



## Are decreases in drug use risk associated with reductions in HIV sex risk behaviors among adults in an urban hospital primary care setting?

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### ABSTRACT

Drug use is associated with increased sexual risk behaviors. We examined whether decreases in drug use risk are associated with reduction in HIV-related sex risk behaviors among adults. Data was from a cohort of participants ( $n = 574$ ) identified by drug use screening in a randomized trial of brief intervention for drug use in an urban primary care setting. Inverse probability of treatment weighted (IPTW) logistic regression models were used to examine the relationship between decreases in drug use risk and sex-related HIV risk behavior reduction from study entry to six months. Weights were derived from propensity score modeling of decreases in drug use risk as a function of potential confounders. Thirty seven percent of the study participants (213/574) reported a decrease in drug use risk, and 7% (33/505) reported decreased sex-related HIV risk behavior at the six-month follow-up point. We did not detect a difference in reduction of risky sexual behaviors for those who decreased drug use risk (unadjusted: OR 1.32, 95% CI 0.65–2.70; adjusted OR [AOR] 1.12, 95% CI 0.54–2.36). Adults who screened positive for high drug use risk had greater odds of reducing sex risk behavior in unadjusted analyses OR 3.71, 95% CI 1.81–7.60; but the results were not significant after adjusting for confounding AOR 2.50, 95% CI 0.85–7.30). In this primary care population, reductions in HIV sex risk behaviors have complex etiologies and reductions in drug use risk do not appear to be an independent predictor of them.

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### 1. Introduction

More than three decades after the first cases of human immunodeficiency virus (HIV) infections were reported, HIV transmission remains a serious public health problem. The Centers for Disease Control and Prevention (CDC) estimates that there are approximately 50,000 newly infected persons each year, with the majority of infections resulting from unprotected sexual contact (Centers for Disease Control and Prevention, CDC, 2013a, 2014). Racial and ethnic minority groups, particularly, Black/African Americans, are disproportionately affected by the HIV/AIDS epidemic, more so than any other racial or ethnic minority group (Centers for Disease Control and Prevention, CDC, 2015, 2016). Alcohol and other drug use are considered important risk factors for the

transmission of sexually transmitted infections (STIs) including HIV (Centers for Disease Control and Prevention, CDC, 2013b; Metrik et al., 2016; Raj et al., 2009; Shuper et al., 2009; Vagenas et al., 2015). The primary pathway is thought to be reduction in inhibition and reasoning ability with concomitant increase in sex risk behaviors such as unprotected sexual intercourse, having multiple sex partners, and participation in survival and transactional sex (Hedden et al., 2011; Justus et al., 2000; MacDonald et al., 2000).

Drug use is associated with sex risk behaviors including non- and inconsistent condom use, having multiple sex partners, and unprotected transactional sex (sex for drugs or money), (Bonar et al., 2014; Booth et al., 1993, 2000; Broz et al., 2014; Hedden et al., 2011). Marijuana use is a contributing factor in HIV risk behaviors (Anderson and Stein, 2011; Hittner and Kennington, 2008), with users more likely to report multiple sexual partners (Valera et al., 2009). Further, Marijuana users are at increased risk of sexually acquiring HIV (Fernandez et al., 2004) and other sexually transmitted diseases (De Genna et al., 2007). Cocaine and opiate using populations are at greater risk for HIV infection (Booth et al., 2000; Metzger et al., 1993), and are more likely

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to have co-occurring medical and psychiatric conditions (McLellan et al., 2000). Interventions addressing drug use have the potential to mitigate negative health consequences and HIV related risk behaviors such as sex risk (Henry-Edwards et al., 2003; Saitz et al., 2010). HIV prevention efforts specific to at-risk adult populations have shown an effect in reducing HIV related risk behaviors (Copenhaver et al., 2006; Crepaz et al., 2007; Herbst et al., 2005, 2007; Johnson et al., 2002; Neumann et al., 2002; Semaan et al., 2002). Prevention interventions in sexually transmitted disease (STD) clinics (Kamb et al., 1998), outpatient based drug treatment facilities (Woody et al., 2003) and inpatient addiction treatment settings (Samet et al., 2008) have an effect on decreasing HIV risk behaviors. However, HIV risk assessments and risk reduction interventions are seldom applied in primary care settings (Wenrich et al., 1997). Little is known about the relationship between decreases in drug use and reduction in sex risk behaviors among adults in primary care settings.

