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Syndemic latent transition analysis in the HPTN 061 cohort: Prospective interactions between trauma, mental health, social support, and substance use

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Abstract

Background: Substance use among Black sexual minority men (BSMM) is a significant public health focus of prevention interventions due to its association with sexual risk behaviors and transmission of HIV. Traumatic experiences and mental health challenges may interact to create a syndemic associated with substance use in this population; this may be moderated by social support however.

Methods: Using a multicenter prospective cohort of 1068 BSMM, we conducted a longitudinal syndemic latent transition analysis testing whether baseline and 6-month race and sexuality-targeted violence, intimate partner violence, other traumatic experiences, depression, and internalized homophobia was associated with 12-month substance use. We also tested if social support modified this and was associated with transitions between statuses.

Results: Our analysis identified four statuses: A “low-risk” status characterized by the lowest proportions of syndemic factors, and 3 “high-risk” statuses, characterized by higher proportions of syndemic factors. All three high-risk statuses were associated with higher substance use than the low-risk status, with the greatest association observed with “high-risk status C” (aRR=4.54, 95% CI 1.98, 10.40). Social support attenuated this association (Interaction aRR = 0.21, 95% CI 0.05,

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Contributors

All named authors contributed significantly to the research design and the development of the manuscript. Dr. Rodman Turpin led the design of the research, conducted the data analysis, and drafted the majority of the manuscript. Dr. Typhanye Dyer provided expertise in syndemic framework and drafted parts of the discussion and introduction. Dr. Derek Dangerfield II provides expertise in substance use literature and also drafted parts of the introduction and discussion. Dr. Hongjie Liu provided expertise in our syndemic predictors and drafted parts of the introduction, methods, and discussion. Dr. Kenneth Mayer provided expertise in syndemics among Black MSM and drafted some of the methods and discussion.

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Conflict of Interest Statement

All of the named authors have no conflict of interest, financial or otherwise.

0.85) and was associated with lower transition rates from low to high-risk status 6 months later (Transition ratio = 0.45, 95% CI 0.29, 0.69).

Conclusions: Our findings identified a syndemic of trauma, depression, and homophobia among BSMM associated with substance use, but attenuated by social support. Future research into the role of social support and resiliency in substance use prevention and recovery is recommended.

Keywords

Black; Men who have sex with men; Trauma; Depression, Homophobia; Substance use; Syndemic; Latent variable

1. Introduction

Substance use is associated with several adverse health outcomes and comorbidities, including risk for overdose, HIV, other sexually transmitted infections (STI), and death (Brown et al., 2017; Duncan et al., 2018; Hegazi et al., 2017; Knox et al., 2017; Nerlander et al., 2018; Ocasio et al., 2016; Pakianathan et al., 2018; Quinn et al., 2016; Young et al., 2016). This makes substance use especially important in the health risk of Black men who have sex with men (BSMM), as they experience greater risk for acquiring HIV and STIs than white MSM despite reporting less frequent sexual risk behaviors (CDC, 2018a, b; Millett et al., 2007; Millett et al., 2012). Substance use results in \$11 billion in healthcare costs and \$193 billion in overall costs annually (Birnbaum et al., 2011; National Drug Intelligence Center, 2011) and has a major impact on BSMM in the U.S.; nationally representative sample data showed a prevalence of 6.5% for opioid use, 5.6% for crack/cocaine use, and 1.8% for amphetamine use among BSMM (Goldstein, 2016). Additionally, the relationship between substance use and sexual risk has been well-established among several MSM subpopulations (Hegazi et al., 2017; Knox et al., 2017; Nerlander et al., 2018; Ocasio et al., 2016; Pakianathan et al., 2018; Pollard et al., 2018).

Since much of the research on substance use among MSM consists of samples of mostly white men (Gonzalez-Baeza et al., 2018; Hegazi et al., 2017; Nerlander et al., 2018; Ottaway et al., 2017; Pakianathan et al., 2018), inferences about BSMM substance use in these samples are unclear and questionable. While some studies show that BSMM report lower substance use compared to other MSM (Millett et al., 2007; Millett et al., 2012), other studies indicate that many psychosocial factors are associated with substance use among BSMM (Brown et al., 2017; Card et al., 2018; Duncan et al., 2018; Dyer et al., 2012; Javanbakht et al., 2018; Jeffries and Johnson, 2018; Nerlander et al., 2018; Ottaway et al., 2017; Quinn et al., 2016; Rowe et al., 2016; Viswanath et al., 2017; Voisin et al., 2017; Wray et al., 2019). Depression, internalized homonegativity, and trauma are associated with substance use and abuse among BSMM (Adams et al., 2018; Beymer et al., 2017; Dyer et al., 2012; Ferlatte et al., 2018; Miltz et al., 2019; Ogunbajo et al., 2018). Substance-using BSMM are also more likely to have experienced race-based and sexuality-based trauma along with intimate partner violence (Adams et al., 2018; Beymer et al., 2017; Duncan et al., 2018). Some BSMM may use substances such as heroin and methamphetamine to cope with social stress (Dangerfield et al., 2017). BSMM often experience concomitant challenges from poverty, stigma, violence, and high community HIV/STI prevalence that produce a

cumulative effect on substance use, sexual risks, and subsequent HIV infection.(Dangerfield et al., 2017; Dyer et al., 2012; Herrick et al., 2013)

