Risk of polysubstance use among sexual minority and heterosexual youth

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**Abstract**

**Background:** Relative to heterosexual youth, sexual minority youth exhibit increased substance use. Risk for polysubstance use, which magnifies drug-related harms, remains largely unexamined for sexual minority youth. This investigation used a nationally-representative dataset to compare polysubstance use patterns between sexual minority and heterosexual youth. **Methods:** The cross-sectional 2015 CDC’s Youth Risk Behavior Surveillance System (*N*=15,624) was utilized. Latent mixture modeling empirically-identified subgroups of youth based on self-reported, past-month use of alcohol, cigarettes, chewing tobacco/snus/snuff, cigars/cigarillos/little cigars, e-cigarettes, marijuana, and past-month binge drinking (all dichotomized: 0 = none; 1 = at least once). Adjusting for race/ethnicity, sex, and age, the risk for being in each substance-using class was compared between youth who self-identified as heterosexual and gay/lesbian, bisexual, or “not sure.” **Results:** Five classes were supported: “non-users” (68.19%), “alcohol users” (13.08%; elevated alcohol use and binge drinking probabilities), “nicotine/marijuana co-users” (5.80%; elevated nicotine and marijuana use), “poly-substance/e-cigarette users” (5.34%; elevated on all substances except tobacco-containing products), and “polysubstance/tobacco users” (7.59%; elevated for all substances). Relative to heterosexual youth, gay/lesbian-identified youth were at risk of being “nicotine and marijuana co-users”, bisexual youth were at risk of being in all four substance-using classes, and the “not sure” youth were at risk of being “polysubstance/tobacco users.” Select disparities were larger for youth who were also female or minority race/ethnicity. **Conclusions**: Sexual minority youth, particularly bisexual youth, were at an increased risk relative to heterosexual youth for polysubstance use. Polysubstance use warrants attention in substance use interventions, including interventions tailored for sexual minority youth.

Keywords: polysubstance use; sexual minority youth; health disparities; alcohol; nicotine; marijuana

**Introduction**

Alcohol, marijuana, and cigarettes are three of the most commonly used drugs among youth, with estimated usage rates in the past 30 days of 32.8%, 21.7%, and 10.8%, respectively (Kann, 2016). A subgroup of youth that appears to be at an increased risk of using alcohol, marijuana, and cigarettes is sexual minority youth (SMY)(Marshal et al., 2008). Youth who use these substances are at risk of several negative health and social outcomes, such as addiction, and poorer cognitive, social, and academic functioning (Hingson and Kenkel, 2004; Mathers et al., 2006; Volkow et al., 2014). These negative consequences are exacerbated when youth use a combination of these substances (Kelly et al., 2015; McKee and Weinberger, 2013; Moss et al., 2014; Ramo et al., 2012); however, the extent and risk of polysubstance use among SMY relative to heterosexual youth remains largely unexamined. Thus, this investigation uses a national epidemiological dataset to describe disparities in substance use patterns, including polysubstance use, associated with sexual orientation.

 “Sexual minority” is a label used to describe an overarching group of individuals that identify with a sexual identity other than heterosexual, report same-sex attraction, and/or report same-sex sexual behavior. According to a meta-analytic investigation, SMY, including lesbian, gay, and bisexual youth, reported nearly three times more substance use than heterosexual youth (Marshal et al., 2008), which included tobacco (Austin et al., 2004; Cochran et al., 2002; Lampinen et al., 2006), alcohol (Robin et al., 2002; Whitbeck et al., 2004), and marijuana (Cochran et al., 2002; Lampinen et al., 2006). Notably, substance use risk differs within SMY, with highest use typically seen for bisexual youth (Dermody et al., 2014; Kerr et al., 2015; Marshal et al., 2008).These disparities have persisted, as demonstrated by a recent analysis of a national epidemiological sample, the 2015 Youth Risk Behavior Surveillance System (YRBS), which found that SMY (i.e., combining lesbian, gay, and bisexual youth) reported higher recent alcohol, marijuana, and cigarette use than heterosexual youth (Kann et al., 2016).