Primary care clinicians and practitioners can play a vital role in facilitating HIV-risk related behavior change for individuals at risk for HIV and other STIs. Primary care settings are thought to provide an important opportunity to identify and deliver interventions to reduce drug use (Bernstein et al., 2005; Babor et al., 2007; Humeniuk et al., 2012; Saitz, 2014). Brief interventions that identify and address drug use behaviors in primary care settings have the potential to reduce drug use and subsequent consequences. For example, addressing drug use during a brief intervention could directly or indirectly motivate individuals to reduce involvement in sex risk behaviors (e.g. condom use, reducing the number of sex partners). However, limited data exist about the relationship between decreases in drug use and reduction in sex risk behaviors among drug using adults who are engaged in brief interventions in primary care settings.

We sought to examine whether decreases in drug use risk are associated with reductions in HIV sex risk behaviors among adults who screened positive for drug use, and those with high drug use severity (consistent with dependence). We hypothesized that decreases in drug use risk are associated with reductions in HIV sex risk behaviors for adults who screened positive for drug use, as well as those with drug dependence.

## 2. Materials and methods

Data originated from the Assessing Screening Plus Brief Intervention's Resulting Efficacy to Stop Drug Use (ASPIRE) study, a 3-group randomized controlled trial of two brief interventions for unhealthy drug use among adult patients in an urban primary care setting, that did not detect differences by type of intervention (Saitz et al., 2014). Details about the assessments, interventions and randomization are previously reported (Saitz et al., 2014 including supplementary online content).

### 2.1. Study population

Our analysis sample was comprised of adults 18 years or older who were enrolled and randomized in the ASPIRE study, and who also completed the 6 month follow-up interview ( $n = 574$ ). Participants were enrolled in the study ( $n = 589$ ) if they screened positive for past 3-month drug use on the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) (Humeniuk et al., 2008). For this analysis, we included all study participants who reported a total ASSIST score of 2 or greater at baseline, indicating some drug use at least once in the past 3 months. This measure allowed for the opportunity to assess reduction in drug use for participants who engaged in low to high drug use risk levels. Note: Saitz et al., 2014 reports only results among participants with ASSIST scores of 4 or greater indicating weekly or more drug use in the past three months, with drug use ranging from moderate to high risk levels (Humeniuk et al., 2008; Saitz et al., 2014).

### 2.2. Measures

#### 2.2.1. Outcome

Reduction in HIV sex risk behaviors (yes vs. no), the primary outcome of this study, was defined based on whether a subject reported fewer unsafe sex practices at the 6-month follow-up compared to baseline. The number of unsafe sex practices at each time point was determined based on condom use and other sex risk behaviors response items. Study participants completed assessments of HIV sex risk and drug use risk behaviors in the past three months (Navaline et al., 1994) using an audio-computer-assisted self-interviewing (ACASI) system at baseline and six month interviews. The ACASI system has been shown to increase disclosure and veracity in responses to sensitive and often stigmatized HIV sex risk behavior questions (Rogers et al., 2005). Unsafe sex was operationalized as the number of times the subject self-reported non-condom use during vaginal or anal intercourse in the past 3 months in the following scenarios: a) having sex with non-primary partner; b) engaging in currency transactional sex (i.e., paid money for sex or received money for sex); and c) engaging in drug transactional sex (i.e., given drugs for sex or received drugs for sex). We calculated the difference in total number of self-reported unsafe sex practices at six months and baseline interview periods (6 month minus baseline). A reduction in unsafe sex was fewer number of unsafe sex episodes at six months. Operationalizing the outcome as a dichotomous variable was considered more clinically interpretable and relevant for these risk behaviors. The rationale for this is that, participants reporting non-condom use with non-primary and transactional partners during either vaginal or anal intercourse, would be at increased the risk for HIV transmission regardless of number of encounters.