Syndemic theory posits that a collection of risk factors are co-prevalent because of common social and structural drivers, which amplify the negative impact of these risk factors on health outcomes, such as substance abuse and behavioral health problems.(Dyer et al., 2012; Singer and Clair, 2003) Based on syndemic theory, race-targeted violence, sexuality-targeted violence, intimate partner violence, other traumatic experiences, depression, and internalized homophobia may interact to form a syndemic that may directly impact risk of substance use, as these factors are associated with substance use and each other.(Singer and Clair, 2003) Syndemic theory has been utilized to more effectively understand HIV/STI risk factors among SMM, including BSMM.(Buttram and Kurtz, 2015; Dyer et al., 2012; Ferlatte et al., 2018; Herrick et al., 2013; Mustanski et al., 2017; Pollard et al., 2018) Many of these syndemic factors are also consistent with minority stress theory, which posits that stigma toward minorities produces stressors that increase vulnerability to adverse psychosocial health outcomes, contributing to minority health disparities.(Meyer, 1995) Internalized homophobia, race-targeted violence, sexuality-targeted violence are notable sources of minority stress.

While many psychosocial and structural factors can increase substance use and related health risk among BSMM, social support can be an important buffer against these adverse health outcomes.(Barry et al., 2018; Buttram, 2019; Friedman et al., 2019; Hermanstynne et al., 2018) BSMM Social relationships are key elements of resilience and facilitators of substance use reduction(Buttram, 2019) by improving one's ability to cope with stress, facilitating resilience. This may attenuate the association between the aforementioned syndemic and substance use among BSMM.

The primary aim of this study was to identify depression, internalized homophobia, and traumatic experiences as a syndemic associated with substance use longitudinally among BSMM. This study also explored social support as a modifier of this association, and tested the association between social support and transitions between syndemic statuses. We hypothesized that syndemic statuses would be associated with greater substance use, that increased social support would attenuate this association, and that social support would be associated with more optimal transitions from syndemic statuses to non-syndemic statuses, and maintenance of non-syndemic status.

2. Materials and Methods

2.1 Participants and Procedures.

We conducted a longitudinal analysis using data from the HIV Prevention Trials Network Study 061 (HPTN 061): The Brothers Study,(Koblin et al., 2013) a prospective cohort of BSMM in the U.S. recruited between July 2009 and October 2010. Eligibility criteria included identifying as a man or having been assigned male at birth, identifying as Black, African-American, Caribbean Black, or multiethnic Black, and having had condomless anal intercourse with at least one man in the past six months. Participants were followed over three visits: baseline, six months, and 12 months. Institutional review boards at all

participating institutions granted approval for the study. Data from this study has been used in several studies of HIV/STI-related risk factors among BSMM.(Chen et al., 2016; Dyer et al., 2018; Hall et al., 2017; Hermanstynne et al., 2018; Koblin et al., 2013; Latkin et al., 2017; Levy et al., 2017; Nelson et al., 2017)

2.2 Measures.

Sexuality and Race-Based Violence.—Sexuality and race-based violence included experiencing actual or threatened physical violence due to one’s sexuality or race in the past 6 months, measured in 3 items: “Being threatened with physical violence”, “Being punched, kicked or beaten, or having an object thrown at me”, and “Being threatened with a knife, gun or another weapon”. For each item, participants could report if this happened because of their sexuality or race (No/Did not happen, Yes).

Trauma.—Trauma was measured using the Davidson Trauma Scale.(Davidson et al., 2002) It included 15 separate items reflecting several dimensions of having experienced trauma in the past 6 months, including gang violence, robbery, and seeing another person killed. Individual items were measured based on if they were experienced in the past 6 months (No, Yes).

Intimate Partner Violence.—Intimate partner violence was measured in 4 experienced items in the past 6 months: emotional abuse, physical abuse, stalking, and pressured/forced/intimidated into performing a sexual act. Each item was measured in frequency of occurrence (Never, rarely, sometimes, often, always).

