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Syndemic Profiles and Sexual Minority Men's HIV-Risk Behavior: A Latent Class Analysis

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Abstract

Syndemic theory posits that “syndemic conditions” (e.g., alcohol misuse, polydrug use, suicidality) co-occur among sexual minority men and influence HIV-risk behavior, namely HIV acquisition and transmission risk. To examine how four syndemic conditions cluster among sexual minority men and contribute to HIV-risk behavior, we conducted latent class analysis (LCA) to: (1) classify sexual minority men ($n = 937$) into subgroups based on their probability of experiencing each syndemic condition; (2) examine the demographic (e.g., race/ethnicity) and social status (e.g., level of socioeconomic distress) characteristics of the most optimally fitting four syndemic classes; (3) examine between-group differences in HIV-risk behavior across classes; and (4) use syndemic class membership to predict HIV-risk behavior with sexual minority men reporting no syndemic conditions as the reference group. The four classes were: (1) no syndemic, (2) alcohol misuse and polydrug use syndemic, (3) polydrug use and HIV syndemic, and (4) alcohol misuse. HIV-risk behavior differed across these latent classes. Demographic and social status characteristics predicted class membership, suggesting that syndemic conditions disproportionately co-occur in vulnerable subpopulations of sexual minority men, such as those experiencing high socioeconomic distress. When predicting HIV-risk behavior, men in the polydrug use and HIV syndemic class were more likely (Adjusted Risk Ratio [ARR] = 2.93, 95% CI: 1.05, 8.21) and men in the alcohol misuse class were less likely (ARR = 0.17, 95% CI: 0.07, 0.44) to report HIV-risk behavior than were men in the no syndemic class. LCA represents a promising methodology to inform the development and delivery of tailored interventions targeting distinct combinations of syndemic conditions to reduce sexual minority men's HIV-risk behavior.

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Conflict of interest

The authors declare that they have no conflict of interest.

Human and Animal Rights

This article does not contain any studies with animals performed by any of the authors.

Informed Consent

We obtained informed consent from all individual participants included in the study.

Keywords

Sexual minority men; Syndemic; HIV-risk behavior; Latent class analysis

Sexual minority men (e.g., gay, bisexual, or other men who have sex with men) often report greater alcohol misuse (Corliss, Rosario, Wypij, Fisher, & Austin, 2008; Talley, Hughes, Aranda, Birkett, & Marshal, 2014), polydrug use (Cochran, Ackerman, Mays, & Ross, 2004; Ross et al., 2014), and suicidality (Brennan, Ross, Dobinson, Veldhuizen, & Steele, 2010; Hottes, Bogaert, Rhodes, Brennan, & Gesink, 2016) compared to heterosexual men. In addition, despite comprising less than 4% of the U.S. population (Gates, 2017), sexual minority men account for nearly 60% of those living with HIV (Hall et al., 2015). Sexual minority men might engage in alcohol misuse and polydrug use to manage the health corrosive impact of minority stress (i.e., distal and proximal stress processes related to having a stigmatized sexual minority status; Baams, Grossman, & Russell, 2015; Hatzenbuehler & Pachankis, 2016; McCabe, Bostwick, Hughes, West, & Boyd, 2010; Meyer, 2003; Pachankis et al., 2015). To further manage the toll of HIV-related stigmatization, sexual minority men living with HIV often are more likely to report alcohol misuse (Radcliffe et al., 2010) and substance use (Quinn et al., 2017) compared to sexual minority men who are not living with HIV. Male sexual orientation disparity in suicidality is at least partially explained by interpersonal risks, including minority stress and HIV stigma (Bränström & Pachankis, 2018; Ferlatte, Salway, Oliffe, & Trussler, 2017; Plöderl et al., 2014; Salter et al., 2010). Indeed, such psychosocial health conditions (i.e., alcohol misuse, polydrug use, suicidality, and HIV) affecting sexual minority men often co-occur (Stall et al., 2001), together exacerbating serious population-level health burdens among sexual minority men compared to heterosexual men (Mustanski, Andrews, Herrick, Stall, & Schnarrs, 2014).

Syndemic theory (Singer, 1994, 2000) explains the concentration and interaction of co-occurring “syndemic conditions” among socially disadvantaged populations such as sexual minority men. As initially proposed by Singer (1994, 2000) and then adapted for sexual minority men (Stall, Friedman, & Catania, 2008; Stall et al., 2003), syndemic theory rests on the assumption that adverse social conditions produce concentrated, co-occurring disease conditions among socially marginalized populations that together corrode the vulnerable population’s overall health profile. For instance, one study demonstrated that young sexual minority men who live in poverty may misuse alcohol and substances to cope with stress associated with economic hardship, the co-occurrence of which drives this population’s mental health morbidity (Herrick, Stall, Egan, Schrager, & Kipke, 2014). Research clearly establishes that syndemic conditions co-occur (Friedman et al., 2019; Halkitis et al., 2015; Parsons, Grov, & Golub, 2012; Stall et al., 2008; Stall & Purcell, 2000) and erode sexual minority men’s health (Mustanski, Garofalo, Herrick, & Donenberg, 2007; Parsons et al., 2017; Rosario, Schrimshaw, & Hunter, 2006; Santos et al., 2014; Stall et al., 2003). Specifically, consistent evidence documents that alcohol misuse, polydrug use, suicidality, and HIV co-occur as a result of the pervasive devaluation of sexual minority identities (Halkitis et al., 2015; Ibañez, Purcell, Stall, Parsons, & Gómez, 2005; Mustanski et al., 2007, 2014; Stall et al., 2001, 2003; Stall & Purcell, 2000). Sexual minority men who

experience these specific syndemic conditions often demonstrate an elevated propensity for engaging in HIV-risk behavior, such as sexual intercourse that takes place without condoms between serodiscordant or HIV status unknown partners when neither partner is protected by pre-exposure prophylaxis (for HIV-negative partners) or undetectable viral load (for HIV-positive partners; Burton, Clark, & Pachankis, 2020; Hart et al., 2017; Hirshfield et al., 2015; Santos et al., 2014; Stall et al., 2003).

Historically, syndemic conditions have been conceptualized and measured as a composite score or count (Tsai & Burns, 2015; Tsai & Venkataramani, 2016). This approach employs an index of the number of syndemic conditions to predict linear associations with adverse health outcomes, including HIV-risk behavior. For example, in their seminal study, Stall et al. (2003) documented that as the count of reported syndemic conditions (i.e., polydrug use, depression, childhood sexual abuse, and intimate partner violence) increased, sexual minority men's sexual-risk behavior also increased. This approach has been used in several subsequent studies (Parsons et al., 2012, 2017; Tomori et al., 2018), typically finding positive associations between the number of those syndemic conditions and HIV-risk behavior. Although not heretofore considered a syndemic condition, self-inflicted violence (i.e., suicidality) is also significantly elevated among sexual minority men (Blosnich & Bossarte, 2012; De Graaf, Sandfort, & ten Have, 2006) and sexual minority men who report suicidality are at greater risk of alcohol misuse, polydrug use, HIV, and HIV-risk behavior (Carrico, Neilands, & Johnson, 2010; Cramer, Colbourn, Graham, & Stroud, 2015; Mereish, O'Cleirigh, & Bradford, 2014; Mustanski et al., 2014).

