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Examining the Relative Contributions of Methamphetamine Use, Depression, and Sexual Risk Behavior on Rectal Gonorrhea/Chlamydia Among a Cohort of Men Who Have Sex with Men in Los Angeles, California

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Abstract

BACKGROUND: Methamphetamine use, sexual risk behaviors, and depression contribute to ongoing HIV and sexually transmitted infection (STI) disparities among men who have sex with men (MSM). The relative contributions of these effects longitudinally are not well understood.

METHODS: This analysis used visit-level data from a longitudinal cohort of MSM, half with HIV, in Los Angeles, California. From 8/2014-3/2020, participants completed follow-up visits every 6 months and underwent testing for rectal gonorrhea/chlamydia (GC/CT) and completed questionnaires including depressive symptoms, number of receptive anal intercourse (RAI) partners, and methamphetamine use. Path analysis with structural equation modeling using concurrent and lagged covariates was used to identify relative contributions of methamphetamine use and depression on number of RAI partners and rectal GC/CT across time.

RESULTS: 557 MSM with up to 6 visits (3 years) were included for a total of 2,437 observations. Methamphetamine use and depressive symptoms were positively associated with number of RAI partners (β=0.28, $p<0.001$; β=0.33, $p=0.018$, respectively) which was positively associated with rectal GC/CT (β=0.02, $p<0.001$). When stratified by HIV status, depressive symptoms were

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positively associated with RAI partners for HIV-negative MSM (β=0.50, p=0.007) but were not associated for MSM living with HIV (β=0.12, p=0.57). Methamphetamine use was positively associated with RAI partners in both strata.

CONCLUSIONS: Factors and patterns which contribute to risk behaviors associated with rectal GC/CT may differ by HIV status. Our findings demonstrate the importance of combined treatment and prevention efforts that link screening and treatment of stimulant use and depression with STI prevention and treatment.

Summary:

Methamphetamine use and depression were associated with increased sexual risk behaviors and rectal STI among a cohort of MSM in Los Angeles, California.

Keywords

methamphetamine; substance use; rectal STI; MSM; depression

INTRODUCTION

Sexual risk behavior, sexually transmitted infections (STIs), and substance use are considered to be key factors that contribute to ongoing HIV transmission among men who have sex with men (MSM) (1, 2). This observation is particularly true in the context of methamphetamine use, which has been independently associated with HIV/STI transmission among MSM and is driven by risky sexual behaviors that occur within high-risk sexual networks (3, 4). Prevalence of methamphetamine use is highest in the Western U.S. with past year methamphetamine use reported among 1.2% of individuals over 18 years old, compared to 0.7% prevalence nationally, and where it is linked to more HIV/STI transmission than any other substance (5, 6). Among MSM, methamphetamine is often used in sexual contexts, leading to increased sexual risk behaviors and risk for HIV/STI transmission (7). Methamphetamine use among MSM is further compounded by the high prevalence of mental health comorbidities that are experienced by this population, with MSM experiencing 17% higher rates of depression compared to heterosexual men, thought to be due in part to minority stress (8, 9). Higher levels of depression symptomatology are associated with poor linkages to healthcare, comorbid substance use, antiretroviral therapy non-adherence, and sexual risk behaviors, such as condomless anal intercourse (10-12).

While the associations of methamphetamine use, sexual risk behaviors, and mental health comorbidities with increased HIV/STI transmission have been well-established in the literature, the relative contributions of these factors are less well understood, particularly when considered together. Furthermore, prior research evaluating these constructs has predominantly been cross-sectional in nature (13-15). As mental health comorbidities and methamphetamine use disorder are often chronic conditions that contribute to sexual risk behavior and thus HIV/STI transmission among MSM, it is important to understand the relative contributions of these factors longitudinally in order to better contextualize the HIV/STI epidemic and to develop targeted, efficacious HIV/STI prevention interventions. To address this gap, this study utilized path analysis with a longitudinal panel design to

understand the relative contributions of methamphetamine use, depression, and sexual risk behaviors on rectal gonorrhea/chlamydia (GC/CT) infection among a high-risk cohort of MSM. A strength of this analysis is that it utilized data from a relatively young cohort of MSM, representing a population that is at highest risk for HIV/STI transmission, and that includes both HIV-negative MSM and MSM living with HIV – allowing for consideration of contributions to both transmission and acquisition of HIV. Findings from this analysis will help contextualize which contributors to HIV/STI transmission need to be prioritized in public health programming efforts.

