Sexual orientation and substance use trajectories in emerging adulthood

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ABSTRACT

Aims The current study examined developmental changes in substance use behaviors (SUBS) based upon sexual orientation. The analyses also attempted to address a number of methodological limitations in the extant longitudinal literature (i.e. distinct operationalizations of sexual orientation, timing of sexual orientation assessment with respect to reports of SUBs, non-linear growth). Participants Data were drawn from a longitudinal study of incoming first-time college students at a large public university (n = 3720). Design After a paper-and-pencil assessment just prior to matriculation, participants completed a web-based survey every fall and spring for 4 years (sub-sample n = 2854). Findings Latent growth models revealed that sexual minorities demonstrated significant heterogeneity with regard to substance use trajectories. Initial levels and trajectories of the frequency of substance use for sexual minority individuals were distinct, generally, from their exclusively heterosexual peers. Methodologically, the timing of the assessment of sexual orientation influenced the results, and modeling non-linear components indicated that sexual minorities are at risk for exponential increases in their frequency of certain SUBs over time (i.e. drunkenness; cannabis use). Conclusions Sexual minority and majority individuals exhibited differences in SUBs during emerging adulthood, especially when using self-identification to define sexual orientation. Individuals who endorsed a sexual minority self-identification at the onset of emerging adulthood, as opposed to 4 years later, evidenced exponential increases in rates of drunkenness and cannabis use. These results support that the timing of assessment is important and that some trajectories of sexual minority SUBs are non-linear during this developmental period.

Keywords Alcohol, drugs, gay, lesbian, longitudinal, sexual orientation, substance use.

INTRODUCTION

Sexual minority individuals are at elevated risk for engagement in substance use behaviors (SUBs; [1–3]). Moreover, disparities between sexual minority and majority women may be more pronounced [2,4–16] than their male counterparts. Demonstrating this liability for the acquisition of SUBs, a recent meta-analysis of 18 studies by Marshall et al. [2] found that the odds of lesbian, gay and bisexual (GLB) adolescents, under age 18 years, using substances (i.e. cigarette, alcohol, illicit drugs) were 190% higher than for heterosexual youth. Several explanations exist for this vulnerability to substance use among sexual minorities (e.g. coping with sexual prejudice [1]; see also [9,17–21] for alternative explanations). An in-depth examination of the developmental pattern of SUBs among sexual minority individuals may be helpful in understanding their distinct etiological pathways.

The majority of past research has been limited to cross-sectional data (e.g. [13,14,16,18,22–25]), and only six studies [4,9,11,26–28] have examined patterns of substance use among non-clinical samples of sexual minority individuals over time and compared those to the patterns of use among samples of sexual majority individuals. Overall, the findings of these longitudinal studies provide further evidence that sexual minority adolescents and young adults may be at increased risk for SUBs, which are generally variable over time.

There are two major issues, however, that are not resolved adequately in previous longitudinal research on sexual orientation and SUBs. First, theoretical (e.g. [29]) and empirical [2,30] distinctions between sexual...
minority self-identifications, sexual attractions and sexual behaviors (i.e. operationalizations of sexual orientation) have not been considered adequately in the extant literature. Secondly, studies have assessed sexual orientation at a single time-point or infer sexual minority status based on participants’ longitudinal endorsement of at least one operationalization of sexual orientation in their past. Illustrating these concerns, studies have assessed self-reported same-sex sexual attractions and behaviors once at the beginning of the study period [29], sexual minority self-identification, sexual attractions and behaviors once at the final wave of the study period [11], combined assessments of sexual minority self-identification and same-sex sexual attractions from one [4] or two different time-points [26,27] or combined a one-time assessment of sexual orientation based on self-identification with at least one report of a same-sex partner in one’s sexual history [9].

To the extent that reports of sexual orientation show evidence of temporal instability (e.g. [30–32] for female samples), interpretations of single-occasion reports of sexual orientation indicators and related changes in SUBs over time are problematic, in that they may provide biased estimates of correlations with time-varying behaviors of interest. Thus, existing research has failed to examine critically temporal relations between distinct operationalizations of sexual orientation and changes in SUBs.