Despite its important role in demonstrating that HIV-risk behavior is a function of the number of syndemic conditions experienced, the count approach limits information that might inform population-specific interventions, such as whether distinct combinations of syndemic conditions are associated with HIV-risk behavior more than other combinations. Indeed, a count approach assumes that each syndemic condition confers equal risk to the health profile of sexual minority men. For instance, when using the count approach to model associations between syndemic conditions and HIV-risk behavior, a syndemic count of two might be composed in several different ways (e.g., polydrug use and suicidality versus polydrug use and alcohol misuse versus alcohol misuse and suicidality and so forth), blurring many combinations that might confer distinct risk. In fact, previous research with sexual minority men finds that the assumption that each syndemic condition confers equal risk may not be empirically justified (Starks, Millar, Eggleston, & Parsons, 2014).

Alternatively, latent class analysis (LCA) can identify a set of subgroups according to distinct combinations of syndemic conditions (e.g., polydrug use and suicidality versus HIV and alcohol misuse). Rather than documenting the raw number of syndemic conditions, as the traditional count approach does, LCA can instead reveal underlying subgroups (i.e., classes) of a population based on the likelihood of experiencing some combination of certain syndemic conditions versus others. Few studies have used LCA to identify latent, or underlying, subgroups of sexual minority men based on their probability of experiencing certain combinations of syndemic conditions (Lanza & Rhoades, 2013; Starks et al., 2014). In one notable exception, Starks et al. (2014) evaluated the utility of using latent factor approaches, such as LCA, to model syndemic conditions among sexual minority men.

Analyses identified broad latent classes, namely “high syndemic stress groups” (three or more syndemic factors) and “low syndemic stress groups” (two or fewer syndemic factors). Research is needed to extend these emerging findings by examining whether subgroups of sexual minority men report distinct combinations of syndemic conditions that represent more than the count of such conditions.

LCA has recently shown promise to uncover subgroups of sexual minority men differentiated by unique combinations of HIV-risk-taking behaviors. For instance, one study used LCA to classify behavioral risk profiles of sexual positioning preferences and serosorting (i.e., majority top/serosorters, versatile/few partners, and majority bottom/some serosorters) among men who have sex with men (MSM) in Paris, France (Dangerfield, Carmack, Gilreath, & Duncan, 2018). Another recent study among Black MSM in the U.S. used LCA to reveal four unique subgroups of HIV-risk and protective factors based on safer sex self-efficacy, negative condom attitudes, having been in difficult sexual situations or relationships, HIV treatment optimism, and perceived HIV stigma (Vincent et al., 2019). In addition, another recent LCA among MSM in China revealed distinct classes of HIV acquisition based on the following risk factors: multiple sexual partners in the past 6 months; recent unprotected anal intercourse; preference as the receptive partner during anal sex; recent group sex; men who had their first sexual encounter with another man before the age of 20; use of the internet or mobile phone apps as the primary means of seeking sexual partners; identifying as gay; and recent drug use (Smith, Stein, Cheng, Miller, & Tucker, 2019). Overall, this evidence suggests that LCA is a useful statistical technique for uncovering distinct subgroups of sexual minority men based on HIV acquisition risk factors. We seek to expand on this application of LCA among sexual minority men to provide new information about key population subgroups who might experience distinct combinations of syndemic conditions (i.e., alcohol misuse, polydrug use, suicidality, and HIV).

While the above studies employed LCA to identify classes of sexual minority men based on their HIV acquisition risk factors, LCA has, to our knowledge, rarely been used to identify classes of syndemic combinations among sexual minority men. Emerging research demonstrates such an approach to be fruitful with other populations disproportionately affected by some syndemic conditions, such as transgender women. In a recent study with transgender women in India, LCA was utilized to uncover four distinct syndemic condition classes (i.e., no syndemic class; depression, alcohol, and violence [DAV] syndemic class; alcohol and violence [AV] syndemic class; and depression and violence [DV] syndemic class; Chakrapani, Willie, Shunmugam, & Kershaw, 2019). Notably, transgender women with a high probability of being in the DAV and AV syndemic classes were significantly more likely to report inconsistent condom use in the past month relative to transgender women in the no syndemic class. This study suggests that LCA is a useful technique to reveal population subgroups experiencing certain combinations of syndemic conditions versus others. Applied to sexual minority men, LCA might serve as a useful technique in elucidating the extent to which sexual minority men reporting some syndemic combinations versus others might be more likely to engage in HIV-risk behavior.

Further, knowing the prototypical demographic (e.g., race/ethnicity, age) and social status (e.g., level of socioeconomic distress) makeup of syndemic classes can inform targeted

prevention and intervention approaches (Robinson, Knowlton, Gielen, & Gallo, 2016; Salas-Wright, Olate, & Vaughn, 2015). Racial/ethnic minority identity, younger age, lower income and education, and unemployment represent key demographic and social status characteristics that have been shown to contribute to sexual minority men's elevated alcohol misuse (Newcomb, 2013), polydrug use (Greenwood et al., 2001; Mimiaga et al., 2008), suicidality (King et al., 2008; O'Donnell, Meyer, & Schwartz, 2011), and HIV infection (Levy et al., 2014; Maulsby et al., 2014; Millett et al., 2012). Prior studies have primarily documented the association between demographic and social status characteristics and one or two syndemic conditions of interest; however, uncovering demographic and social status characteristics associated with distinct combinations of syndemic conditions among sexual minority men can inform targeted intervention efforts by revealing the tendency for certain demographic and social status groups to experience more harmful combinations of syndemic conditions than others. Additionally, such an application expands qualitative research documenting differing demographic and social status characteristics of those sexual minority men who do and do not experience syndemic conditions (e.g., Reed & Miller, 2016).

