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Substance Use, HIV Serostatus Disclosure, and Sexual Risk Behavior in People Living with HIV: An Event-level Analysis

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Substance Use, HIV Serostatus Disclosure, and Sexual Risk Behavior in People Living
with HIV: An Event-level Analysis

Matthew Sullivan

B.A., Williams College, 2011

A Thesis

Submitted in Partial Fulfillment of the

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at the

University of Connecticut

2018

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APPROVAL PAGE

Master of Science Thesis

Substance Use, HIV Serostatus Disclosure, and Sexual Risk Behavior in People Living
with HIV: An Event-level Analysis

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ABSTRACT

Objective. HIV remains a highly stigmatized illness in the United States, and many people living with HIV (PLWH) in treatment must make difficult decisions about disclosing their HIV status to sexual partners. Because knowledge of a sexual partner's HIV serostatus can facilitate preventative health measures, an understanding of the factors that affect disclosure decision-making and subsequent condom use behavior may help to design effective interventions. Alcohol and illicit drug use are prevalent in PLWH engaged in medical care, and could impact these decision-making processes. We sought to examine the acute relationships between substance use, HIV serostatus disclosure, and condom use on an event-level basis.

Method. Men and women living with HIV were recruited from community services and infectious disease clinics in a southeastern US city. Participants reported on demographic information and psychosocial and physical health variables via audio-computer assisted self-interviews (ACASI) at study entry, and completed a urine drug toxicity screen. Participants also reported daily sexual behavior for 28 consecutive days via daily interactive text message prompts. Daily reports specified whether anal or vaginal intercourse occurred, whether with a first-time sexual partner, whether the participant disclosed their HIV-positive serostatus, whether the participant ascertained their partner's HIV status, whether the participant and/or their partner used substances prior to intercourse (including alcohol or other drugs), and whether a condom was used. We employed multi-level modeling to evaluate the event-level associations between substance use, HIV serostatus

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disclosure, and condom use in all first-time sexual encounters involving sexual partners whose HIV serostatus was HIV-negative or unknown.

Results. Out of a larger study sample, 251 participants (85% male, 92% African American) reported engaging in anal or vaginal intercourse with a first-time sexual partner whose HIV status was negative or unknown, with a total of 529 first-time partners reported during the study period (mean=2.11 partners). At the event level, substance use at the time of sex did not predict odds of condom use among inconsistent condom users ($p>0.05$); however, on average, heavier alcohol users tended to be those most likely to engage in condomless sex ($p=0.01$). Participants disclosed their HIV serostatus to only 32% of first-time non-HIV-positive sexual partners. Event-level substance use negatively predicted HIV serostatus disclosure across the 28-day study period (odds ratio=0.46; $p=0.04$). Disclosure was more frequent among consistent condom users than those who consistently engaged in condomless sex ($p<0.01$), yet disclosure was not related to increased condom use among inconsistent condom users at the event level ($p>0.05$).

Conclusions. This study demonstrates that substance use just prior to intercourse is associated with decreased HIV serostatus disclosure in PLWH. This is the first study to use multilevel modeling techniques to examine the relationship between substance use and HIV serostatus disclosure at the daily event level. Substance using PLWH may benefit from interventions designed to moderate substance use or enhance behavior skills for reducing HIV transmission risk when using substances.

INTRODUCTION

Sexual Transmission of HIV/AIDS in the United States

With over 1.2 million people currently living with HIV (PLWH) in the United States, HIV continues to contribute to major health disparities (Center for Disease Control and Prevention, 2016) . Over 90% of new infections in 2016 were attributable to sexual contact, with marked disparities in incidence by race, income, gender, and sexual identity. Men who have sex with men (MSM) accounted for a disproportionate two-thirds of new diagnoses in 2016, and HIV incidence continues to rise in Black and Latino MSM (Center for Disease Control and Prevention, 2017) . Despite significant advances in available HIV treatment and prevention options (e.g., highly active antiretroviral therapy (HAART) and Pre-Exposure Prophylaxis (PrEP)), efforts have failed to curb sexual transmission of HIV. Thus, efforts to understand and modify health-related behaviors remain crucial for HIV prevention.

HIV Partner Disclosure

Disclosure of positive HIV serostatus enables sexual partners of PLWH to make informed choices regarding acceptable levels of HIV transmission risk. As such, sexual partner disclosure has been targeted as an important component of prevention interventions in PLWH (Chiasson, Shaw, Humberstone, Hirshfield, & Hartel, 2009; Conserve, Groves, & Maman, 2015; Kalichman et al., 2001; Serovich, Laschober, Brown, & Kimberly, 2017) . Such interventions propose that if non-HIV-

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positive sex partners are informed of their acute risk of HIV transmission, they will be more motivated to implement HIV prevention strategies such as condom use.

Decisions concerning whether to disclose positive HIV status are complicated by the highly charged social and legal context in which they occur (Parsons, VanOra, Missildine, Purcell, & Gómez, 2004; Parsons, Schrimshaw, Bimbi et al., 2005). Given that disclosure affords sex partners of PLWH the opportunity to make more informed decisions concerning their acceptable levels of HIV risk, some public health officials have argued that HIV disclosure is a moral imperative, with PLWH possessing a “duty to warn” (Marks & Crepaz, 2001; Stein et al., 1998). In many US states, this stance has been codified into law; approximately half of states currently impose criminal penalties for non-disclosure of positive HIV status to sexual partners (Lehman et al., 2014). Research indicates that many PLWH believe themselves to be personally responsible for preventing potential HIV transmission to their sexual partners (Serovich & Mosack, 2003; Wolitski, Bailey, O'Leary, Gómez, & Parsons, 2003). Yet despite legal repercussions and public health strategies designed to increase HIV disclosure in PLWH, non-disclosure of HIV status to sexual partners occurs frequently. One probability sample of PLWH in medical care found that 42% of MSM, 19% of heterosexual men, and 17% of heterosexual women living with HIV reported having sex without disclosing (Ciccarone et al., 2003; Serovich & Mosack, 2003).

Reasons for non-disclosure of HIV status vary. HIV remains a highly stigmatized illness in the United States, and the large majority of PLWH engaged in care endorse internalized negative attitudes regarding HIV (Baugher et al., 2017).

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The competing consequences theory of disclosure suggests that PLWH tend to disclose their HIV status in instances in which they appraise the benefits of disclosure to outweigh the perceived costs (Serovich, 2001). Thus, PLWH must often weigh the potential HIV prevention benefits against a number of potential costs. Anticipated negative partner reactions and fear of secondary disclosure are each associated with decreased likelihood of disclosure to sexual partners (Baugher et al., 2017; Bird, Eversman, & Voisin, 2017; Galletly & Dickson-Gomez, 2009; Przybyla et al., 2013; Smit et al., 2012). High rates of intimate partner violence following disclosure present serious threats for both MSM and women living with HIV, and risk of victimization is especially high among people who report greatest levels of substance use (Brown, Serovich, & Kimberly, 2016; Gielen, McDonnell, Burke, & O'campo, 2000). Thus, low self-efficacy about communicating HIV status to partners as well as anticipated negative consequences of disclosure often hinder disclosure efforts (Bird & Voisin, 2013; Crawford, Rodden, Kippax, & Van de Ven, 2001; Serovich & Mosack, 2003).

In the face of these significant barriers, many PLWH practice selective disclosure to sexual partners, disclosing their HIV-positive status to some but not others (Bird & Voisin, 2013; Parsons et al., 2005; Przybyla et al., 2013). Such decisions require a weighing of the costs and benefits associated with disclosing to a specific sexual partner (Serovich, 2001). Perceptions of partner trustworthiness have been identified as one important determinant of such decisions to disclose (Bird et al., 2017). A range of research has indicated that serostatus disclosure occurs less frequently with casual as opposed to with regular sex partners, perhaps

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in part because less may be known about the trustworthiness of sexual partners in such encounters (Bird & Voisin, 2013; Ciccarone et al., 2003; Perry et al., 1994; Przybyla et al., 2013) . Additionally, demand characteristics across a variety of casual sex contexts may further pressure individuals to engage in sex with little prior conversation (Bird et al., 2017; Prestage et al., 2001) . Thus, sexual encounters between PLWH and their non-regular sexual partners are particularly likely to involve uninformed decision-making regarding sexual risk reduction. As such, these encounters pose particularly high risk for HIV transmission. A comprehensive understanding of disclosure decision-making in casual or first-time sexual encounters is therefore valuable for informing HIV prevention strategies. One important factor in decisions to disclose may be substance use.