The primary explanatory framework for understanding SMY disparities is the Minority Stress Theory (Meyer, 2003). Minority Stress Theory proposes that discrimination, violence, and victimization due to a pervasive homophobic culture are the primary sources of stress and most probable core etiological causal mechanisms of health problems among sexual minority individuals, including substance use disparities. Consistent with this theory, a recent review of cross-sectional research supported associations between victimization, including both general victimization and sexual minority-related victimization, with alcohol, cigarette, and marijuana use (Goldbach et al., 2013).

While SMY have been shown to be at risk for alcohol, cigarette, and marijuana use independently, these findings may be partially explained by a subset of SMY who use multiple types of or all three substances. According to the syndemic model of disease burden (Singer, 2009), SMY who simultaneously experience several poor physical and social conditions would be expected to experience a full array of interconnected health and social problems. In fact, recent research suggests that SMY are at risk of polysubstance use (Dermody et al., 2016b; Kecojevic et al., 2017). Using a community-based cohort of US youth (n=13,519), Kecojevic et al (2017) identified individuals who reported any polysubstance in the past 12 months (i.e., any use of 3 or more legal or illicit substances). They found that SMY, particularly females, were at risk for past-year polysubstance use relative to completely heterosexual youth. Consistent findings have been supported in a sample of urban female youth (N=2,064) using mixture modeling. Mixture modeling is a person-centered analytic approach that can identify relatively homogenous substance use classes based on patterns of use of multiple substances. There are several advantages of using mixture modeling to identify polysubstance users, such as (1) empirically-determining underlying subgroups of individuals based on the intersection of multiple observed substance-using behaviors, and (2) evaluating and considering various patterns of substance co-use and polysubstance use with varied risk profiles. Using this approach, Dermody et al (2016b) identified five substance-using subgroups: non-users (72%), alcohol-only users (8%), marijuana/alcohol co-users (5%), cigarette/alcohol co-users (8%), and polysubstance users (7%). Relative to female heterosexual youth, female SMY were at an increased risk for being in each substance co-use and polysubstance use group than the non-users group. This initial evidence suggests that there is considerable overlap in these substance-using behaviors among SMY, which could exacerbate the negative consequences of substance use.

An important next step is to attempt to replicate these polysubstance use disparities in a nationally-representative sample, as the few existing studies on SMY polysubstance use has relied on community samples (Dermody et al., 2016b; Kecojevic et al., 2017). The present investigation uses the aforementioned CDC’s nationally-representative epidemiological sample of youth, YRBS. A novel contribution of this study is using a nationally-representative sample to evaluate polysubstance disparities between SMY and heterosexual youth using mixture modeling, which offers several advantages (described above) to accurately describe substance and polysubstance use patterns (including relative use of alcohol, marijuana, and a variety of nicotine-containing products (e.g., cigarettes, smokeless tobacco, e-cigarettes) and associated disparities. Consistent with prior research and the guiding minority stress and syndemic frameworks, it is hypothesized that SMY would be over-represented in the polysubstance group(s) than heterosexual youth.

Using a diverse large-scale nationally-representative and mixture modeling will also allow for evaluating disparities in various forms of substance and polysubstance use among subgroups of SMY and individuals with multiple, intersecting minority identities, which has not been fully addressed in prior research. Preliminary evidence supports larger SMY substance use disparities among racial minorities (Poteat et al., 2009) and, among SMY, a reduced protective effect of minority race/ethnicity on substance use (Talley et al., 2014); however, interactions between sexual orientation and race/ethnicity have not been evaluated for polysubstance use patterns. Furthermore, substance use and polysubstance use disparities related to sexual orientation appear to be strongest for female youth (Corliss et al., 2008; Corliss et al., 2012; Dermody et al., 2014; Kecojevic et al., 2017; Marshal et al., 2008) and bisexual youth (Dermody et al., 2014; Kecojevic et al., 2017; Kerr et al., 2015; Marshal et al., 2008). In line with prior research, it is expected that these substance use disparities will be exacerbated among youth who are bisexual, female, or minority/race.