MATERIALS AND METHODS

Participants and Recruitment

We analyzed data collected as part of the Men Who Have Sex with Men and Substance Use Cohort at UCLA Linking Infections, Noting Effects (mSTUDY; NIDA U01 DA036267) (16, 17). The mSTUDY is a longitudinal cohort of predominantly Black/African American and Latinx/Hispanic MSM designed to evaluate the impact of substance use on HIV transmission dynamics among minority MSM in Los Angeles. The cohort consists of half MSM living with HIV and half with active substance use at enrollment. HIV-negative MSM were recruited from the UCLA Vine Street Clinic, a community-based university research clinic, through community flyers and online advertisements. Participants living with HIV were recruited from sexual health and HIV clinics associated with the Los Angeles LGBT Center, which provides a broad spectrum of clinical and community resources for the lesbian, gay, and transgender community in Los Angeles. Inclusion criteria for the mSTUDY cohort were: 1) 18-45 years old at enrollment, 2) born male, and 3) condomless anal intercourse with a man in past 6 months (if HIV-negative). Participant enrollment for the mSTUDY started in August 2014 with participants having follow-up every 6 months. This analysis consists of study visits that occurred between August 2014 and March 2020 from all 557 MSM enrolled in the cohort with up to 6 study visits (3 years) for a total of 2,437 observations. Not all participants were followed across all 6 study visits due to dropout or enrollment within the past 3 years (recruitment is ongoing to replace participant dropout).

Following written informed consent, participants underwent clinician interview, specimen collection (rectal and pharyngeal swabs and urine) for STI testing as well as blood and saliva for clinical laboratory assessments, and completion of a computer-assisted self-interview survey at each study visit that collected demographic data, sexual risk behaviors, depression symptoms, and substance use. STI testing was conducted at each visit using rectal swabs that were tested for GC/CT infection with nucleic acid amplification testing (NAAT) (Aptima Combo 2, GenProbe, San Diego, CA). HIV testing used antibody testing (ELISA) with Western blot confirmation. STI/HIV testing results were made available to participants, and study personnel assisted with notifying participants of their test results and facilitated linkages to care for positive test results.

Measures

Demographics.—Participants self-reported their age and race/ethnicity at baseline, and options included American Indian or Alaskan Native, Asian, Asian Indian, Black or African

American, Native Hawaiian or Pacific Islander, White, Hispanic or Latinx or Spanish, or other race. As this cohort consisted predominantly of Black/African American and Latinx/Hispanic MSM, this variable was trichotomized to Black, Latinx, and non-Black/non-Latinx.

HIV status.—At enrollment, participants underwent HIV testing. HIV status is a dichotomous variable (living with HIV or HIV-negative).

Depression.—Participants reported depressive symptoms using the Center for Epidemiological Studies – Depression (CESD) scale. The CESD is a validated 20-item measure that asks participants to rank how often they have experienced depressive symptoms, such as feelings of loneliness, sadness, or hopelessness as well as having restless sleep or poor appetite (18). Response options are 0 = “rarely or none of the time”, 1 = “some or little of the time”; 2 = “moderately or much of the time,” 3 = “most or almost all the time”. Scores ranged from 0-60 with higher scores indicative of more severe depressive symptoms. The CESD has been demonstrated to have good sensitivity and high internal consistency with a Cronbach’s alpha of 0.85-0.90 (18, 19). While cutoff scores of 16 or greater are used to identify individuals who are at risk for clinical depression, this variable was dichotomized with a variable cutoff of 23, which has been shown to be more optimal to evaluate clinical depression risk among individuals living with HIV (20). Depressive symptoms were dichotomized to positive and negative CESD score (< 23 or ≥ 23).

Methamphetamine use.—Methamphetamine use in past 6 months was adapted from the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) (21). Participants were asked the question “In the past 6 months, how often have you used methamphetamine (speed, crystal meth, ice, etc.)?”. Response options were on an ordinal scale (0 = “None,” 1 = “Once,” 2 = “Less often than monthly,” 3 = “Monthly,” 4 = “Weekly,” and 5 = “Daily”).

Sexual risk behavior.—As our outcome variable was rectal GC/CT infection, sexual risk behavior was measured by self-reported number of partners with whom the participant had receptive anal intercourse (RAI) in the past 6 months (continuous). As this variable was highly right skewed (median 1; interquartile range [IQR] 0-3; range 0-1,100 partners), this variable was Winsorized to a maximum value of 15 (95^{th} percentile of reported RAI partners).