Substance Use and HIV Transmission Risk

Use of alcohol and other drugs has been widely studied for its role in understanding HIV transmission risk behavior (Bourne & Weatherburn, 2017; Bryan, Schmiege, & Magnan, 2012; Scott-Sheldon et al., 2013) . On average, people who engage in heavier drug and alcohol use are more likely to have condomless anal and vaginal sex, to engage in unprotected sex with a greater number of partners, and to acquire HIV (Cooper, 2002; Koblin et al., 2006a; Reilly & Woo, 2001; Weinhardt & Carey, 2000) . However, the extent to which these associations are causal or attributable to co-occurring risk factors is less certain. Person-level studies, or those that measure participants' average (global) behavior, cannot observe whether behaviors of interest co-occur at a given time within an individual. By contrast, event-level research has helped to investigate the direct relationship

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between these behaviors by examining whether the likelihood of condomless sex is greater in sexual events where substance use is present. While many such studies have suggested a relationship between substance use and risky sexual behavior, not all event-level studies have observed this substance use-sexual risk link (Bryan et al., 2012; Colfax et al., 2004; Koblin et al., 2006a; Venable et al., 2004; Vosburgh, Mansergh, Sullivan, & Purcell, 2012) . Some researchers have also noted that an event-level relationship between substance use and sexual risk behavior does not by itself demonstrate causation, as this relationship may be confounded by situational characteristics of the sexual event (Barta et al., 2008) . Efforts to disentangle this relationship have observed a dose-related relationship of alcohol use with sexual risk-taking in PLWH and in young non-positive MSM, suggesting that a greater number of drinks prior to a sexual event is associated with an increasing likelihood of engaging in condomless sex (Barta et al., 2008; Kahler et al., 2015) .

Differences in personal and situational factors may help to explain the mixed relationships between substance use and sexual risk behavior across event-level studies. While one event-level study found that young MSM were more likely to engage in condomless anal sex with serodiscordant partners on drinking days, a study in adolescent women found no relationship between alcohol or marijuana use and condom use (Hensel, Stupiansky, Orr, & Fortenberry, 2011; Kahler et al., 2015) . Another study in MSM found that alcohol use had no effect on condom use with primary partners, but greatly increased risk of unprotected sex with non-primary

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sex partners (Venable et al., 2004) . Thus, the link between substance use and sexual risk appears to be moderated by a number of factors.

The link between substance use and sexual risk behavior is also likely to vary across drug types. Event-level associations appear to be particularly strong in the cases of alcohol use and methamphetamine use, and have also demonstrated increased sexual risk taking associated with marijuana and ecstasy/MDMA use (Bourne & Weatherburn, 2017; Bryan et al., 2012; Card et al., 2017; Vosburgh et al., 2012) . Event-level research regarding other types of drug use is sparse, although global and situational association studies tend to support consistent links between various classes of drug use and sexual risk taking, including stimulant drug use (crystal meth, crack & other cocaine), club drug use (methamphetamine, MDMA, ketamine, GHB, poppers), and use of intravenously delivered drugs such as heroin (Colfax et al., 2004; Khan et al., 2013; Mayer, Colfax, & Guzman, 2006; Mayer, Skeer, O'Cleirigh, Goshe, & Safren, 2014; Purcell, Parsons, Halkitis, Mizuno, & Woods, 2001; Thiede et al., 2009) . Of note, these global associations between substance use and sexual risk taking have been observed in a number of populations at highest risk for acquiring or transmitting HIV in the US, including MSM receiving medical treatment for HIV, non-HIV-positive MSM, and young adult men and women (Bruce, Kahana, Harper, Fernandez, & ATN, 2013; Jones-Webb, Smolenski, Brady, Wilkerson, & Rosser, 2013; Mayer et al., 2014; Patrick, O'Malley, Johnston, Terry-McElrath, & Schulenberg, 2012; Reilly & Woo, 2001; Scott-Sheldon et al., 2013) .

Why does substance use increase sexual risk behavior?

Physiological effects of substance use on sexual risk behavior

Researchers have identified multiple pathways by which substance use may confer increased risk of sexual transmission of HIV. One such pathway is the direct physiological effect of a substance such as alcohol on executive function and decision-making processes (Day, Kahler, Ahern, & Clark, 2015; Simons, Maisto, Wray, & Emery, 2016). Traditional sociocognitive frameworks for understanding sexual risk behavior hold that people make decisions based on a number of key appraisals. For instance, the Theory of Planned Behavior holds that people make behavioral decisions based on their attitudes regarding a given behavior (e.g., “Do I consider using condoms to be important? Unpleasant?”), perceived social norms regarding the behavior (e.g., “Do others like me usually use condoms?”), and the perceived degree of control they feel they have over performing the behavior (e.g., “Can I successfully negotiate condom use with my sexual partner?”) (Ajzen, 2002; Albarracin, Johnson, Fishbein, & Muellerleile, 2001). Yet while these cognitive appraisals have been shown to predict behavioral intentions and subsequent HIV transmission risk behaviors, such assessments of risks and benefits are unlikely to remain stable in the “heat of the moment” when substance use is involved (Davis et al., 2016).

Alcohol myopia theory has suggested one explanation for alcohol’s interference with typical appraisal-based behavior patterns. According to alcohol myopia theory, the acute pharmacological effects of alcohol produce impairment in executive functioning, therefore altering the cognitive processes underlying behavioral decision-making (Field, Wiers, Christiansen, Fillmore, & Verster, 2010;

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Steele & Josephs, 1990) . The theory holds that people under the acute influence of alcohol increasingly attend to immediate, impelling cues (such as sexual arousal), and reduce attention to more distant or abstract inhibiting cues (such as the risk of sexually transmitted infections (STIs)) (Steele & Josephs, 1990; Taylor & Leonard, 1983) . This narrowed attentional focus, in conjunction with increases in subjective sexual arousal, is thought to engender increased willingness to engage in risky sexual behaviors (Day et al., 2015; Simons et al., 2016) .

The extant literature suggests that a similar impaired cognitive processing framework may apply to a number of psychoactive substances beyond alcohol, yet mechanisms of the relationships between drug use and sexual risk taking have been infrequently studied outside of the context of alcohol use (Broyd, van Hell, Beale, Yucel, & Solowij, 2016; Vosburgh et al., 2012) . Although variation across drug types is expected, event-level research has nevertheless supported links between acute use of other drugs and sexual risk taking. For instance, use of methamphetamine at the time of sex is strongly associated with increased sexual risk taking in MSM (Mansergh et al., 2006) . A few studies examining club drugs such as ecstasy/MDMA, ketamine, and GHB have also shown relationships with increased sexual risk in bivariate, yet not in multivariate analyses (Vosburgh et al., 2012) . By contrast, evidence regarding substances such as nitrite inhalants (i.e., “poppers”) and erectile dysfunction drugs has demonstrated mixed or weak associations with sexual risk taking—likely due to differing or negligible effects on cognitive processing (Vosburgh et al., 2012) . Overall, however, studies regarding event-level associations

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between specific classes of psychoactive drug use and sexual risk behavior remain lacking.

Psychological effects of substance use on sexual risk behavior

In addition to the acute physiological effects substance use on sexual risk behavior, learned expectancies concerning alcohol and other drug use have been found to play important roles in shaping sexual behavior while under the influence (Crowe & George, 1989; Kalichman, Simbayi, Cain, & Jooste, 2007; McKirnan, Vanable, Ostrow, & Hope, 2001; Wells, Golub, & Parsons, 2011) .

For PLWH who encounter high levels of stress related to their stigmatized HIV diagnosis, substance use may serve as a means of coping with undesirable thoughts and emotions concerning their stigmatized identity (Martin, Pryce, & Leeper, 2005; Wardell, Shuper, Rourke, & Hendershot, 2018; Wells et al., 2011) . Commonly held expectancies concerning the anxiety-reducing effects of alcohol and other drugs have been shown to contribute to the likelihood and frequency of substance use behavior (Young et al., 1990; Boys et al., 2001; Parks & Kennedy, 2004) (Parks & Kennedy, 2004; Young, OEI, & Knight, 1990) . Thus, substance use may be conceptualized as a form of disengagement coping; a style of coping characterized by orientation away from stress, as opposed to attempting to influence or change the conditions of a stressor (Carver, Scheier, & Weintraub, 1989; Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001; Park & Iacocca, 2014; Yi, Sandfort, & Shidlo, 2010) .

Such disengagement tactics may serve as a coping strategy both for PLWH and for individuals at risk of acquiring HIV, such as sexually active MSM. In people

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who believe they are at risk of acquiring HIV, substance use has been hypothesized to serve as a means of “cognitive escape” from the perceived threat of HIV (McKirnan, Ostrow, & Hope, 1996; Wells et al., 2011) . Paradoxically, risky sexual behavior itself has also been suggested to serve as a form of disengagement coping to reduce the anxiety elicited by HIV transmission threat, frequently in conjunction with substance use (Folkman, Chesney, Pollack, & Phillips, 1992; Martin et al., 2005) .

In PLWH, substance use may serve to facilitate disengagement from a distinct set of threats. PLWH may use substances to disengage from stress associated with the perceived risk of being personally responsible for transmitting HIV to sexual partners. PLWH may also use substance to cope with the perceived risk of negative partner reactions to disclosure of HIV-positive status, with potential consequences including partner rejection, secondary disclosure of one’s HIV-positive status, and intimate partner violence (Brown et al., 2016; Serovich & Mosack, 2003) .

Substance Use and HIV Status Disclosure

The decision of whether or not to disclose one’s HIV-positive status to a sexual partner is a complex social behavior that depends on both personal factors (e.g., disclosure self-efficacy) and situational factors surrounding the sexual event (Bird & Voisin, 2011; Kalichman & Nachimson, 1999; Kalichman, Kalichman, Cherry, & Grebler, 2016) . While a number of situational factors related to HIV partner disclosure have been examined (e.g., meeting venue; sexual partner characteristics),

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the role of substance use in HIV disclosure decision-making is not well understood (Elwood, Greene, & Carter, 2003; Jones-Webb et al., 2013; Rutledge, 2007) .