#### 2.2.2. Independent variables

Participants were assessed for drug use risk using the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) at baseline and in six month follow-up interviews (Humeniuk et al., 2008). The clinical question of interest for this study was to evaluate any decrease in drug use, this was considered the most clinically relevant main independent variable. The main independent variable, decrease in drug use risk (yes/no), was therefore operationalized as any reduction in the total ASSIST score at six month follow-up compared to baseline (6 month value minus baseline value). Participants who indicated a lower ASSIST score at the six month follow-up period were categorized as “yes = decreased drug use risk” while those who had increased or same scores at follow-up were categorized as “no = same or increased drug use risk”. The ASSIST score identifies risk of health and other problems from the participant's current pattern of use (Humeniuk et al., 2008), therefore, the term “drug use risk” is used in this study to appropriately measure more than use. The choice to use the binary independent variable allowed us to study the association between decrease in drug use risk and decrease in sex risk in a manner that is clinically relevant, rather than examining this relationship using decrease in points on a scale such as the ASSIST that in our study ranges from 2 to 131.

In secondary analyses, we further explored the relationship between reduction in HIV sex risk and drug use risk by examining adults who screened positive for high drug use risk (consistent with dependence) at study entry compared to those with low to moderate risk. We used a binary Alcohol, Smoking, and Substance Involvement Screening Test [ASSIST] score operationalized as  $\geq 27 =$  high risk of experiencing severe health, social and other problems as a result of current pattern of use and are likely to be dependent and;  $\leq 26 =$  low and moderate risk of health and other problems. The operationalization of this measure has a clinical and practical basis as participants with higher ASSIST scores are thought to need drug treatment (Humeniuk et al., 2008), and thus a threshold for tailoring interventions and treatment for individuals experiencing severe problems.

### 2.2.3. Covariates

The Gelberg–Andersen Behavioral Model for Vulnerable Populations (Gelberg et al., 2000), a revised version of the Andersen Behavioral Health Model (Aday and Awe, 1997; Andersen, 1968, 1995) that includes domains relevant to understanding vulnerable populations who are at higher risk for illness, was used to guide the selection of covariates including demographics, depression, and heavy alcohol use at baseline, that may influence the relationship between decreases in drug use risk and HIV sex risk reduction.

**Predisposing factors:** included age (18 years and older), gender (male and female), level of education (completed high school education), and race/ethnicity (Black/African American, White, Other, and Hispanic, respectively). Due to the small sample sizes for Asian, Alaska Native, Native Hawaiian/Other Pacific Islander, American Indian, these categories were included in “Other”. Predisposing factors specific to vulnerable populations included homelessness, meaning that the participant spent one or more nights on the street or in an overnight shelter at least once in the past three months.

**Enabling factors:** included having personal or family resources as social support system(s) (“Are there people you feel you could turn to if you were feeling bad and needed someone to talk to about something that was important to you?”); and self-help seeking skills such as participating in a self-help group, Alcoholics Anonymous (AA), Narcotics Anonymous (NA), Cocaine Anonymous (CA) in the past six months.

**Severity and need factors:** included screening positive for depression as assessed using the Patient Health Questionnaire (PHQ-9) (Kroenke et al., 2001); alcohol use operationalized as number of heavy drinking days in the past month with heavy drinking defined as >3 standard drinks for women, >4 standard drinks for men in a day (National Institute on Alcohol Abuse and Alcoholism, NIAAA, 2005); participant’s main drug at study entry, and substance use treatment operationalized as outpatient or inpatient treatment for alcohol, drugs or mental health in the past three months as assessed using the 90-Alcohol Intake Revised Economic Data (AIR/ED) form (Miller, 1996).