Rectal GC/CT.—Participants underwent testing for rectal GC/CT at each study visit. Positive rectal GC/CT was defined as positive testing for rectal gonorrhea and/or chlamydia based on NAAT. Rectal GC/CT is a dichotomous variable (positive versus negative test).

Statistical Analysis

The purpose of this analysis was to evaluate how methamphetamine use, sexual risk behaviors, and depressive symptoms contribute to rectal GC/CT infection longitudinally. Differences between participant demographic factors, methamphetamine use, depressive symptoms, number of RAI partners, and rectal GC/CT according to HIV status were assessed using chi-square analysis for categorical variables and Kruskal-Wallis tests for continuous variables. As the relationship between depressive symptoms and

methamphetamine use on rectal GC/CT is mediated by sexual risk behavior, and given the longitudinal nature of the data, we created a longitudinal panel model adapted from Selig & Preacher using a structural equation modeling (SEM) approach (Figure 1) (22). We selected this approach to test the relationships and mediation paths between variables in a more rigorous manner and to control for time-varying confounding longitudinally. To reduce the number of coefficients reported and aid in the interpretability of results, all paths that were repeated across timepoints were constrained to estimate one common coefficient across timepoints, which we reported as unstandardized path coefficients (β). Models were also stratified by HIV status to evaluate whether there were differences in the relationships between depressive symptoms, methamphetamine use, sexual risk behavior, and rectal GC/CT according to HIV status.

Models were fit using SEM with full information maximum likelihood to account for missing values (23). Modification indices were iteratively calculated to select correlated error terms to improve model fit (23, 24). Correlated error terms were limited to repeated measures of the same variable and methamphetamine use with depressive symptoms at the same timepoint, as the literature demonstrates that there is a relationship between methamphetamine and depression but the directionality is unclear (25, 26). Goodness of fit (GOF) was evaluated using the following GOF indices: the chi-square test (goal $p > 0.05$), root mean square error of approximation (RMSEA; cutoff <0.5), the comparative fit index (CFI; cutoff > 0.90), and the Tucker Lewis index (TLI; cutoff > 0.90) (27, 28). As chi-square GOF tests are dependent on sample size, chi-square tests were assessed in the context of other goodness of fit indices when selecting the final model (28). This study was approved by the UCLA IRB and all analyses were conducted using Stata 15.1 (StataCorp, College Town, TX).

RESULTS

This sample consisted of 557 participants across 2,437 observations, with 48.7% (n=271/557) having follow-up through their sixth visit. At baseline, median age was 30 years (IQR 26-37) and 278 (49.9%) of participants were living with HIV (Table 1). Most participants were Black (40.6%) or Latinx (49.0%). Median CESD baseline score was 18 (IQR 10-28), with 37.5% of participants reporting symptoms concerning for depression (CESD ≥ 23). Median number of last 6-month RAI partners was 2 (IQR 0-5) and 11.1% of participants had rectal GC/CT at baseline (n=62). Almost half (44.2%) of participants reported methamphetamine use in last 6 months. When stratified by HIV status, participants living with HIV tended to be older (median age 34, IQR 28-39) compared to HIV-negative MSM (median age 28; IQR 24-33). Participants living with HIV also had higher prevalence of methamphetamine use at baseline (57.6%) compared to those who were HIV-negative (30.9%).

Path Models

Both methamphetamine use (β=0.28; 95% CI 0.21-0.36) and depression (0.33; 0.06-0.61) were positively associated with number of RAI partners reported at the same visit (Table 2). Number of RAI partners in last 6 months was associated with rectal GC/CT infection

(β=0.02; 95% CI 0.01-0.02). Past depressive symptoms, methamphetamine use, and number of RAI partners were associated with future depressive symptoms, methamphetamine use, and RAI partners, respectively. Similarly, past rectal GC/CT infection was associated with future rectal GC/CT (β=0.10; 95% CI 0.05-0.15).