As previously discussed, acute drug intoxication has been hypothesized to decrease attention to non-immediate social or health-related consequences of behavior (Cusick, 1999; Simons et al., 2016; Steele & Josephs, 1990) . Moreover, given widely shared beliefs that substance use impairs decision making, substance use has also been hypothesized to serve as a social “excuse” for nondisclosure, enabling denial of personal agency during sexual encounters due to a presumed decreased in awareness and judgment (Crowe & George, 1989; Cusick, 1999; MacAndrew & Edgerton, 1969) . A recent study found that men living with HIV who had engaged in nondisclosed condomless sex with a non-HIV-positive partner in the past month were more likely to report having used drugs or alcohol before sex (Kalichman et al., 2016) . Qualitative research, by contrast, has suggested a social lubricant effect of substance use, reporting instances in which substance use before sex has been reported to facilitate disclosure, with some individuals “blurting out” their HIV status while “high” (Cusick, 1999) . Yet analyses that do not distinguish between-person differences in behavior from within-person relationships between behaviors are vulnerable to confounding.

The Present Study

To date, little research has examined the role of substance use within the context of sexual partner HIV disclosure. The few existing studies have examined only between-person differences in substance use behavior, and therefore provide limited insight into the event-level relationship between acute substance use

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intoxication and disclosure. The present study uses a multi-level modeling approach to isolate and examine the event-level correlates of HIV disclosure across a number of sexual events within a sample of PLWH. Implications of event-level substance use and HIV serostatus disclosure for condom use behavior are also examined.

The present study observes PLWH's reported sexual behavior within a one-month daily prospective observational study. Sexual events of interest were those in which participants reported anal or vaginal sex with first-time sexual partners whose HIV serostatus was HIV-negative or unknown. The study examined sexual events with new sexual partners, rather than longer-term primary partners, due to the especially risky nature of such encounters; PLWH tend to engage in greater sexual risk behavior with non-primary sexual partners, with whom they may feel less comfort, agency, and responsibility disclose their stigmatized identity or negotiate condom use (Bird et al., 2017; Cusick, 1999; Kalichman & Nachimson, 1999). Moreover, prior event-level research has found that alcohol use is related to a higher likelihood of condom-unprotected sex with non-primary partners but not with primary partners (Venable et al., 2004). Thus, an understanding of HIV risk behavior in the context of first-time sexual encounters is of particular importance for prevention efforts.

While some qualitative reports suggest that disinhibiting effects of substance use may facilitate HIV partner disclosure, both executive impairment theories (e.g., alcohol myopia theory) and substance use expectancy theories (e.g., disengagement coping) suggest that substance use may reduce the likelihood of PLWH disclosing their HIV status prior to sex (Steele & Josephs, 1990; Wells et al., 2011).

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Sociocognitive theories such as the Theory of Planned Behavior and the Information-Motivation-Behavioral skills (IMB) model further suggest that this decreased information concerning one's HIV transmission risk is likely to reduce the likelihood of engaging in risk reduction behavior such as condom use (Ajzen, 2002; Fisher & Fisher, 1992). Thus, we hypothesized that decreased likelihood of disclosure may be one mechanism by which substance use confers increased risk of HIV transmission.

Multilevel mediation was conducted to examine the relationships between substance use, HIV partner disclosure, and condom use as it varies at the average, between-person level and at the daily event level (Figure 1). We proposed first to test a main effect of event-level substance use on condom use. We then chose to examine HIV serostatus disclosure as a mediator of the relationship between substance use and condom use.

Specific hypotheses

H1: We hypothesize that substance use at the time of sex use will be associated with a decreased likelihood of condom use with first-time sexual partners whose serostatus is HIV-negative or unknown.

H2: We hypothesize that substance use at the time of sex will be associated with decreased likelihood of HIV serostatus disclosure to first-time sexual partners whose serostatus is HIV-negative or unknown.

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H3: We further hypothesize that nondisclosure of HIV serostatus will be associated with a lower likelihood of condom use during sex with first-time sexual partners whose serostatus is HIV-negative or unknown.

H4: We hypothesize that nondisclosure of HIV serostatus will mediate the event-level relationship between substance use and condom use.

METHOD

Participants

Men and women age 18 or older were recruited from community services and infectious disease clinics in Atlanta, Georgia over a 12-month period between 2013 and 2014. Eligible participants had documentation of being HIV-positive. From this sample, this study examined a subsample of men and women who reported anal or vaginal intercourse with one or more first-time sexual partners whose status was HIV- or unknown. Atlanta, Georgia has an annual HIV incidence of 30.3 per 100,000, higher than the mean rate of 19.6 new infections per 100,000 across major US cities. Georgia state law prohibits persons with HIV from engaging in sexual intercourse without informing their sexual partner of their HIV-positive status. Violation of this law carries a felony penalty punishable by imprisonment of up to 10 years [Ga. Code Ann. x 16-5-60(c)]. Awareness of this law among participants was not assessed.

Procedures

Targeted community sampling was used to recruit participants, including both venue recruitment and snowball sampling methods. Study brochures were placed in waiting rooms of HIV service providers and infectious disease clinics throughout metropolitan Atlanta. Over 60% of participants were recruited from a major HIV clinic and outpatient treatment center; the remainder was recruited from a range of private and public health service providers.

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Participants were provided informed consent at the initial office study assessment before reporting demographic and health information via audio-computer assisted self-interview (ACASI). Such computer interviews have been shown to increase reporting of socially sensitive behaviors such as drug use and sexual behavior (Gribble et al., 2000; Morrison-Beedy, Carey, & Tu, 2006). Participants also provided urine samples for drug toxicity screening.

Over the following month, participants reported their sexual behavior prospectively via daily text-message surveys. Past day sexual behavior surveys were completed for 28 consecutive days on study-provided cell phones. Antiretroviral medication adherence was assessed by means of unannounced pill counts (Kalichman et al., 2007). Participants were provided \$145 for completing all study assessments. All study procedures were approved by the university Institutional Review Board. Study participants were protected by a Federal certificate of confidentiality.

Measures

Time-invariant measures

Computer-assisted self-interviews for demographic and health information

Using ACASI, participants reported on their age, gender, years of education, employment status, race/ethnicity, and the year they first tested HIV-positive. Participants indicated whether they were currently on antiretroviral therapy (ART), and noted whether they were aware of their most recent viral load test results.

Participants reported on their global alcohol use using the 10-item Alcohol Use Disorders Identification Test (AUDIT) (Saunders, Aasland, Babor, De la Fuente,

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Juan R, & Grant, 1993) . The AUDIT asks participants to denote their alcohol use quantity and frequency in the past month, in addition to other indicators of problematic alcohol use.

The 10-item version of the Drug Abuse Screening Test (DAST-10) was used to assess participants' global drug use behavior (Skinner, 1982) . The measure asked participants to respond "Yes" or "No" to 10 questions regarding the participant's non-alcohol drug abuse behavior during the past 3 months. The 10-item version of the DAST has demonstrated acceptable internal consistency (Cronbach's alpha > .85) and test-retest reliability ($r > .70$) (Cocco & Carey, 1998) .

Participants were also asked to report on their current depression symptoms using the Center for Epidemiological Studies Depression questionnaire (CES-D) (Radloff, 1977) . The CES-D is a 20-item measure that assesses the presence and severity of depressive symptoms during the past week. The CES-D has been shown to be reliable in previous research (alpha > .85) (Hann, Winter, & Jacobsen, 1999) .

Drug use screening

To assess for illicit drug use, an FDA-approved multipanel urine dip-test was administered. This test was used to screen for 12 drugs or their metabolites, including methamphetamine, cocaine, and THC. The test is reliable and valid for initial detection of drug use. A positive result for a given drug indicated current use (Reditest-12; Redwood Toxicology Labs).

Event-level measures

Text message-reported daily behavior

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At the study's initial office assessment, each participant was provided with a cell phone and received instruction on how to use the phone's text messaging functions. Over the subsequent 28 days, participants received a prompt by text message to report on their past-day sexual behavior. Daily text message reporting methods have been shown to provide reliable assessment of socially sensitive behaviors (Bernhardt et al., 2009; McAuliffe, DiFranceisco, & Reed, 2010).

Participants were asked to report whether or not they had sex the previous day; if so, participants were prompted to specify whether they engaged in anal or vaginal sex, whether or not they used a condom, the gender of their partner, whether or not their partner was aware of the participant's HIV-positive status (Told Partner/ Didn't tell but assumed partner knew/Partner didn't know), and whether the participant was aware of their partner's HIV status (Told HIV+/Assume HIV+/Told HIV-/Assume HIV-/Don't Know). Participants also reported whether substances were being used at the time of sex ("I used"/"My partner used"/"Both Used"/"Neither used"). All responses were coded dichotomously. Only explicit verbal confirmation regarding HIV status was considered to be HIV disclosure (i.e., responses of "Told partner HIV+ status" were considered disclosure, whereas responses of either "Didn't tell but assumed partner knew" and "Partner didn't know" were both coded as nondisclosure). Partner HIV status was also coded dichotomously; participants who responded that their partners "Told that they were HIV+" were coded as HIV+, whereas all other responses, including "Assume HIV+," were coded as "HIV- or unknown." For primary analyses, event-level substance use was defined as either "I used," "My partner used," or "Both used," whereas "Neither

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used” was defined as no substance use. A separate variable was created to examine participant-specific substance use, in which substance use was defined as “I used” or “Both used”, and no substance use was defined as “Partner used” or “Neither used.” A third substance use variable was created to examine partner-specific substance use; for this variable, substance use was defined as “Partner used” and “Both used,” whereas no substance use was defined as “I used” or “Neither used.”