Providing the basis for this report, a recent study by Marshal et al. [11] examined substance use trajectories among sexual minority adolescents from the Add Health Study who were in grades 7–12 (e.g. [30,33]) at baseline. Marshal et al. [11] revealed that individuals who endorsed a sexual minority self-identification (i.e. any non-exclusively heterosexual sexual identity), as opposed to those who endorsed an ‘exclusively heterosexual’ self-identification, reported a higher frequency of binge drinking, alcohol use and cigarette use at the first wave of data collection and increased more sharply in their frequency of drunkenness, alcohol use, cigarette use and cannabis use over time. Notably, the findings were found to be somewhat distinct for each operationalization of sexual orientation.

Although Marshal et al.’s [11] results provide compelling evidence that sexual minority youth are at greater risk for engagement in SUBs, their findings are limited in several ways. One issue, as noted by Marshal et al., is that the assessment of sexual orientation occurred only at the last measurement occasion. Thus, sexual orientation at the end of the developmental period was used to predict initial differences in substance use trajectories at the first wave of data collection and subsequent linear growth over three waves (i.e. postdictively), precluding an examination of whether sexual orientation assessed in adolescence provided distinct prospective predictions regarding trajectories of SUBs.

Additionally, although it is known that there are non-linear changes in the frequency of substance use in adolescent and young adults samples (e.g. [26,34]), it was not possible for Marshal et al. to examine non-linear changes (e.g. quadratic growth) in substance use across time because only three measurement occasions were assessed. We anticipated possible differences in the magnitude and pattern of the relations between our study and Marshal et al. because, whereas Marshal et al. examined only linear changes in SUBs beginning in early adolescence and extending into emerging adulthood, our sample was comprised exclusively of individuals in emerging adulthood, a period in which substances are likely to become readily available and in which the frequency and quantity of substance use is known fluctuate in a non-linear fashion (e.g. [26,34]).

**The current study**

The current study sought to replicate and extend the findings of Marshal et al. [11] in a prospective cohort of individuals matriculating in a university as first-time students to determine if differences in substance use trajectories between sexual majority and sexual minority individuals occurred during emerging adulthood, a developmental period characterized by more normative use. Specifically, based on prior research (e.g. [1–3]), we anticipated that sexual minority individuals would report heightened levels and distinct trajectories of SUBs compared to their sexual majority peers (e.g. [11]). Because the transition to emerging adulthood is accompanied by a large, normative increase in drinking behavior [35], we also considered that differences with regard alcohol use may be less pronounced during this developmental period [5,6].

Additionally, as outlined above, we attempted to address a number of methodological concerns in the extant literature that we thought could materially affect previous findings. Specifically, we examined relations between all three facets of sexual orientation and compared them on associations with SUBs during emerging adulthood. Next, we examined whether differential effects emerged when substance use trajectories were predicted from sexual orientation indicators that were assessed at the conclusion of the developmental period under investigation (i.e. eighth semester in college) as opposed to the onset (i.e. second semester in college). Finally, given that misspecification of statistical models may greatly influence the interpretation and implications of results [36], we examined quadratic effects in substance use trajectories to capture more adequately changes in patterns of SUBs [35].
METHOD

Participants

Data were drawn from a prospective study of substance use and health behaviors. For the pre-college assessment, 3720 (88%) of 4226 incoming first-time college students at the University of Missouri—Columbia completed a paper-and-pencil questionnaire in the summer orientation preceding college matriculation. This pre-college sample was followed-up and administered a web-based survey every fall (October/November) and spring (March/April) of the subsequent 4 years. Thus, a 1-unit change in wave corresponds to an approximate 6-month time interval. Written parental permission/consent was obtained for all participants under age 18 years, and assent/consent was obtained from each participant.

The data from the current report are limited to those collected beginning in the second semester of college (n = 2854) because that is when sexual orientation was assessed initially. Participants were 61% female, 90% Caucasian and 18.76 (SD = 0.46) years of age on average at the first assessment. Fifty-five per cent of the baseline sample participated in at least one follow-up assessment throughout the first 4 years of emerging adulthood (i.e. college) and 45% completed all assessments. Recent findings have provided evidence that this sample was influenced minimally by retention biases ([35]; see supporting analyses).

Measures

Sexual orientation indicators

As in Marshal et al. [11], sexual orientation was operationalized in three ways: (i) self-identification (i.e. self-labeling of sexual identity); (ii) sexual attraction (i.e. degree of opposite-versus same-sex sexual attractions); and (iii) sexual behavior (i.e. degree of opposite-versus same-sex sexual activity).