Depression.—Depression was measured using the CESD-20 scale, a 20-item scale covering multiple dimensions of depressive symptoms in the past 2 weeks, such as hopelessness, difficulty enjoying usual activities, and feelings of sadness, with each item measured in Likert-scale format (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree).(Carleton et al., 2013)

Internalized Homophobia.—Current internalized homophobia was adapted from Herek and Glunt’s Internalized Homophobia Scale.(Herek, 1995) It was measured using 7 items covering dimensions of current internalized homophobia, such as “I wish I weren’t attracted to men” and “I feel that being attracted to men is a personal shortcoming for me”. Each item was measured in Likert-scale format.

Social Support.—Current social support was measured in 6 items, including questions such as “How often is there someone available to whom you can count on to listen to you when you need to talk” and “How often can you count on anyone to provide you with emotional support (talking over problems or helping you make a difficult decision).” Each item was measured based on frequency (None of the time, A little of the time, Some of the time, Most of the time, All of the time). For all analyses, we used a summed index for this measure (range 0 to 30), scaled in percentage for interpretability (range 0 to 100%).

Substance Use.—Substance use measures at 12 months included marijuana, inhaled nitrates, crack, powder cocaine, methamphetamine, heroin, non-prescribed Vicodin/

Oxycontin/Xanax, and any other stimulant use. Each item was measured as any use in the past 6 months (No, Yes). For all analyses, we used a summed index for this measure (range 0 to 8).

2.3 Missing Data:

Overall missingness for any individual item was low (5% or less), with the majority of items having less than 1% missingness. We used intrascale stochastic imputation to impute missing items from other items within each aforementioned variable group. For covariates, we imputed income missingness using age and education, both of which demonstrated significant associations with income (<1% missingness imputed). The strong internal consistency within each group (all $>.70$) and overall individual low missingness both support this approach to imputation. After imputation, our analytic dataset included 1,063 participants.

Analytic Plan: Latent transition analysis (LTA) was used to identify syndemic statuses based on the presence of syndemic factors and identify transitions between these statuses over time. LTA allows for identification of homogeneous subgroups within a heterogeneous population to evaluate how a set of behaviors coalesce and change over time. (Lanza et al., 2010) LTA allows us to assess not only how a syndemic of depression, internalized homophobia, and traumatic experiences is associated with substance use, but how this syndemic changes overtime among BSMM. We also tested if latent statuses were associated with subsequent substance use, and identified if social support modified this association for BSMM. This method also uniquely allows us to identify how social support is associated with transitions between statuses.

Pre-LTA Analyses: Prior to LTA, correlations between indices of all syndemic factors, substance use, and social support were measured using Spearman's rank-sum correlation coefficient. Percentage of observations above the median for each syndemic factor index, age, education, and income are presented for each latent status as well. Associations between profiles, syndemic factor indices, and sociodemographics were tested using a Kruskal-Wallis test with multiple-comparison correction for p-values. We also conducted two cross-sectional latent profile analyses (LPA) at baseline and six months. This was to determine that the number of profiles measured at baseline match; otherwise an LTA would be invalid. After identifying the ideal number of latent statuses, we compared an LTA model with no parameter restriction to an LTA model with fixed parameter equality. This identified measurement invariance, a significant ($p<.05$) difference in fit between the two models using an adjusted likelihood ratio test indicates a violation of the assumption of measurement invariance.

2.4 LTA:

LTA was conducted using all syndemic items (sexuality-targeted violence, race-targeted violence, trauma, intimate partner violence, internalized homophobia, depression) at baseline and six months. Twelve-month data was not used here to keep latent statuses temporally distal from our substance use outcome at 12 months. The LTA model was selected based on the Vu-Lo-Mendel-Rubin likelihood ratio test, the Bayesian Information

Criterion (BIC), and entropy. Entropy is a measure of certainty of latent status, with more extreme values (closer to 0 or 1) indicating greater certainty of status. All LTA incorporated correlated residuals to address local interdependence. LPA and LTA were conducted using Mplus 8.2.(Muthén, 2017)

2.5 Substance Use Regression Analyses:

Associations between latent statuses and the 12-month substance use index were measured using a cumulative logit odds model. All models included terms for latent statuses, the social support index, and the interaction term for the two. Both unadjusted models and models adjusted for age, education, household income, and site were generated. These variables were included due to demonstrating confounding (>10% change in estimates for our exposures, moderator, or interactions).