Data Analytic Plan

A multilevel modeling approach was employed to account for the nested structure of the data (i.e., daily sexual events within participants). Data at level 1 were characteristics of the daily sexual event, such as whether substances were used, whether a condom was used, and whether the participant disclosed their HIV serostatus to their partner. Data at level 2 were (time-invariant) participant characteristics, such as participant gender, age, and global drug (DAST) and alcohol use behavior (AUDIT), self-reported at study entry.

For our primary analysis, we tested a two-level random effects mediation model of the within-person relations between event-level (i.e., at the time of sex) substance use, disclosure, and condom use (Figure 1). These models utilized maximum likelihood estimation with robust standard errors to account for the dichotomous nature of the dependent variables. The results of this within-person model are presented in Table 3. Following a test of the indirect effect, we examined the proposed mediation paths independently to observe potential moderating effects.

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We also tested a series of models to examine the effects of between-person differences in overall substance use behavior. These models examine the likelihood of disclosure and condom use given individual differences in the following measures: A) recent alcohol use behavior (AUDIT), and B) recent drug use behavior (DAST), and C) proportion of sexual events in which participants reported using substances (Tables 4A-C).

We also conducted sensitivity analyses to compare the effects of different types of event-level substance use (e.g., PLWH used substances vs. both partners used vs. PLWH's partner used) (Tables 5A-C). We further examined moderating effects of participant and partner gender.

Within-person effects (i.e., characteristics of the sexual event) were coded dichotomously. Between-person variables based on event-level responses (e.g., individual patterns of substance use, disclosure, and condom use during sexual events) were calculated as proportions. For example, the between-person term for a participant who reported condom use on 50% of all reported sexual events was calculated as 0.5. Between-person effects based on ACASI responses (i.e., participant characteristics and patterns of behavior) were analyzed as continuous (e.g., age, AUDIT score, number of illicit substances for which participant screened positive at baseline) or categorical (e.g., gender) variables. Results for both within-person and between-person effects were reported as unstandardized betas (β) along with 95% confidence intervals (95% CIs). Within-person effects were also reported as odds ratios (ORs) for ease of interpretation.

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To examine the degree to which observations were non-independent across clusters, intra-class correlation coefficients (ICCs) were approximated, as the categorical nature of the data prevented ICC calculation. Intraclass correlation was therefore approximated using two methods to determine the proportion of variance accounted for at level 1 (within-participant variance) and level 2 (between-participant variance). ICCs were approximated first by testing the unconditional (empty) model with a linear outcome distribution and again by testing the model with a logistic outcome distribution (McCoach, 2017). The resulting two figures provide an approximate range of the proportion of variance in the dependent variable accounted for at level 2.

Multilevel statistical analyses were conducted in MPlus version 8 (Muthén, L.K. and Muthén, B.O., 2012). Time-invariant data collected at study entry were largely complete (less than 3.2% missing for all variables of interest). Missing data were considered to be missing completely at random (MCAR). Therefore, full information maximum likelihood imputation was utilized to account for missing data (Little & Rubin, 2014). Model fit was assessed using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) fit indices (Vrieze, 2012).

Demographic statistics were analyzed in SPSS version 23 (IBM Corp, 2015). Intraclass correlation coefficients were estimated using Hierarchical Linear Modeling Version 7 (Raudenbush, Bryk, & Congdon, 2017). Participant demographic data were reported as percentages and as means (M) with standard deviations (SD). Event-level sexual behavior characteristics were reported as percentages.

RESULTS

Demographic Characteristics of the Sample

From a larger sample of 760 men and 280 women living with HIV, 251 participants reported having had anal or vaginal sex with at least one first-time sexual partner whose HIV serostatus was negative or unknown (Kalichman et al., 2016). Participant characteristics are described in Table 1. The mean age of the sample was 42 years, and participants were predominately male (84.9%), Black/African American (91.6%), and lower income (62.9% reported annual income less than \$10,000).

Sexual event characteristics

Characteristics of sexual events are described in Table 2. During the 28-day study period, participants reported a total of 529 sexual events with first-time sexual partners whose HIV status was negative or unknown ($M=2.11$ per participant). Participants reported having between one and twelve such partners during the study period, with 120 participants (47.8%) reporting two or more such partners. The majority of sexual events (348 events; 65.7%) occurred between two men. Male participants ($N=213$) reported 462 sexual events in total ($M=2.17$ per participant); and female participants ($N=38$) reported 67 sexual events in total ($M=1.76$ per participant).

Participants reported using a condom during half (49.5%) of all sexual events and using substances during 36.5% of all sexual events. Between both participants

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and their sexual partners, substance use was reported during 46.7% of events. Participants disclosed their HIV-positive serostatus to a third (32.1%) of their first-time, non-HIV-positive sexual partners. A non-significant trend suggested that participants who reported more first-time non-HIV-positive sexual partners were less likely to disclose their HIV serostatus during a given sexual event, despite similar patterns of event-level substance use ($\beta = -0.028, p=0.067$).

Among participants who reported two or more first-time non-HIV-positive partners, nearly half reported inconsistent substance use (40%) and condom use (40%) across events. Yet the majority (72.5%) reported a consistent pattern of serostatus disclosure or nondisclosure across sexual events. Thus, within-person variance in disclosure across events was only observed within in a small subset of participants (N=33); these inconsistent disclosers accounted for only a small proportion of the total sample (13.1%). This small proportion of variance at the event level was corroborated by estimates of intra-class correlation. Estimated ICCs suggested that approximately 49% to 58% of variance in HIV serostatus disclosure was accounted for at level 2 (person-level factors). For condom use, approximately 40% to 46% of variance was estimated to be attributable to between-person factors.

Multilevel Mediation Models

To examine the relations between substance use, HIV serostatus disclosure, and condom use in a sample of PLWH and their first-time non-HIV-positive partners, we tested a series of two-level random intercept models.

Substance Use and Condom Use (Direct effect)

As part of our primary within-person model, the event-level association between substance use and condom use was tested (Table 3). This two-level random intercept model controlled for participant characteristics including age and gender as well as the effect of sexual partner gender. Contrary to our hypothesis, results demonstrated no event-level relationship between substance use and condom use, suggesting that substance use at the time of sex was not associated with likelihood of condomless sex (OR = 1.18, β = 0.16, 95% CI [-0.50, 0.82], $p=0.630$).

Despite the absence of a statistically significant direct effect of event-level substance use on condom use behavior, we nevertheless sought to examine the potential mediating role of HIV serostatus disclosure on the hypothesized substance use and condom use relationship. Where the mediator is hypothesized to act as a suppressor variable for the relationship between the independent and dependent variables, the direct effect need not be statistically significant to test for mediation effects (MacKinnon, Fairchild, & Fritz, 2007) . Since we expected that disclosure would suppress the hypothesized negative relationship between substance use and condom use, inconsistent mediation was conducted (Cusick, 1999; Kalichman et al., 2016) .

Between-Person Models

We also examined the relations between individuals' overall substance use behavior and their patterns of disclosure and condom use using between-person models. Results showed that self-reported heavier drinkers (measured by AUDIT)

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used condoms less regularly ($p=0.05$) (Table 4A). Self-reported heavier drug users (measured by DAST) also reported using condoms less frequently, although the latter trend did not meet statistical significance ($p=0.09$) (Table 4B). When drug use was measured objectively by number of different substances used at study entry (positive urine drug screens), number of drugs used did not predict condom use. Participants who more frequently reported using substances in their first-time sexual encounters with non-HIV-positive partners were no less likely to use condoms on average (Table 4C).

Substance Use and HIV Disclosure (Path A)

To examine whether HIV serostatus disclosure mediates the relation between substance use and condom use, we first examined the relation between event-level substance use and event-level HIV serostatus disclosure (Table 3). In support of our hypothesis, results of our two-level random intercept model indicated that when either partner was using substances at the time of sex, participants were 54% less likely to disclose their HIV serostatus ($OR=0.46$, $\beta = -0.78$, $SE = 0.38$, $95\% CI [-1.53, -0.05]$, $p = 0.037$). Neither AUDIT nor DAST scores were statistically significant predictors of disclosure after accounting for the event-level effect of substance use, and were therefore excluded from the model.

