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Risk Behaviors Associated with Patterns of Sexualized Stimulant and Alcohol Use among Men Who Have Sex with Men: a Latent Class Analysis

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Abstract Substance use during sexual encounters (sexualized substance use) is an important driver of HIV and sexually transmitted infection (STI) disparities that are experienced by men who have sex with men (MSM). This analysis aimed to identify patterns of sexualized substance use and their associations with HIV risk behaviors. We utilized visit-level data from a longitudinal cohort of predominantly Black/Latinx MSM, half with HIV and half with substance use in Los Angeles, California. Every 6 months from 8/2014 to 3/2020, participants underwent STI testing and completed surveys on demographics, sexualized substance use (stimulant and/or alcohol intoxication during oral sex, receptive anal intercourse [RAI] and/or insertive anal intercourse [IAI]), transactional sex, biomedical HIV prevention (pre-/post-exposure prophylaxis use or undetectable viral load), and depressive symptoms. Latent class analysis was used to identify patterns of sexualized substance use. Multinomial logit models evaluated risk behaviors associated with latent classes. Among 2386 study visits from 540 participants, 5 classes were identified: no substance use, sexualized stimulant use, sexualized alcohol use, sexualized stimulant and alcohol use, and stimulant/alcohol use during oral sex and RAI. Compared to the no sexualized substance use class, sexualized stimulant use was associated with transactional sex, current diagnosis of STIs, not using HIV biomedical prevention, and depressive symptoms. Sexualized alcohol use had fewer associations with HIV risk behaviors. Patterns of sexual activities, and the substances that are used during those activities, confer different risk behavior profiles for HIV/STI

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transmission and demonstrate the potential utility of interventions that combine substance use treatment with HIV prevention.

Keywords Substance use · Men who have sex with men · HIV · Stimulants · Alcohol

Introduction

Men who have sex with men (MSM) are disproportionately impacted by the HIV epidemic, particularly among MSM of color and MSM with a history of substance use. [1, 2] Among MSM, Black and Latinx MSM experience higher rates of HIV incidence compared to their White counterparts, representing 45% of new HIV diagnoses. [3] These disparities are compounded by unique substance use patterns that are reported among MSM, with substance use commonly occurring within sexual encounters or during sexual activity (sexualized substance use). [4] Two substances that are highly prevalent among MSM and often used in sexual contexts are alcohol and stimulants (e.g., methamphetamine and cocaine). [5, 6] As stimulant use frequently occurs within sexual contexts, these drugs are independently associated with sexual risk behaviors, HIV, sexually transmitted infections (STIs), and mental health comorbidities among MSM. [7–9] Additionally, alcohol consumption is associated with increased sexual risk behaviors as well as reduced health preventative behaviors, such as condom use. [10, 11]

There is mounting evidence that distinct substance use patterns confer separate behavioral risk profiles for HIV/STI transmission. [12–14] While sexualized substance use is associated with higher prevalence of sexual risk behaviors for HIV/STI transmission, risk for HIV/STI transmission differs based on sex act as well as sexual positioning. [15–17] This differential risk for HIV/STI transmission is especially true for MSM, with condomless receptive anal intercourse (RAI) conferring higher risk for HIV/STI acquisition than condomless insertive anal intercourse (IAI). [18, 19] Furthermore, unlike heterosexual networks, MSM can engage in both insertive (high risk for transmission) and receptive (high risk for acquisition) anal intercourse, contributing to the rapid and efficient spread of HIV and STIs within sexual networks. [20, 21] This consideration is particularly relevant in the context of sexualized substance use, as certain substance use patterns are associated with sexual positioning. For example, MSM who use stimulants may experience erectile dysfunction resulting in a propensity to participate in RAI. [22]

