)~	0.62 (0.32, 1.19)	1.24 (0.72, 2.12)	
Income						
≤$40,000	1.00	1.00	1.00		1.00	
$40,001–$80,000	1.45 (0.97, 2.17)~	1.41 (0.94, 2.13)	0.70 (0.42, 1.18)		1.30 (0.83, 2.04)	
>$80,000	2.16 (1.25, 3.74)**	2.08 (1.19, 3.62)**	0.83 (0.43, 1.62)		1.34 (0.74, 2.39)	
Race/ethnicity						
White	1.00		1.00	1.00	1.00	
Black	0.95 (0.54, 1.66)		1.97 (1.05, 3.70)*	2.02 (1.05, 3.91)*	0.66 (0.34, 1.30)	
Hispanic	0.56 (0.29, 1.08)		1.20 (0.55, 2.62)	1.09 (0.49, 2.44)	1.14 (0.57, 2.79)	
Other	0.44 (0.18, 1.12)~		1.60 (0.61, 4.21)	1.58 (0.58, 4.31)	1.19 (0.48, 2.97)	
Primary partner						
No	1.00		1.00		1.00	1.00
Yes	1.08 (0.75, 1.55)		1.07 (0.68, 1.69)		1.49 (0.99, 2.25)*	1.41 (0.93, 2.14)*
HIV disease stage and treatment						
Plasma RNA[b]						
≤75 copies/ml	1.00		1.00	1.00	1.00	
>75 copies/ml	1.42 (0.99, 2.04)~		1.67 (1.08, 2.60)*	1.66 (1.03, 2.67)*	0.67 (0.65, 1.45)	
Currently on HIV medication						

	Alcohol		Excessive alcohol use		Marijuana	
	Adjusted bivariate[a]	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
No	1.00	1.00	1.00		1.00	
Yes	1.47 (1.02, 2.13) **	0.62 (0.42, 0.93) *	0.59 (0.37, 0.93) *		1.35 (0.87, 2.10)	
Sexual risk						
Transmission risk behavior						
No	1.00	1.00	1.00		1.00	1.00
Yes	2.30 (1.33, 3.97) **	1.33 (0.91, 1.95)	1.25 (0.80, 1.97)		1.62 (1.06, 2.45) *	1.63 (1.05, 2.51) *
Sexually transmitted infections						
No	1.00		1.00		1.00	
Yes	0.66 (0.31, 1.40)		0.43 (0.13, 1.43)		0.97 (0.43, 2.23)	
Mental health						
Depression						
No depression	1.00		1.00	1.00	1.00	
Other depressive disorder	1.17 (0.65, 2.14)		1.35 (0.65, 2.78)	1.37 (0.65, 2.89)	1.20 (0.62, 2.32)	
Major depressive disorder	0.93 (0.55, 1.59)		1.90 (1.05, 3.46) *	1.62 (0.86, 3.04)	1.10 (0.60, 2.00)	
Anxiety disorder						
No	1.00		1.00		1.00	
Yes	1.04 (0.73, 1.49)		1.61 (1.02, 2.52) *		0.84 (0.55, 1.26)	
ADHD						
No	1.00		1.00		1.00	
Yes	0.85 (0.47, 1.53)		1.00 (0.48, 2.08)		1.84 (0.96, 3.50) ~	
Childhood sexual abuse						
No	1.00		1.00		1.00	1.00
Yes	0.94 (0.66, 1.34)		1.27 (0.82, 1.97)		1.50 (1.01, 2.23) *	1.54 (1.02, 2.34) *

	Inhalants		Methamphetamine		Cocaine	
	Adjusted bivariate	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Demographics						
Age	0.97 (0.95, 1.00) ~		0.96 (0.93, 0.99) *		0.98 (0.95, 1.01)	