Given the significant effect of partner gender on disclosure, we also examined the relation between substance use and disclosure separately in partner gender subgroups. In events in which men had sex with non-HIV-positive men ($N=175$; 348 events), a similar strength of effect was found, indicating a negative relationship between substance use and disclosure, although results did not remain statistically

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significant in this smaller subgroup ($\beta = -0.67$, $SE = 0.43$, 95% CI [-1.51, -0.16], $p = 0.11$). In women living with HIV who reported sex with non-HIV-positive men ($N=38$; 67 events), an especially large effect of substance use on disclosure was observed ($\beta = -1.37$, $SE = 0.99$, 95% CI [-3.30, 0.57], $p = 0.16$). Although this effect did not remain statistically significant in this smaller subgroup, results suggested that when substances were used at the time of sex, women were 74% less likely to disclose their HIV serostatus than when neither partner used substances. Finally, during sexual events in which men living with HIV reported sex with non-HIV-positive women ($N=51$; 100 events), the relationship between substance use and disclosure did not approach statistical significance ($\beta = -0.27$, $SE = 1.18$, 95% CI [-2.59, 2.05], $p = 0.82$).

To examine the effect of substance use specifically in the HIV-positive partners reporting sexual events (as opposed to the substance use of their sexual partners), we also examined the effect on disclosure of whether *participants themselves* were using substances at the time of sex (i.e., excluding the role of partner substance use) (Table 5A). In this sensitivity analysis, the effect of participant's own substance use at the time of sex did not have a statistically significant relation with likelihood of disclosure. Although this effect did not approach statistical significance, the direction of effect nevertheless suggested that when participants used substances at the time of sex, they were 33% less likely to disclose their HIV serostatus than when substances were not used ($OR=0.67$, $\beta = -0.40$, $SE = 0.35$, 95% CI [-1.08, 0.28], $p = 0.25$). We also examined whether events in which *both partners* were using substances were associated with different

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disclosure likelihood than events in which neither or only one partner used substances (Table 5B). No statistically significant relationship was found. Finally, we also compared the likelihood of disclosure when *the first-time non-HIV-positive sexual partner* of the participant used substances or not (Table 5C). Sexual partner substance use was not statistically significantly associated with disclosure, although the direction of the non-significant effect suggested that PLWH may be less likely to disclose their serostatus when their first-time non-HIV-positive partners are using substances (OR=0.70 $\beta = -0.36$, SE = 0.37, 95% CI [-1.07, 0.36], $p = 0.33$).

Between-person models

Heavier drinkers and drug users by self-report were less likely to disclose their HIV status to sexual partners on average, although number of positive drug screens did not predict disclosure (Tables 4A & 4B). In participants who more frequently used substances during sexual encounters, these participants were less likely to disclose their HIV serostatus (Table 4C).

HIV Disclosure and Condom Use (Path B)

In our primary analysis, we also examined the event-level relation between HIV serostatus disclosure and condom use (Table 3). Contrary to hypotheses, in participants who used condoms inconsistently (N=48), participants were no less likely to report condom use during sexual events in which they disclosed their HIV status (OR=1.01, $\beta = 0.01$, SE = 95% CI [-0.68, 0.69], $p=0.99$). This finding stands in contrast to our hypothesis that disclosure would increase the likelihood of condom use.

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We next examined the separate within-person and between-person effects of disclosure on condom use together in one model (Table 6). Despite the counterintuitive within-person effect (in this model, event-level disclosure was associated with *decreased* likelihood of condom use among inconsistent condom users), the between-person result indicated that participants who consistently used condoms (N=106) were more likely to have disclosed their HIV status than participants who consistently engaged in condomless sex (N=97) ($\beta = 1.67$, SE = 0.62, 95% CI [0.65, 2.69], $p < 0.01$). Thus, the relationship between disclosure and condom use appears to differ between consistent and inconsistent disclosers.

Although event-level substance use was not associated with greater condom use in the total sample, we sought to examine whether substance use may exert a different effect on condom use behavior in sexual events in which disclosure had occurred vs. those in which disclosure had not occurred. Our subgroup analyses showed that in either case, substance use at the time of sex was not significantly associated with condom use behavior (p 's > 0.05). Thus, event-level substance use does not appear to account for condom non-use following disclosure.

To better understand this counterintuitive finding, we performed exploratory follow-up analyses to examine participant characteristics associated with condom non-use during sexual events in which HIV disclosure had occurred. We included all participants who reported disclosing their HIV status to at least one non-HIV-positive sex partner. We then compared the characteristics of those who always used condoms during such events to those who did not always use condoms in spite of disclosure. Independent-sample t-tests were used for continuous

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variables and X^2 analyses for categorical variables. Comparisons were made at the person level. Individuals who reported condomless sex following disclosure were found to have fewer common HIV-related symptoms ($t(2, 90)=2.14, p=0.035$), poorer safe sex behavioral skills ($t(2, 90)=2.31, p=0.007$), and better social support ($t(2, 89)=-2.73, p=0.008$) than those who always reported condom-protected sex following disclosure. Marginal trends suggested that those who engaged in condomless sex following disclosure perceived less HIV transmission risk associated with condomless sex ($t(2, 89)=1.81, p=0.075$), and reported greater drug use (DAST) ($t(2, 74.4)=-1.76, p=0.083$). No statistically significant differences were observed for age, gender, years since HIV diagnosis, AUDIT score, ARV medication adherence, CD4 count, HIV viral load, or beliefs that treatment reduces HIV transmission risk. Those who engaged in condomless sex following disclosure were no more likely to have concurrent STIs, to have a positive drug screen, or to be prescribed antiretroviral treatment.

Tests of Indirect Effects

A test of the indirect effect in our primary model did not find a mediating effect of disclosure on the event-level relationship between substance use and condom use ($\beta = -0.00, SE = 0.28, 95\% CI [-0.55, 0.54], p = 0.99$) (Table 3). While event-level substance use was associated with decreased likelihood of HIV serostatus disclosure (Path A), nondisclosure was not associated with condom non-use among inconsistent condom users (Path B).

In our models of the between-person effects of substance use on condom use behavior (i.e., models examining AUDIT scores, DAST scores, number of positive

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drug screens, and proportion of sexual events involving substances), we similarly found no statistically significant mediation effects, owing to a lack of a relationship between disclosure and condom use (Tables 4A-4C).

DISCUSSION

To prevent transmission of HIV, an understanding of the role of substance use in sexual risk behavior is of critical importance. Results of our study indicate that substance use at the time of sex reduces the likelihood of PLWH informing casual non-HIV-positive sexual partners of their HIV-positive status. Given that PLWH who engage in condomless nondisclosed sex are more likely to demonstrate several indicators of increased infectiousness (i.e., poorer ARV adherence, more recent STI infections, and higher HIV viral load), this finding is especially consequential for informing HIV prevention efforts (Kalichman et al., 2016).

The strength of the relationship between substance use and disclosure appeared to differ substantially depending on the genders of PLWH and their sexual partners. While smaller sample sizes across these subgroups precludes definitive conclusions, our results suggest that the negative relationship between substance use and disclosure appears to be largest among women living with HIV, and smallest among men living with HIV when their non-HIV-positive partners are women. These results are consistent with prior research indicating that women—particularly those with a history of sexual victimization—may be more likely to abdicate sexual safety decision-making while intoxicated due to anticipation of negative partner reactions (George et al., 2016; Stappenbeck et al., 2016).

While we anticipated that HIV disclosure would facilitate taking greater preventative health precautions, we were surprised to find that disclosure was not associated with a greater likelihood of using a condom among those who reported

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inconsistent condom use. This unanticipated finding suggests that the potential risk reduction benefit of increasing HIV disclosure in casual sexual encounters may be overestimated. While surprising in light of prevailing sociocognitive theories of behavior, our finding adds to a growing body of literature demonstrating mixed support for an effect of HIV disclosure on condom use behavior (Simoni & Pantalone, 2004; Sullivan, 2005).

A number of factors may help to explain the counterintuitive finding that disclosure of HIV status to non-HIV-positive partners did not appear to increase the frequency of condom use in casual encounters. Previous qualitative research has suggested that sexually risky men and women with HIV who perceive themselves to be responsible for protecting their partners may use risk reduction strategies such as condom use to avoid the socially risky act of disclosing their HIV status (Bird & Voisin, 2011; Cusick, 1999). However, efforts to avoid disclosure may not always result in increased frequency of condom use. In contrast, some PLWH have reported that when they wish to conceal their HIV status, they may avoid using a condom out of fear that doing so would betray their HIV-positive status (Cusick, 1999). Another critical consideration is that condom use likely provides an incomplete measure of sexual risk reduction efforts. It is therefore possible that the lack of a relationship between disclosure and condom use may be attributable to sexual harm reduction methods not captured in the present study (Parsons, Schrimshaw, Wolitski et al., 2005). Risk reduction strategies such as strategic positioning, serosorting, and withdrawal before ejaculation may be alternative methods by which PLWH and their partners attempt to decrease HIV transmission risk (Crues et al., 2017;

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Dangerfield, Smith, Williams, Unger, & Bluthenthal, 2017; Eaton, Kalichman, O'Connell, & Karchner, 2009; McFarland et al., 2012; Vallabhaneni et al., 2012). Although not captured in the present study, reliance upon such alternative risk reduction tactics could help to explain high rates of condomless sex between serodiscordant partners even following disclosure. Some potential partners of PLWH may also abstain from anal or vaginal sex altogether following their partner's HIV disclosure, rather than using condoms.