When stratified by HIV status (Table 3), depressive symptoms were positively associated with number of RAI partners in last 6 months for HIV-negative MSM (β=0.50; 95% CI 0.14-0.85) but was not associated among MSM living with HIV (β=0.12; −0.29-0.54). Methamphetamine use was positively associated with number of RAI partners for both groups, though a slightly higher magnitude of association was observed among MSM living with HIV (β=0.38; 95% CI 0.26-0.50) compared to those who were HIV-negative (β=0.25; 0.13-0.37). Past depressive symptoms and methamphetamine use were associated with future depressive symptoms and methamphetamine use for both groups, respectively. The positive association of past number of RAI partners on number of future RAI partners had a higher magnitude of association among MSM living with HIV (β=0.44; 95% CI 0.38-0.50) compared to their HIV-negative counterparts (β=0.20; 0.05-0.34). However, the positive association between number of RAI partners in last 6 months and rectal GC/CT were similar in magnitude between both groups (β=0.02; 95% CI 0.01-0.02 for MSM living with HIV and 0.01; 0.01-0.02 for HIV-negative MSM). While past rectal GC/CT infection was associated with future rectal GC/CT among MSM living with HIV (β=0.14; 95% CI 0.08-0.21), past and future rectal GC/CT were not associated among HIV-negative MSM.

DISCUSSION

Our findings demonstrate that depression and methamphetamine use were positively associated with number of RAI partners which, in turn, was associated with rectal GC/CT. While associations between depression and methamphetamine use with risky sexual behaviors and HIV/STI transmission have been well-documented in the literature (29, 30), our analysis extends the current body of knowledge by using a path analysis on longitudinal data that utilizes a laboratory diagnosis (not self-report) of rectal GC/CT. A strength of the longitudinal design of our panel model is that it enables us to evaluate both contemporaneous effects as well as the effects of past behaviors on future outcomes.

Methamphetamine use was positively associated with number of RAI partners which was not unexpected as methamphetamine use has been associated with increased sexual risk behaviors (7, 31s). Our analysis revealed that past methamphetamine use was strongly associated with future methamphetamine use, with the highest magnitude of association of all paths included in our model. These findings are consistent with previous research demonstrating high rates of sustained methamphetamine use among younger MSM subpopulations (32s, 33s) and adds to the literature by providing insight into the magnitude of this association across time relative to other risk behaviors. Given the association of methamphetamine use with sexual risk behaviors and the persistence of methamphetamine use over time, these findings underscore the importance of prioritizing screening and treatment of substance use disorders in STI screening and HIV prevention programs. For example, such strategies could incorporate substance use disorder screening into existing

STI programming efforts and facilitate linkages to substance use treatment programs for those individuals who screen positive for substance use disorders.

In addition to methamphetamine use, depressive symptoms were independently associated with number of RAI partners. Depressive symptoms may lead to sexual risk behaviors as a means to mitigate negative symptoms through sensation-seeking, reliance on avoidant coping mechanisms, or lower self-efficacy surrounding HIV preventative behaviors (11, 34s). As higher levels of methamphetamine use have been shown to worsen depressive symptoms, it is possible that depressive symptoms may contribute to co-morbid methamphetamine use and vice versa (35s, 36s). Furthermore, severe depressive symptoms occurring in the context of co-morbid methamphetamine use may act synergistically to increase sexual risk-taking and ongoing HIV/STI transmission within the sexual networks of methamphetamine-using MSM (37s). These findings highlight the importance of aggressive screening for depressive symptoms and methamphetamine use disorders among MSM at risk for HIV, particularly given the elevated prevalence of methamphetamine and depression that is observed within this population (6, 38s, 39s). An additional benefit of prioritizing treatment for methamphetamine use among methamphetamine-using MSM with depressive symptoms is that treatment for methamphetamine use disorder has been demonstrated to reduce depressive symptoms (35s).

When stratified by HIV status, methamphetamine use was positively associated with number of RAI partners for both groups. While methamphetamine use is linked with risky sexual behaviors regardless of HIV status, these findings demonstrate that the epidemic of methamphetamine use among MSM is likely complex and multifaceted (40s, 41s). The higher magnitudes of association between methamphetamine use and RAI partners as well as RAI partners over time that were observed among MSM living with HIV may be related to increased stimulant-associated sexual risk behaviors. It is possible that these stimulant-associated risk behaviors may have led to HIV acquisition and may have also persisted following HIV seroconversion (32s).