**Methods**

*Study participants and design*

The study used the 2015 national school-based dataset, YRBS, conducted by the CDC’s Youth Risk Behavior Surveillance System (Brener et al., 2013). A goal of the YRBS is to monitor key health and risk behaviors in adolescence, including substance use. In 2015, YRBS also included a sexual identity item in the national survey.

YRBS utilizes a three-stage, cluster sample design to produce a nationally-representative sample of students in grades 9-12 in the United States (U.S. high schools) as a whole (Brener et al., 2013). The first stage includes primary sampling units (PSUs) of large-sized counties or groups of smaller, adjacent counties. The second stage involves selecting schools from the PSUs. The targeted population is inclusive of public and private schools from all 50 states and the District of Columbia.

 The YRBS is self-administered survey on a computer-scannable questionnaire booklet/answer sheet. All participants are asked each question. A total of 15,624 participants completed the 2015 survey.

*Measures*

Demographic questions assessed each person’s age, gender, race, and ethnicity. One item assessed sexual identity using the question “Which of the following best describes you?” with the following response options: “heterosexual (straight)”, “gay or lesbian”, “bisexual”, and “not sure.”

Cigarette use was assessed with “During the past 30 days, on how many days did you smoke cigarettes?” Other tobacco product use was measured with “During the past 30 days, on how many days did you use chewing tobacco, snuff, or dip, such as Redman, Levil Garrett, Beechnut, Skoal, Skoal Bandits, or Copenhagen?” (7 response options: “0 days” to “all 30 days”) and “During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?” E-cigarette use was determined using “During the past 30 days, on how many days did you use an electronic vapor product?”

Alcohol use was assessed with “During the past 30 days, on how many days did you have at least one drink of alcohol?” Each of these questions used the following 7-point Likert-scale response options: “0 days”, “1 or 2 days”, “3 to 5 days”, “6 to 9 days”, “10 to 19 days”, “20 to 29 days” and “all 30 days.” Binge drinking was assessed with the question, “During the past 30 days, on how many days did you have 5 or more drinks of alcohol in a row, that is, within a couple of hours?” with 7 response options including, “0 days”, “1 day”, “2 days”, “3 to 5 days”, “6 to 9 days”, “10 to 19 days”, and “20 or more days.”

Recent marijuana use was measured with an item asking, “During the past 30 days, how many times did you use marijuana?” with the following response options “0 times”, “1 or 2 times”, “3 to 9 times”, “10 to 19 times”, “40 or more times.”

*Statistical Analysis*

All analyses were conducted using Mplus version 8 (Muthén and Muthén, 1998-2017). For all substance use measures, the analyzed variables were binary representing no use in the past 30 days (coded as ‘0’) and any use (coded as ‘1’). Missing data were addressed using robust full information maximum likelihood (FIML) estimation, which estimates model parameters using all available data.

*Substance use classes*

Mixture modeling was carried out to identify subgroups of individuals based on binary alcohol, cigarette, chewing tobacco/snus/snuff, cigar/cigarillo/little cigar, e-cigarette, and marijuana use, and binge drinking in the past 30 days (0 = none; 1 = at least one time). The modeling approach identifies distinct and homogenous subgroups in the sample based on the patterns of responses on the provided variables (Muthén and Muthén, 1998-2017). The complex sampling structure of the data was taken into account using the provided stratification, cluster and sampling weights.

To extract meaningful substance use subgroups that fit the data well, between one and six-class solutions were estimated and compared. Consistent with the methodological framework for LCA outlined in Lanza & Rhoades (2013), absolute and relative model fit and interpretability of the classes were considered when choosing the number of classes. Adequate absolute model fit was supported with a non-significant likelihood-ratio chi-square statistic (Agresti, 2002). Relative model fit comparisons favored lower AIC and BIC (Nylund et al., 2007) and Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (LMRT), which, when significant (*p* < .05), indicates that the computed model has better fit than a model with one fewer class (Lo et al., 2001).The convention was used of selecting a solution with at least 5% of the sample allocated to each class (Nagin, 2005).