	Inhalants		Methamphetamine		Cocaine	
	Adjusted bivariate	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Education						
<College degree	1.00	1.00	1.00		1.00	
College degree	1.19 (0.72, 1.96)	0.98 (0.57, 1.66)	1.28 (0.73, 2.27)		0.74 (0.43, 1.29)	
Graduate degree	2.25 (1.26, 4.00) **	2.11 (1.14, 3.91) *	1.36 (0.69, 2.71)		0.85 (0.44, 1.66)	
Income						
≤$40,000	1.00		1.00		1.00	
$40,001–$80,000	1.43 (0.86, 2.35)		1.10 (0.61, 1.97)		1.02 (0.59, 1.78)	
>$80,000	1.71 (0.91, 3.22) ~		1.18 (0.56, 2.00)		0.82 (0.38, 1.75)	
Race/ethnicity						
White	1.00	1.00	1.00		1.00	
Black	0.44 (0.19, 0.99) *	0.36 (0.15, 0.86) *	0.38 (0.13, 1.08)		1.66 (0.81, 3.43)	
Hispanic	0.39 (0.15, 0.99) *	0.38 (0.14, 0.99) *	1.20 (0.49, 2.93)		0.69 (0.78, 2.43)	
Other	0.92 (0.33, 2.51)	0.66 (0.21, 2.09)	1.92 (0.67, 5.49)		0.97 (0.31, 3.10)	
Primary partner						
No	1.00		1.00		1.00	
Yes	1.34 (0.86, 2.09)		0.79 (0.46, 1.38)		1.07 (0.65, 1.77)	
HIV disease stage and treatment						
Plasma RNA						
≤75 copies/ml	1.00		1.00		1.00	
>75 copies/ml	1.13 (0.73, 1.75)		1.98 (1.20, 3.28) **		1.57 (0.96, 2.55) *	
Currently on HIV medication						
No	1.00		1.00		1.00	
Yes	0.88 (0.55, 1.40)		0.69 (0.41, 1.17)		0.67 (0.41, 1.11)	
Sexual risk						
Transmission risk behavior						
No	1.00	1.00	1.00	1.00	1.00	
Yes	3.30 (2.10, 5.18) ***	3.38 (2.11, 5.42) ***	4.19 (2.47, 7.08) ***	4.05 (2.38, 6.88) ***	1.46 (0.87, 2.44)	
Sexually transmitted infections						
No	1.00	1.00	1.00	1.00	1.00	
Yes	3.21 (1.44, 7.56) **	3.38 (1.37, 8.31) **	3.74 (1.57, 8.90) **	3.27 (1.34, 8.02) **	0.54 (0.18, 1.67)	

	Inhalants		Methamphetamine		Cocaine	
	Adjusted bivariate	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Mental health						
Depression						
No depression	1.00		1.00		1.00	1.00
Other depressive disorder	0.49 (0.21, 1.13)~		1.09 (0.46, 2.59)		1.38 (0.62, 3.09)	1.38 (0.62, 3.09)
Major depressive disorder	0.57 (0.28, 1.14)		1.52 (0.76, 3.03)		2.02 (1.06, 3.83)*	2.02 (1.06, 3.83)*
Anxiety disorder						
No	1.00		1.00		1.00	
Yes	0.91 (0.58, 1.42)		1.65 (0.97, 2.79)~		1.65 (0.99, 2.74)~	
ADHD						
No	1.00		1.00		1.00	
Yes	1.56 (0.79, 3.06)		1.12 (0.52, 2.39)		1.08 (0.52, 2.28)	
Childhood sexual abuse						
No	1.00		1.00		1.00	
Yes	1.00 (0.65, 1.55)		1.05 (0.61, 1.79)		1.07 (0.66, 1.74)	

	Tranquilizers or barbiturates		Hallucinogens (such as LSD or ecstasy)		Crack	
	Adjusted bivariate	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Demographics						
Age	1.00 (0.69, 1.04)		0.96 (0.92, 1.01)		0.99 (0.95,1.03)	
Education						
<College degree	1.00		1.00		1.00	
College degree	1.17 (0.55, 2.49)		1.07 (0.47, 2.43)		0.56 (0.26, 1.24)	
Graduate degree	1.22 (0.50, 2.99)		1.29 (0.51, 3.22)		0.37 (0.12, 1.12)~	
Income						
<$40,000	1.00		1.00		1.00	1.00
$40,001–$80,000	1.32 (0.60, 2.92)		0.55 (0.22, 1.39)		0.10 (0.02, 0.42)**	0.12 (0.03, 0.51)**
>$80,000	1.94 (0.75, 5.01)		1.15 (0.41, 3.26)		0.10 (0.01, 0.78)*	0.12 (0.02, 0.94)*
Race/ethnicity						
White	1.00		1.00		1.00	1.00