### 2.3. Statistical analysis

To characterize the study sample, descriptive statistics were calculated overall and stratified by primary predictor (decrease in drug use risk). To control for confounding in the analysis of whether decreases in drug use risk are associated with reductions in HIV sex risk behaviors, we analyzed data using inverse probability of treatment weighted (IPTW) logistic regression models. First we modeled the main independent variable, decrease in drug use risk, using a multiple logistic regression model adjusting for potential confounders of the association between a decrease in drug use risk and reduction in HIV sex risk behaviors. Based on this model, we calculated the predicted probabilities of having a decrease in drug use risk, (i.e. the propensity score for each subject). Covariate balance was assessed in the weighted sample by assessing the standardized differences between exposure groups, where an absolute difference of <0.20 was considered acceptable (Lanza et al., 2013). Lastly, the propensity scores were incorporated into the analyses using IPTW logistic regression models and robust standard errors are reported. Secondary analyses for ASSIST score  $\geq 27$  at baseline were conducted using the same approach. Two-tailed tests and an alpha level of 0.05 were used for all tests. Analyses were conducted using SAS version 9.3 (SAS Institute Inc., 2011).

## 3. Results

Demographic characteristics of the study sample are shown in Table 1. Of the 589 participants enrolled and randomized in the ASPIRE study, 574 (98%) completed the six month follow-up interview and comprise the analytic sample for this study. The average age of study participants was 42 (SD 12.3) years. The majority of the participants were male (68%), Black or African American (70%), and reported

**Table 1**  
Characteristics of study sample.

Variable	n (%), mean (std. dev)
Number times unsafe sex (N = 527)	1.8 (SD 19.9)
Total ASSIST score <sup>a</sup>	20.3 (SD 18.5)
Total ASSIST score	
Total ASSIST <26	430 (74.9%)
Total ASSIST $\geq 27$	144 (25.1%)
Randomization group	
MOTIV-intervention <sup>b</sup>	189 (32.9%)
BNI-intervention <sup>c</sup>	191 (33.3%)
Intervention control	194 (33.8%)
Age	41.5 (SD 12.3)
Gender	
Male	390 (67.9%)
Female	184 (32.1%)
Race/ethnicity	
Black African American	397 (70.3%)
Hispanic	53 (9.4%)
White	110 (19.5%)
Other	5 (0.9%)
Main drug <sup>d</sup>	
Cocaine	106 (18.5%)
Marijuana	363 (63.2%)
Opioids	94 (16.4%)
Other drug	11 (1.9%)
Number heavy drinking days	4.5 (SD 8.0)
Depression (PHQ-9 Score)	
PHQ <10	381 (66.4%)
PHQ $\geq 10$	193 (33.6%)
Homelessness (past 3 months)	
Yes	89 (15.5%)
No	485 (84.5%)
High school graduate	
Yes	404 (70.4%)
No	170 (29.6%)
Self-help group	
Yes	94 (16.4%)
No	480 (83.6%)
Substance use disorder treatment	
Yes	147 (25.7%)
No	426 (74.3%)
Support systems	
Yes	509 (88.7%)
No	65 (11.3%)

Support systems = personal or family resources as social support system(s) (“Are there people you feel you could turn to if you were feeling bad and needed someone to talk to about something that was important to you?”). PHQ = Patient Health Questionnaire.

<sup>a</sup> The total Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) score.

<sup>b</sup> Motivational interviewing (MOTIV) enhanced intervention.

<sup>c</sup> Brief negotiated interview (BNI) standard intervention.

<sup>d</sup> Main drug” was the substance that concerned the participant the most.

an education level of completed high school or more (70%). Only 16% of the study sample reported being homeless. The main drug was marijuana (63%) with participants also reported an average of 4.5 (SD 8.0) heavy drinking days in the past month. A quarter (26%) of the study sample indicated utilizing either inpatient or outpatient treatment for alcohol, drugs or mental health in the past three months; 16% had participated in self-help groups in the past six months. While more than three quarters of the study sample reported having some form of social support system (89%), a substantial proportion reported moderate to severe depression (34%). Thirty seven percent (213/574) reported a decrease in drug use risk at the six month follow up period, and 7% (33/505) reported a reduction in HIV sex risk behaviors. Note that 69 participants were missing data on HIV sex risk behaviors from baseline to six months.