Our study also contributes to a conflicting body of evidence concerning the acute effects of substance use on condom use decision-making. Consistent with prior literature, our between-person measures of substance use suggested that heavier alcohol drinkers were those most likely to engage in condom-unprotected sex (Koblin et al., 2006b; Mayer et al., 2014; Scott-Sheldon et al., 2013). Yet our test did not support an event-level relationship between substance use and condom use, suggesting that substance use at the time of sex did not increase sexual risk-taking after accounting for these between-person characteristic use patterns. Although lab-based research has indicated that acute alcohol intoxication is associated with increased willingness to engage in condomless sex, results from this sample corroborate previous event-level analyses that have failed to find an immediate relationship between substance use and sexual risk behavior (Davis et al., 2009; George et al., 2009; Gillmore et al., 2002; Reilly & Woo, 2001). This evidence may point to the primacy of person-level factors such as sensation seeking in explaining the relationship between substance use and sexual risk behavior. Alternatively, they

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may indicate a lack of sensitivity in the current study's assessment of substance use behavior.

In spite of the design strengths of the present study, several notable limitations warrant discussion. As is true of the majority of sexual behavior research, our study was limited by its reliance on self-report. With regard to measurement of socially sensitive behaviors such as condom use, HIV disclosure, and substance use, some underreporting is likely. Previous examinations of alcohol use self-report have demonstrated limited test-retest reliability (Johnson, Pratt, Neal, & Fisher, 2010). Sexual behavior data is also vulnerable to underreporting bias, with inaccuracy of self-report during retrospective recall found to be greatest among those at highest transmission risk, such as those who report more casual partners and those with lower education levels (Jaccard et al., 2004). To minimize the possibility of underreporting bias, our study utilized state-of-the-art daily electronic data collection methodology. This method has demonstrated reliable measurement of socially sensitive behaviors in previous research, yet such methods cannot entirely remove the possibility of underreporting (Bernhardt et al., 2009; McAuliffe et al., 2010).

A second limitation of our study is the lack of specific data characterizing event-level substance use. To reduce study burden, participants answered one item regarding substance use during each sexual event (i.e., specifying whether both the participant and/or their sexual partner had used substances). While this brief question format provided participants with a less demanding daily burden, greater specificity concerning the variety of substance(s) used would have offered valuable

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data concerning differential substance use effects. As substances vary in their psychoactive effects and associated behavioral expectancies, the present study's lack of granularity concerning the types of substances used may have obscured some relationships between substance use and associated sexual behaviors. Further, as prior event-level studies of alcohol use have detected relationships between number of drinks consumed and daily sexual risk behavior, predictive value may also have been missed by failing to capture impairment (Barta et al., 2008).

Finally, our study was limited in its scope. Much event-level research does not account for the potential importance of contextual factors such as meeting venue for HIV transmission risk behavior (Groves, 2012; Horvath, Bowen, & Williams, 2006; Jones-Webb et al., 2013). While some research has indicated that sexual risk behavior appears to be more contingent on personal psychosocial factors than on meeting venue features, risk behavior norms nevertheless appear to differ significantly across venue types in MSM (Groves, Parsons, & Bimbi, 2007; Groves, 2012).

Despite these limitations, this study utilized sensitive and state-of-the-art electronic diary data collection, and applied a multilevel modeling analytic approach that provided significant methodological advantages. Analytic methods that fail to account for non-independence of observations when data is clustered increase the likelihood of Type I error (Musca et al., 2011). Additionally, attempts to examine within-person phenomena using between-person measures are vulnerable to a variety of potential confounders that may bias findings (Robinson, 1950). In contrast, the present study utilized a robust and conservative analytic approach to

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isolate the event-level factors that influence sexual risk decision-making. In the present study, all estimates of intraclass correlation indicated that a substantial proportion of variance in the dependent variables was accounted for by level 2 factors. These tests provide another strong statistical justification for the necessity of a multilevel analytic approach rather than ignoring participant variance in analysis of specific events.

Future directions

The present study highlights the complex and multifactorial interplay of personal and situational factors that influence HIV transmission risk behavior in PLWH. Future research should continue to utilize event-level methodology to better understand the causal pathways by which substance use may influence sexual risk behavior. Greater specificity in measurement substance use type and impairment is needed to better understand the impact of substance use on health behavior decision-making.

Irrespective of the immediate effects that substance use may exert on sexual health decision-making, substance use is strongly linked to HIV transmission risk through a number of indirect pathways. Problematic drug and alcohol use has been consistently linked with lack of successful engagement in HIV testing and care among PLWH, which increases the risk of transmission of HIV due to unsuppressed HIV viral load, in addition to increasing HIV disease severity (Cohen, 1998; Lucas, Cheever, Chaisson, & Moore, 2001; Parsons, Kowalczyk, Botsko, Tomassilli, & Golub, 2013; Quinn et al., 2000; Vagenas et al., 2015; Williams et al., 2018) . Personal factors such as sexual compulsivity, sensation seeking, and belonging to high-risk

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sexual networks may also account for much of the association between substance use and HIV transmission risk (Day et al., 2015; Hernandez-Romieu et al., 2015; Kalichman, Cain, Zweben, & Swain, 2003; Newcomb, Clerkin, & Mustanski, 2011; Norris et al., 2009) . Thus, future studies should strive to measure and examine relevant risk-related beliefs as well as personality and demographic factors that may contribute to increased HIV transmission risk behavior in substance-using PLWH and their partners.

In light of the disproportionately high risk of HIV transmission among people who use substances, interventions that address sexual risk reduction in this population must address the complex etiology of HIV risk behaviors in this population. Successful behavioral change interventions should target multiple behaviors concurrently (Coates, Richter, & Caceres, 2008) . Promotion of partner HIV disclosure may be a valuable adjunct to sexual risk reduction strategies, yet alone may be insufficient for reliably improving sexual health behavior. Addressing substance use disorders, barriers to medication adherence, concurrent STIs, trauma, stigma, and mental health concerns, are all critical supplements for successful behavioral prevention interventions in PLWH (Burnham et al., 2016; Kalichman et al., 2016; Stappenbeck et al., 2016; Williams et al., 2018) . For instance, methadone maintenance treatment for opioid drug using PLWH may help to reduce sexual risk behavior by reducing reliance on transactional sex (Karki, Shrestha, Huedo-Medina, & Copenhaver, 2016) . Promotion of sexual risk reduction in the context of more recreational forms of alcohol or other drug use is also warranted.

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Given the multiple means by which people may attempt to reduce sexual transmission risk, future research should examine use of alternative risk reduction strategies beyond condom use. Understanding use of perceived sexual harm reduction practices such as strategic sexual positioning may shed greater light on the decision-making frameworks utilized by PLWH and their partners (Parsons et al., 2005). Similarly, greater understanding of evolving HIV risk perceptions and beliefs (e.g., treatment-as-prevention beliefs) may help to understand sexual risk behaviors (Kalichman et al., 2017). Considering the fundamentally interpersonal nature of sexual risk behaviors, dyadic analysis may also help to understand the interplay of beliefs, behaviors, risk perceptions, skills, and anticipated partner reactions involved in negotiating sexual health decisions between partners.

Researchers should also examine the role of emerging pharmaceutical alternatives such as Pre-Exposure Prophylaxis (PrEP) in sexual health decision-making. Such biomedical alternatives carry tremendous potential to reduce the consequences associated with sexual risk behaviors made in the “heat of the moment” among partners of PLWH. Nevertheless, potential risk compensation behavior such as condom non-use in PrEP user should be scrutinized, given the increased risk of HIV transmission associated with concurrent STI infection (Cohen, 1998; Cohen, 2012). Uptake of PrEP remains sporadic, and rates of PrEP use remain particularly low among those at greatest risk for acquiring HIV (Eaton, Driffin, Bauermeister, Smith, & Conway-Washington, 2015; Mimiaga, Closson, Kothary, & Mitty, 2014). Thus, sexual partners of PLWH may be especially unlikely to obtain

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the benefits of PrEP, further emphasizing the importance of effective behavioral prevention interventions in PLWH.

Conclusions

This study is the first to apply multilevel modeling methodology to examine the immediate determinants of HIV serostatus disclosure in PLWH's first-time sexual encounters with non-HIV-positive partners. Our findings offer an important contribution to understanding the role of substance use in HIV transmission risk behavior. We found that use of substances at the time of sex appears to be associated with lower likelihood of disclosing one's HIV-positive status to casual sex partners. Yet while nondisclosure of HIV status was more frequent when substances were used at the time of sex, this nondisclosure was not associated with lower likelihood of condom use in those who used condoms inconsistently. Our study also contributes to the mixed literature concerning the relationship between substance use and condom use. We found that heavier alcohol users were more likely to engage in condomless sex, yet substance use at the time of sex was not associated with a greater likelihood of condomless sex in inconsistent condom users. Our findings provide insight regarding the socially fraught process of sexual health decision-making in PLWH, and add nuance regarding the complex and multiple relations between substance use and sexual risk behavior.