The current results pertain to operationalizations of sexual orientation assessed during the second and eighth semesters of college. To assess self-identification, participants were asked: ‘How would you describe your sexual orientation?’ Response options were: 1 = exclusively homosexual, 2 = primarily homosexual, 3 = equally homosexual and heterosexual, 4 = primarily heterosexual and 5 = exclusively heterosexual. Similarly, sexual attractions and sexual behaviors were assessed with single, seven-point items asking participants, respectively, ‘To which group are you sexually attracted?’ and ‘With which group do you engage in sexual behavior?’ (1 = opposite-sex only; 2 = opposite-sex mostly; 3 = opposite-sex somewhat; 4 = both sexes equally; 5 = same-sex somewhat; 6 = same-sex mostly; 7 = same-sex only). A dichotomous variable denoted two groups, based on participants’ sexual orientation self-identification (0 = exclusively heterosexual; 1 = primarily heterosexual/equally homosexual and heterosexual/primarily homosexual/exclusively heterosexual). Similarly, two dichotomous variables denoted groups based on participants’ sexual attractions and behaviors, respectively (0 = opposite-sex only; 1 = opposite-sex mostly/opposite-sex somewhat/both sexes equally/same-sex somewhat/same-sex mostly/same-sex only).

Substance use frequency

Drunkenness was assessed with a single item, ‘How many times in the past 30 days did you get drunk on alcohol?’. Binge drinking was assessed with a single item, ‘In the past 30 days, how many times have you had five or more drinks in a single setting?’ A single item at each assessment measured the frequency with which participants used a number of substances (i.e. alcohol, cigarettes, cannabis) in the previous 3 months on an eight-point scale (0 = never/not in the past 3 months; 7 = more than 40 times).

Covariates

Participants reported their age during the initial intake into the study (in years) and this variable was centered at baseline. Additionally, participants indicated their sex (0 = female, 1 = male), ethnicity (0 = non-Hispanic, 1 = Hispanic) and race (0 = white/European American, 1 = black/African American, American Indian/Native American, Asian/Pacific Islander, other).

Analytical procedure

To examine substance use trajectories based on sexual orientation, latent growth modeling (LGM) was utilized. LGMs were estimated using Mplus version 5.1 [37]. These models examine the development of individuals on one or more outcome variables over time by using random effects conceptualized as continuous latent growth factors [38]. This approach has a number of advantages, including the use of multiple assessment periods and the models being tolerant of missing data. The substance use outcomes intercept and slope factors represent the modeling of the respective outcome variables (i.e. frequency of drunkenness, binge drinking, alcohol and drug use). The intercept factor represents initial levels (roughly age 18) of the respective constructs of substance use involvement. The slope factors represent change in the respective construct over the entire study period (see Supporting Information details at the end). Maximum likelihood estimation with robust standard errors [39] was employed for the LGMs. To allow for analysis of data containing

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missing values, all LGMs were estimated using full-information maximum likelihood.

RESULTS

Initially, changes in sexual orientation from wave 2 to wave 8 were examined. A non-trivial number of individuals (n = 251) were found to change their sexual orientation self-identification, providing some evidence for the fluid nature of sexual orientation and suggesting that prospective and postdiction models may differ. Observed means, at each time-point, regarding the frequency of drunkenness, binge drinking, alcohol use, cigarette use and cannabis use are shown in Table 1.

Unconditional linear growth model

The unconditional growth models revealed that intercepts for each of the outcomes were significantly different from zero, indicating that participants generally reported at least some substance use at baseline. Linear slopes were also significant for frequency of drunkenness, binge drinking and alcohol use, suggesting significant mean-level (i.e. normative) increases in these behaviors during college. By contrast, frequency of cigarette and cannabis use did not exhibit significant mean-level linear changes during college. These models also indicated significant variation around both intercepts and linear slopes, suggesting individual differences in trajectories across time.

Do findings from an adolescent sample generalize to a sample in emerging adulthood?

Conditional postdiction models examined whether unique patterns of SUBs were evidenced across different operationalizations of sexual orientation endorsed at the end of the study period. Consistent with Marshal et al. [11], the intercept was initialized at the first wave of the study period (i.e. wave 2) and linear growth trajectories were predicted using sexual orientation indicators reported during the last wave of the study period (i.e. wave 8). As shown in Table 2, compared to their exclusively heterosexual peers (n = 1605), individuals who endorsed any degree of a sexual minority self-identification during the last wave of the study period (n = 288) reported higher initial frequencies of alcohol, \( \beta = 0.15, P < 0.05 \), cigarette, \( \beta = 0.26, P < 0.001 \) and cannabis use, \( \beta = 0.36, P < 0.001 \), but not drunkenness or binge drinking, at the onset of emerging adulthood. Subgroups of sexual minority participants [i.e. exclusively/primarily homosexual (n = 93), bisexual (n = 9), primarily heterosexual (n = 186)] were created and their substance use trajectories were compared to those of exclusively heterosexual participants (n = 1605; see Table 2, model 2). These findings generally replicated model 1 with regard to higher initial rates of cigarette and cannabis use among self-identified sexual minority subgroups.