2.6 Social Support and Transition Regression Analyses:

We tested the association between social support and transition between latent statuses using Poisson regression models with scale parameter (to correct for overdispersion). For these analyses, we used dichotomized latent statuses (low and high-risk), to accurately capture transitions resulting in substantial risk differences (as transitions between high-risk profiles do not capture a substantive risk difference). We generated transition ratios stratified by baseline low-risk and baseline high-risk status. Among those in a baseline low-risk status, ratios reflect transition from low to high-risk compared to maintenance of low-risk. Among those in a baseline high-risk status, ratios reflect transition from high to low-risk compared to maintenance of high-risk. There was no evidence of intercollinearity (all VIF<5). Bivariate and regression analyses were conducted in SAS 9.4.(SAS Institute Inc., 2014)

3. Results

3.1 Sample Characteristics and Bivariate Analyses:

The median sample age was 40 years (range 18 to 64), with median education of high school or less (58%) and median household income of \$15,000 (Figure 1). Approximately half of participants had at least one experience with sexuality-targeted or race-targeted violence, and/or other traumas. The median CESD-20 score was 14 (out of 80), and 41% of participants had a CESD-20 score of 16 or greater, indicating risk of clinical depression. The median internalized homophobia score was 7 (out of 30). Among participants, 61% had used at least one substance, while 29% had used at least 2 substances. Just over half of the sample (51%) reported marijuana use. For individual substances other than marijuana, proportions of usage in the overall sample included 3% for heroin, approximately 5% for methamphetamines, illicit use of prescription drugs, and other substances, approximately 10% for inhaled nitrates and cocaine, and 18% for crack. Half of participants had a social support index of 14 or less (out of 30). Additionally, we identified positive associations among nearly every single syndemic factor, with the exception that no association was detected between internalized homophobia and intimate partner violence or experienced sexuality-targeted violence (Table 1). Factors associated with any 12 month substance use included higher baseline trauma, intimate partner violence, depression, lower baseline social support, education level, and income, and site location (Table 2).

3.2 Latent Transition Analyses:

In both cross-sectional LPA models, we identified a 4-profile model as optimal (Supplement 1). Sexuality-targeted violence, internalized homophobia, and depression were all slightly higher in 6 month profiles compared to baseline profiles. The ordinal differences between profiles were fully consistent between baseline and 6 month timepoints, with the greatest syndemic factors in “High-Risk Profile A”, followed by “High-Risk Profile B”, and “High-Risk Profile C”. The “Low-Risk Profile” had the lowest syndemic factors with the exception of internalized homophobia. We proceeded with a four status model for all subsequent analyses (Table 3). Our LTA identified four distinct statuses (Figure 1). While we only used our syndemic factors in generating latent statuses, we also observed differences in both our outcomes and moderator across these statuses. One status was characterized by the lowest syndemic factors overall, and had the lowest substance use, and highest social support. This was also the most socioeconomically advantaged status, with the highest education and income. This was labeled the “low-risk” status, and used as the reference status for all subsequent analyses. The other three profiles were labeled “high-risk” statuses. High-risk status A had the highest proportions of syndemic factors overall, but lower substance use than the other high-risk statuses. It also included younger participants, with the lowest education levels and household income. High-risk statuses B and C both had overall lower syndemic factors than status A, but higher substance use, with high-risk status C having the greatest substance use. High risk status C also had fewer experiences with race-targeted violence and sexuality targeted violence than either High-risk status A or B. High-risk status B had higher proportions of experienced sexuality-targeted violence and race-targeted violence compared to High-risk status A.

3.3 Substance Use Regression Analyses:

Table 3 shows the results of the cumulative logit odds regression. Both before and after adjusting for confounders, all of the high-risk statuses had significantly higher odds of greater substance use compared to the low-risk status, with the greatest odds observed in high-risk status C (aOR = 4.54, 95% CI 1.98, 10.40). While there was no significant main association between social support and substance use, there were significant interactions between social support and latent status, with a strong negative interaction (Interaction aOR = 0.21, 95% CI 0.05, 0.83) between high-risk status C and social support. At the highest levels of social support, the association between high-risk status C and substance use was nearly 5 times lower than predicted. Among covariates, participants in Boston, MA and San Francisco, CA had the greatest greater substance use (compared to Atlanta, GA).

3.4 Social Support and Transition Regression Analyses:

Among participants above the median social support index, we observed greater percentages of maintenance of low-risk status (84.2% compared to 75.9%) and transition from high-risk to low-risk (63.5% compared to 44.6%) compared to those below or at the median social support index (Figure 2). In regression analyses, among low-risk status participants at baseline, a greater social support index was significantly associated with lower rates of transition from low to high-risk status (TR = 0.45, 95% CI 0.29, 0.69). Among high-risk participants at baseline, we observed a greater social support index associated with a trend

towards transition from high to low-risk status, though this was not statistically significant (TR = 1.45, 95% CI 0.53, 4.00).