For the LCA, the automated 3-step method in Mplus was utilized as described by Asparouhov and Muthén (2013). Specifically, in step 1, the latent class model was extracted using the 7 aforementioned binary substance use variables. In step 2, the posterior distribution obtained in step 1 is used to assign each participant to their mostly likely class. Then, step 3, a latent class regression analysis is performed where the mostly likely class membership in step 2 is predicted by the variables of interest. Using this approach, the predictor variables are specified as auxiliary variables and thus do not alter latent class formation. The predictors of interest included three dummy-coded sexual orientation variables with “heterosexual (straight)” as the reference group (coded as 0): “gay/lesbian,” “bisexual,” and “not sure.” The following covariates were also included given their known associations with substance use and sexual identity: chronological age, and minority race/ethnicity (0=non-Hispanic Caucasian, 1=other race/ethnicity), and gender variables (0=male; 1=female).

Sex and minority race/ethnicity were also examined as moderators of sexual orientation differences in class membership by including interaction terms as auxiliary variables between each sexual orientation variable and gender or minority race/ethnicity in separate models. Given the relatively small cell sizes when considering all of the sexual minority subgroups by sex or minority race/ethnicity, for the moderation analyses, the lesbian, gay, and bisexual sexual minority subgroups were combined into a single SMY group and individuals who were “not sure” of their sexual identify were omitted.

**Results**

*Descriptive statistics*

Of the total available sample (N=15,624), 17 individuals were omitted from the latent class analyses because they had missing data on all of the substance use items, resulting in an analytic sample of 15,607 (99.89% of the full sample). Of these 15,607 participants, 82.97% (n=12,949) endorsed heterosexual identity, 2.08% (n=324) gay/lesbian identity, 5.90% (n=921) bisexual identity, and 3.22% (n=503) “not sure”, and 5.83% (n=910) did not respond. Of the analysis sample, 49.66% endorsed being female, 49.59% male, and 0.75% did not respond to the question. As for age, 11.16% were 14 years old or younger, 24.43% were 15, 25.82% were 16, 24.54% were 17, 13.63% were 18 or more, and .42% did not report their age. With respect to race/ethnicity, 43.85% of participants reported being non-Hispanic White; whereas, the remaining participants reported being at least one minority race/ethnicity (53.86%) or did not respond to the question (2.28%).

*Substance use classes*

The five-class solution (n=15,607) was chosen based on both relative model fit and the interpretability of the classes (Table 1). The five-class solution was the most parsimonious solution that had a non-significant likelihood-ratio chi-square statistic. The five-class solution also had lower AIC, BIC, and aBIC values than models with fewer classes. While the LMRT for the five-class solution was non-significant, suggesting fit was not better than four-classes, aBIC was prioritized in the model comparison process because it has been shown to identify the correct class solution more often than LMRT (Morgan, 2015). Finally, although the six-class solution had improved fit than five-class solution, one class was quite small (n=506, 3% of sample), thus, the more parsimonious five-class solution was retained.

 The sample size and model estimated probabilities of substance use for each class in the five-class model are summarized in Table 2 and Figure 1. The classes were labelled descriptively based on the most heavily used substance(s). The largest class (n=10,642, 68.19%) reported very low probabilities of use for all substances (.00 - .06), and thus is referred to as the “non-users” class. The second largest class (n=2,041, 13.08%) was labeled the “alcohol users” class because all participants reported alcohol use and most reported binge drinking (probability: .54); use of other substances was uncommon.