The present study aimed to add to the syndemics literature by modeling syndemic conditions using LCA with an explicit focus on distinct combinations, rather than the sum, of syndemic conditions and their associations with sexual minority men's HIV-risk behavior. Given primary reliance on the count approach in existing syndemics research, person-centered statistical methods (e.g., LCA) can bring needed nuance to modeling syndemic conditions. To do this, we first sought to utilize LCA to uncover classes of sexual minority men reporting distinct combinations of syndemic conditions (i.e., alcohol misuse, polydrug use, suicidality, and HIV), within a sample of sexual minority men recruited across geographically representative regions of the U.S. Second, we aimed to expand upon existing research by examining associations between demographic (e.g., race/ethnicity, sexual orientation, age) and social status characteristics (i.e., parent class background, hometown rurality, level of socioeconomic distress) and syndemic class membership. Third, we sought to determine whether HIV-risk behavior differed across syndemic latent classes. Fourth, we sought to examine sexual minority men's syndemic class membership as a predictor of HIV-risk behavior. Results from this study can reveal how syndemic conditions might cluster in populations of sexual minority men and document how distinct syndemic combinations might drive HIV-risk behavior. Additionally, such findings can inform the development and delivery of targeted interventions addressing syndemic conditions in this population.

Method

Participants

Participants were recruited from the largest sexual minority men's geosocial mobile application (i.e., Grindr) to complete measures regarding stress experiences, coping behaviors, mental health, and HIV-risk behavior. We conducted a three-stage sampling strategy to recruit a sample representative of the geographic distribution of the U.S. First, we recruited from the four most populous cities in the U.S. (i.e., New York, Los Angeles, Chicago, and Houston). Second, we recruited from 20 randomly selected small

urban areas in the U.S. (i.e., cities with a population of 100,000 or more, excluding the 10 most populous cities). Third, we recruited from 20 randomly selected rural counties in the U.S. (i.e., counties with a population of 250,000 or fewer). Eligibility criteria included being at least 18 years of age, assigned male sex at birth, identifying as a sexual minority man (i.e., gay or bisexual or reporting recent attraction to or sex with men), and current U.S. residence. In total, 1409 participants met eligibility criteria and began the survey and 1100 completed the outcome of interest (i.e., HIV-risk behavior). Of these 1100, we dropped 163 who had missing data on the following measures: demographics, social status characteristics, and syndemic conditions. Thus, our final analytic sample included 937 sexual minority men, and we used complete case analysis. Post-hoc sensitivity analyses utilizing multiple imputation methods to impute missing data for the 163 dropped participants found negligible differences in results from those presented below. That is, we found similarities in the direction, magnitude, and significance in the association between latent class membership and HIV-risk behavior while accounting for classification error in class assignment when using the imputed data compared to the dataset using complete case analysis. All participants provided informed consent, and study procedures were approved by the Human Subjects Committee at Yale University.

Measures

Demographic Characteristics.—Participants indicated their race/ethnicity (response options included: American Indian/Alaska Native, Asian, Black/African American, Native Hawaiian/Pacific Islander, Multiracial, White, and other), sexual orientation (response options included: gay, bisexual, heterosexual, queer, uncertain, and asexual), and age. Because of small cell sizes and based on prior studies using a similar approach (e.g., Pantalone, Valentine, Woodward, & O’Cleirigh, 2018), racial/ethnic groups were collapsed into white and people of color (i.e., American Indian/Alaska Native, Asian, Black/African American, Native Hawaiian/Pacific Islander, Multiracial, and other). Sexual orientation groups were collapsed into gay, bisexual, and other (i.e., queer, uncertain, and asexual).

Social Status Characteristics.—To measure social status characteristics shown to be associated with syndemic conditions among sexual minority men (McKee et al., 2018; Millett et al., 2012; Oster et al., 2014; Parsons et al., 2017; Reif, Safley, McAllaster, Wilson, & Whetten, 2017; Stall et al., 2008; Vincent et al., 2019), we measured parent class background, hometown rurality, and current socioeconomic distress. Parent class background was assessed through a question that asked participants to indicate the class background of their parents (i.e., rich, upper middle class, middle class, working class, and poor). This variable was dichotomized to indicate individuals whose parents were considered poor (7.5%) versus working class or greater (92.5%). Hometown rurality was assessed through a question that asked participants to indicate the type of location they grew up (i.e., large central city; medium size city; suburb of a large or medium size city; small city; and, town, village, or unincorporated area). This variable was dichotomized to indicate those who lived in a town, village or small city (28.6%) versus those who lived in a medium size city or larger (71.0%).

Socioeconomic distress was assessed through four questions: (1) total yearly personal income during the past year on a scale of 1 (\$9999 or less per year) to 11 (\$100,000 or more per year); (2) how participants feel about their current financial situation on a scale of 1 (never worry about it) to 5 (always worry about it); (3) current employment status on a scale of 1 (unemployed) to 7 (full time [40 h or more per week]); and (4) level of education on a scale of 1 (some high school) to 8 (advanced graduate school degree). To calculate socioeconomic distress, total personal yearly income was dichotomized as having earned \$20,000 or more per year (0) versus having earned \$19,999 or less per year (1), similar to prior research examining syndemic conditions among sexual minority men (Vincent et al., 2019). Worry about current financial situation was dichotomized as “do not always worry about current financial situation” (0) versus “always worry about current financial situation” (1). Current employment status was dichotomized as employed full time (0) versus unemployed or employed part time (1). Education was dichotomized as having more than a high school diploma or GED (0) versus receiving up to a high school diploma or GED (1). A composite variable was created to indicate individuals who earned less than \$20,000 per year, were “always worried” about their current financial situation, were currently unemployed or employed part time, or did not complete education beyond a high school diploma or GED—known indicators of socioeconomic distress (Cuevas et al., 2020; Vincent et al., 2019). Scores on socioeconomic distress ranged from 0 (44.7%, $n = 419$) to 4 (1.2%, $n = 11$). Finally, a dichotomous variable was created to indicate individuals who reported low socioeconomic distress (i.e., those who reported a 2 or below on the composite socioeconomic distress variable; 89.2%, $n = 836$) versus high socioeconomic distress (i.e., those who reported a 3 or above on the composite socioeconomic distress variable; 10.8%, $n = 101$).

HIV-Risk Behavior.—Participants indicated the number of times they had sexual intercourse in the past 90 days, and for each sexual event, they specified self and partner HIV status (positive or unknown versus negative), self and partner pre-exposure prophylaxis use (when either was HIV-negative), and self and partner undetectable viral load status (when either was HIV-positive). HIV-risk behavior was calculated as sexual intercourse, excluding oral events, that took place without condoms between serodiscordant or HIV status unknown partners when neither partner was protected by pre-exposure prophylaxis (for HIV-negative partners) or undetectable viral load (for HIV-positive partners). This approach recognizes current HIV prevention strategies and lends itself to identifying those participants who are not only at high risk of HIV infection but also HIV transmission. Approximately 16.6% of the sample ($n = 156$) indicated at least one such HIV-risk event. The range of HIV-risk events was 0 to 126.