As shown in Table 2a, the inverse probability of treatment weighted (IPTW) method using the propensity score resulted in acceptable balance for all covariates (i.e., all standardized differences <0.20 in absolute value) between those who did and did not decrease drug use risk. Covariate balance was also achieved for the secondary analysis of ASSIST score  $\geq 27$  vs. <27 (Table 2b).

**Table 2a**  
 Characteristics of those with decreased drug use risk vs. same or increased drug use risk (baseline to 6 months) for the unweighted and weighted samples<sup>a</sup>.

Variable		Unweighted			Weighted by IPTW		
		Decreased drug use risk	Drug use risk same or higher	Standardized difference <sup>b</sup>	Decreased drug use risk	Drug use risk same or higher	Standardized difference <sup>b</sup>
Randomization group	MOTIV-intervention <sup>c</sup>	32.9%	33.0%	0.00	32.9%	32.9%	0.00
	BNI-intervention <sup>d</sup>	34.7%	32.4%	0.07	34.0%	33.7%	0.01
	Intervention control	32.4%	34.6%	0.07	33.1%	33.5%	0.01
Age (mean)		41.2	41.7	0.04	41.6	41.4	0.01
Male		73.2%	64.8%	0.26	69.0%	68.3%	0.02
Race/ethnicity	Black African American	64.8%	73.5%	0.26	72.0%	71.2%	0.02
	Hispanic	11.4%	8.2%	0.16	9.3%	9.1%	0.01
	White	22.9%	17.5%	0.19	18.2%	19.0%	0.03
	Other	1.0%	0.9%	0.02	0.6%	0.7%	0.03
Main drug <sup>e</sup>	Cocaine	22.1%	16.3%	0.21	17.9%	18.0%	0.00
	Marijuana	51.6%	70.1%	0.54	63.9%	63.5%	0.01
	Opioids	22.5%	12.7%	0.37	16.3%	16.3%	0.00
	Other drug	3.8%	0.8%	0.28	2.0%	2.2%	0.02
Heavy drinking days (mean)		4.3	4.7	0.05	4.5	4.6	0.00
Depression (PHQ-9 score <10)		63.4%	68.1%	0.14	67.2%	66.8%	0.01
Homeless (past 3 months)		19.3%	13.3%	0.23	15.3%	15.7%	0.01
High school graduate		68.1%	71.7%	0.11	70.2%	70.6%	0.01
Self-help group		22.1%	13.0%	0.34	15.8%	16.0%	0.01
Substance use disorder treatment		31.0%	22.5%	0.27	24.1%	24.8%	0.02
Support systems		87.3%	89.5%	0.10	89.0%	89.0%	0.00

PHQ = Patient Health Questionnaire.

<sup>a</sup> Drug use risk is measured using the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) score.

<sup>b</sup> Absolute value of standardized difference.

<sup>c</sup> Motivational interviewing (MOTIV) enhanced intervention.

<sup>d</sup> Brief negotiated interview (BNI) standard intervention.

<sup>e</sup> “Main drug” was the substance that concerned the participant the most Support systems = personal or family resources as social support system(s) (“Are there people you feel you could turn to if you were feeling bad and needed someone to talk to about something that was important to you?”).

We fit both an unadjusted and an inverse probability of treatment weighted logistic regression model using propensity scores. As shown in Table 3, among adults in an urban hospital primary care setting, we did not detect a statistically significant decrease in HIV sex risk behavior for adults who had decreased drug use risk from baseline to six months (unadjusted: OR 1.32, 95% CI: 0.65–2.70; AOR 1.12, 95% CI: 0.54–2.36).