While sexualized substance use and sexual risk behavior represent dominant drivers of ongoing HIV/STI transmission among MSM, there is a paucity of data evaluating the joint patterns of sexual activities that occur in the context of sexualized stimulant and alcohol use. As risk for HIV/STI acquisition differs according to sexual practices, it is increasingly important to understand the patterns of specific sexual activities that occur within the setting of sexualized substance use to appropriately contextualize the impact substance use has on sexual risk and, consequently, HIV/STI transmission among MSM. This analysis aims to differentiate patterns of stimulant and alcohol use that occur during specific sexual activities among a cohort of racially/ethnically diverse MSM in Los Angeles, California. We used latent class analysis (LCA) to determine patterns of sexual activities (e.g., oral sex, RAI, IAI) that occur with stimulant and/or alcohol consumption and to evaluate whether certain characteristics or distal outcomes were associated with each latent class. Syndemic theory has been used to explain the disparity among marginalized populations by assessing the intersection of mental health, substance use, and other conditions on health outcomes, which was used to inform these analyses. [23, 24] Collectively, these analyses seek to determine nuanced heterogeneities in sexualized stimulant and alcohol use within a cohort of MSM that are high-risk overall for HIV/STI transmission. Given the complex relationship of substance use and sexual risk behavior among MSM, further understanding of sexualized substance use patterns and how they relate to HIV/STI transmission is increasingly important for the development of novel and efficacious HIV prevention interventions.

Methods

Data Source

We analyzed data collected as part of an ongoing longitudinal cohort study designed to evaluate the impact of substance use on HIV transmission dynamics

among MSM of color in Los Angeles, California (mSTUDY; U01 DA036267). Methods have been previously described. [25, 26] Briefly, participants were recruited from a community-based university research clinic and a community-based organization that provide clinical and community resources for the lesbian, gay, bisexual, and transgender community. Follow-up visits occur every 6 months, and the cohort consists of half MSM living with HIV and half with active substance use at enrollment. Inclusion criteria for the cohort include (1) 18–45 years old at study enrollment, (2) born male, and (3) condomless anal intercourse with a man in the past 6 months (if HIV-negative). This analysis consists of study visits that took place from August 2014 (study inception) to March 2020 among participants who reported oral and/or anal intercourse in the past 3 months. A total of 540 participants of the 577 enrolled in the mSTUDY met the eligibility criteria for this analysis. There were 2580 visits during the study period: 194 observations were excluded due to missing data, resulting in a final sample size of 2386 observations across 540 participants.

Study Procedures

At study visits, participants underwent clinician interview, STI testing, and completion of a computer-assisted self-interview survey that collected sociodemographic data as well as information surrounding substance use, depression symptoms, HIV pre-exposure or post-exposure prophylaxis (PrEP/PEP) use, and sexual risk behaviors. At each visit, urine samples as well as rectal and pharyngeal swabs were collected for gonorrhea/chlamydia (GC/CT) testing (Aptima Combo 2, GenProbe, San Diego, CA). Blood samples were collected at each study visit and tested for syphilis as well as HIV (if HIV-negative) and/or measurement of HIV-1 RNA levels (if living with HIV). Syphilis testing used rapid plasma reagin (RPR) with confirmatory testing via the *Treponema pallidum* particle agglutination test (TPPA). Infectious syphilis (i.e., primary, secondary, or early latent) was defined using the Centers for Disease Control and Prevention determination following positive test results and local health department confirmation. [27] STI testing results were made available to participants, and study personnel facilitated linkages to care for positive test results. The study was reviewed and approved by the Office of Human Research Participant Protection (OHRPP) at the University of California, Los Angeles.

Measures

Demographics

Participants self-reported their race and ethnicity. Participants were first asked if they were of Hispanic, Latinx, or Spanish origin. Participants were then asked to report their race (options included Black or African American, White, American Indian or Alaskan Native, Asian, Asian Indian, Native Hawaiian or Pacific Islander, or other race). As 89.6% of the cohort self-identified as Latinx/Latino/Hispanic and/or Black/African American, this variable was trichotomized to Black (non-Latinx), Latinx, and non-Black/non-Latinx.

Sexual risk behaviors and substance use during sexual activity

Participants were asked the question "Which drugs and/or alcohol did you use during this sexual activity in the last 3 months?" Possible sexual activities included oral sex, RAI, and IAI. Possible substances used included alcohol, methamphetamine, cocaine powder, and crack cocaine. Participants responded "yes" or "no" for whether they used each substance during each sexual activity. Methamphetamine, cocaine powder, and crack cocaine were combined into one "stimulants" variable for each sexual activity. These variables were combined into six possible substance/sexual activity combinations: alcohol use during oral sex (yes/no), stimulant use during oral sex (yes/no), alcohol use during IAI (yes/no), stimulant use during IAI (yes/no), alcohol use during RAI (yes/no), and stimulant use during RAI (yes/no). Participants also reported whether they had attended a circuit party, hookup, or sex party in the last 6 months. Participants reported whether they had engaged in transactional sex in the past 3 months (i.e., exchanged drugs, money, shelter, or other goods for sex).