4. Discussion

We identified a syndemic of several dimensions of trauma, depression, and internalized homophobia among BSMG over time, confirming our hypotheses. The high prevalence of these factors indicates crucial needs among BSMG. More than half of the sample experienced race-targeted violence and sexuality-targeted violence in the past 6 months. Nearly half had a risk of depression (CESD-20 of 16 or more). Approximately a quarter of the sample had experienced intimate partner violence in the past 6 months as well. These factors formed a syndemic prospectively associated with greater substance use after 12 months of follow-up. Findings are consistent with our understanding of each of these factors individually; several studies have documented the association between these factors and substance use. (Jeffries and Johnson, 2018; Miltz et al., 2019; Ogunbajo et al., 2018; Quinn et al., 2016; Smith et al., 2016; Voisin et al., 2017) Our study is novel in that we identified these as components of a syndemic, and identified that the syndemic is transient at the individual level. Substance abuse interventions tailored to BSMG should address these psychosocial syndemic contexts, which change overtime. Experiences of sexuality-targeted violence, experienced race-targeted violence, and internalized homophobia were especially impactful, demonstrating the most stark differences between high and low-risk statuses. These are critically important considerations for public health intervention and policy among BSMG that are directly related to their multiple minority status. A “one-size fits all” approach to substance use harm reduction and treatment policy does not appropriately consider the additional psychosocial and structural stressors faced by minority populations such as BSMG. This is relevant not only to substance use, but also to several additional outcomes directly associated with substance use, including sexual risk behaviors that increase the HIV/STI risk. In the context of the disproportionate HIV/STI burden among BSMG (CDC, 2018a, b), more effectively informed substance abuse interventions are of significant public health importance.

While we identified three overall “high-risk” syndemic statuses with distinct differences related to the proportions of syndemic factors and how strongly social support moderated the association with 12 month substance use. High risk status A was characterized by the greatest syndemic factors overall but the lowest polysubstance use of the three high-risk profiles, and was the least attenuated by social support. Conversely, high risk-status C had the lowest syndemic factors of the three high-risk statuses, and was the most attenuated by social support. The strength of interaction with social support paralleled the proportions of social support in each profile as well, with high-risk status A having the lowest social support, and high-risk status C having the highest social support of the high-risk statuses. Participants in high-risk status A may be the most marginalized overall, and thus social support is a less impactful deterrent to substance use and abuse. Notably this was the largest status as well, nearly twice as large as the low-risk status. This underscores the burden of these syndemic factors among BSMG.

We found that greater current social support was associated with transition from high to low-risk status. This is consistent with the attenuative interaction we identified between current social support and high-risk profiles. Social support has been demonstrated as a key factor in both substance use recovery and prevention of substance use initiation in previous studies. (Buttram, 2019; Buttram and Kurtz, 2015) A strong social support network can be instrumental in the ability to healthily cope with stressors, deterring maladaptive coping through substance abuse. (Pollard et al., 2018) Peer support may be impactful to effective harm reduction, preventing adverse substance use outcomes such as substance overdose. This is useful for the development of intervention research and policy, as this underscores the importance of social support in the success of substance abuse interventions. The formation of healthy support networks has been a core component of many social policies and programs for the treatment of substance abuse; these networks may be of notable importance for developing harm reduction strategies and facilitating substance abuse treatment among BSMM. The relevance of social support in buffering the adverse effects of syndemics may also reflect how social support can foster resilience among BSMM. A study by Fadardi et al found that an adaptive motivational structure characterized by approach tendencies, good knowledge of what to do, high senses of control and commitment, high expectations of success, and emotional involvement in pursuit of the goal, was associated with lower substance use. (Fadardi et al., 2010) Given that BSMM are a marginalized population with multiple minority status, resilience is especially important to coping with additional discrimination-related stressors, including the sexuality-targeted violence, race-targeted violence, and internalized homophobia that partially comprised our measured syndemic.

Our research has several strengths. We utilized a large, multicenter cohort of BSMM at several sites across the United States, allowing our research to include BSMM from several geographic backgrounds. The use of prospective cohort data with a distal outcome allowed us to effectively assess temporality; this is of critical importance, as substance use otherwise has a bidirectional association with mental health. Prospective analyses are necessary to ensure we capture substance use measures subsequent to our exposures of interest. Our study also used several multi-item measures for each syndemic factor, allowing us to identify a nuanced syndemic covering several dimensions of trauma, violence, and mental health. While there is much literature on syndemics among BSMM, prospective analyses of syndemics with transitions in syndemic status over time are far more limited. Our study helps fill this significant gap in the literature. Finally, our use of LTA contributed several strengths to our research. First, much like latent class and latent profile analyses, we were able to identify multiple profiles with distinct, non-linear differences in syndemic factors. Additionally, LTA was able to identify changes in syndemic factors over time, with approximately half of all participants transitioning between high and low risk groups. In developing our understanding of risk factors cumulatively affecting health outcomes among BSMM, research should acknowledge that adverse psychosocial and structural circumstances are not inherently static, and can change over time. LTA acknowledges this by allowing for the measurement of these changes.