In addition, substance use trajectories of individuals who reported some degree of attraction to same-sex individuals (n = 315) and those who reported engaging in some degree of same-sex sexual behaviors (n = 110) were compared to individuals who reported completely opposite-sex attractions (n = 1582) and behaviors (n = 1649), respectively (see Table 2, models 3 and 4). Consistent with results for self-identification, individuals who endorsed any same-sex sexual attractions during the last wave of the study period reported higher initial frequencies of alcohol, \( \beta = 0.12, P < 0.05 \), cigarette, \( \beta = 0.45, P < 0.001 \) and cannabis use, \( \beta = 0.51, P < 0.001 \) at the onset of emerging adulthood, as well as greater linear increases in their cigarette use over time, \( \beta = 0.26, P < 0.01 \), compared to their peers, who endorsed only opposite-sex attractions. When comparing individuals who endorsed any degree of same-sex sexual

Table 1 Descriptive statistics regarding substance use behaviors (SUBS) for the overall sample.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Wave 2</th>
<th>Wave 3</th>
<th>Wave 4</th>
<th>Wave 5</th>
<th>Wave 6</th>
<th>Wave 7</th>
<th>Wave 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drunkenness</td>
<td>1.28 (1.34)</td>
<td>1.24 (1.31)</td>
<td>1.19 (1.32)</td>
<td>1.29 (1.26)</td>
<td>1.29 (1.30)</td>
<td>1.33 (1.29)</td>
<td>1.34 (1.31)</td>
</tr>
<tr>
<td>Binge drinking</td>
<td>1.26 (1.39)</td>
<td>1.28 (1.41)</td>
<td>1.25 (1.41)</td>
<td>1.31 (1.36)</td>
<td>1.32 (1.42)</td>
<td>1.36 (1.38)</td>
<td>1.33 (1.40)</td>
</tr>
<tr>
<td>Freq. of alcohol use</td>
<td>2.58 (1.87)</td>
<td>2.75 (1.86)</td>
<td>2.67 (1.86)</td>
<td>2.96 (1.78)</td>
<td>3.1 (1.73)</td>
<td>3.30 (1.67)</td>
<td>3.27 (1.65)</td>
</tr>
<tr>
<td>Freq. of cigarette use</td>
<td>1.19 (2.06)</td>
<td>1.19 (2.05)</td>
<td>1.13 (2.01)</td>
<td>1.17 (2.02)</td>
<td>1.06 (1.97)</td>
<td>1.13 (2.02)</td>
<td>1.03 (1.95)</td>
</tr>
<tr>
<td>Freq. of cannabis use</td>
<td>0.67 (1.46)</td>
<td>0.62 (1.42)</td>
<td>0.59 (1.38)</td>
<td>0.61 (1.45)</td>
<td>0.58 (1.39)</td>
<td>0.60 (1.41)</td>
<td>0.55 (1.39)</td>
</tr>
</tbody>
</table>

Freq.: frequency. SD: standard deviation. Majority: exclusively heterosexual at wave 2; minority: primarily heterosexual, bisexual, primarily homosexual or exclusively homosexual at wave 2. Drunkenness was assessed with a single item, ‘How many times in the past 30 days did you get drunk on alcohol?’. Binge drinking was assessed with a single item, ‘In the past 30 days, how many times have you had five or more drinks in a single setting?’. Participants were asked on an eight-point scale (0 = never/not in the past 3 months; 7 = more than 40 times) how often in the past 3 months they had used a number of substances (i.e. alcohol, cigarettes, cannabis).
behavior during the last wave of the study period to their peers who reported having only opposite-sex sexual partners, only higher initial rates of cigarette use, $\beta = 0.34$, $P < 0.01$, were found.