Syndemic Conditions.—Syndemic conditions included alcohol misuse, polydrug use, suicidality, and HIV. All syndemic conditions were treated as dichotomous given that this study focused on advancing knowledge of the clustering of sexual minority men who report an accumulation of risk of alcohol misuse, polydrug use, suicidality, and HIV-positive status, consistent with the syndemic framework (Stall et al., 2003) and with prior syndemics research (Chakrapani et al., 2019). Alcohol misuse in the past year was measured by the Alcohol Use Disorders Identification Test (AUDIT), a 10-item questionnaire that identifies

hazardous drinkers, harmful drinkers, and individuals with alcohol use dependency (Bohn, Babor, & Kranzler, 1995). Item responses range from 0 (never) to 4 (daily or almost daily). A cutoff value of 8 was used to identify, with high sensitivity and specificity, hazardous or harmful alcohol misuse (Conigrave, Saunders, & Reznik, 1995; Reinert & Allen, 2002), consistent with research examining psychosocial health problems among sexual minority men (Ogunbajo et al., 2020; Tan, Leon-Carlyle, Mills, Moses, & Carvalhal, 2016). Alcohol misuse was dichotomized as no alcohol misuse (0) versus alcohol misuse (1). Polydrug use was measured by the Self-Evaluation of Drug Use measure, an 11-item measure that identifies illicit substance use in the past three months (Miller & Appel, 2010). For each substance type (e.g., tranquilizers, methamphetamine, etc.), participants indicated if they used that substance in the past three months, and if so, on how many days. Consistent with previous research, participants reporting use of more than one substance in the past three months were coded as having engaged in polydrug use (Boeri, Sterk, Bahora, & Elifson, 2008; Daskalopoulou et al., 2014; Smith, Farrell, Bunting, Houston, & Shevlin, 2011). Polydrug use was dichotomized as no polydrug use (0) versus any polydrug use (1). Suicidality was measured by an affirmative response to one item from the Brief Symptom Inventory (Derogatis & Melisaratos, 1983) that asked participants to indicate if in the past seven days they had thoughts of ending their life. Suicidality was dichotomized as absence of suicidality (0) versus presence of suicidality (1). HIV status was measured by one question that asked participants to indicate if their HIV status was positive, negative, or unknown. HIV status was dichotomized as negative or unknown (0) versus positive (1).

Analytic Plan

Descriptive statistics were conducted to describe the demographic, social status characteristics, and syndemic conditions of the sample. We then used the three-step latent class analytic approach, which prevents measurement bias related to class membership by correcting for classification error (Bakk, Tekle, & Vermunt, 2013), to carry out the following four study aims: (1) uncover classes of sexual minority men reporting distinct combinations of syndemic conditions; (2) examine associations between demographic and social status characteristics and syndemic class membership; (3) assess between-group differences in HIV-risk behavior across syndemic latent classes; and (4) test syndemic class membership as a predictor of sexual minority men's past-90-day HIV-risk behavior. Specifically, the three-step analytic approach was performed using the following three steps: First, a latent class model was built for our set of syndemic indicators. Second, participants were assigned to their most likely latent class. These first two steps were used to execute the first study aim. Then, the latent classification scores were related to external variables of interest (i.e., demographic and social status characteristics, HIV-risk behavior), correcting for the classification error to prevent bias (Bakk et al., 2013). For all regression models (i.e., step three), we utilized the bias-adjusted maximum likelihood approach (Bakk et al., 2013). This third step in the three-step approach as outlined by Bakk et al. (2013) was employed to fulfill the remaining three study aims, respectively.

In the first step, we conducted LCA with four binary variables representing four syndemic conditions: (1) alcohol misuse; (2) polydrug use; (3) suicidality; and (4) HIV. LCA is a finite mixture modeling approach used to classify individuals into mutually exclusive subgroups,

or classes, based on their probability of affirmative response to each indicator variable, in this case each syndemic condition (Collins & Lanza, 2010; Muthén & Muthén, 2000). We fit models with 1 to 7 classes and specified a priori the following criteria to identify the most optimally fitting LCA model: relative fit, including low Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and sample-size adjusted BIC (SABIC); entropy above .70; a significant p value for the Lo–Mendell–Rubin (LMR) test; and class size (Lanza & Rhoades, 2013; Nylund-Gibson & Choi, 2018) and inter-pretability based on whether the classes were in line with our conceptual and theoretical framing (Collins & Lanza, 2010; Dias, 2006), namely syndemic theory (Singer, 1994, 2000). The average posterior probabilities of class membership or size of the class were used to examine class homogeneity (Nylund, Asparouhov, & Muthén, 2007). Posterior probabilities above 0.60 indicate that the classes are well separated and that the class assignment accuracy is adequate (Nagin, 2005).

In the second step, participants were assigned to their most likely latent class based on the posterior membership probabilities derived from the first step (Vermunt & Magidson, 2016).

In the third step, we employed a multinomial logistic regression, an omnibus test, and a quasi-Poisson regression model to satisfy the remaining aims of the current study, respectively. Specifically, we utilized multinomial logistic regression to model associations between demographic and social status characteristics with syndemic condition classes identified by the LCA. To do this, we regressed latent class membership onto demographic and social status characteristics while accounting for classification error in class assignment (Bakk et al., 2013). For this model, the reference class was “No Syndemic Class.”

An omnibus test was then conducted to detect differences in HIV-risk behavior across syndemic latent classes. Significant pairwise comparisons of class differences were interpreted as differences in HIV-risk behavior between syndemic latent classes. Because our examination of multiple pairwise comparisons might have inflated Type I error, we performed a post hoc adjustment of p values using Benjamini–Hochberg procedures (Benjamini & Hochberg, 1995) for comparisons between syndemic latent classes and HIV-risk behavior. All effects that were significant at $p < .05$ before adjustment remained significant at $p < .05$ post-adjustment, except for the comparison between Class 1 (“No Syndemic Class”) and Class 3 (“Polydrug Use and HIV Syndemic Class”).

Finally, a quasi-Poisson regression model was used to examine latent class membership as a predictor of HIV-risk behavior. Count of HIV-risk behavior events was regressed onto latent class membership while accounting for classification error in class assignment. Regression models were adjusted for sexual orientation and age based on theoretical and empirical evidence documenting the association between these predictors and both the independent (i.e., syndemic conditions) and dependent (i.e., HIV-risk behavior) variables (Mimiaga et al., 2015; Mustanski et al., 2007; Stall et al., 2003).

We present Wald test statistics, adjusted odds ratios (AOR), adjusted risk ratios (ARR), and 95% confidence intervals. Descriptive statistics were conducted in SPSS version 24 (IBM Corp., 2016), LCA was conducted in MPlus version 8.1 (Muthén & Muthén, 2017), and the

bias-adjusted three-step latent class analytic approach (Bakk et al., 2013) was implemented in Latent GOLD software version 5.1 (Vermunt & Magidson, 2016).