There are limitations in our research that are important to acknowledge. First, because our study was limited to BSMM, results are not generalizable to MSM of other racial/ethnic

groups, or to populations other than MSM. Our focus on BSMM is warranted however given the additional relevance of substance use to several adverse health outcomes in this population. Because our cohort lasted 12 months, and our research necessitated a temporally distal substance use outcome, we could only assess syndemic profile transitions in a six month period. As there were some differences in the recall period between some of our syndemic factors, the syndemic factors may not be completely concurrent. They do precede the recall period for our prospective outcome however, so temporality is preserved. Our outcome is limited to use of substances, which does not necessarily indicate substance dependence. Given the growing decriminalization, legalization, and acceptance of marijuana use across the United States, marijuana use in current times is not likely to be fully reflective of marijuana use a decade earlier, when our data were collected. Finally, social desirability bias is likely to affect our measures.

5. Conclusion

Our research identified a syndemic of race and sexuality-targeted violence, intimate partner violence, other traumatic experiences, depression, and internalized homophobia that was associated with greater risk of substance use after 12 months. These results were largely unchanged after adjustment for age and socioeconomic factors. Social support mitigated this association, in part due to negative associations between social support and transition from low to high-risk status. Future research into the longer-term impact of trauma and mental health on substance use is recommended. This may also provide a better understanding of long-term transitions between syndemic statuses and substance use. More detailed studies into the mechanisms of how social support attenuates the association between this syndemic and substance use may further our understanding of social support can better inform substance abuse and harm reduction interventions in this population; the role of peer support in substance recovery is an especially important area for future research. Resiliency and motivation among BSMM are notably important focal points for future research. More effective and accessible substance-related harm reduction services for BSMM, such as needle exchange programs, are also of great importance. These services can often help prevent serious adverse substance-related outcomes, and are thus critically important to the health of substance-using BSMM. Social and legal policy that directly addresses many of the syndemic factors identified, particularly sexuality and race-targeted violence, are necessary for effective substance use harm reduction, and thus subsequent HIV and STI vulnerability in this population. Policy informed by a nuanced understanding of the patterns of these syndemic factors and their relationship with substance use is necessary to health promotion towards BSMM.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- We identified a syndemic based on trauma, internalized homophobia, and mental health.
- All syndemic statuses were associated with higher substance use.
- Social support attenuated the association between syndemics and substance use.
- Social support was also associated with fewer transitions into syndemic statuses.