However in secondary analyses, adults who had high drug use risk at baseline (ASSIST ≥27) appeared to have higher odds of reducing sex risk behaviors within a six month period compared to those with lower ASSIST scores (unadjusted OR 3.71, 95% CI 1.81–7.60, p < 0.001). After adjusting for potential confounding factors, these differences were not statistically significant (AOR: 2.50, 95% CI 0.85–7.30).

**Table 2b**  
 Characteristics of those with ASSIST score equal to or >27 vs. less than or equal to 26 (baseline) for the unweighted and weighted samples<sup>a</sup>.

Variable		Unweighted			Weighted by IPTW		
		Total ASSIST ≥27	Total ASSIST 0–26	Standardized difference <sup>b</sup>	Total ASSIST ≥27	Total ASSIST 0–26	Standardized difference <sup>b</sup>
Randomization group	MOTIV-intervention <sup>c</sup>	31.9%	33.3%	0.04	39.6%	34.0%	0.16
	BNI-intervention <sup>d</sup>	30.6%	34.2%	0.11	27.2%	32.6%	0.17
	Intervention control	37.5%	32.6%	0.15	33.2%	33.4%	0.01
Age (mean)		41.7	41.4	0.02	39.4	41.5	0.10
Male		70.8%	67.0%	0.12	70.0%	66.8%	0.10
Race/ethnicity	Black African American	54.2%	75.7%	0.63	75.4%	72.4%	0.10
	Hispanic	13.4%	8.0%	0.24	7.4%	8.8%	0.07
	White	31.7%	15.4%	0.55	17.1%	18.0%	0.03
	Other	0.7%	1.0%	0.04	0.2%	0.9%	0.13
Main drug <sup>e</sup>	Cocaine	35.4%	12.8%	0.78	17.6%	19.3%	0.06
	Marijuana	21.5%	77.2%	1.90	65.3%	64.0%	0.04
	Opioids	38.2%	9.1%	1.03	15.1%	14.6%	0.02
	Other drug	4.9%	0.9%	0.33	2.0%	2.1%	0.01
Heavy drinking days (mean)		6.5	3.9	0.32	4.7	4.4	0.02
Depression (PHQ-9 score <10)		46.5%	73.0%	0.79	67.4%	66.5%	0.03
Homeless (past 3 months)		26.4%	11.9%	0.53	11.0%	14.1%	0.13
High school graduate		72.9%	69.5%	0.11	72.5%	69.8%	0.08
Self-help group		34.7%	10.2%	0.87	16.0%	15.7%	0.01
Substance use disorder treatment		51.4%	17.0%	1.10	27.4%	25.2%	0.07
Support systems		85.4%	89.8%	0.19	86.7%	87.9%	0.05

PHQ = Patient Health Questionnaire.

<sup>a</sup> The total Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) score.

<sup>b</sup> Absolute value of standardized difference.

<sup>c</sup> Motivational interviewing (MOTIV) enhanced intervention.

<sup>d</sup> Brief negotiated interview (BNI) standard intervention.

<sup>e</sup> “Main drug” was the substance that concerned the participant the most Support systems = personal or family resources as social support system(s) (“Are there people you feel you could turn to if you were feeling bad and needed someone to talk to about something that was important to you?”).



**Table 3**  
Unadjusted and adjusted analyses of decrease in sex risk behavior (baseline to 6 months).

Predictors	Unadjusted logistic regression n = 505		Propensity score adjusted <sup>a</sup> logistic regression n = 504	
	Crude OR (95% CI)	p-Value	Adjusted OR (95% CI)	p-Value
Decreased ASSIST <sup>b</sup> (baseline to 6 months)	1.32 (0.65, 2.70)	0.45	1.12 (0.54, 2.36)	0.76
ASSIST $\geq 27^b$ (baseline)	3.71 (1.81, 7.60)	<0.01	2.50 (0.85, 7.30)	0.10

<sup>a</sup> Adjusted for randomization group, gender, age, race/ethnicity, main drug, number of heavy drinking days, depression (PHQ-9), homelessness, education (high school or higher), self-help group, substance use disorder treatment and social support systems.

<sup>b</sup> Based on total Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) score.