Results

Sample Characteristics

Table 1 shows the demographic and social status characteristics of the sample. Participants' mean age was 30.78 years old ($SD = 9.8$). Most participants identified as white (62.9%). A majority of participants identified as gay (73.4%) or bisexual (23.7%). Most reported their parent class background as working class or greater (92.5%) and that they grew up in a medium size city or larger (71.0%), were employed full time (57.5%), earned \$20,000 or more per year (64.1%), and had at least a high school education (89.4%). Fewer than half of participants "sometimes worry" about their financial status (40.9%) and most reported low socioeconomic distress (89.2%). A total of 25.2% of the participants engaged in alcohol misuse in the past year, 17.9% engaged in polydrug use the past three months, 23.4% experienced suicidality in the past week, and 8.6% were living with HIV. Of the sample, 108 (12.6%) of sexual minority men not living with HIV reported an HIV-risk event in the past 90 days compared to 48 (59.6%) of sexual minority men living with HIV.

Model Fit Assessment and Model Comparisons of Syndemic Latent Classes

To identify the optimal number of syndemic latent classes, we estimated models ranging from one to seven classes (see Table 2). Although the two-class solution had the lowest BIC and aBIC and a significant p -value for the LMR test, the AIC decreased with the three-class solution. In addition, the entropy increased with the four-class solution, indicating that class separation is relatively high in this class and suggesting better model fit than the one-, two-, or three-class solutions (Morgan, 2015). Further, the AIC, BIC, and aBIC continue to increase and the entropy continues to decrease in the five-, six-, and seven-class solutions, indicating that class separation is relatively low in each of these classes. As such, the 4-class LCA solution was deemed most optimal based on the previously noted model fit criteria (Lanza & Rhoades, 2013).

Figure 1 presents the profile plot of the four-class model where the specific item class probabilities are plotted on the y -axis and the four LCA syndemic condition indicators are on the x -axis. Class 1 was characterized by low probabilities across alcohol misuse, polydrug use, suicidality, and HIV-positive status ("No Syndemic Class"; $n = 791$; 84.4%). Class 2 was characterized by high probabilities of alcohol misuse and polydrug use and low probabilities of suicidality and HIV-positive status ("Alcohol Misuse and Polydrug Use Class"; $n = 72$; 7.7%). Class 3 was characterized by a high probability of polydrug use and HIV-positive status and moderate probabilities of alcohol misuse and suicidality ("Polydrug Use and HIV Syndemic Class"; $n = 23$; 2.5%). Class 4 was characterized by a high probability of alcohol misuse, a moderate probability of suicidality, and low probabilities of polydrug use and HIV-positive status ("Alcohol Misuse Class"; $n = 51$; 5.4%).

Demographic and Social Status Characteristics Across Latent Class Membership

Table 3 presents results from multinomial logistic regression models regressing latent class membership (reference class = “No Syndemic Class”) on demographic and social status characteristics. Age emerged as a significant predictor of latent class membership (Wald = 16.93, $p < .001$). Specifically, older sexual minority men compared to younger sexual minority men demonstrated lower odds of being in the “Alcohol Misuse and Polydrug Use Syndemic Class” (AOR = 0.96, 95% CI: 0.93, 0.99) and greater odds of being in the “Polydrug Use and HIV Syndemic Class” (AOR = 1.05, 95% CI: 1.01, 1.08) than in the “No Syndemic Class.” In addition, socioeconomic distress was a significant predictor of sexual minority men’s latent class membership (Wald = 9.34, $p < .05$). Sexual minority men who reported high socioeconomic distress had greater odds of being in the “Polydrug Use and HIV Syndemic Class” (AOR = 4.02, 95% CI: 1.19, 13.63) than in the “No Syndemic Class” compared to sexual minority men who reported low socioeconomic distress. Contrary to our hypotheses, there were no differences across race/ethnicity, sexual orientation, parent class background, or hometown rurality in sexual minority men’s likelihood of being in the “Alcohol Misuse and Polydrug Use Syndemic Class,” the “Polydrug Use and HIV Syndemic Class,” or the “Alcohol Misuse Class” compared to the “No Syndemic Class.”

Differences in HIV-Risk Behavior Across Syndemic Latent Classes

We conducted pairwise comparisons for HIV-risk behavior to determine which syndemic latent classes significantly differed from each other (Table 4). After adjusting for multiple comparisons, we found that significant differences in HIV-risk behavior emerged between sexual minority men in the “No Syndemic Class” and the “Alcohol Misuse Class” (Wald = 13.84, $p < .001$), between sexual minority men in the “Alcohol Misuse and Polydrug Use Syndemic Class” and the “Polydrug Use and HIV Syndemic Class” (Wald = 6.38, $p < .01$), and between sexual minority men in the “Polydrug Use and HIV Syndemic Class” and “Alcohol Misuse Class” (Wald = 18.50, $p < .001$). There were no differences in HIV-risk behavior between sexual minority men in the “No Syndemic Class” and the “Alcohol Misuse and Polydrug Use Class” and between the “Alcohol Misuse and Polydrug Use Syndemic Class” and the “Alcohol Misuse Class.”

Syndemic Class Membership as a Predictor of HIV-Risk Behavior

Table 5 presents results from a quasi-Poisson regression model regressing count of HIV-risk behavior events onto latent class membership with “No Syndemic Class” as the reference group. After adjusting for sexual orientation and age, a Wald test indicated that syndemic class membership was a significant predictor of HIV-risk behavior (Wald = 21.39, $p < .001$). Specifically, the risk of engaging in HIV-risk behavior among sexual minority men in the “Polydrug Use and HIV Syndemic Class” and the “Alcohol Misuse Class” was 193% higher and 83% lower, respectively, than the risk of engaging in HIV-risk behavior among sexual minority men in the “No Syndemic Class.”

Discussion

With a diverse sample of sexual minority men in the U.S., we employed LCA to: (1) uncover classes of sexual minority men who report distinct combinations of syndemic conditions

(i.e., alcohol misuse, polydrug use, suicidality, and HIV); (2) identify the demographic (e.g., race/ethnicity) and social status (e.g., level of socioeconomic distress) characteristics associated with each syndemic class; (3) determine whether HIV-risk behavior differed across latent classes of syndemic conditions; and (4) examine class membership as a predictor of recent HIV-risk behavior. Findings demonstrated that four unique classes of syndemic conditions emerged: “No Syndemic Class,” “Alcohol Misuse and Polydrug Use Syndemic Class,” “Polydrug Use and HIV Syndemic Class,” and “Alcohol Misuse Class.” In addition, classes were distinctly associated with age and socioeconomic distress. We also found that HIV-risk behavior differed across latent classes. Finally, latent class membership predicted HIV-risk behavior. Taken together, findings from the current study suggest the importance of identifying unique subgroups of sexual minority men at greatest risk of HIV-risk behavior as well as demographic and social status characteristics associated with syndemic classes.