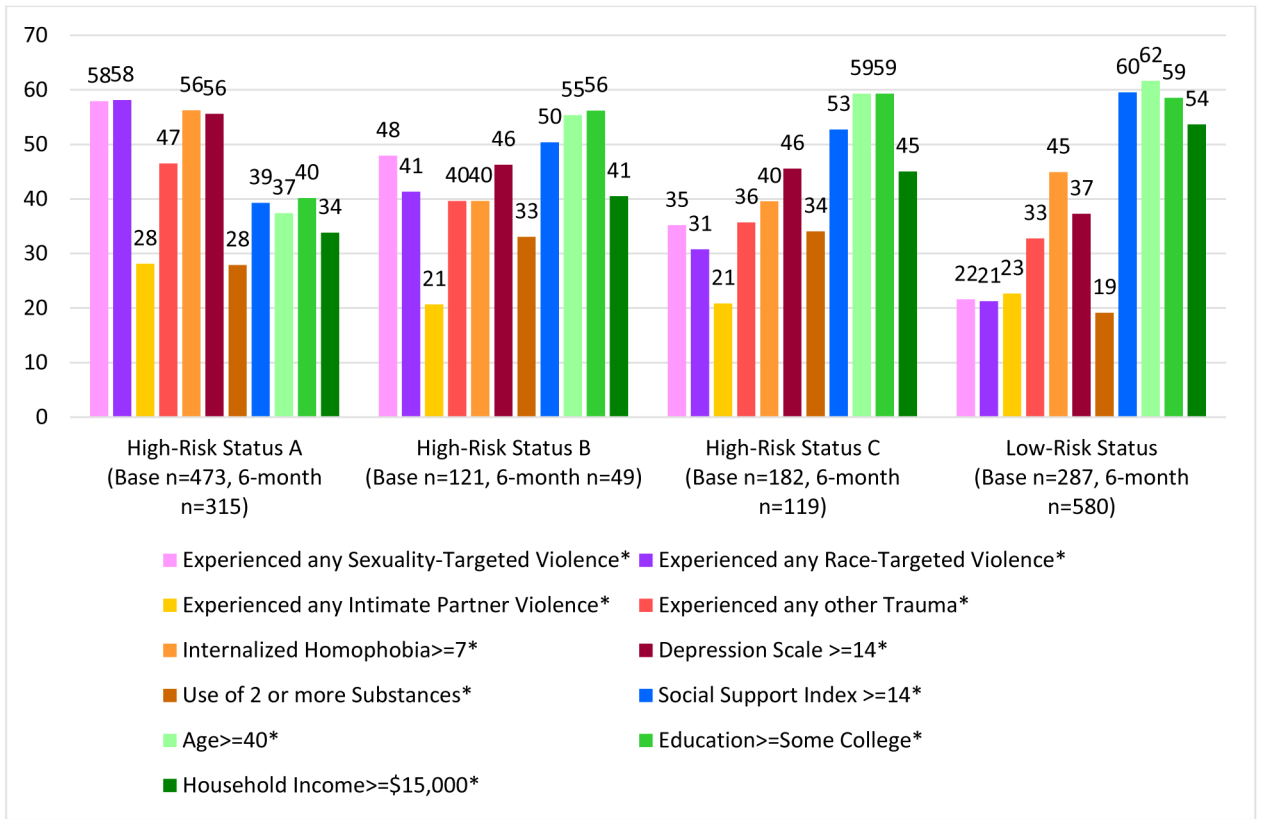


Figure 1. Distribution of Syndemic Factors, Substance Use, Social Support, and Demographics (% above median) across baseline Latent Statuses (n=1063).
 *All syndemic factor, substance use, social support indices, age, education, and income were associated with profiles (p<.05) using a Kruskal-Wallis test with a multiple comparisons corrected p-value.

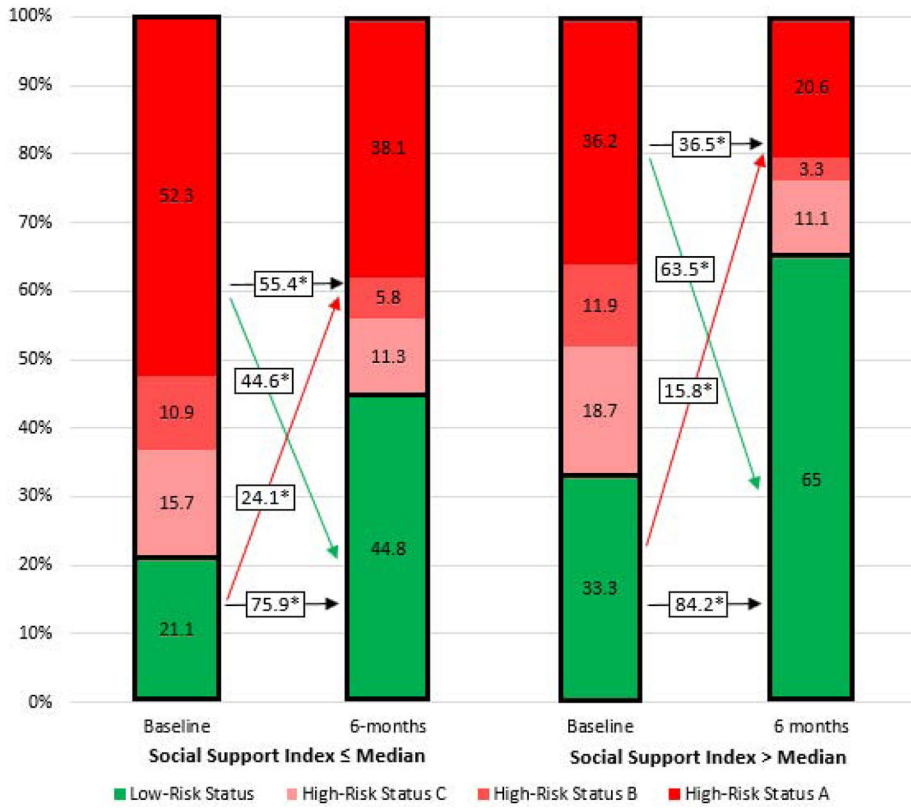


Figure 2. Transitions between latent statuses at baseline and 6 months stratified by social support index above the median (n=1063).
 *Percentages are of each binary transition status (low-risk, high risk) that transitioned to low/high risk status after 6 months.
¹Significant negative association (p<.05) between social support index % (continuous) and transition from low to high risk status (Transition ratio = 0.45, 95% CI 0.29, 0.69), reference maintenance of low risk status.
²Non-statistically significant (p>.05) positive association between social support index % (continuous) and transition from high risk to low risk status (Transition ratio = 1.45, 95% CI 0.53, 4.00), reference maintenance of high risk status.

Table 1.

Correlation¹ Matrix of Indices of syndemic factors and social support at baseline, and substance use at endtime (n=1063).