#### 4. Discussion

Brief interventions for drug use in primary care patients have the potential to reduce drug use and improve health outcomes (Saitz et al., 2010). This research provides valuable information about whether the goal of drug use intervention in primary care settings (brief or otherwise)—a decrease in drug use and related risks—might have an objective clinical benefit, specifically, sex risk behavior reduction. Among adults who screened positive for drug use in primary care, we did not detect a difference in HIV sex risk behavior reduction for those who decreased drug use risk over a six-month period compared to those who did not. Study findings also suggest that adults who screened positive for high drug use risk had greater odds of reducing sex risk behavior, but these findings were not statistically significant in adjusted models.

Drug using adults engaging in sex risk behaviors place themselves at increased risk for HIV infection. Certain interventions addressing drug use behaviors have a strong impact on preventing HIV infection (e.g., syringe exchange). However, evidence suggests that among drug users, drug treatment (Sorensen and Copeland, 2000) and HIV prevention interventions (van Empelen et al., 2003) are more effective at reducing drug use and less effective at changing sex risk behaviors. For individuals that screen positive for drug use, exposure to brief intervention to reduce drug use in primary care is thought to potentially have many benefits, one of which is to reduce social and health risk behaviors such as sex risk behaviors (Henry-Edwards et al., 2003). However, exposure to drug use screening and brief intervention does not necessarily reduce drug use behavior (Saitz et al., 2014), and our findings demonstrate that a decrease in drug use risk is not associated, in this primary care sample, with reduced sex risk behaviors. Addressing drug use may not be enough to change sex risk behaviors among drug users, and therefore, one should not necessarily expect a change in sex risk behaviors even when individuals reduce drug use risk; other mechanisms may be at play.

Adults with drug dependence have more negative health outcomes and co-occurring conditions (McLellan et al., 2000) and are at greater risk for HIV infection (Booth et al., 2000; Metzger et al., 1993). Although not statistically significant, our results suggest that adults with drug dependence who reduce their drug use risk may have greater odds of reducing sex risk behavior than those with lower ASSIST scores in primary care settings. However, this study raises questions about “how much drug use risk reduction is needed to reduce sex risk behaviors,” and the scope and breadth of interventions needed to affect both drug use and sex risk behavior.

While individual drug use behaviors are an important predictor for HIV sex risk (Bonar et al., 2014; Booth et al., 1993, 2000), our study findings call attention to recognizing factors beyond individual behavior change in the intertwining syndemic of HIV and drug use, and how these factors may differ by population group. For instance, our study participants are predominantly marijuana smokers and Black/African American, a racial and ethnic group that is disproportionately at higher risk for HIV infection and HIV related deaths due to contextual challenges including, lack of access to health care, higher rates of other sexually transmitted infections, stigma, and lack of awareness of HIV status (Centers for Disease Control and Prevention, CDC, 2015, 2016; Seth et al., 2013; Siddiqi et al., 2015). While marijuana is a contributing factor

for HIV infection (Anderson and Stein, 2011; Hittner and Kennington, 2008), and African Americans are at greater risk for HIV infection (Centers for Disease Control and Prevention, CDC, 2015, 2016), the etiology of drug use – type of drug, route of transmission – must be addressed when designing preventive interventions to address drug use and HIV sex risk.

Future research and interventions should be enhanced to address the multi-dimensional nature of HIV sex risk behaviors that go beyond individual level drug behavior change. Contextual factors including health and social resources, social capital, social norms, physical and neighborhood environments influence drug use and sex risk behaviors among vulnerable populations (Galea et al., 2003). Several research studies have noted the importance of addressing HIV risk among drug users in the context of social and structural factors and or environments that influence HIV risk (Rhodes, 2002, 2005; Strathdee et al., 2010; Gupta et al., 2008). In this study, the primary care setting, an ‘enabling environment’ for the adoption of protective behaviors in which drug use risk decreased, did not appear to enable sex risk reduction for a vulnerable drug using adult population. This finding may in part be explained by the fact that participants in this study predominantly used marijuana, a drug that is often not an independent risk factor for HIV sex risk, which may limit our ability to generalize our findings about reductions in sex risk behaviors to other patient populations. While primary care settings provide an important opportunity for providing screening and brief intervention for drug use, these interventions will need to be enhanced in order to address both drug use and HIV risk behaviors.