Similar to a previous study among transgender women (e.g., Chakrapani et al., 2019), distinct classes of syndemic conditions were observed among sexual minority men and differentially associated with HIV-risk behavior. Specifically, sexual minority men living with HIV were at elevated risk of engaging in HIV-risk behavior, with this association exacerbated by the additional presence of polydrug use. Indeed, sexual minority men living with HIV were not at elevated risk of engaging in HIV-risk behavior compared to those who did not report any syndemic conditions. Further, 40.7% sexual minority men living with HIV did not report an HIV-risk event in the past 90 days, highlighting that the co-occurrence of HIV-positive status and polydrug use was a unique driver of HIV-risk behavior in this population. These findings are in line with evidence documenting that sexual minority men living with HIV are less likely to use condoms and sexual minority men reporting substance use are more likely to engage in HIV-risk behavior (Boone, Cook, & Wilson, 2013; Halkitis et al., 2013; Kurtz, Buttram, Surratt, & Stall, 2012). Further, sexual minority men living with HIV may face additional discrimination from within and outside the gay community (Cloete, Simbayi, Kalichman, Strebel, & Henda, 2008; Dowshen, Binns, & Garofalo, 2009). Indeed, HIV-related stigmatization has been linked to HIV-risk behavior among sexual minority men living with HIV (Rao, Kekwaletswe, Hosek, Martinez, & Rodriguez, 2007; Rendina et al., 2016). Sexual minority men living with HIV might experience unique stressors not faced by sexual minority men who are not living with HIV, which might contribute to greater HIV-risk behavior (Rendina et al., 2016).

This study also documented that sexual minority men in the alcohol misuse class might be protected from engaging in HIV-risk-taking behavior compared to sexual minority men in the no syndemic class. Prior studies have demonstrated inconsistent findings regarding the association between alcohol misuse and HIV-risk behavior among sexual minority men (Newcomb, Clerkin, & Mustanski, 2011). For instance, some studies have shown that rates of HIV-risk behavior do not vary as a function of sexual minority men’s alcohol use (Venable et al., 2004; Weatherburn et al., 1993), while other findings have demonstrated a positive relationship between alcohol misuse and HIV behavior among sexual minority men who engage in receptive anal intercourse (Irwin, Morgenstern, Parsons, Wainberg, & Labouvie, 2006). One possibility is that sexual minority men who misuse alcohol may develop firmly established routines associated with drinking, including condom use and HIV

medication adherence, reducing risk of HIV infection and transmission in this population (Sankar, Wunderlich, Neufeld, & Luborsky, 2007). In addition, sexual minority men who use alcohol may report greater community connectedness with other sexual minority men – a known protective factor for reducing risk of HIV acquisition and transmission (Zarwell, Ransome, Barak, Gruber, & Robinson, 2019). More research is needed into other factors (e.g., treatment history, psychiatric comorbidity, health consciousness, impulsivity) that might help to explain why sexual minority men who reported higher levels of alcohol misuse were at reduced risk of engaging in HIV-risk behavior compared to sexual minority men who reported low levels of alcohol misuse, polydrug use, suicidality, and HIV. Importantly, this finding is at odds with the traditional count approach often used to analyze the association between syndemic conditions and sexual minority men's HIV risk which generally suggests that a higher number of syndemic conditions confers greater risk. Instead, this finding highlights the utility of employing more nuanced analytic approaches, such as LCA, that offer a person-centered approach to understanding HIV risk in the lives of sexual minority men.

Our findings highlight the importance of identifying subgroups of sexual minority men who report certain combinations of syndemic conditions that might not be directly observable when examining bivariate associations (Lanza & Rhoades, 2013). In addition, the current study is one of the first, to our knowledge, to examine associations between demographic and social status characteristics with syndemic class membership among a diverse sample of sexual minority men in the U.S. Younger sexual minority men were more likely to be in the “Alcohol Misuse and Polydrug Use Syndemic Class” than the “No Syndemic Class” compared to older sexual minority men. This finding is noteworthy considering that earlier initiation of alcohol and substance use is associated with persistent use and misuse among sexual minority men (Newcomb, Ryan, Greene, Garofalo, & Mustanski, 2014; Thiede et al., 2003). Our finding that membership in the “Polydrug Use and HIV Syndemic Class” was concentrated among older sexual minority men is consistent with previous findings over the past decade documenting greater comorbidity for older HIV-positive sexual minority men (e.g., Lyons, Pitts, & Grierson, 2013; Lyons, Pitts, Grierson, Thorpe, & Power, 2010). These issues present challenges for health services providers caring for older HIV-positive sexual minority men given that drug use in older adults living with HIV does not decline with age (Lyons et al., 2010; Rabkin, McElhiney, & Ferrando, 2004). Furthermore, the burden of drug use among older sexual minority men living with HIV may contribute to depression and anxiety, cognitive decline, limitations in social life, and impairment in functioning (Peate, 2013; Rosenfeld, Bartlam, & Smith, 2012; Skalski, Sikkema, Heckman, & Meade, 2013).

In line with syndemic theory (Singer, 1994, 2000) and prior literature documenting that the HIV epidemic is tied to poverty and other syndemic conditions such as polydrug use (Halkitis et al., 2011; Wolitski, Stall, & Valdiserri, 2008), this study demonstrated that sexual minority men who reported high socioeconomic distress (e.g., living in poverty, always worrying about financial status) were more likely than those who reported low socioeconomic distress to be in the “Polydrug Use and HIV Syndemic Class” than the “No Syndemic Class.” The current findings offer additional evidence that poor social conditions, including poverty, financial-related worry, unemployment or underemployment, and low educational attainment, are associated with distinct combinations of

syndemic conditions (e.g., polydrug use, HIV) among sexual minority men and that these combinations of syndemic conditions are associated with differential HIV-risk behavior. Indeed, socioeconomic distress may drive sexual minority men's risk of HIV acquisition due to lacking adequate healthcare, accessing financial resources through transactional sex, and engaging in coping-oriented substance use (Bond et al., 2019; Earnshaw et al., 2020; Wilson et al., 2014). Future studies should examine mechanisms that help to explain trajectories of syndemic class membership over time to improve recommendations for modifiable targets for prevention of alcohol misuse, polydrug use, suicidality and HIV among sexual minority men.