STI Testing and HIV Status

Positive STI testing was dichotomous and was defined as having a positive test for GC and/or CT at any site

(pharyngeal, urethral, and/or rectal) and/or infectious syphilis. HIV status was defined as a positive or negative HIV test.

Biomedical Prevention

As this cohort consisted of half HIV-negative MSM and half MSM who were living with HIV, a variable evaluating PrEP and/or PEP use (for HIV-negative participants) and undetectable HIV viral load (for participants living with HIV) was created to evaluate use of a biomedical strategy to prevent HIV acquisition/transmission. HIV-negative participants were asked if they had a current prescription for PrEP or PEP (yes/no). Blood samples from participants who were living with HIV were evaluated for whether they had an undetectable HIV-1 viral load (detectable or undetectable viral load). These variables were combined to create a biomedical prevention variable with two levels "Yes" (i.e., current prescription for PrEP/PEP or undetectable HIV viral load) or "No" (i.e., no current prescription for PrEP/PEP or detectable HIV viral load).

Depression

Participants reported depressive symptoms using the Center for Epidemiological Studies – Depression (CESD) Scale, a validated 20-item measure that assesses depressive symptoms. [28, 29] While cutoff scores of 16 or greater are suggestive of clinical depression (Cronbach's alpha of 0.85–0.90), [28, 29] we utilized a score cutoff of 23, which has been shown to be more optimal to evaluate clinical depression among individuals living with HIV. [30] Depression was a dichotomous variable based on positive or negative CESD score (<23 or ≥ 23).

Statistical Analysis

The purpose of this analysis was to describe patterns of sexualized stimulant and alcohol use and to evaluate characteristics associated with different sexualized substance use patterns. LCA was used to determine and evaluate distinct patterns of substance use during sexual activity. As the research question centered around visit-level outcomes and not changes over time, data was analyzed at the visit-level (serial cross-sectionally). Descriptive statistics (frequency, percentage, median, interquartile range [IQR]) of the study population and predictors of interest were calculated for the entire cohort. We conducted LCA using the expectation maximization algorithm to develop a parsimonious model with the appropriate number of latent classes. [31] We used the likelihood ratio statistic (G^2), the Akaike information criterion (AIC), the consistent AIC (CAIC), the Bayesian information criterion (BIC), and adjusted BIC (ABIC) as fit statistics to evaluate models with successive number of classes (Supplemental Table 1). [32, 33] We selected a five-class model because decreasing decrements in fit statistics were minimal beyond five classes. Item response probabilities were calculated to determine class homogeneity with item responses. Class membership probabilities were also calculated to evaluate the proportion of the sample that comprised each latent class. [34, 35]

Multinomial logistic regression models were used to evaluate predictors associated with class membership. Predictors of interest included sexual risk behaviors (e.g., attendance at a circuit/sex party, [36] transactional sex [37]), health protective behaviors (i.e., use of biomedical prevention), [38, 39] STI diagnosis, [40] and depression, [41] given their known associations with HIV transmission in the literature. To evaluate differences in class membership according to self-reported race/ethnicity, we stratified multinomial logistic regression models by race/ethnicity. Measurement invariance was imposed to ensure item response probabilities were equal across racial/ethnic groups. [42] Equation-wise deletion for missing variables was used to develop latent classes and complete case analysis was used for all regression analyses. Analyses were conducted using Stata 16.1 (StataCorp, College Town, TX).

Results

HIV-negative participants completed 50.0% ($n=1192$) of visits and 50.0% ($n=1194$) were completed by participants living with HIV (Table 1). Median age was 32 years (range 18–50) and 49.8% ($n=1189$) of visits were completed by Latinx participants, 39.3% ($n=938$) by Black participants, and 10.9% ($n=259$) by non-Black/non-Latinx participants. A positive test for GC/CT and/or infectious syphilis occurred at 18.1% of visits, and

Table 1 Participant characteristics, sexual risk behaviors, mental health, and sexualized substance use reported at mSTUDY visits 8/2014–3/2020 ($N = 2386$)