 The remaining classes were elevated on two or more substances. One group (n=905, 5.79%) exhibited moderate probabilities of marijuana (.48) and e-cigarette use (.58), and was labeled the “marijuana/nicotine co-users” group. The majority of members of this group self-reported using at least one nicotine-containing product (probability: .88). There was also a class in which all participants reported alcohol and marijuana use and most participants reported binge drinking and e-cigarette usage, which is referred to as the “polysubstance/e-cig co-users” class (n=835, 5.35%). A final class with similar patterns of polysubstance use was identified; however, in addition to alcohol, marijuana, and e-cigarettes, the use of tobacco products was widely reported. Thus, this group was labeled the “polysubstance/tobacco co-users” class (n=1,184, 7.59%).

*Class membership differences based on sexual orientation*

The 1,271 additional cases that had missing data on at least one of the auxiliary variables (sexual orientation, sex, race/ethnicity, age) were not included in the predictor model analyses, resulting in a final sample size to test SMY disparities of 14,336 (91.86% of full sample). It was most common to see missing data for the sexual identity item (n=910, 71.59% of 1,271 cases with missing data), then race/ethnicity (n=356, 28.01%), sex (n=117, 9.21%), and age (n=65, 5.11%).

The associations between sexual orientation and membership in each of the substance use classes (n=14,336) is summarized in Table 2. Each odds ratio represents the likelihood of a sexual minority subgroup, compared to heterosexual youth, to belong in the substance-using class relative to the non-users group (Muthén and Muthén, 1998-2017).

Controlling for sex, age, and ethnicity/race, relative to the heterosexual group, the lesbian/gay subgroup had an increased likelihood of being in the marijuana/nicotine co-users group than the non-users group (*p*=.02). There was a trend for a similar effect for the polysubstance/tobacco co-users group (*p*=.08). Bisexual youth had an increased likelihood than the heterosexual group for being in all of the substance-using groups relative to the non-users group, including the alcohol users class (*p*=.03), marijuana/nicotine co-users class (*p*<.001), polysubstance/e-cig co-users class (*p*=.002), and polysubstance/tobacco users class (*p*<.001). Individuals who reported being “not sure” of their sexual identity had a significantly increased likelihood relative to the heterosexual group of being in the polysubstance/tobacco users group than non-users group (*p*=.001). There were no other group differences based on sexual orientation.

*Moderators of associations between sexual orientation and substance use class membership*

Controlling for age and sex, race/ethnicity was a significant moderator of the relation between sexual orientation and membership in the polysubstance/tobacco users group (*p*=.02; Table 3). Among non-Hispanic White youth, there was no association between sexual minority status and the likelihood of being in the polysubstance/tobacco users relative to the non-users group (OR=1.43, *p*=.40). In contrast, among youth of minority race/ethnicity, SMY were significantly more likely than heterosexual youth to be classified in the polysubstance/tobacco co-users group relative to the non-users group (OR=4.20, *p*<.001). Race did not significantly moderate the associations between sexual minority status and likelihood of being in the alcohol users only, marijuana/nicotine co-users, and polysubstance/e-cig users groups.

Controlling for age and minority race/ethnicity, sex was a significant moderator of the relation between sexual orientation and likelihood of membership in the marijuana/nicotine co-users (*p*=.01) and polysubstance/tobacco co-use groups (Table 3). Among male youth, there was no association between sexual minority status and likelihood of being classified in the marijuana/nicotine co-users group relative to the non-users group (OR=.98, *p*=.97). In contrast, among female youth, there was a significant SMY effect (OR=4.31, *p*<.001), such that female SMY had an increased likelihood of being classified in the marijuana/nicotine co-users group than non-users group relative to female heterosexual youth. Similarly, for male youth, there were no disparities in likelihood of being classified in the polysubstance/tobacco users group relative to non-users group (OR = 1.50, *p*=.24); however, female SMY had a significantly increased likelihood of being classified in the polysubstance/tobacco users group relative to the non-users group than female heterosexual youth (OR = 5.34, *p*<.001). No additional sex differences in sexual minority-related disparities were supported.