Public Health and Clinical Relevance

Results from this study indicate the need to develop targeted prevention and treatment approaches for sexual minority men most likely to engage in HIV-risk behavior, namely those who are engaging in polydrug use and living with HIV. For instance, sexual minority men who test positive for HIV should be linked to HIV care and referred to health care providers who offer comprehensive sexual health evaluations, routine testing for sexually transmitted infections, and substance use treatment (Centers for Disease Control and Prevention, 2015). Additionally, referrals and case management should make targeted efforts to support aging sexual minority men given their increased risk of polydrug use in addition to chronic diseases, including HIV, whose effects can accumulate with time. For instance, providers should routinely assess polydrug use among older sexual minority men seeking services for HIV and offer psychoeducation regarding coping-oriented substance use (Lyons et al., 2010).

Providers might consider engaging sexual minority men at highest risk of HIV-risk behavior (i.e., those engaging in polydrug use and living with HIV) in online prevention and treatment interventions given their efficacy in reducing substance use and HIV-risk behavior in this subpopulation (Lelutiu-Weinberger et al., 2015; Mustanski, Garofalo, Monahan, Gratzner, & Andrews, 2013). In addition to targeted HIV prevention efforts, our findings support the need for structural and institutional interventions that emphasize support for young sexual minority men who are using alcohol and other substances given that younger sexual minority men were more likely to be in the "Alcohol Misuse and Polydrug Use Syndemic Class" than the "No Syndemic Class" compared to older sexual minority men. Finally, this study suggests a need for affordable education, job training programs, and financial management to reduce the prevalence of polydrug use and HIV among sexual minority men living in high socioeconomic distress.

Limitations

Results reported here should be interpreted in light of the study's limitations. The cross-sectional design of this study precludes causal inference and the inconsistent timeframe of its variables further limits understanding temporal ordering of sexual minority men's demographic and social status characteristics, syndemic conditions, and HIV-risk behavior. Future longitudinal research can evaluate the temporal associations among these phenomena, including by employing latent transition analysis to examine how combinations of syndemic conditions change over time. Further, while LCA was used here to uncover distinct

subgroups of sexual minority men based on HIV acquisition risk factors, LCA does not establish causal relationships. Ecological momentary assessment of syndemic conditions, including alcohol misuse, polydrug use, suicidality, and HIV diagnosis or testing, would allow for an examination of the more immediate temporal influence of these syndemic conditions on HIV-risk behavior. Additionally, this study utilized retrospective self-report measures of demographic and social status characteristics, syndemic conditions, and HIV-risk behavior, thereby introducing the possibility of biased reporting. This study also used only one item to reflect hometown rurality and parent class background, respectively, which could have limited variability in these predictors of syndemic latent classes. Moreover, this study only used one item to reflect the presence of suicidality, which could have caused misclassification in our latent classes.

Conclusion

The present study used latent class analysis (LCA) to uncover population subgroups of sexual minority men based on classes of their syndemic conditions, determine differences in HIV-risk behavior across syndemic latent classes, identify the demographic and social status characteristics of syndemic class membership, and examine associations between syndemic class membership and HIV-risk behavior in this population. Findings demonstrate that, in comparison with sexual minority men not experiencing syndemic conditions, sexual minority men concurrently engaging in polydrug use and living with HIV demonstrate elevated HIV-risk behavior while sexual minority men engaging in higher levels of alcohol misuse demonstrate reduced HIV-risk behavior. Our study also highlights the shortcomings of the traditional count analytic approach used to examine the association between syndemic conditions and HIV-risk among sexual minority men and, instead, demonstrates that LCA represents a promising approach to understanding how specific combinations of syndemic conditions correspond to HIV-risk behavior in this population. The current study's use of LCA provides novel information that can be used to guide the development and delivery of tailored interventions targeting combinations of syndemic conditions among sexual minority men. Moreover, these findings underscore the importance of reducing the social determinants of sexual minority men's numerous adverse health experiences, with attention to age, poverty, education, and employment, found here to be uniquely associated with alcohol misuse, polydrug use, and HIV in this population.

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Fig. 1.
Conditional item probability profile plot for the four-class model of syndemic conditions

Table 1Sample characteristics ($N = 937$)

	<i>n</i> (%)	<i>M</i> (<i>SD</i>)
<i>Demographic characteristics</i>		
Race/ethnicity		
American Indian or Alaskan Native	17 (1.8)	
Asian	65 (6.9)	
Black/African American	100 (10.7)	
Native Hawaiian or other Pacific Islander	6 (.6)	
Multiracial	97 (10.4)	
White	589 (62.9)	
Other (please specify):	63 (6.7)	
Sexual orientation		
Gay	668 (73.4)	
Bisexual	222 (23.7)	
Other ^a	27 (2.9)	
Age (range: 18–68; median = 28)		30.78 (9.8)
<i>Social status characteristics</i>		
Parent class background		
Poor	70 (7.5)	
Working class or greater	867 (92.5)	
Hometown rurality		
Town, village, or small city	268 (28.6)	
Medium size city or larger	665 (71.0)	
Employment status		
Unemployed or employed part time	398 (42.5)	
Employed full time	539 (57.5)	
Annual income		
\$9,999 or less	193 (20.6)	
\$10,000 to \$19,999	143 (15.3)	
\$20,000 to \$29,000	137 (14.6)	
\$30,000 to \$39,000	118 (12.6)	
\$40,000 to \$49,000	102 (10.9)	
\$50,000 to \$59,000	58 (6.2)	
\$60,000 to \$69,000	45 (4.8)	
\$70,000 to \$79,000	37 (3.9)	
\$80,000 to \$89,000	19 (2.0)	
\$90,000 to \$99,000	16 (1.7)	
\$100,000 or more	69 (7.4)	
Education		
High school/GED or lower	99 (10.6)	
Greater than high school/GED	838 (89.4)	

	<i>n</i> (%)	<i>M</i> (<i>SD</i>)
Worry about financial status		
Never worry about it	41 (4.4)	
Rarely worry about it	156 (16.6)	
Sometimes worry about it	383 (40.9)	
Most of the time worry about it	219 (23.4)	
Always worry about it	136 (14.5)	
Socioeconomic distress		
Low socioeconomic distress	836 (89.2)	
High socioeconomic distress	101 (10.8)	
Syndemic conditions		
Alcohol misuse	236 (25.2)	
Polydrug use	168 (17.9)	
Suicidality	219 (23.4)	
HIV-positive status	81 (8.6)	

Note

^aOther sexual orientation includes men who identified as queer ($n = 21$, 2.2%), heterosexual ($n = 1$, 0.1%), or unsure ($n = 5$, 0.5%)

Table 2
Model fit indices and model comparison statistics for mixture modeling of syndemic conditions