This exploratory secondary analysis adds to the literature on HIV risk reduction in the context of screening and brief intervention for drug use in primary care for adults who are at higher risk for HIV sex risk behaviors and other drug use consequences. Study findings contribute to our understanding of drug use and sex risk behaviors and clarify the paths to consider when developing targeted interventions among this vulnerable population in primary care settings.

#### 5. Limitations

Our study has several limitations. First, this is an observational study, which often limits the ability to draw causal inferences. However, use of the propensity score methods in this paper allows us to estimate the causal effect of reduced drug use risk on decreased HIV sex risk behaviors. Second, the number of participants reporting a decrease in sex risk behaviors at six months was relatively small in this secondary data analysis, which may have limited our study power. In post-hoc power calculations, assuming 6% of those who did not decrease drug use risk at follow-up (based on data at 6 months) had a reduction in sex risk behaviors, the study would have approximately 80% power to detect an odds ratio as small as 2.6. For the secondary analysis of screening positive for drug use risk consistent with dependence, assuming 4% of those who did not screen positive for drug use risk consistent with dependence at follow-up (based on data at 6 months) had a reduction in sex risk behaviors, the study would have approximately 80% power to detect an odds ratio as small as 3.3. Thus the study was likely underpowered to detect effect sizes of the observed magnitudes. Despite the relatively small sample size and event rate, the results of this exploratory

study provide useful descriptive and hypothesis generating data that can provide useful effect size estimates for the design of larger scale studies on this important topic. Third, the drug use measure was inclusive of a wide array of drugs, and not limited to the main drug. As such, our analysis was an aggregate effect of reduction in a range of drugs, and did not focus on a specific drug. However, our focus on more than one drug allowed for the examination of exposure to all drug use risk that would not be captured by focusing on one specific drug. Fourth, this study does not control for unmeasured confounders that may inform the relationship between decreased drug use risk and a reduction in sex risk behaviors. Fifth, we did not use momentary assessments of drug use and sex risk behaviors therefore we cannot speak to encounter-level drug and sex risk behaviors. Finally, data are obtained by self-report and are subject to recall bias or may be underreported or overreported.

## 6. Conclusions

The HIV/AIDS epidemic continues to impact many high-risk vulnerable populations. Drug use and drug use disorders increase the likelihood of HIV transmission through HIV risk behaviors, including sex risk behaviors. Primary care settings have potential to be important avenues for drug use and HIV prevention efforts. We were unable to detect a significant effect of decreases in drug use risk on reductions in HIV sex risk behaviors. One potential implication is that there is a need for a complex approach that addresses the individual, social, structural and environmental factors that influence HIV sex risk behaviors. The results also raise questions about common assumptions that addressing drug use risk in clinical settings is sufficient to warrant reductions in other health risk behaviors among drug users. These findings highlight the potential need for behavioral interventions that address multiple risk behaviors, and that go beyond reductions in drug use when addressing drug use and disorders in primary care settings.

## Conflict of interest statement

All authors declare that they have no personal or financial conflict of interest. Dr. Cheng reported having served on data monitoring committees for Janssen Research & Development, outside the submitted work.

## Author disclosures

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## Contributors

All authors are responsible for this reported research. A. W. Walter conceptualized the study, conducted the literature review and drafted the initial manuscript. R. Saitz helped conceptualize the study design and draft the manuscript. D. Cheng and C.A. Lloyd-Travaglini conducted the statistical analyses, helped interpret findings and draft the manuscript. J. Bernstein and J. Samet conducted the study from which these data were obtained, reviewed and edited the manuscript. All authors have reviewed and revised the manuscript, and approved the final manuscript as submitted.

## Transparency document

The Transparency document associated with this article can be found, in online version.

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