**Does timing of sexual orientation assessment influence analytical conclusions?**

Prediction models parallel to those discussed previously were run that utilized sexual orientation assessed at the onset of emerging adulthood. As shown in Table 2, results indicated that individuals endorsing any level of sexual minority self-identification at the onset of emerging adulthood reported higher initial levels of binge drinking, $\beta = 0.16$, $P < 0.05$, as well as higher frequencies of alcohol, $\beta = 0.15$, $P < 0.05$, cigarette, $\beta = 0.35$, $P < 0.001$ and cannabis use, $\beta = 0.44$, $P < 0.001$. In contrast to the postdiction models, prediction models indicated that participants who self-identified as sexual minorities during at the onset of emerging adulthood ($n = 301$) experienced decreases (as opposed to normative increases) in rates of binge drinking over time, $\beta = -0.25$, $P < 0.05$, compared to their exclusively heterosexual peers ($n = 2003$).

For individuals endorsing any degree of same-sex sexual attraction ($n = 234$) at the onset of emerging adulthood, results indicated higher risk for cigarette, $\beta = 0.36$, $P < 0.001$ and cannabis use, $\beta = 0.59$, $P < 0.001$, compared to their peers, who were attracted only to opposite-sex sexual partners. Critically, no differences were found among any alcohol involvement variables. Finally, among those who endorsed any degree of same-sex behavior at the onset of emerging adulthood, compared to their counterparts who only engaged in opposite-sex sexual behaviors, higher initial rates of alcohol, $\beta = 0.23$, $P < 0.05$, cigarette, $\beta = 0.54$, $P < 0.001$ and cannabis use, $\beta = 0.15$, $P < 0.001$, were found. Notably, an examination of model fit indices [i.e. Akaike’s information criterion (AIC), Bayesian information criterion (BIC)] indicated that postdiction models provided a better fit to the data.

**Does sexual minority status influence non-linear changes in substance use?**

Corrected $\chi^2$ difference tests suggested that quadratic models were a significant improvement over linear-slope-only models for all outcomes. Significant variation

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Latent growth models testing the postdictive (wave 8) and predictive (wave 2) association between operationalizations of sexual orientation and linear substance use trajectories, controlling for covariates ($n = 2854$).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Drunkenness</td>
</tr>
<tr>
<td>Intercept</td>
<td>Slope</td>
</tr>
<tr>
<td>Wave 8</td>
<td>0.09</td>
</tr>
<tr>
<td>Wave 2</td>
<td>0.12</td>
</tr>
<tr>
<td>Wave 8 PS</td>
<td>0.05</td>
</tr>
<tr>
<td>Wave 2 PS</td>
<td>0.09*</td>
</tr>
<tr>
<td>Wave 8 Bi</td>
<td>0.05</td>
</tr>
<tr>
<td>Wave 2 Bi</td>
<td>0.09</td>
</tr>
<tr>
<td>Wave 8 P/EG</td>
<td>0.07</td>
</tr>
<tr>
<td>Wave 2 P/EG</td>
<td>0.06</td>
</tr>
<tr>
<td>Wave 8</td>
<td>0.05</td>
</tr>
<tr>
<td>Wave 2</td>
<td>0.09</td>
</tr>
<tr>
<td>Wave 8</td>
<td>0.00</td>
</tr>
<tr>
<td>Wave 2</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Bold text denotes significant coefficients. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. Standardized, adjusted coefficients are presented. Drunkenness: ‘How many times in the past 30 days did you get drunk on alcohol?’. Binge drinking: ‘In the past 30 days, how many times have you had five or more drinks in a single setting?’. Frequency of alcohol, cigarettes and cannabis use ($0 = never/not in the past 3 months; 7 = more than 40 times). PS: primarily heterosexual; Bi: bisexual; P/EG: primarily/exclusively homosexual. Model 1: [0 = exclusively heterosexual (ES); 1 = PS, Bi, P/EG]. Model 2: MS (0 = ES; 1 = PS); Bi (0 = ES; 1 = Bi); P/EG (0 = ES; 1 = P/EG). Model 3: same-sex sexual attraction (0 = opposite-sex only; 2 = opposite-sex mostly/opposite-sex somewhat/both sexes equally/same-sex mostly/same-sex only). Model 4: same-sex sexual behavior (same anchors as attraction).
around intercepts, linear changes and acceleration rates for all primary outcome variables was found in all models, suggesting heterogeneity with regard to individual trajectories. When discussing the outcomes of quadratic models, the term ‘accelerate’ is used to denote the curvilinear increases/decreases in the rate of a given behavior over the course of time. Due to space limitations, the postdictive, quadratic models are not reviewed in detail. Nevertheless, the results of the parallel postdiction and prediction quadratic models are presented in Table 3. In addition, Figs 1 and 2 provide visual depictions of substance use trajectories for both postdictive and predictive models with regard to sexual orientation self-identification.