	Tranquilizers or barbiturates		Hallucinogens (such as LSD or ecstasy)		Crack	
	Adjusted bivariate	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Black	0.17 (0.02, 1.32)~		0.49 (0.11, 2.28)		3.85 (1.58, 9.38)**	2.68 (1.01, 7.18)*
Hispanic	0.24 (0.03, 1.86)		1.35 (0.35, 5.29)		0.85 (0.19, 3.87)	0.60 (0.13, 2.86)
Other	0.60 (0.12, 2.97)		0.34 (0.04, 2.81)		1.15 (0.24, 5.50)	1.00 (0.20, 5.14)
Primary partner						
No	1.00		1.00	1.00	1.00	
Yes	1.42 (0.71, 2.85)		2.66 (1.21, 5.82)*	2.32 (1.13, 6.07)*	1.21 (0.61, 2.41)	
HIV disease stage and treatment						
Plasma RNA						
≤75 copies/ml	1.00		1.00		1.00	
>75 copies/ml	1.29 (0.66, 2.52)		1.77 (0.26, 3.62)		1.58 (0.79, 3.09)	
Currently on HIV medication						
No	1.00		1.00		1.00	
Yes	0.68 (0.34, 1.34)		0.87 (0.42, 1.79)		0.53 (0.27, 1.06)~	
Sexual risk						
Transmission risk behavior						
No	1.00		1.00	1.00	1.00	
Yes	1.91 (0.92, 3.92)~		2.65 (1.21, 5.81)*	1.87 (0.78, 4.47)	1.26 (0.60, 2.63)	
Sexually transmitted infections						
No	1.00		1.00		1.00	
Yes	0.91 (0.27, 3.02)		1.04 (0.31, 3.53)		0.26 (0.03, 2.07)	
Mental health						
Depression						
No depression	1.00		1.00		1.00	1.00
Other depressive disorder	0.96 (0.29, 3.10)		0.52 (0.11, 2.43)		1.06 (0.30, 3.81)	1.05 (0.28, 3.91)
Major depressive disorder	1.36 (0.58, 3.20)		2.40 (1.04, 5.51)*		2.56 (1.13, 5.81)*	1.89 (0.77, 4.66)
Anxiety disorder						
No	1.00		1.00	1.00	1.00	
Yes	2.05 (0.97, 4.31)~		3.54 (1.51, 8.28)**	3.06 (1.25, 7.49)*	2.21 (1.02, 4.78)*	
ADHD						
No	1.00	1.00	1.00		1.00	

	Tranquilizers or barbiturates		Hallucinogens (such as LSD or ecstasy)		Crack	
	Adjusted bivariate	Final multivariable	Adjusted bivariate	Final multivariable	Adjusted bivariate	Final multivariable
Yes	2.67 (1.18, 6.05) *	2.67 (1.18, 6.05) *	1.40 (0.57, 3.44)		1.50 (0.59, 3.85)	
Childhood sexual abuse						
No	1.00		1.00		1.00	
Yes	0.84 (0.43, 1.64)		0.91 (0.45, 1.85)		1.58 (0.79, 3.14)	

	Opiates		Ketamine		Multiple drug use	
	Adjusted bivariate	Final multivariable	Adjusted bivariate	Final multivariable	Adjusted bivariate	Final multivariable
Demographics						
Age	1.01 (0.96, 1.05)		0.93 (0.88, 0.99) *		0.97 (0.94, 0.99) *	
Education						
<College degree	1.00		1.00		1.00	
College degree	0.56 (0.24, 1.37)		1.08 (0.45, 2.57)		0.80 (0.48, 1.32)	
Graduate degree	0.77 (0.29, 2.05)		0.55 (0.17, 1.81)		1.13 (0.63, 2.04)	
Income						
≤$40,000	1.00		1.00		1.00	
$40,001–$80,000	1.13 (0.50, 2.56)		1.07 (0.42, 2.73)		0.74 (0.44, 1.24)	
>$80,000	0.84 (0.27, 2.65)		1.40 (0.44, 4.42)		0.75 (0.38, 1.48)	
Race/ethnicity						
White	1.00		1.00		1.00	
Black	0.25 (0.03, 1.94)		0.74 (0.15, 3.64)		0.42 (0.17, 1.01) ~	
Hispanic	0.31 (0.04, 2.39)		2.37 (0.54, 10.43)		0.46 (0.18, 1.20)	
Other	0.41 (0.05, 3.33)		0.46 (0.05, 3.94)		1.23 (0.47, 3.22)	
Primary partner						
No	1.00		1.00		1.00	
Yes	0.93 (0.44, 1.98)		1.07 (0.48, 2.38)		1.11 (0.71, 1.75)	
HIV disease stage and treatment						
Plasma RNA						
≤75 copies/ml	1.00		1.00		1.00	1.00
>75 copies/ml	1.51 (0.73, 3.14)		2.30 (1.12, 5.21) *		1.82 (1.17, 2.84) **	1.73 (1.04, 2.86) *
Currently on HIV medication						