In addition, motivations and settings associated with methamphetamine use may differ according to status. For example, qualitative evidence demonstrated that MSM living with HIV tended to use methamphetamine for sexual reasons while HIV-negative MSM used methamphetamine socially, which may be reflected in the higher magnitude of RAI partners over time that was observed among MSM living with HIV (41s). Furthermore, in a study evaluating methamphetamine use patterns between MSM living with and without HIV, MSM living with HIV were more likely than their HIV-negative counterparts to report methamphetamine use in sexualized settings, such as bath houses or sex parties, and to avoid unpleasant emotions or social pressures (42s). The higher use of methamphetamine in sexual contexts among MSM living with HIV suggests that methamphetamine may be used as an avoidant coping strategy to deal with an HIV diagnosis or to dismiss potential fears or anxieties associated with sexual activity (41s, 43s). Collectively, these motivations and contexts of methamphetamine use among MSM living with HIV may result in comparatively riskier sexual behaviors compared to HIV-negative MSM. This is further supported by the finding that rectal GC/CT was associated across timepoints among MSM living with HIV, yet not among their HIV-negative counterparts. These results suggest that MSM living with

HIV may have more persistent sexual risk behaviors within networks of high HIV/STI prevalence and demonstrate the need for aggressive STI screening as well as efforts to achieve and maintain virologic control within this population.

Depression was positively associated with RAI partners among HIV-negative MSM, yet this path was not associated among participants living with HIV. One possibility for this observation could be that participants living with HIV may be more likely to receive treatment for their depressive symptoms through their HIV-related care. Certain factors that are distinct to HIV-negative MSM may also contribute the relationship between depressive symptoms and sexual risk. In a qualitative study involving MSM who were predominantly HIV-negative, participants who reported depressive symptoms were more likely to have increased sexual interest and to utilize sexual contact as a means of validation or to improve negative symptoms (44s). Depression may also lead to increased sexual risk-taking due to diminished concern about negative consequences including HIV risk (45s, 46s). This finding is particularly relevant in the context of our findings as RAI poses a greater health risk for HIV-negative MSM compared to those living with HIV. It is also possible that sexual risk-taking among HIV-negative MSM with depressive symptoms may be related to the desire for intimacy or fatalistic beliefs about staying HIV-negative (47s, 48s). Conversely, anxiety related to acquiring HIV from sexual risk behaviors may result in increased anxiety or depressive symptoms among HIV-negative participants (49s). These findings demonstrate the importance of improved efforts toward depression screening and treatment among HIV-negative MSM, particularly those with a history of stimulant use.

Limitations

Our findings must be considered in the context of limitations. As this analysis comprises a cohort of MSM who are predominantly of color and with high prevalence of substance use, generalizations of our findings to other populations of MSM may be limited. While the longitudinal design is a strength in our analysis, causal inferences cannot be drawn from our results. Given the numerous paths across timepoints, the use of constraints aids in the interpretability of our models, yet the use of constraints relies on the assumption that associations are consistent across time and may lead to misspecification. However, as the goal of this analysis was to evaluate aggregate relationships between variables across time, rather than individual associations at each timepoint, we feel that the use of constraints was justified. While the longitudinal design of our analysis allows us to test relationships between variables in a more rigorous manner, a drawback is the number of paths that are generated by this approach which prevented us from being able to measure standardized β coefficients or total, indirect, and direct effects across paths.

Though number of RAI partners is an important indicator of risk, other factors may have contributed to STI risk (e.g., condom use), which is an important consideration when interpreting our results. Further, it is possible that some participants who were negative for GC/CT may have only acted as insertive sex partners, potentially leading to misclassification bias. While HIV status at baseline was used in models, a small number of participants (n=10) underwent HIV seroconversion during the study, which may have changed their behavior patterns. However, we conducted a sensitivity analysis by excluding

participants who underwent HIV seroconversion and our results did not change (data not shown). Additionally, for data that are self-reported, there is the risk of recall and social desirability bias, though surveys were administered through computer-assisted self-interview to minimize such bias. Furthermore, while the association between depressive symptoms and methamphetamine use has been well-documented in the literature, the directionality of this relationship is unclear. This consideration caused us to not place a path between methamphetamine use and depression as it would require assumptions regarding the direction of this relationship. However, we attempted to account for the potential relationship between depression and methamphetamine use by correlating their error terms.

