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Concurrent Polysubstance Use in a Longitudinal Study of U.S. Youth: Associations with Sexual Orientation

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Abstract

Aims—To estimate longitudinal associations between self-reported sexual orientation and past-year polysubstance use among youth, and test how gender, age, and early onset of tobacco and alcohol use contributed to variation in polysubstance use.

Design—Longitudinal community-based cohort of U.S. adolescents from the Growing Up Today Study (GUTS 1) (N=16,873) followed from ages 12–29 years.

Setting—United States of America (USA).

Participants—13,519 individuals (7,839 females; 5,680 males) who responded to at least one of five self-administered questionnaires from 1999–2010. Ninety-three percent reported their race/ethnicity as non-Hispanic white.

Measurements—Multivariable repeated measures generalized estimating equations estimated relative risks (RRs) of concurrent polysubstance use (i.e., past 12-month use of three or more substances) comparing sexual orientation minority youth (i.e., mostly heterosexual [MH], bisexual [BI], gay/lesbian [GL]) to their same-gender, completely heterosexual (CH) counterparts. Mediation analyses tested whether early onset of tobacco and/or alcohol use explained relationships between sexual orientation and concurrent polysubstance use.

Findings—Compared with their same-gender CH peers, sexual minorities evidenced higher risk for concurrent polysubstance use over all repeated measures (RRs for sexual minority subgroups: 1.63–2.91, p-values: <0.001), and for all age groups (RRs: 1.50–4.04, p-values: <0.05–<0.001), except GL males aged 18–20 years. Differences between sexual minorities and CHs were larger among females than males (p-values for sexual-orientation-by-gender interactions were <0.05 for MHs and BIs), and among younger vs. older ages (p-values for sexual-orientation-by-age interactions were <0.05 except for BI males). Sexual minorities' younger age of smoking and/or drinking initiation contributed to their elevated polysubstance use (% of effect explained was between 9.4–24.3, p-values: 0.04–<0.001), except among GL males.

Conclusions—Sexual minority youth in the USA, and in particular younger females, appear to be at disproportionate risk for concurrent past-year polysubstance use. Early onset of smoking and drinking may contribute to elevated risk of polysubstance use among sexual minorities.

Keywords

polysubstance use; adolescents; emerging adults; sexual orientation

1. Introduction

Youth substance use is a significant public health problem contributing to preventable morbidity and mortality (1). Polysubstance use, i.e., the consumption of more than one substance over a defined period, simultaneously or at different times, for either therapeutic or recreational purposes (2), may be especially problematic among youth because of its detrimental health implications. Polysubstance use has been linked to increased levels of intoxication and a greater likelihood of overdose (3,4), negative physical and psychological outcomes including drug dependence (5), decreased cognitive functioning (2), psychiatric comorbidity (6), high-risk sexual behaviors (7), and excess burden of HIV disease (8). In recent years, research examining polysubstance use in adolescents and young adults has grown. Much of this body of research has relied on small convenience samples, including studies focusing on youth who attend clubs (9), inject drugs (10), or are traveling (11). Additional studies have investigated polysubstance use with large, population-based samples of youth from Australia (12,13), Europe (14,15), and USA (16,17). These studies suggest that between 12–34% of youth report polysubstance use depending on the region and time-frame.

Not all youth populations share similar risk for substance use. For example, sexual orientation minority youth (i.e., lesbians, gay men, bisexuals [LGB] and those reporting same-sex sexual attractions/behaviors such as those who describe themselves as “mostly heterosexual” (18,19)) are at greater risk for substance use and dependence than heterosexuals (20–22). Disparities have been documented for different substances including cigarette smoking (21,23), problematic alcohol use (24,25), marijuana use (26), nonmedical use of prescription drugs (27,28), and non-marijuana illicit drug use (27,29). Studies on sexual-orientation disparities in youth substance use has generally been limited to investigations of a single substance, a single class of drugs, or a composite drug use measure (i.e., four-category index of illicit drug risk) (30). Recently, several studies have found that polysubstance use was prevalent among sexual or gender minorities (31), including men

who have sex with men (32,33) and transgender women (34). However, there is a dearth of national research on how sexual orientation is associated with polysubstance use in youth, particularly studies presenting longitudinal data.

Definitions of polysubstance use in research have varied. Polysubstance use typically refers to use of multiple illicit drugs, but it can also include alcohol, tobacco, and nonmedical use of prescription drugs (2). Definitions may include lifetime prevalence (13,17), past 1-, 6- or 12-month prevalence, i.e. concurrent polysubstance use (12,14,16,35), or use of multiple substances on the same occasion, i.e. simultaneous polysubstance use (9,12,16). Simultaneous polysubstance use has been rarely assessed in large-scale population studies (12), usually because of the burden of asking about many drug combinations (2). Previous studies of adolescent concurrent polysubstance use have focused on the most commonly used substances during adolescence, i.e. alcohol, cigarettes, and marijuana (17), or combinations of alcohol or tobacco and other drugs (16,36). Although polysubstance use has been defined as the use of at least two psychotropic substances, researchers recommend including at least three substances (37). Given high prevalence of tobacco, alcohol and marijuana use among adolescents (38), and because the study's questionnaires assessed illicit and nonmedical prescription drug use, we opted for a more stringent definition of polysubstance use as concurrent use of at least three substances during the past 12 months. This is consistent with prior studies (39–41) and the method of assessment of substance use in the study's questionnaires.