Number of classes	Akaike information criterion	Bayesian information criterion	Sample-size adjusted Bayesian information criterion	Lo, Mendell, and Rubin Likelihood Ratio Test	Entropy	Number of free parameters
1	3516.86	3536.23	3523.53	N/A	N/A	4
2	3468.44	3512.03	3483.44	<.001	1	9
3	3466.38	3534.18	3489.71	0.06	0.73	14
4 [*]	3474.14	3566.15	3505.80	0.30	0.88	19
5	3483.06	3599.28	3523.06	0.74	0.64	24
6	3493.06	3633.50	3541.40	0.91	0.69	29
7	3503.06	3667.71	3559.73	0.01	0.57	34

Note

* Model selected as providing the best fit, as demonstrated by the relatively small Akaike Information Criterion, Bayesian Information Criterion, relatively high entropy, and relatively few number of parameters

Table 3
Multinomial logistic regression model of predictors of syndemic latent classes among sexual minority men

Predictors	Class 2 ("Alcohol Misuse and Polydrug Use Syndemic Class"; <i>n</i> = 72; 7.7%)		Class 3 ("Polydrug Use and HIV Syndemic Class"; <i>n</i> = 23; 2.5%)		Class 4 ("Alcohol Misuse Class"; <i>n</i> = 51; 5.4%)		Wald statistic	Omnibus <i>p</i> -value
	AOR (95% CI)	SE	AOR (95% CI)	SE	AOR (95% CI)	SE		
<i>Demographic Characteristics</i>								
Race/ethnicity								
White	ref		ref		ref		3.10	.38
Racial/ethnic minority	0.85 (0.50, 1.45)	0.27	1.19 (0.42, 3.35)	0.53	0.65 (0.39, 1.08)	0.26		
Sexual orientation							7.13	.31
Gay	ref		ref		ref			
Bisexual	0.56 (0.28, 1.14)	0.36	0.21 (0.03, 1.54)	1.01	1.24 (0.73, 2.11)	0.27		
Other ^a	0.38 (0.05, 3.04)	1.06	1.84 (0.25, 13.45)	1.02	1.15 (0.31, 4.28)	0.67		
Age	0.96 (0.93, 0.99)	0.02	1.05 (1.01, 1.08)	0.02	0.97 (0.95, 1.00)	0.01	16.93***	<.001
<i>Social status characteristics</i>								
Parent class background							.64	.89
Working class or greater	ref		ref		ref			
Poor	0.75 (0.25, 2.20)	0.55	0.47 (0.03, 6.81)	1.37	1.08 (0.46, 2.53)	.44		
Hometown rurality							3.83	.28
Town, village, or small city	ref		ref		ref			
Medium size city or larger	0.91 (0.52, 1.60)	0.29	5.27 (0.91, 30.53)	0.90	0.88 (0.53, 1.46)	0.26		
Socioeconomic distress ^b							9.34*	.03
Low socioeconomic distress	ref		ref		ref			
High socioeconomic distress	0.59 (0.22, 1.58)	0.51	4.02 (1.19, 13.63)	0.62	0.44 (0.17, 1.14)	0.49		

Note AOR adjusted odds ratio; CI confidence interval; ref reference group. Omitted (reference) category is "Class 1 (No Syndemic Class)" for latent classes of syndemic conditions (*n* = 791, 84.4%)

^a Other sexual orientation includes men who identified as queer (*n* = 21, 2.2%), heterosexual (*n* = 1, 0.1%), or unsure (*n* = 5, 0.5%)

^b Socioeconomic distress (i.e., a composite index of current financial status, education attainment, work status, and worry about current financial status)

* $p < .10$,

* $p < .05$,

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Table 4

Paired comparisons between latent classes of syndemic conditions on HIV-risk behavior using a 4-class solution

Comparison between classes	Wald statistic	p-value	Benjamini–Hochberg adjusted p-value
Class 1 (“No Syndemic Class”) and Class 2 (“Alcohol Misuse and Polydrug Use Syndemic Class”)	1.45	.23	.23
Class 1 (“No Syndemic Class”) and Class 3 (“Polydrug Use and HIV Syndemic Class”)	4.18 [‡]	.04	.06
Class 1 (“No Syndemic Class”) and Class 4 (“Alcohol Misuse Class”)	13.84 ^{***}	<.001	<.001
Class 2 (“Alcohol Misuse and Polydrug Use Syndemic Class”) and Class 3 (“Polydrug Use and HIV Syndemic Class”)	6.38 [*]	.01	.02
Class 2 (“Alcohol Misuse and Polydrug Use Syndemic Class”) and Class 4 (“Alcohol Misuse Class”)	3.51 [‡]	.06	.07
Class 3 (“Polydrug Use and HIV Syndemic Class”) and Class 4 (“Alcohol Misuse Class”)	18.50 ^{***}	<.001	<.001

Note A significant adjusted p-value associated with the Wald statistic indicates that the parameters significantly differ between the respective classes. Degrees of freedom for all models = 1

[‡] $p < .10$,
^{*} $p < .05$,
^{**} $p < .01$,
^{***} $p < .001$

Table 5
Quasi-Poisson regression model demonstrating latent class predicting HIV-risk behavior

	HIV-risk behavior	Adj. RR	SE	95% CI	Wald statistic	Omnibus <i>p</i> -value
<i>Syndemic Class</i>						
Class 1 ("No Syndemic Class"; <i>n</i> = 791; 84.4%)	<i>ref</i>				21.39 ***	<.001
Class 2 ("Alcohol Misuse and Polydrug Use Syndemic Class"; <i>n</i> = 72; 7.7%)	0.56		0.49	0.22, 1.45		
Class 3 ("Polydrug Use and HIV Syndemic Class"; <i>n</i> = 23; 2.5%)	2.93 *		0.53	1.05, 8.21		
Class 4 ("Alcohol Misuse Class"; <i>n</i> = 51; 5.4%)	0.17 ***		0.47	0.07, 0.44		
<i>Demographic characteristics</i>						
Sexual orientation						
Gay	<i>ref</i>				2.95	.23
Bisexual	1.48		0.40	0.67, 3.25		
Other	2.71		0.62	0.80, 9.20		
Age	1.01		0.02	0.98, 1.05	0.53	.47

Note Adj. RR adjusted rate ratio; *SE* standard error; *CI* confidence interval; *ref* reference group. All models adjusted for sexual orientation and age

^a HIV-risk behavior (i.e., number of times participants had sexual intercourse in the past 90 days, excluding oral events, that took place without condoms between serodiscordant or HIV status unknown partners when neither partner was protected by pre-exposure prophylaxis [for HIV-negative partners] or undetectable viral load [for HIV-positive partners])

* *p* < .10,

* *p* < .05,

** *p* < .01,

*** *p* < .001