	Homophobic Violence	Racist Violence	Trauma	Internalized Homophobia	Partner Violence	Depression	Social Support
Racist Violence	0.78	-	-	-	-	-	-
Trauma	0.14	0.15	-	-	-	-	-
Internalized Homophobia	0.01	0.08	<u>0.05</u>	-	-	-	-
Partner Violence	0.22	0.13	0.24	0.02	-	-	-
Depression	0.29	0.24	0.06	0.28	0.19	-	-
Social Support	-0.18	-0.20	-0.16	-0.17	<u>-0.04</u>	-0.35	-
Substance Use	0.07	0.06	0.07	<u>0.05</u>	0.06	0.12	0.07

Significant (p<.05) correlations bolded. Marginally significant (.05<p<.10) correlations ud.

¹ All correlations tested using Spearman's Rank-Sum Correlation.

Table 2.

Baseline syndemic factors, social support, and sociodemographics stratified by any 12 month substance use (n=1063).

	Total	No 12 month substance use (n=411)	Any 12 month substance use (n=652)
Median Syndemic Factors¹			
Sexuality-targeted Violence	0	0	0
Race-targeted Violence	0	0	0
Trauma	1	0	1
Internalized Homophobia	7	6	7
Intimate Partner Violence	0	0	1
Depression	14	12	14
Median Social Support¹	14	15	14
Age¹	40	40	
Education Level¹			
High School or Less	15.5%	11.9%	17.8%
Vocational or Trade School	34.3%	34.6%	34.1%
Some College	36.4%	40.4%	33.9%
College or Greater	13.8%	13.1%	14.3%
Household Income¹			
Less than \$10,000	36.8%	33.3%	39.0%
\$10,000 to \$29,999	34.7%	34.6%	34.8%
\$30,000 or more	28.5%	32.1%	26.2%
Site Location²			
New York, NY (Harlem)	12.5%	10.5%	13.8%
Washington, DC	15.0%	18.5%	12.7%
Boston, MA	13.4%	10.0%	15.5%
Los Angeles, CA	18.0%	20.9%	16.1%
New York, NY (New York Blood Center)	10.6%	10.7%	10.6%
San Francisco, CA	13.1%	9.0%	15.6%
Atlanta, GA	17.5%	20.4%	15.6%

Statistically significant (p<.05) differences bolded.

¹Tested using Cochran-Armitage test of trend.

²Tested using Chi-Square test.

Table 3.

Comparisons of log-likelihood* (LL), Bayesian Information Criterion (BIC), and entropy between latent transition models with fixed numbers of latent statuses (n=1063).

Number of Statuses	2	3	4	5
Log-likelihood	38814	38329	36530	36130
LL Difference	-	485	1799	400
BIC	84093	83592	79147	78951
Entropy	0.99	0.96	0.94	0.98

* Significant difference in log likelihood ($p < .05$) compared to the model with n-1 profiles using the Vu-Lo-Mendel-Rubin adjusted likelihood ratio test bolded.

Models using more than 5 profiles resulted in either failure to fit or no notable improvement in fit.

Table 4.

Cumulative Logit Risk Ratios for Substance Use across baseline latent statuses, social support, interactions, and covariates (n=1063).

	Model 1	Model 2
Baseline Latent Status		
High-Risk Status (A)	1.86 (1.01, 3.45)	1.97 (1.05, 3.67)
High-Risk Status (B)	2.89 (1.11, 7.50)	3.02 (1.15, 7.94)
High-Risk Status (C)	4.31 (1.90, 9.80)	4.54 (1.98, 10.40)
Low-Risk Status	Reference	Reference
Social Support Index % (Continuous)	1.23 (0.52, 2.92)	1.60 (0.66, 3.83)
Latent Profiles * Social Support Interactions		
Social Support Index * High-Risk Status A	0.63 (0.22, 1.83)	0.50 (0.17, 1.47)
Social Support Index * High-Risk Status B	0.44 (0.09, 2.27)	0.41 (0.08, 2.13)
Social Support Index * High-Risk Status C	0.21 (0.05, 0.83)	0.21 (0.05, 0.85)
Social Support Index * Low-Risk Status	Reference	Reference
Age (Continuous)		0.99 (0.98, 1.00)
Education Level		
High School or Less		1.03 (0.66, 1.62)
Vocational or Trade School		0.76 (0.52, 1.12)
Some College		0.67 (0.43, 1.01)
College or Greater		Reference
Household Income		
Less than \$10,000		1.17 (0.85, 1.61)
\$10,000 to \$29,999		1.06 (0.77, 1.45)
\$30,000 or more		Reference
Site Location		
New York, NY (Harlem)		1.50 (0.99, 2.27)
Washington, DC		0.84 (0.55, 1.28)
Boston, MA		1.93 (1.28, 2.89)
Los Angeles, CA		0.90 (0.61, 1.32)
New York, NY (New York Blood Center)		1.24 (0.80, 1.93)
San Francisco, CA		2.37 (1.56, 3.59)
Atlanta, GA		Reference
Significant (p<.05) estimates bolded.		