Variable	*n* (%)
Age (median, IQR)	32 (27–38)
HIV	
Negative	1192 (50.0%)
Living with HIV	1194 (50.0%)
Race/ethnicity	
Non-Black/Non-Latinx	259 (10.9%)
Black	938 (39.3%)
Latinx	1189 (49.8%)
Sexually transmitted infection	
Negative	1955 (81.9%)
Positive	431 (18.1%)
Biomedical prevention	
No	1563 (65.5%)
Yes	823 (34.5%)
Transactional sex	
No	1944 (81.5%)
Yes	442 (18.5%)
Circuit/sex party	
No	1913 (80.2%)
Yes	473 (19.8%)
Depression	
No	1588 (66.6%)
Yes	798 (33.5%)
Oral sex	
No	38 (1.6%)
Yes	2346 (98.4%)
IAI	
No	587 (24.7%)
Yes	1794 (75.4%)
RAI	
No	727 (30.6%)
Yes	1652 (69.4%)
Sexualized substance use**	***n* (%)**
Oral sex stimulants	
No	1540 (64.6%)
Yes	844 (35.4%)
Oral sex alcohol	
No	1453 (61.0%)
Yes	931 (39.1%)
IAI stimulants	
No	1805 (75.8%)
Yes	576 (24.2%)
IAI alcohol	
No	1692 (71.1%)
Yes	689 (28.9%)
RAI stimulants	
No	1735 (72.9%)
Yes	644 (27.1%)
RAI alcohol	
No	1742 (73.2%)
Yes	637 (26.8%)

IAI, insertive anal intercourse; *RAI*, receptive anal intercourse

**May not equal 2386 as equation-wise deletion was used for development of latent classes

biomedical prevention (i.e., used PrEP/PEP or undetectable viral load) was reported at 34.5% of visits. Positive depression screen occurred at 33.5% of visits. Among sexual activities reported, oral sex was reported at 98.4%, IAI at 75.3%, and RAI at 69.4% of visits. Participants reported using alcohol or stimulants during oral sex at 39.1% and 35.4% of visits, respectively. IAI while using alcohol or stimulants was reported at 29.0% and 24.1% of visits, respectively.

Class labels were determined by identifying the more highly self-reported (proportion ≥ 0.6) substances used during sexual activity and revealed 5 classes: no substance use, stimulants/alcohol use (i.e., used both stimulants and alcohol during oral sex, IAI, and RAI), stimulants only, alcohol only, and stimulants/alcohol during oral sex and RAI (Table 2). Multinomial logistic regression models for factors associated with predicted class membership are in Table 3. Participants in the stimulants only class had two times higher odds of having a positive depression screen (aOR 2.05; 95% CI 1.57–2.68) compared to the no substance use class. Compared to the no substance use class, participants among all classes where substances were used had higher odds of attending a circuit/sex party except for those belonging to the stimulants/alcohol use during oral sex and RAI class. The stimulants/alcohol and stimulants only classes had higher odds of having an STI and reporting transactional sex compared to the no substance use class. Additionally, the stimulants only and stimulants/alcohol use during oral sex and RAI groups both had lower odds of using biomedical HIV prevention strategies compared to the no substance use class.

Table 2 Item response and membership probabilities of each latent class

	No substance use	Stimulants only	Alcohol only	Stimulants/alcohol	Stimulants/alcohol with oral sex and RAI
Membership probability	44.8%	17.5%	22.5%	11.3%	4.0%
Sex type/substance used					
Oral sex stimulants	0.047	**0.983**	0.043	**0.999**	**0.941**
Oral sex alcohol	0.045	0.007	**0.974**	**0.992**	**0.954**
IAI stimulants	0.003	**0.739**	0.010	**0.962**	0.007
IAI alcohol	0.001	0.003	**0.789**	**0.976**	0.019
RAI stimulants	0.013	**0.842**	0.004	**0.809**	**0.636**
RAI alcohol	0.017	0.012	**0.624**	**0.807**	**0.682**

Note: Item response probabilities > 0.6 are in bold

IAI, insertive anal intercourse; *RAI*, receptive anal intercourse

Table 3 Multivariable adjusted associations of predicted sexualized substance use latent class membership with HIV serostatus, sexual risk behaviors, and depression