CONCLUSIONS

To the best of our knowledge, this analysis is one of the first to explicitly evaluate the relative contributions of methamphetamine use, depression, and sexual risk behavior on rectal GC/CT longitudinally, which is an important step in disentangling the relationship between depression and methamphetamine use with HIV/STI transmission. Our findings demonstrate that depression and methamphetamine use were associated with increased sexual risk behaviors which, in turn, were associated with rectal GC/CT. Furthermore, our results suggest that the factors and patterns which are associated with risk behaviors may differ according to HIV status. Specifically, depression may have a stronger influence on sexual risk behaviors among HIV-negative MSM while methamphetamine use may have a more substantial impact for MSM living with HIV. Collectively, our findings demonstrate the importance of screening for stimulant use and making linkages to substance use treatment programs for MSM regardless of HIV status. Additionally, HIV-negative MSM may benefit from HIV prevention interventions that screen for depressive symptoms and facilitate linkages to mental healthcare. These findings also suggest the potential utility of combined treatment and prevention efforts that link screening and treatment of stimulant use and depression with HIV/STI prevention and treatment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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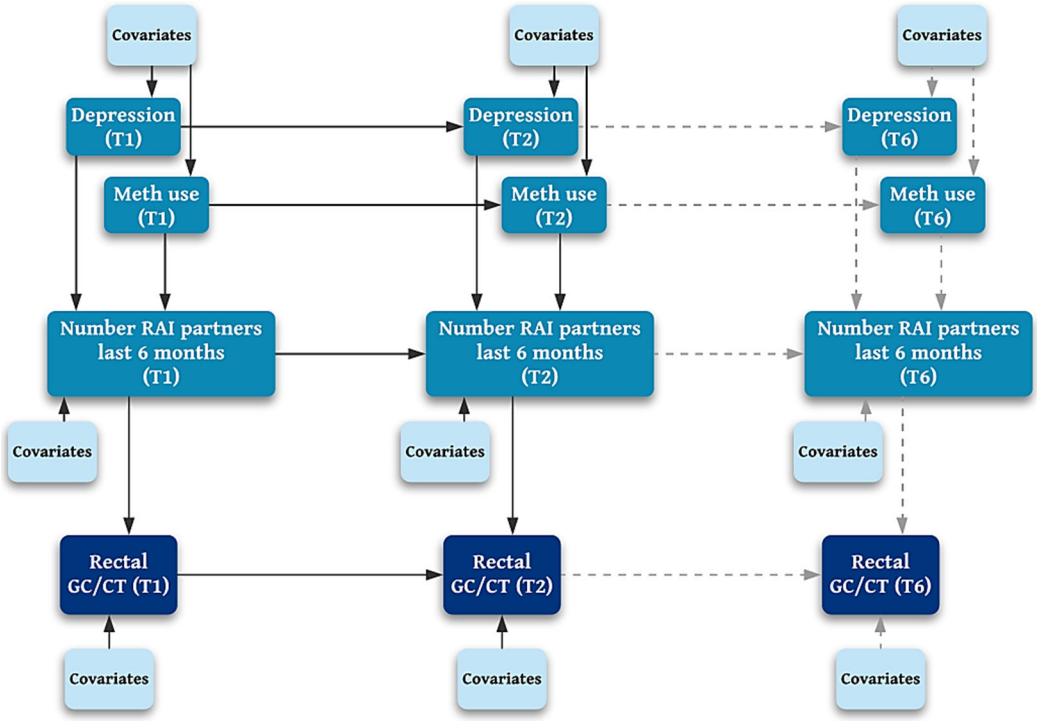

Figure 1: Path model evaluating the association of depression, methamphetamine use, and sexual risk behavior on rectal gonorrhea/chlamydia

Meth = methamphetamine; GC/CT = gonorrhea/chlamydia; RAI = receptive anal intercourse

Covariates = HIV status, race/ethnicity, age

T = timepoint/visit

Note: Solid arrows demonstrate direct paths. Dashed arrows represent paths that are repeated across timepoints.