**Discussion**

 The primary aim of this investigation was to describe disparities in patterns of polysubstance use between SMY and heterosexual youth. To accomplish this, five homogenous groups that had distinct patterns of recent substance use were identified using the total sample (N = 15,607): non-users group (68.19%), alcohol users group (13.08%), marijuana/nicotine co-users group (5.80%), polysubstance/e-cig users group (5.35%), and polysubstance/tobacco users group (7.59%). The groups were generally consistent with prior latent class analyses of other nationally-representative samples of youth, which have identified 4 or 5 substance-using classes with similar proportions of polysubstance users (8-14%) and similar or more alcohol-only users (15-23%)(Conway et al., 2013; Dierker et al., 2007). Consistent with Conway et al. (2013), there was no cigarette-users only group; instead, a marijuana/nicotine co-users group was identified. This group as well as the polysubstance/tobacco users group reported using a variety of nicotine products, which is consistent with an emerging pattern of poly-use of nicotine products identified in recent epidemiological studies of youth (Collins et al., 2017; Villanti et al., 2016). Taken together, the findings of the present study further highlight the complexities of youth substance use patterns.

 As hypothesized, SMY were at risk of being in each of the drug using groups, including polysubstance using groups, relative to heterosexual youth. These findings are consistent with the existing SMY substance use disparities literature (Dermody et al., 2014; Kann, 2016; Lee et al., 2009; Marshal et al., 2013; Marshal et al., 2008), but adds that many of the previously supported disparities of individual substances likely occurred in a broader context of polysubstance use (Dermody et al., 2016b; Kecojevic et al., 2017). The disproportionate risk of polysubstance use among SMY is consistent with a syndemic model of disease burden (Singer, 2009)—in which SMY simultaneously experience several poor physical and social conditions. While minority stress has been linked to SMY substance use in cross-sectional (Goldbach et al., 2014) and longitudinal (Dermody et al., 2016a) research, it has yet to be empirically tested as an explanatory model for polysubstance use patterns that are emblematic of a syndemic. Additional explanatory models are also worthy of further consideration to help to explain SMY’s risk for polysubstance use. Recent longitudinal work suggests that, greater affiliation with substance-using peers relative to heterosexual youth helped to explain increased substance use among SMY over time, even after accounting for effects of minority stress (Dermody et al., 2016a). It is necessary to have a better understanding of these interacting substance use patterns and underlying explanatory pathways in order to advance comprehensive interventions.

The results of the present study also support that when evaluating SMY disparities in substance use, it is critical to also consider intersecting identities. Consistent with prior research (Dermody et al., 2014; Kerr et al., 2015; Marshal et al., 2008), substance use disparities relative to heterosexual youth were the most robust for bisexual youth. Furthermore, consistent with and building upon prior research (Poteat et al., 2009; Talley et al., 2014), some sexual minority-related substance use disparities were exacerbated by minority race/ethnicity. Specifically, for the polysubstance/tobacco users group, sexual minority-related disparities were observed among racial/ethnic minorities but not non-Hispanic White youth. Similarly, consistent with prior research focusing on the use of single substances (Corliss et al., 2008; Corliss et al., 2012; Dermody et al., 2014; Marshal et al., 2008) and polysubstance use (Kecojevic et al., 2017), larger sexual minority-related disparities in substance use were seen for female youth than male youth. By considering polysubstance use, it was demonstrated that female SMY were specifically at risk relative to heterosexual youth of being classified as marijuana/nicotine co-users and polysubstance/tobacco users; whereas, there were no sexual minority-related disparities among males for these groups. As a whole, these findings highlight the nuanced nature of SMY disparities in the context of specific and intersecting identities.