Variable	**Stimulants only** aOR (95% CI)	**Alcohol only** aOR (95% CI)	**Stimulants/alcohol** aOR (95% CI)	**Stimulants/alcohol with oral sex and RAI** aOR (95% CI)
HIV	**4.74 (3.55–6.33)**	**0.57 (0.45–0.72)**	**1.87 (1.39–2.50)**	1.68 (0.98–2.86)
Positive STI	**2.35 (1.74–3.18)**	0.96 (0.71–1.31)	**1.57 (1.11–2.22)**	1.41 (0.77–2.56)
Biomedical prevention	**0.69 (0.53–0.91)**	1.07 (0.85–1.35)	0.85 (0.63–1.14)	**0.40 (0.23–0.71)**
Transactional sex	**6.25 (4.51–8.65)**	0.83 (0.55–1.24)	**5.55 (3.94–7.83)**	**6.40 (3.74–10.94)**
Circuit/sex party	**2.26 (1.65–3.09)**	**1.77 (1.32–2.35)**	**2.59 (1.86–3.62)**	1.36 (0.74–2.48)
Depression	**2.05 (1.57–2.68)**	1.01 (0.79–1.30)	**1.83 (1.36–2.45)**	1.10 (0.67–1.81)

Reference group: No substance use during oral sex, IAI, and RAI

Note: Bold indicates aOR does not cross 1

IAI, insertive anal intercourse; *RAI*, receptive anal intercourse

When stratified by race/ethnicity (Table 4), class membership probabilities remained similar overall across racial/ethnic groups. Higher proportions of Black and Latinx participants comprised the alcohol only class (23.0% and 22.2%, respectively) compared to non-Black/non-Latinx participants (15.8%). Living with HIV was positively associated with belonging to the stimulants only class across all racial/ethnic groups. Among both Black and Latinx participants, belonging to the stimulants only class had higher odds of a positive STI test (aOR 1.06, 95% CI 1.06–2.92 for Black participants; and aOR 1.96, 95% CI 1.96–4.34 for Latinx), compared to the no substance use class. Among Black participants, all substance-using classes were positively associated with attending a circuit/sex party except for the stimulants/alcohol use during oral sex and RAI class. Belonging to the stimulants only or stimulants/alcohol use during oral sex and RAI classes was associated with lower odds of biomedical prevention among Black participants. No associations were observed between any of the substance use classes and biomedical prevention for Latinx and non-Black/non-Latinx participants. Among Latinx participants, the stimulants/alcohol and stimulants only classes had higher odds of having a positive depression screen.

Discussion

To the best of our knowledge, this analysis is among the first to utilize LCA to evaluate patterns of substances used during specific sexual activities. Among this diverse cohort of MSM, we utilized

Table 4 Multivariable adjusted associations of predicted sexualized substance use latent class membership stratified by race/ethnicity

	Stimulants only	Alcohol only	Stimulants/alcohol	Stimulants/alcohol with oral sex and RAI
Non-Black/Non-Latinx				
Membership probability	22.5%	15.8%	10.9%	2.5%
Variable	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
HIV	**2.29 (2.29–10.88)**	**0.12 (0.12–0.59)**	0.39 (0.39–2.03)	0.25 (0.25–16.07)
Positive STI	0.80 (0.80–3.71)	0.38 (0.38–2.25)	0.41 (0.41–2.73)	0.00 (0.00–61.59)
Biomedical prevention	0.42 (0.42–1.61)	0.69 (0.69–3.09)	0.81 (0.81–4.17)	0.03 (0.03–4.83)
Circuit/sex party	**1.85 (1.85–8.01)**	**1.05 (1.05–5.98)**	**1.50 (1.50–8.63)**	0.34 (0.34–19.50)
Depression	**2.03 (2.03–7.78)**	0.49 (0.49–2.35)	0.74 (0.74–3.97)	0.86 (0.86–38.65)
Black				
Membership probability	13.6%	23.0%	10.0%	4.8%
Variable	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
HIV	**2.32 (2.32–5.75)**	0.67 (0.67–1.33)	**1.64 (1.64–4.17)**	0.91 (0.91–3.86)
Positive STI	**1.06 (1.06–2.92)**	0.76 (0.76–1.88)	0.85 (0.85–2.57)	0.40 (0.40–2.33)
Biomedical prevention	**0.32 (0.32–0.84)**	0.75 (0.75–1.51)	0.46 (0.46–1.20)	**0.10 (0.10–0.73)**
Circuit/sex party	**1.07 (1.07–3.09)**	**1.11 (1.11–2.61)**	**1.27 (1.27–3.72)**	0.88 (0.88–4.48)
Depression	**1.80 (1.80–4.25)**	0.46 (0.46–1.02)	0.98 (0.98–2.47)	0.92 (0.92–3.61)
Latinx				
Membership probability	19.1%	22.2%	11.7%	4.3%
Variable	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
HIV	**2.93 (2.93–6.36)**	**0.29 (0.29–0.57)**	0.92 (0.92–2.05)	0.52 (0.52–1.85)
Positive STI	**1.96 (1.96–4.34)**	0.49 (0.49–1.23)	1.00 (1.00–2.64)	0.58 (0.58–3.38)
Biomedical prevention	0.64 (0.64–-1.31)	0.77 (0.77–1.50)	0.64 (0.64–1.44)	0.28 (0.28–1.24)
Circuit/sex party	**2.46 (2.46–5.64)**	**1.05 (1.05–2.43)**	**2.95 (2.95–7.23)**	0.70 (0.70–3.75)
Depression	**1.59 (1.59–3.23)**	0.85 (0.85–1.72)	**2.15 (2.15–4.76)**	0.54 (0.54–2.26)