Prediction models revealed that, compared to their exclusively heterosexual peers, individuals who reported any degree of a sexual minority self-identification at the onset of emerging adulthood endorsed higher initial levels of drunkenness, β = 0.17, P < 0.05 and binge drinking, β = 0.20, P < 0.01, as well as a greater frequency of alcohol, β = 0.14, P < 0.05, cigarette, β = 0.36, P < 0.001 and cannabis use, β = 0.49, P < 0.001. For alcohol involvement outcomes (i.e. drunkenness, binge drinking), significant intercept differences were found consistently across various endorsements of minority self-identifications (e.g. primarily heterosexual; bisexual) but not necessarily reports of same-sex sexual attractions or behaviors (see Table 3). Critically, there was also evidence for an acceleration in the frequency of drunkenness among individuals who endorsed a sexual minority self-identification, compared to those who reported an exclusively heterosexual self-identification (see Fig. 1). This curvilinear growth in predictive models was also replicated for individuals who endorsed same-sex sexual attractions, but not for those who endorsed same-sex sexual behaviors.

As seen in Fig. 2, higher initial rates of cigarette and cannabis use were found for individuals who endorsed a sexual minority self-identification at the onset of emerging adulthood (see Table 3 for similar results pertaining to same-sex sexual attraction or behavior), compared to their sexual majority counterparts. Additionally, individuals who endorsed a minority, as opposed to a majority, self-identification at the onset of emerging adulthood evidenced curvilinear growth in the frequency of their cannabis use over time, β = 0.30, P < 0.05 (see Table 3, model 1; see also Fig. 2).

**DISCUSSION**

Building on previous studies (e.g. [4–7,9,11,23,26,28]), the current findings suggest significant developmental differences between sexual minority and majority individuals on a range of SUBs in emerging adulthood. Additionally, the current study extends the literature in important ways. First, it provides suggestive evidence that the initiation and course of SUBs may differ for individuals who endorse a sexual minority sexual orientation at the onset of emerging adulthood versus 4 years later. Secondly, it suggests that self-identification as a sexual minority, *per se*, may contribute to heightened risk for engagement in certain SUBs. Thirdly, it argues effectively that non-linear changes in the SUBs of sexual minorities need to be considered to characterize adequately the unfolding of their substance use patterns. Evidence for gender-moderated effects, however, was sparse in the current sample (see supporting analyses), suggesting that the patterns described above are similar for women and men.

**Operationalization of the assessment for sexual orientation matters**

The current findings are consistent with studies suggesting that distinct operationalizations of sexual orientation may be associated differentially with SUBs (e.g. [2,7,8,11,16,40]). Specifically, patterns of heightened alcohol involvement were found more often for individuals endorsing a sexual minority self-identification and replicated less often for individuals who reported same-sex sexual attractions (see also [11]; cf [7,16,40]) or behaviors (see also [11], cf [5,7,8,16,40]). These results suggest that self-identification as a sexual minority may, in and of itself, impose heightened risk for the acquisition and maintenance of alcohol-related behaviors during emerging adulthood.

The findings examining cigarette and cannabis use among sexual minority individuals suggest that sexual minority self-identification [7,11], as well as same-sex sexual attractions or behaviors [5,7,11,16,40], predicted greater initial and sustained use of both substances, compared to their respective sexual majority counterparts. Individuals with a sexual minority self-identification at the onset of emerging adulthood were also found to accelerate in their cannabis use over time, suggesting that self-identification as a sexual minority may, as with alcohol-related behaviors, impose heightened risk for the accelerated use of illicit substances during emerging adulthood.

**Timing of the assessment for sexual orientation matters**

Although similarities between the postdictive and predictive findings may be more apparent with regard to drunkenness and cigarette use, there were noticeable differences with regard to the frequency of binge drinking and cannabis use. For example, whereas those who endorsed a sexual minority self-identification at the onset of emerging adulthood first declined and then increased...
Table 3 Latent growth models testing the postdictive (wave 8) and predictive (wave 2) association between operationalizations of sexual orientation and non-linear substance use trajectories, controlling for covariates (n = 2854).