 The results of the present study should be considered in light of some limitations and strengths. While the study utilized a large nationally-representative sample of use, the study design was cross-sectional and relied on self-report. This design prevented examining SMY-related polysubstance use disparities across development, which can shift from adolescence to adulthood (Corliss et al., 2012; Dermody et al., 2014). Furthermore, to reduce comparisons and ensure adequate cell sizes, racial/ethnic and SMY subgroups were combined when examining intersectionality of these identities in substance use risk. Future research would benefit from oversampling SMY or combining several national datasets in order to facilitate more nuanced comparisons. Moreover, it was not possible from the data collected to determine the extent to which individuals who reported use of multiple substances used these substances together in a single substance using session. Furthermore, data was not collected about the nicotine content of e-cigarettes used, which varies greatly between and within e-cigarette brands (Zhu et al., 2014) and could include very low or nicotine-free e-cigarettes. Finally, the national YRBS dataset did not include a question assessing gender identity, which prevented examining polysubstance use among transgender youth.

 The present study extends the current literature by using a nationally-representative sample to support higher rates of polysubstance use among SMY relative to heterosexual youth. An important next step is to determine what factors are contributing to this syndemic among SMY, such as minority stress and peer influences, and to identify potential protective factors. It is imperative that these future efforts consider the role of intersecting identities like sex and race/ethnicity and account for the complexities of substance use behaviors among SMY.

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Table 1. Model fit indices and model comparison statistics for mixture modeling of substance use

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number of classes | Entropy | Likelihood ratio chi-square test | df | p-value | LMRT | p-value | AIC | BIC | aBIC |
| 1 | N/A | 413.70 | 88 | < .001 | N/A | N/A | 92659.87 | 92713.46 | 92691.21 |
| 2 | .88 | 277.91 | 109 | < .001 | 19739.09 | < .001 | 72681.23 | 72796.07 | 72748.40 |
| 3 | .85 | 214.34 | 101 | < .001 | 1459.06 | .02 | 71219.29 | 71395.36 | 71322.27 |
| 4 | .80 | 129.55 | 94 | .009 | 1126.63 | .03 | 70094.08 | 70331.40 | 70232.88 |
| 5 | .80 | 105.38 | 86 | .08 | 123.67 | .57 | 69984.81 | 70283.37 | 70159.43 |
| 6 | .74 | 86.53 | 79 | .26 | 111.88 | .59 | 69887.48 | 70247.28 | 70097.92 |

Note: AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, aBIC = sample size adjusted BIC, LMRT = Lo-Mendell-Rubin Test.

Table 2. The five substance use classes and their associations with sexual orientation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total sample(N=15,607) | Non-users(n=10,642) | Alcohol users(n=2,041) | Marijuana/ nicotine co-users(n=905) | Polysubstance/e-cig users(n=835) | Polysubstance/tobacco users(n=1,184) |
|  | Model estimated probability (standard deviation)a |
| Alcohol | .33 (.01) | .06 (.01) | 1.00 (.00) | .24 (.10) | 1.00 (.00) | 1.00 (.00) |
| Binge drinking | .18 (.01) | .00 (.00) | .54 (.05) | .00 (.00) | .75 (.06) | .88 (.03) |
| Marijuana | .22 (.01) | .04 (.00) | .29 (.06) | .48 (.03) | 1.00 (.00) | .71 (.04) |
| Cigarettes | .11 (.01) | .00 (.00) | .08 (.02) | .31 (.03) | .31 (.13) | .76 (.04) |
| Chewing tobacco/snus/snuff | .07 (.01) | .01 (.00) | .09 (.02) | .13 (.02) | .02 (.05) | .55 (.07) |
| Cigars/cigarillos/little cigars | .10 (.01) | .00 (.00) | .04 (.02) | .26 (.03) | .27 (.11) | .78 (.04) |
| E-cigarettes | .24 (.01) | .06 (.01) | .37 (.03) | .58 (.04) | .73 (.06) | .80 (.03) |
|  | Effects of sexual minority subgroup and covariates (95% confidence interval)b |
| Lesbian/gay |  | **Reference** | 1.18 (.64, 2.15) | **2.67 (1.20, 5.92)\*** | 1.66 (.52, 5.29) | 2.14 (.92, 4.97)† |
| Bisexual |  | **Reference** | **1.54 (1.04, 2.27)\*** | **2.78 (1.75, 4.42)\*\*\*** | **2.13 (1.33, 3.39)\*\*** | **2.64 (1.62, 4.29)\*\*\*** |
| Not sure |  | **Reference** | 1.10 (.62, 1.97) | 1.15 (.45, 2.95) | .61 (.10, 3.54) | **2.61 (1.48, 4.63)\*\*** |
| Female |  | **Reference** | 1.23 (.98, 1.56)† | .**54 (.38, .76)\*\*\*** | 1.59 (.99, 2.56)† | **.21 (.14, .30)\*\*\*** |
| Age |  | **Reference**  | **1.37 (1.27, 1.48)\*\*\*** | **1.52 (1.33, 1.74)\*\*\*** | **1.36 (1.19, 1.55)\*\*\*** | **1.52 (1.33, 1.75)\*\*\*** |
| Non-white |  | **Reference** | .83 (.59, 1.17) | .97 (.71, 1.32) | .84 (.54, 1.30) | **.68 (.49, .94)\*** |