Reference group: No substance use during oral sex, IAI, and RAI

Note: Bold indicates aOR does not cross 1

IAI, insertive anal intercourse; *RAI*, receptive anal intercourse

LCA to determine (1) patterns of stimulant and alcohol use during specific sexual activities, (2) whether risk behaviors and syndemic conditions served as predictors for class membership, and (3) if predictors of class membership differed by race/ethnicity. We identified five classes of sexualized stimulant and alcohol use in this analysis: stimulant/alcohol use during all sexual activities, no substance use, stimulants only, alcohol only, and stimulants/alcohol use during oral sex and RAI. Collectively, our findings revealed that patterns of sexual activities and the specific substances used during those activities conferred different risk behavior profiles for HIV/STI acquisition/transmission.

Most classes with sexualized substance use had higher odds of participating in a circuit/sex party compared to the no sexualized substance use class. While stimulant use has classically been associated with the MSM party scene and sexualized settings, [8, 43] participants who only consumed alcohol in sexual contexts had almost twice higher odds of attending a circuit/sex party compared to those without sexualized substance use— supporting the concept that any substance use (not just stimulants or club drugs) may result in increased sexual risk behaviors. Within these settings, sexualized substance use may be used as a method to overcome inhibitions, physical limitations (such as fatigue or hunger), or to form connections

with others without restrictions or limitations [44, 45]. Given the increased prevalence of condomless sex, sexual concurrency, and risk behaviors associated with circuit/sex parties, these risks are likely amplified not just among those who report stimulant use but also among those who report only using alcohol, which should also be considered in the context of HIV/STI prevention and treatment efforts [36, 46].

Membership to any stimulant-using class was associated with 5–6 times higher odds of engaging in transactional sex compared to the no sexualized substance use class. Prevalence of recent transactional sex in this cohort was 18.6%, which is higher than the 5–12.2% estimated in other studies that evaluated transactional sex among MSM, and may be partially due to this cohort representing a group of relatively young MSM who were selected based on history of substance use and risk for HIV/STI transmission. [47, 48] Power differentials that occur during transactional sex may limit health protective behaviors, such as condom negotiation, and may be augmented when drugs are exchanged for sex. [49, 50] This power imbalance may be particularly relevant to our findings as the two classes that associated most highly with transactional sex either endorsed sexualized stimulant use only or used stimulants/alcohol during RAI but not IAI. As these two classes were also less likely to use biomedical prevention, MSM engaging in these sexualized substance use patterns may be at increased risk for HIV transmission/acquisition. Individuals who engage in transactional sex may also experience co-occurring vulnerabilities that pose barriers to engagement in HIV prevention/treatment services, such as economic instability, unstable housing, lack of health insurance, or medical distrust. [37, 51, 52] Furthermore, while lack of a current PrEP/PEP prescription or having a detectable viral load may be related to substance use itself, patterns of sexualized substance use, such as frequency of drug use and ability to plan for sex, may also affect acceptability and adherence to PrEP. [53–55] As MSM who engage in sexualized substance use and transactional sex are particularly vulnerable to HIV/STIs, these findings demonstrate the importance of improving outreach efforts and reducing barriers to PrEP/PEP and HIV care among stimulant-using MSM.