	Opiates		Ketamine		Multiple drug use	
	Adjusted bivariate	Final multivariable	Adjusted bivariate	Final multivariable	Adjusted bivariate	Final multivariable
No	1.00		1.00		1.00	
Yes	0.97 (0.45, 2.09)		0.84 (0.38, 1.88)		0.74 (0.47, 1.18)	
Sexual risk						
Transmission risk behavior						
No	1.00		1.00	1.00	1.00	1.00
Yes	0.90 (0.40, 1.99)		3.41 (1.35, 8.59) **	3.19 (1.25, 8.16) *	4.62 (2.88, 7.40) ***	3.98 (2.45, 6.48) ***
Sexually transmitted infections						
No	1.00		1.00	1.00	1.00	
Yes	0.41 (0.05, 3.21)		4.74 (1.49, 15.14) **	4.14 (1.26, 13.58) *	2.08 (0.94, 4.59) ~	
Mental health						
Depression						
No depression	1.00		1.00		1.00	
Other depressive disorder	0.72 (0.16, 3.32)		1.45 (0.41, 5.14)		0.89 (0.40, 1.99)	
Major depressive disorder	3.05 (1.31, 7.08) **		0.85 (0.30, 2.38)		2.17 (1.21, 3.90) **	
Anxiety disorder						
No	1.00		1.00		1.00	
Yes	1.50 (0.69, 3.27)		2.19 (0.39, 5.19) *		1.62 (1.02, 2.57) *	
ADHD						
No	1.00		1.00		1.00	1.00
Yes	3.22 (1.34, 7.70) **		1.11 (0.41, 2.98)		3.19 (1.73, 5.89) ***	2.93 (1.52, 5.65) **
Childhood sexual abuse						
No	1.00	1.00	1.00		1.00	
Yes	2.10 (1.01, 4.41) *	2.10 (1.01, 4.41) *	1.09 (0.50, 2.39)		1.06 (0.68, 1.65)	

	Drug abuse	
	Adjusted bivariate	Final multivariable
Demographics		
Age	0.96 (0.94, 0.98) **	
Education		
<College degree	1.00	

	Drug abuse	
	Adjusted bivariate	**Final multivariable**
College degree	0.65 (0.42, 1.02)	
Graduate degree		
Income		
≤$40,000	1.00	
$40,001–$80,000	0.76 (0.48, 1.22)	
>$80,000	0.93 (0.51, 1.68)	
Race/ethnicity		
White	1.00	1.00
Black	0.71 (0.37, 1.37)	0.68 (0.32, 1.45)
Hispanic	0.30 (0.12, 0.81) *	0.27 (0.09, 0.82) *
Other	0.84 (0.31, 2.27)	0.71 (0.22, 2.32)
Primary partner		
No	1.00	
Yes	1.00 (0.67, 1.51)	
HIV disease stage and treatment		
Plasma RNA		
≤75 copies/ml	1.00	1.00
>75 copies/ml	2.03 (1.36, 3.04) ***	1.73 (1.06, 2.81) *
Currently on HIV medication		
No	1.00	
Yes	0.62 (0.40, 0.94) *	
Sexual risk		
Transmission risk behavior		
No	1.00	
Yes	4.37 (2.86, 6.68) ***	3.90 (2.46, 6.20) ***
Sexually transmitted infections		
No	1.00	
Yes	2.55 (1.15, 5.65) *	
Mental health		
Depression		