<table>
<thead>
<tr>
<th>Sexual minority self-identification</th>
<th>Drunkenness</th>
<th>Binge drinking</th>
<th>Alcohol use</th>
<th>Cigarette use</th>
<th>Cannabis use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wave 8</td>
<td>0.18*</td>
<td>-0.53***</td>
<td>0.59***</td>
<td>0.11</td>
<td>-0.22</td>
</tr>
<tr>
<td>Wave 2</td>
<td>0.17*</td>
<td>-0.47***</td>
<td>0.48**</td>
<td>0.20**</td>
<td>-0.32*</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wave 8 PS</td>
<td>0.10*</td>
<td>-0.31***</td>
<td>0.35***</td>
<td>0.05</td>
<td>-0.11</td>
</tr>
<tr>
<td>Wave 2 PS</td>
<td>0.11*</td>
<td>-0.24*</td>
<td>0.24*</td>
<td>0.12**</td>
<td>-0.16*</td>
</tr>
<tr>
<td>Wave 8 Bi</td>
<td>0.14</td>
<td>-0.50***</td>
<td>0.57***</td>
<td>0.08</td>
<td>-0.22*</td>
</tr>
<tr>
<td>Wave 2 Bi</td>
<td>0.13*</td>
<td>-0.39***</td>
<td>0.38**</td>
<td>0.15*</td>
<td>-0.24*</td>
</tr>
<tr>
<td>Wave 8 P/EG</td>
<td>0.13*</td>
<td>-0.32**</td>
<td>0.34**</td>
<td>0.10*</td>
<td>-0.15</td>
</tr>
<tr>
<td>Wave 2 P/EG</td>
<td>0.11*</td>
<td>-0.36***</td>
<td>0.37**</td>
<td>0.12*</td>
<td>-0.26*</td>
</tr>
<tr>
<td>Same-sex sexual attraction</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Model 3</td>
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</tr>
<tr>
<td>Wave 8</td>
<td>0.14</td>
<td>-0.44***</td>
<td>0.51***</td>
<td>0.08</td>
<td>-0.20</td>
</tr>
<tr>
<td>Wave 2</td>
<td>0.14</td>
<td>-0.47***</td>
<td>0.45*</td>
<td>0.09</td>
<td>-0.27*</td>
</tr>
<tr>
<td>Same-sex sexual behavior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wave 8</td>
<td>0.11</td>
<td>-0.50*</td>
<td>0.69**</td>
<td>-0.04</td>
<td>-0.13</td>
</tr>
<tr>
<td>Wave 2</td>
<td>0.21*</td>
<td>-0.48*</td>
<td>0.42</td>
<td>0.12</td>
<td>-0.16</td>
</tr>
</tbody>
</table>

Bold text denotes significant coefficients. *P < 0.05; **P < 0.01; ***P < 0.001. Standardized, adjusted coefficients are presented. Drunkenness: ‘How many times in the past 30 days did you get drunk on alcohol?’ Binge drinking: ‘In the past 30 days, how many times have you had five or more drinks in a single setting?’ Frequency of alcohol, cigarettes and cannabis use (0 = never/not in the past 3 months; 7 = more than 40 times). Inter: intercept; Quad: quadratic; PS: primarily heterosexual; Bi: bisexual; P/EG: primarily/exclusively homosexual. Model 1: (0 = exclusively heterosexual [ES]; 1 = PS, Bi, P/EG). Model 2: MS (0 = ES; 1 = PS); Bi (0 = ES; 1 = Bi); P/EG (0 = ES, 1 = P/EG). Model 3: same-sex sexual attraction (0 = opposite-sex only; 2 = opposite-sex mostly/opposite-sex somewhat/both sexes equally/same-sex somewhat/same-sex mostly/same-sex only). Model 4: same-sex sexual behavior (same anchors as attraction).
expONENTIALLY (I.E. ACCELERATED) IN THEIR CANNABIS USE OVER TIME, INDIVIDUALS WHO ENDORSED A SEXUAL MINORITY SELF-IDENTIFICATION AT THE LAST ASSESSMENT DID NOT EVIDENCE ACCELERATION IN CANNABIS USE AND, INSTEAD, SIMPLY MAINTAINED ELEVATED RATES OF CANNABIS USE THROUGHOUT THE FIRST 4 YEARS OF EMERGING ADULthood. THAT DISTINCT PATTERNS OF SUBs WERE FOUND BETWEEN POSTdictIVE AND PREDICTIVE MODELS SUGGESTS THAT THE TIMING OF THE ASSESSMENT OF INDIVIDUALS’ SEXUAL ORIENTATION IS IMPORTANT (SEE ALSO [41,42]).