aThe model estimated probabilities (standard deviations) that can be interpreted as the probability that a given individual in the class endorsed using each substance or binge drinking during the past 30 days.

bResults are odds ratios (95% confidence interval) from a latent variable multinomial logistic regression analysis performed where the mostly likely class membership is predicted by the variables of interest. Using this approach, the predictor variables are specified as auxiliary variables and thus do not alter latent class formation. The results are based on the subsample of 14,336 participants that had complete data on the auxiliary variables. \*\*\**p* < .001, \*\**p* < .01, \* *p* < .05, † *p* < .10

Table 3. Moderating role of minority race/ethnicity and sex in the association between sexual minority status and membership in substance-using classes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Non-users | Alcohol users | Marijuana/nicotine co-users | Polysubstance/e-cig users | Polysubstance/tobacco users |
| Moderating effect of race on sexual minority differences (95% confidence interval) |
| SMY | **Reference**  | 1.56 (.99, 2.47) † | **2.72 (1.41, 5.23)\*\*** | 1.78 (.81, 3.92) | 1.43 (.63, 3.26) |
| Non-White | **Reference**  | .83 (.58, 1.19) | .96 (.69, 1.34) | .81 (.50, 1.32) | **.60 (.43, .83)\*\*** |
| SMY x Non-White | **Reference**  | .85 (.48, 1.53) | 1.02 (.42, 2.46) | 1.31 (.50, 3.47) | **2.94 (1.07, 8.12)\*** |
| Moderating effect of sex on sexual minority differences (95% confidence interval) |
| SMY | **Reference**  | 1.30 (.67, 2.53) | .98 (.39, 2.45) | 1.44 (.51, 4.01) | 1.50 (.77, 2.94) |
| Sex | **Reference**  | 1.22 (.96, 1.54) | **.46 (.32, .68)\*\*\*** | 1.65 (.99, 2.73)† | **.16 (.10, .25)\*\*\*** |
| SMY x Sex | **Reference**  | 1.19 (.57, 2.48) | **4.37 (1.50, 12.77)\*\*** | 1.34 (.42, 4.24) | **3.56 (1.44, 8.81)\*\*** |

Note: Results are odds ratios (95% confidence interval) from a latent variable multinomial logistic regression analysis performed where the mostly likely class membership is predicted by the variables of interest. SMY was coded 0 for heterosexual and 1 for lesbian/gay and bisexual. Individuals who endorsed “not sure” for the sexual identity question were omitted. The resulting sample size was 13,860 for the Table 3 analyses. Race was coded 0 for non-Hispanic white and 1 for all other ethnic and racial groups. Sex was coded 0 for male and 1 for female. \*\*\**p* < .001, \*\**p* < .01, \* *p* < .05, † *p* < .10

Figure 1. Patterns of use of nicotine-containing products, marijuana, and alcohol by a nationally-representative sample of youth categorized into five substance use classes. Note that probabilities reported in the top panel of Table 2 are depicted here, which represent the probabilities that youth in each class reported any use of each of the substances in the past 30 days.