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TABLES & FIGURES

Table 1: Participant Demographics

	N= 251
	Mean (SD)/ N (%)
Age (Years)	42.0 (10.1)
Gender	
Male	213 (84.9%)
Female	38 (15.1%)
Trans Male	10 (4.0%)
Trans Female	8 (3.2%)
Race/Ethnicity	
Black/African American	230 (91.6%)
White	14 (5.6%)
Hispanic/Latino	2 (0.8%)
Other	5 (2.0%)
Household Annual Income	
Under \$10,000	158 (62.9%)
\$11,000-\$20,000	57 (22.7%)
\$21,000-\$30,000	25 (10.0%)
Over \$30,000	10 (4.0%)
Healthcare	
Coverage in past 2 years	179 (71.3%)
No coverage past 2 years	72 (28.7%)
Employment Status	
Unemployed	81 (32.3%)
Working	48 (19.1%)
On disability	109 (43.4%)
Student	6 (2.4%)
Other	7 (2.8%)
Education	
7 th -11 th grade	43 (17.1%)
12 th grade or GED	74 (29.5%)
Some College	81 (32.3%)
Completed College	53 (21.1%)
Years since HIV Diagnosis	12.3 (8.3)
CES-D (0-60)	17.6 (12.2)
AUDIT (0-40)	
0	74 (29.5%)
1-8	135 (53.7%)
8+	39 (15.5%)
Drug Abuse Screening Test (DAST) (0-10)	1.5 (2.0)

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Drug Use (Positive urine tox screen %)	
THC (Cannabis)	70 (27.9%)
Cocaine	70 (27.9%)
Benzodizepines	24 (9.6%)
Opiates	9 (3.6%)
Methamphetamine	9 (3.6%)
Amphetamines	7 (2.8%)
Oxycontin	7 (2.8%)
MDMA	3 (1.2%)
PCP	2 (0.8%)
Barbituates	1 (0.4%)
Methadone	1 (0.4%)
Number of first-time non-HIV-positive sexual partners in 28-day study period	
1	131 (52.2%)
2	63 (25.1%)
3	22 (8.8%)
4	12 (4.8%)
5 or more	23 (9.2%)

Table 2: Sexual Event Characteristics
(Event N=529)

<i>Participant Gender (PLWH)</i>	Man			Woman
	Man (348 events)	Woman (100 events)	Transgender (14 events)	Man (67 events)
Participant and/or partner used substances	166 (47.7%)	46 (46.0%)	7 (50%)	28 (41.8%)
Participant Used Substances	132 (37.9%)	30 (30.0%)	6 (42.9%)	25 (37.3%)
Partner Used Substances	115 (33.0%)	28 (28.0%)	5 (35.7%)	12 (17.9%)
Participant disclosed positive HIV serostatus	106 (30.5%)	34 (34.0%)	7 (50%)	23 (34.3%)
Condom Used	151 (43.4%)	71 (71.0%)	9 (64.3%)	31 (46.3%)

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Table 3: Within-Person Mediation Model

	OR	Estimate (95% CI)	SE	t	p
<i>Within-Person Effects</i>					
Disclosure					
Either partner used substances (Path A)	0.46	-0.79 (-1.53, -0.05)	0.38	-2.09	0.037
Partner gender	1.81	0.59 (-0.34, 1.53)	0.48	1.25	0.212
Condom Use					
Either partner used substances (Direct Effect)	1.18	0.16 (-0.50, 0.82)	0.34	0.48	0.630
Participant disclosed HIV+ status (Path B)	1.01	0.01 (-0.68, 0.69)	0.35	0.01	0.990
Partner Gender	4.43	1.49 (0.56, 2.42)	0.47	3.14	0.002
<i>Between-Person Effects</i>					
Disclosure					
Participant gender		0.57 (-0.91, 2.05)	0.76	0.76	0.451
Participant age		0.03 (-0.02, 0.09)	0.03	1.14	0.256
Condom use					
Participant gender		0.18 (-0.95, 1.32)	0.58	0.32	0.753
Participant age		-0.03 (-0.07, 0.01)	0.02	-1.49	0.137
<i>Test of indirect effect</i>					
Path A*Path B		-0.00 (-0.55, 0.54)	0.28	-0.01	0.990

AIC: 1214.87; BIC: 1270.39

OR: odds ratio; 95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level.

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Table 4A: Between-Person Mediation Model—Alcohol Use (AUDIT)

	Estimate (95% CI)	SE	t	p
<i>Between-Person Effects</i>				
Disclosure				
AUDIT (Path A)	-0.01 (-0.02, -0.00)	0.04	-2.59	0.010
Participant gender	0.05 (-0.12, 0.21)	0.08	0.56	0.576
Participant age	0.00 (-0.00, 0.01)	0.00	1.39	0.166
Condom Use				
AUDIT (Direct Effect)	-0.07 (-0.14, 0.00)	0.04	-1.93	0.054
Participant disclosed HIV+ status (Path B)	0.65 (-0.25, 1.54)	0.46	1.42	0.157
Participant gender	-0.32 (-1.45, 0.80)	0.58	-0.56	0.573
Participant age	-0.02 (-0.06, 0.02)	0.02	-1.01	0.311
<i>Test of indirect effect</i>				
Path A*Path B	-0.01 (-0.02, 0.00)	0.01	-1.21	0.227

AIC: 1284.41; BIC: 1339.93

OR: odds ratio; 95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level.

Table 4B: Between-Person Mediation Model—Illicit Drug Use (DAST)

	Estimate (95% CI)	SE	t	p
<i>Between-Person Effects</i>				
Disclosure				
DAST (Path A)	-0.03 (-0.05, -0.01)	0.01	-2.34	0.019
Participant gender	0.05 (-0.12, 0.21)	0.08	0.56	0.579
Participant age	0.01 (-0.00, 0.01)	0.00	1.59	0.113
Condom Use				
DAST (Direct Effect)	-0.16 (-0.34, 0.03)	0.09	-1.68	0.094
Participant disclosed HIV+ status (Path B)	0.68 (-0.23, 1.58)	0.46	1.47	0.143
Participant gender	-0.33 (-1.46, 0.80)	0.58	-0.57	0.568
Participant age	-0.02 (-0.06, 0.02)	0.02	-0.87	0.387
<i>Test of indirect effect</i>				
Path A*Path B	-0.02 (-0.05, 0.01)	0.02	-1.23	0.221

AIC: 2020.90; BIC: 2076.42

95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level.

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Table 4C: Between-Person Mediation Model—Frequency of Using Substances at Time of Sex

	Estimate (95% CI)	SE	t	p
<i>Between-Person Effects</i>				
Disclosure				
Participant substance use frequency (Path A)	-0.17 (-0.29, -0.04)	0.06	-2.59	0.009
Participant gender	0.05 (-0.11, 0.20)	0.08	0.61	0.542
Participant age	0.00 (-0.00, 0.01)	0.00	1.24	0.216
Condom Use				
Participant substances use frequency (Direct Effect)	-0.28 (-1.26, 0.71)	0.50	-0.55	0.580
Participant disclosed HIV+ status (Path B)	0.71 (-0.20, 1.62)	0.47	1.53	0.126
Participant gender	-0.24 (-1.50, 1.01)	0.64	-0.38	0.706
Participant age	-0.02 (-0.06, 0.02)	0.02	-0.88	0.376
<i>Test of indirect effect</i>				
Path A*Path B	-0.12 (-0.29, 0.06)	0.09	-1.34	0.182

AIC: 3330.01 BIC: 3402.62

95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level.

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Table 5A: Path A Model Predicting Participant HIV Disclosure from Event-Level Substance Use (Participant using)

	OR	Estimate (95% CI)	SE	t	p
<i>Within-Person Effects</i>					
Participant used substances	0.67	-0.40 (-1.08, 0.28)	0.35	-1.16	0.25
Partner gender	1.80	0.59 (-0.34, 1.52)	0.47	1.24	0.21
<i>Between-Person Effects</i>					
Participant gender		0.77 (-0.70, 2.24)	0.75	1.03	0.30
Participant age		0.03 (-0.02, 0.08)	0.03	1.10	0.27

AIC: 1304.41; BIC: 1338.6

OR: odds ratio; 95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level.