Consistent with previous research, depressive symptoms were positively associated with sexualized stimulant use in our analysis. [56, 57] While stimulant use itself has been associated with depression, recent studies have linked sexualized substance use with depressive symptoms. [58, 59] As MSM have been shown to utilize both stimulants and sexual intercourse as avoidant coping mechanisms for depression, MSM in this cohort may have utilized sexualized stimulant use as a means of sensation seeking in order to mitigate negative depressive symptoms. [60, 61] Collectively, these findings further support a syndemic of substance use, transactional sex, depression, sexual risk behavior, and HIV risk among MSM, which contribute to ongoing HIV/STI disparities that are observed among MSM subpopulations. [62, 63] These results further affirm the need for continued development of comprehensive HIV prevention/treatment programs that address these intersecting burdens which are contributing to the ongoing HIV/STI epidemic, rather than interventions that exclusively focus on biomedical prevention.

When stratified by race/ethnicity, our findings demonstrated that HIV risk behaviors, depression, and STIs were highly associated with membership in a sexualized substance-using class among Black and Latinx MSM. These disparities were particularly notable for Black MSM, who represented the only racial/ethnic group where sexualized substance use was negatively associated with biomedical prevention. MSM of color face numerous barriers to engagement in HIV prevention/treatment services, including socioeconomic factors, stigma, difficulties navigating the health system, discrimination from healthcare providers, and medical distrust, all of which contribute to disparities in PrEP utilization and viral load suppression. [64, 65] Further complicating these barriers are high rates of social marginalization and minority stress experienced by MSM of color, which have been shown to contribute to increased rates of depression, substance use, transactional sex, and condomless sex. [23, 24, 66] In a recent study, Black MSM who reported more syndemic conditions, such as sexual orientation stigma, substance use, depression, and transactional sex, were less likely to use PrEP, despite having high rates of PrEP knowledge. [67] Higher prevalence of HIV/STIs within sexual networks that comprise Black and Latinx MSM further reinforces the impact that these social and structural barriers have on HIV/STIs experienced by these subpopulations [68, 69]. Consequently, interventions are needed to address these intersecting vulnerabilities

contributing to ongoing HIV/STI disparities experienced by MSM of color.

Limitations

Our findings must be considered in the context of limitations. Given that this analysis comprises a cohort of MSM with high prevalence of substance use and sexual risk behaviors, generalization of our findings to other populations of MSM may be limited. While LCA provided us with the ability to group individuals based on latent constructs and to evaluate characteristics based on class membership, this method does come with limitations. As LCA assigns individuals to classes based on response patterns to select variables, assignment of individuals to the correct class may not occur [70, 71]. Regression models that incorporate class membership as a predictor and do not account for class membership uncertainty, such as our multinomial regressions, can underestimate variability and introduce bias for coefficient estimates. Furthermore, as latent class models are constrained to measures contained within the data, there is the potential for omitted variables bias or poor specification of the latent classes. This limitation is particularly relevant as this was a secondary data analysis and certain constructs regarding sexual risk behaviors were not captured within the dataset, such as sexual partnership dynamics within specific dyadic relationships and contexts/settings in which the substance use and sexual activities took place. Similarly, other sexualized substances (such as erectile dysfunction medications and poppers) were not included in this study. As all data were self-reported, there is the possibility of social desirability and recall bias, though surveys were administered through computer-assisted self-interview to minimize such bias.

Conclusions

As sexualized substance use is an important contributor to ongoing HIV/STI disparities that are experienced by MSM, research evaluating risk behaviors and contexts surrounding sexualized substance use are critical to inform public health efforts designed to reduce disparities that are experienced by this population. To the best of our knowledge, this analysis is among the first to utilize LCA to evaluate patterns of sexualized stimulant and alcohol use at the level of specific sex acts that occurred. These findings demonstrate the potential utility of interventions that link substance use treatment with HIV/STI treatment/prevention as well as the importance of future research to better understand the contexts during which sexualized stimulant use occurs. Additionally, our findings demonstrated that Black and Latinx MSM who engaged in sexualized stimulant use were more likely to experience syndemic health conditions, such as having an STI and depressive symptoms, than their Black or Latinx counterparts who did not engage in sexualized stimulant use. These disparities were particularly notable among Black MSM, where stimulant use only or stimulant/alcohol use during oral sex and RAI was negatively associated with the use of biomedical prevention strategies. Together, these results highlight the disproportionate impact that sexualized substance use has on HIV/STI transmission dynamics among MSM of color. Our findings underscore the importance of future research and interventions that are designed to both understand and address these intersecting vulnerabilities which contribute to ongoing HIV/STI disparities experienced by subpopulations of substance-using MSM.

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