	Drug abuse	
	Adjusted bivariate	**Final multivariable**
No depression	1.00	1.00
Other depressive disorder	1.28 (0.66, 2.49)	1.06 (0.50, 2.25)
Major depressive disorder	3.16 (1.78, 5.61)***	2.60 (1.28, 5.30)**
Anxiety disorder		
No	1.00	
Yes	2.11 (1.38, 3.20)***	
ADHD		
No	1.00	1.00
Yes	4.44 (2.37, 8.33)***	2.90 (1.42, 5.95)**
Childhood sexual abuse		
No	1.00	
Yes	1.22 (0.82, 1.82)	

~ $p<0.10$;

* $p<0.05$;

** $p<0.01$;

*** $p<0.001$

[a] All bivariate and multivariable models adjusted for a multiple drug use variable that did not include the outcome drug

[b] CD4 count was added as a covariate when viral load was included in multivariable models

Table 2

Adjusted bivariate and block-stepwise multivariable logistic regression models examining associations of demographics, HIV disease stage and treatment, sexual risk, and mental health indicators with stimulant and depressant class drugs

	Drug class: stimulants		Drug class: depressants	
	Adjusted bivariate[a]	Final multivariable	Adjusted bivariate	Final multivariable
Demographics				
Age	0.97 (0.95, 0.99) *		0.98 (0.94, 1.01)	
Education				
<College degree	1.00		1.00	
College degree	0.94 (0.60, 1.49)		0.80 (0.43,1.49)	
Graduate degree	0.91 (0.51, 1.63)		0.79 (0.37, 1.68)	
Income				
≤$40,000	1.00		1.00	
$40,001–$80,000	0.78 (0.49, 1.26)		1.21 (0.64, 2.29)	
>$80,000	0.86 (0.47, 1.60)		1.16 (0.51, 2.61)	
Race/ethnicity				
White	1.00		1.00	1.00
Black	1.39 (0.74, 2.62)		0.24 (0.07, 0.85) *	0.23 (0.06, 0.85) *
Hispanic	0.84 (0.39, 1.79)		0.39 (0.11, 1.42)	0.37 (0.09, 1.46)
Other	1.67 (0.45, 3.00)		0.43 (0.11, 1.70)	0.47 (0.12, 1.87)
Primary partner				
No	1.00		1.00	
Yes	0.91 (0.60, 1.40)		1.01 (0.58, 1.78)	
HIV disease stage and treatment				
Plasma RNA[b]				
≤75 copies/ml	1.00	1.00	1.00	1.00
>75 copies/ml	1.98 (1.31, 3.00) **	1.70 (1.08, 2.69) *	1.85 (1.07, 3.19) *	2.20 (1.21, 4.00) *
Currently on HIV medication				
No	1.00		1.00	
Yes	0.65 (0.42, 1.01) *		1.02 (0.57, 1.82)	
Sexual risk				
Transmission risk behavior				
No	1.00	1.00	1.00	
Yes	2.59 (1.69, 3.98) ***	2.54 (1.63, 3.94) ***	1.73 (0.97, 3.08) ~	
Sexually transmitted infections				
No	1.00		1.00	
Yes	1.53 (0.67, 3.48)	1.15 (0.41, 3.21)		
Mental health				
Depression				
No depression	1.00	1.00	1.00	

	Drug class: stimulants		Drug class: depressants	
	Adjusted bivariate[a]	**Final multivariable**	**Adjusted bivariate**	**Final multivariable**
Other depressive disorder	1.38 (0.70, 2.75)	1.40 (0.69, 2.84)	1.04 (0.40, 2.71)	
Major depressive disorder	2.25 (1.23, 4.10) **	2.09 (1.12, 3.90) *	2.08 (1.03, 4.23) *	
Anxiety disorder				
No	1.00		1.00	
Yes	1.62 (1.06, 2.48) *		1.80 (1.00, 3.24)~	
ADHD				
No	1.00	1.00	1.00	
Yes	1.37 (0.69, 2.75)	2.17 (1.03, 4.58) *	2.28 (1.08, 4.79) *	
Childhood sexual abuse				
No	1.00		1.00	
Yes	1.28 (0.84, 1.94)		1.30 (0.75, 2.23)	

~ $p<0.10$;

* $p<0.05$;

** $p<0.01$;

*** $p<0.001$

[a] All bivariate and multivariable models adjusted for a multiple drug use variable that did not include the drugs in the outcome class

[b] CD4 count was added as a covariate when viral load was included in multivariable models