THE CURRENT FINDINGS ALSO SUPPORTED DIAMOND’S [31,32] WORK WITH SAMPLES OF FEMALE SEXUAL MINORITIES, BY PROVIDING ADDITIONAL EVIDENCE THAT SEXUAL IDENTITY DEVELOPMENT IS A FLUID PROCESS SUCH THAT INDIVIDUALS MAY NOT ENDORSE CONSISTENT SEXUAL IDENTITIES, ATTRACTIONS OR BEHAVIORS OVER TIME. AS EVIDENCE, A SIGNIFICANT PROPORTION OF INDIVIDUALS IN THE CURRENT SAMPLE CHANGED THEIR SEXUAL ORIENTATION OVER THE STUDY (6–8% OF THE SAMPLE). SPECULATIVELY, INDIVIDUALS IDENTIFYING AS SEXUAL MINORITIES AT THE ONSET OF EMERGING ADULTHOOD MAY BE MORE ENGAGED IN A TENTATIVE EXPLORATION OF SEXUALITY OR MAY NOT HAVE FULLY ACCEPTED A NON-HETEROSEXUAL IDENTITY (E.G. [43–49]), WHEREAS THOSE WHO IDENTIFY AS SEXUAL MINORITIES 4 YEARS LATER MAY HAVE ACHIEVED A RELATIVELY STABLE SEXUAL IDENTITY AND HAD MORE TIME TO INTEGRATE THEIR SEXUAL IDENTITY INTO THEIR SELF-CONCEPT [48].

Thus, individuals who identify as sexual minorities at an earlier age may be otherwise engaged in a myriad of exploratory behaviors and grappling with identity-related stress. As such, their SUBs may follow a trajectory distinct from those who identify as sexual minorities 4 years later and who may have had time to develop more appropriate competencies necessary for managing their sexual identity and SUBs [42].

EVIDENCE FOR NON-LINEAR CHANGES IN SUBSTANCE USE

Misspecification of statistical models may greatly influence the interpretation of results [36]. Indeed, there were a number of disparate findings when non-linear substance use trajectories were estimated and compared to linear trajectories. Thus, it is imperative that researchers consider and test higher-order or non-linear time effects, when appropriate, to capture adequately changes in these behaviors over time.
Limitations and future directions

There are limitations that must be considered when interpreting the study’s findings. First, the data are based on a sample of college students, the majority of whom are white/Caucasian. It is difficult to know whether these results are likely to generalize to other populations (e.g. individuals not attending college; ethnic minorities). A recent review of the literature [50], however, found that SUBs among lesbians and gay men of color appear more similar to those of white lesbians and gay men than to their racial/ethnic heterosexual counterparts, suggesting that the current results may generalize to other demographic strata. Nevertheless, future studies are needed to confirm this. Secondly, only two assessments of sexual orientation were considered. Given that the current study implied individual differences with regard to the fluidity of sexual orientation, it may be fruitful for future researchers to examine how changes in sexual orientation over time correspond to changes in trajectories of substance use over time.

Although previous researchers have highlighted the role that minority stress plays in provoking the use of drugs and alcohol as means to cope with sexual prejudice and its associated stressors (e.g. [13,14,24,25,51,52]), others have posited that sexual minorities may use alcohol and drugs due to more permissive peer norms [9,25] or as a way to reinforce a valued group identity through shared social activities (e.g. [13–15,53]). That the current findings revealed some SUBs accelerated in emerging adulthood (i.e. drunkenness) suggests that environmental/social factors (i.e. attaining legal drinking age, socializing in public bars) may exacerbate the use of alcohol and certain types of drugs among sexual minorities in this stage of life. Although the current study did not address what explanatory variables may account for the discrepancies in the patterns of SUBs, future research should examine which explanations may account for changes in these behaviors during emerging adulthood. Once the risks for disparities are identified, they may be examined in the context of an individual’s sexual identity development process to understand more clearly their...
contributions to sustained and detrimental patterns of use (e.g., experimentation, peer influence). By considering the findings from the extant literature, we may be able to manage more effectively the diagnosis and treatment of substance use disorders and the associated comorbid psychopathology among sexual minority individuals.

Declarations of interest

None.

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References


Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Attrition-adjusted analyses.

Figure S1 Latent growth model.

Table S1 Sex composition based on operationalization of sexual orientation.

Table S2 Correlations between primary predictor and outcomes variables.

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