Table 5B: Path A Model Predicting Participant HIV Disclosure from Event-Level Substance Use (Both partners using)

	OR	Estimate (95% CI)	SE	t	p
<i>Within-Person Effects</i>					
Both used substances	0.96	-0.04 (-0.97, 0.89)	0.47	-0.09	0.93
Partner gender	1.80	0.59 (-0.35, 1.53)	0.48	1.22	0.22
<i>Between-Person Effects</i>					
Participant gender		0.70 (-0.78, 2.18)	0.76	0.93	0.35
Participant age		0.03 (-0.03, 0.08)	0.03	0.98	0.32

AIC: 1110.25; BIC: 1144.42

OR: odds ratio; 95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level

Table 5C: Path A Model Predicting Participant HIV Disclosure from Event-Level Substance Use (Sexual partner using)

	OR	Estimate (95% CI)	SE	t	p
<i>Within-Person Effects</i>					
Partner used substances	0.70	-0.36 (-1.07, 0.36)	0.37	-0.98	0.33
Partner gender	1.77	0.57 (-0.35, 1.50)	0.47	1.21	0.23
<i>Between-Person Effects</i>					
Participant gender		0.63 (-0.83, 2.10)	0.75	0.85	0.40
Participant age		0.03 (-0.03, 0.08)	0.03	0.99	0.32

AIC: 1257.92; BIC: 1292.11

OR: odds ratio; 95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level

Table 6: Path B Model Predicting Condom Use from Event-Level HIV Disclosure

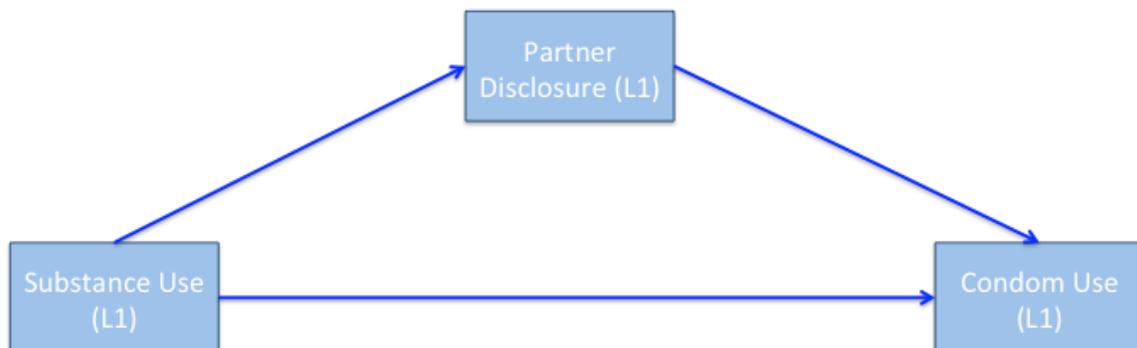
	OR	Estimate (95% CI)	SE	t	p
<i>Within-Person Effects</i>					
Participant HIV Disclosure	0.39	-0.94 (-1.62, -0.26)	0.41	-2.27	0.02
Partner gender	4.51	1.51 (0.74, 2.27)	0.47	3.23	0.001
<i>Between-Person Effects</i>					
Disclosure Frequency		1.67 (0.65, 2.69)	0.62	2.69	0.007
Participant gender		0.02 (-0.92, 0.96)	0.57	0.04	0.97
Participant age		-0.03 (-0.07, 0.00)	0.02	-1.67	0.10

AIC: 1656.42 BIC: 1703.41

OR: odds ratio; 95% CI: 95% confidence interval. SE: standard error.

Bold denotes statistically significant effect at p<0.05 level

Figure 1: Proposed Mediation Model



APPENDIX: MPlus Code for Event-Level Analyses

Within-Person Mediation Model (Results Reported in Table 3)

INPUT INSTRUCTIONS

TITLE: Substance use, disclosure, and condom use mediation – Within-person

DATA: FILE IS Data.csv;

VARIABLE: NAMES ARE id condomuse substanceuse disclosure partnergender
participantgender age;

USEVAR ARE id condomuse substanceuse disclosure partnergender
participantgender age;

CATEGORICAL ARE disclosure condomuse;

CLUSTER = id;

WITHIN = substanceuse partnergender;

BETWEEN = participantgender age;

Missing are all (-99);

ANALYSIS: TYPE = twolevel random;

ESTIMATOR=mlr;

MODEL: %WITHIN%

disclosure ON substanceuse (awithin);

condomuse ON disclosure (bwithin);

condomuse ON substanceuse;

condomuse ON partnergender;

disclosure ON partnergender;

%BETWEEN%

disclosure condomuse;

disclosure ON participantgender;

disclosure ON age;

condomuse ON participantgender;

condomuse ON age;

MODEL CONSTRAINT:

NEW (indw);

indw=awithin*bwithin;

OUTPUT: sampstat cinterval;

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Between-Person Mediation Model (Results Reported in Tables 4 A-C)

Four model versions alternately utilized between-person “substanceuse” terms derived from a) AUDIT score, b) DAST score, c) proportion of events using substances, and d) number of positive drug screens at study entry

INPUT INSTRUCTIONS

TITLE: Substance use, disclosure, and condom use mediation – Between-person

DATA: FILE IS Data.csv;

VARIABLE: NAMES ARE id condomuse substanceuse disclosure partnrgender

participantgender age;

USEVAR ARE id condomuse substanceuse disclosure partnrgender

participantgender age;

CATEGORICAL ARE condomuse;

CLUSTER = id;

WITHIN =;

BETWEEN = substanceuse disclosure participantgender age;

Missing are all (-99);

ANALYSIS: TYPE = twolevel random;

ESTIMATOR=mlr;

MODEL: %WITHIN%

%BETWEEN%

substanceuse disclosure condomuse gender age;

disclosure ON substanceuse (abetween);

condomuse ON disclosure (bbetween);

condomuse ON substanceuse;

condomuse ON participantgender;

condomuse ON age;

disclosure ON participantgender;

disclosure ON age;

MODEL CONSTRAINT:

NEW (indb);

indv=abetween*bbetween;

OUTPUT: sampstat cinterval;

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Path A Model Predicting Participant HIV Disclosure from Event-Level Substance Use (Results Reported in Tables 5 A-C)

Model versions A-C alternately utilized independent variable “substanceuse” terms derived from event level reporting of a) Participant Using Substances, b) Both Partners Using Substances, and c) Participant’s Sexual Partner Using Substances

INPUT INSTRUCTIONS

TITLE: Path A: Event-level substance use and disclosure

DATA: FILE IS Data.csv;

VARIABLE: NAMES ARE id condomuse substanceuse disclosure partnergender participantgender age;

USEVAR ARE id substanceuse disclosure partnergender participantgender age;

CATEGORICAL ARE disclosure;

CLUSTER = id;

WITHIN = substanceuse parntergender;

BETWEEN = participantgender age;

Missing are all (-99);

ANALYSIS: TYPE = twolevel random;

ESTIMATOR=mlr;

MODEL: %WITHIN%

substanceuse;

disclosure ON substanceuse;

disclosure ON partnergender;

%BETWEEN%

disclosure;

disclosure ON participantgender;

disclosure ON age;

OUTPUT: sampstat cinterval;

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Path B Model Predicting Condom Use from Event-Level HIV Disclosure— Within-Person and Between-person terms included (Results Reported in Table 6)

INPUT INSTRUCTIONS

TITLE: Path B: Event-level disclosure and condom use

DATA: FILE IS Data.csv;

VARIABLE: NAMES ARE id condomuse disclosure disclosurefrequency
partnrgender participantgender age;

USEVAR ARE id condomuse disclosure disclosurefrequency partnrgender
participantgender age;

CATEGORICAL ARE condomuse;

CLUSTER = id;

WITHIN = disclosure partnrgender;

BETWEEN = disclosurefrequency participantgender age;

Missing are all (-99);

ANALYSIS: TYPE = twolevel random;

ESTIMATOR=mlr;

MODEL: %WITHIN%

disclosure;

condomuse ON disclosure;

condomuse ON partnrgender;

%BETWEEN%

condomuse;

condomuse ON disclosurefrequency;

condomuse ON participantgender;

condomuse ON age;

OUTPUT: sampstat cinterval;

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Main effect subgroup analyses: disclosure status

Identical model run in subgroups of a) events in which HIV disclosure was reported and b) events in which HIV non-disclosure was reported

INPUT INSTRUCTIONS

TITLE: Substance use, disclosure, and condom use mediation – Between-person

DATA: FILE IS Data.csv;

VARIABLE: NAMES ARE id condomuse substanceuse disclosure partnrgender
participantgender age;

USEVAR ARE id condomuse substanceuse disclosure partnrgender
participantgender age;

CATEGORICAL ARE condomuse;

CLUSTER = id;

WITHIN = substanceuse parntergender;

BETWEEN = participantgender age;

Missing are all (-99);

ANALYSIS: TYPE = twolevel random;

ESTIMATOR=mlr;

MODEL: %WITHIN%

substanceuse;

condomuse ON substanceuse;

condomuse ON partnrgender;

%BETWEEN%

substanceuse;

condomuse ON participantgender;

condomuse ON age;

OUTPUT: sampstat cinterval;

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Main effect subgroup analyses by gender and partner gender

To examine potential moderating effects of gender/partner gender, the full mediation model reported in Table 3 was applied separately to participant gender/partner gender subgroups, with gender and partner gender terms removed (displayed below). The identical model was run in a) MSM, b) MSW, and c) WSM participant subgroups.

INPUT INSTRUCTIONS

TITLE: Substance use, disclosure, and condom use mediation – Within-person

DATA: FILE IS Data.csv;

VARIABLE: NAMES ARE id condomuse substanceuse disclosure age;

USEVAR ARE id condomuse substanceuse disclosure age;

CATEGORICAL ARE disclosure condomuse;

CLUSTER = id;

WITHIN = substanceuse;

BETWEEN = age;

Missing are all (-99);

ANALYSIS: TYPE = twolevel random;

ESTIMATOR=mlr;

MODEL: %WITHIN%

disclosure ON substanceuse (awithin);

condomuse ON disclosure (bwithin);

condomuse ON substanceuse;

%BETWEEN%

disclosure condomuse;

disclosure ON age;

condomuse ON age;

MODEL CONSTRAINT:

NEW (indw);

indw=awithin*bwithin;

OUTPUT: sampstat cinterval;