Table 1:

Descriptive Statistics and Bivariate Analysis of Baseline Characteristics of mSTUDY Cohort Stratified by HIV Status (N=557)

	Total (n=557)		HIV-negative (n=279)		Living with HIV (n=278)		
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**p-value**
Age (median, IQR)	30	(26-37)	28	(24-33)	34	(28-39)	<0.001
Race/Ethnicity							
Black	226	(40.6%)	114	(40.9%)	112	(40.3%)	0.99
Latinx	273	(49.0%)	136	(48.8%)	137	(49.3%)	
Non-Black/Non-Latinx	58	(10.4%)	29	(10.4%)	29	(10.4%)	
Rectal GC/CT							
Negative	495	(88.9%)	251	(90.0%)	244	(87.8%)	0.41
Positive	62	(11.1%)	28	(10.0%)	34	(12.2%)	
CESD							
Negative	347	(62.3%)	187	(67.0%)	160	(57.6%)	0.021
Positive	210	(37.7%)	92	(33.0%)	118	(42.5%)	
RAI partners (median, IQR)∫	2	(0-5)	1	(0-4)	2	(0-5)	0.014
Methamphetamine use∫							
Never	309	(55.8%)	192	(69.1%)	117	(42.4%)	<0.001
Once	39	(7.0%)	19	(6.8%)	20	(7.3%)	
Less than monthly	49	(8.8%)	23	(8.3%)	26	(9.4%)	
Monthly	31	(5.6%)	8	(2.9%)	23	(8.3%)	
Weekly	67	(12.1%)	18	(6.5%)	49	(17.8%)	
Daily	59	(10.7%)	18	(6.5%)	41	(14.9%)	

IQR = interquartile range; GC/CT = gonorrhea/chlamydia; CESD = Center for Epidemiological Studies Depression scale; RAI = receptive anal intercourse

∫last 6 months

Note: p-values calculated from chi-square or Kruskal-Wallis tests comparing MSM living with HIV to HIV-negative MSM

Table 2:

Unstandardized path coefficients of path model evaluating the association of depression, methamphetamine use, and sexual risk behavior on rectal gonorrhea/chlamydia 8/2014-3/2020

Predictor variable Outcome variable	Unstandardized β (95% CI)	p
Depression		
RAI partners$^{\int}$	0.33 (0.06-0.61)	**0.018**
Depression*	0.41 (0.35-0.47)	**<0.001**
Methamphetamine use$^{\int}$		
RAI partners$^{\int}$	0.28 (0.21-0.36)	**<0.001**
Methamphetamine use$^{\int *}$	0.66 (0.62-0.70)	**<0.001**
RAI partners$^{\int}$		
Rectal GC/CT	0.02 (0.0-0.02)	**<0.001**
RAI partners$^{\int *}$	0.46 (0.42-0.49)	**<0.001**
Rectal GC/CT		
Rectal GC/CT*	0.10 (0.05-0.15)	**<0.001**

χ^2 (287) = 535.42, RMSEA 0.039, CFI 0.937, TLI 0.924

GC/CT = gonorrhea/chlamydia; RAI = receptive anal intercourse

*Path from T_n to T_{n+1};

$^{\int}$last 6 months

Note: estimates are adjusting for HIV status, age, and race/ethnicity

Table 3:

Unstandardized path coefficients of lagged panel model evaluating the association of depression, methamphetamine use, and sexual risk behavior on rectal gonorrhea/chlamydia stratified by HIV status 8/2014-3/2020

Predictor variable	**HIV-negative**		**Living with HIV**	
Outcome variable	**β (95% CI)**	**p**	**β (95% CI)**	**p**
Depression				
RAI partners$^{\int}$	0.50 (0.14-0.85)	**0.007**	0.12 (−0.29-0.54)	0.57
Depression*	0.36 (0.29-0.42)	**<0.001**	0.38 (0.32-0.43)	**<0.001**
Methamphetamine use$^{\int}$				
RAI partners$^{\int}$	0.25 (0.13-0.37)	**<0.001**	0.38 (0.26-0.50)	**<0.001**
Methamphetamine use$^{\int *}$	0.70 (0.65-0.75)	**<0.001**	0.66 (0.61-0.70)	**<0.001**
RAI partners$^{\int}$				
Rectal GC/CT	0.01 (0.01-0.02)	**<0.001**	0.02 (0.01-0.02)	**<0.001**
RAI partners$^{\int *}$	0.20 (0.05-0.34)	**0.008**	0.44 (0.38-0.50)	**<0.001**
Rectal GC/CT				
Rectal GC/CT*	0.03 (−0.03-0.10)	0.32	0.14 (0.08-0.21)	**<0.001**

χ^2 (554) = 876.10, RMSEA 0.046, CFI 0.918, TLI 0.904

GC/CT = gonorrhea/chlamydia; RAI = receptive anal intercourse

*Path from T_n to T_{n+1};

$^{\int}$last 6 months

Note: estimates are adjusting for age and race/ethnicity