Research with general population samples has demonstrated gender differences in substance use prevalence, risk of susceptibility, age of initiation, and physiological consequences (42). While studies have revealed that gender differences in substance use have narrowed over recent decades (43), males are still more likely to use alcohol than females (44). Among general adolescent populations, some studies have found that males are more likely to smoke cigarettes than females (45), while others have found no gender differences (46). Studies of the relationship between sexual orientation and substance use have identified gender as a modifier of this relationship. Principally, among sexual minority youth, substance use may be higher among females than males (47–49). Furthermore, bisexual females have been found to report higher rates of substance use when compared to heterosexuals or lesbians (27,48). Nonetheless, little is known about how gender and sexual orientation differences are related to polysubstance use.

Additionally, it is important to consider the timing of substance use initiation because initiation at younger ages is positively associated with risk of drug use (50) and substance dependence (51). Among U.S. adolescents, alcohol and tobacco are typically the first substances used, (52,53) and the majority of individuals who use substances start using alcohol and tobacco before progressing to using other drugs (54). Several studies have found that the most prevalent early age for the onset of alcohol and tobacco use is between ages 13–15 years (5,55,56). Adolescents who begin using alcohol and cigarettes by these ages have a heightened risk for developing an alcohol use disorder (57) or nicotine dependence (58,59). Further evidence suggests that compared to heterosexual youth, sexual minority youth begin smoking and drinking at younger ages (13,23,60). Other research has examined gender differences in transitions across milestones (e.g., ages at first use, problem use, and

treatment). These studies show that although females typically initiate use at older ages (42,61), they transition to later milestones more quickly than males (62). While these studies suggest that an early onset of substance use is an indicator of greater risk for substance involvement later in life, little is known whether sexual orientation and gender differences in age at initiation of cigarette smoking or alcohol drinking have later implications for polysubstance use among young adults. As such, exploring the early onset of smoking or drinking at or prior to age 14 years, a critical period of initiation, may be important in informing developmentally responsive interventions and public health approaches.

To improve understanding of how sexual orientation is related to polysubstance use among adolescents and young adults, we analyzed data from Growing Up Today Study 1 (GUTS 1), a large U.S. cohort of youth who reported their sexual orientation and substance use on multiple waves of data collection. The study objectives were to: 1) Estimate sexual orientation differences in longitudinal patterns of past-year concurrent polysubstance use during ages 12–29 years; 2) Test if gender and age modified sexual orientation differences in risk of past-year concurrent polysubstance use; and 3) Test if early initiation of alcohol and/or tobacco use mediated associations between sexual orientation and concurrent polysubstance use in stratified analyses by gender and age.

2. Methods

2.1. Design

GUTS 1 is a U.S. community-based longitudinal cohort of 16,873 children of women participating in the Nurses' Health Study II. GUTS participants' mothers were recruited into the Nurses' Health Study II (N=116,430) in 1989 by mailing baseline questionnaires to approximately 520,000 registered nurses from 14 of the most populous U.S. states. After obtaining maternal consent, baseline GUTS questionnaires were mailed in October 1996 to potential participants. Children agreeing to participate returned a completed questionnaire thereby assenting to the study. Recruitment occurred at the family level, hence some participants are siblings. Since 1996, participants have completed self-administered questionnaires, initially on an annual basis and then approximately every two years between 2001–2010. The GUTS cohort is 93.3% non-Hispanic white, 2.2% other races/ethnicities, 1.5% Asian, 1.5% Hispanic, 0.9% African American, and 0.8% Native American. Additional information about the study, including enrollment procedures, is reported elsewhere (63). The Brigham and Women's Hospital Institutional Review Board approved this study.

2.2. Study sample

The current analysis is comprised of 13,519 participants (7839 females and 5680 males, representing 80.1% of the original cohort) who provided information on sexual orientation and substance use on at least one of five questionnaires administered between 1999–2010. Prior to 1999, participants were not asked about their sexual orientation or drug use (except tobacco and alcohol). In addition, in 2005 participants were not asked about their drug use, hence 2005 data were excluded. A total of 2,327 participants from the 1996 baseline survey stopped responding to questionnaires prior to wave 1999, thereby reducing the baseline

number for comparisons by sexual orientation to 14,546 participants. The analytic sample consists of 92.9% of these participants. When considering the 1999 baseline cohort, participants included in this analysis were more likely than participants not included in this analysis to be female than male (95.6% vs. 89.5% included, $p<0.001$) and younger at the 1999 baseline age (14.6 vs. 15.0 years; $p<0.001$). Participants residing in the Western region of the United States in 1999 were more likely to be included in the analysis (94.4% included) than those residing in the Northeast (92.6% included; $p=0.003$), or in the Midwest/South (92.8% included; $p=0.005$). No difference was observed in relation to race/ethnicity ($p=0.67$). Among the analytic sample, 87.2% responded to the 1999 survey, 75.0% responded in 2001, 78.1% in 2003, 72.4% in 2007, and 63.8% in 2010. Among those included in analysis, 43.3% responded to all 5 waves, 19.5% responded to 4 waves, 16.5% responded to 3 waves, 11.8% responded to 2 waves, and 8.9% responded to 1 wave.

2.3. Measures

2.3.1. Sexual Orientation—An item adapted from the Minnesota Adolescent Health Survey (64) assessed sexual orientation in all 5 waves (1999, 2001, 2003, 2007, 2010). Youth were asked, “Which of the following best describes your feelings?” Response options were: “completely heterosexual (attracted to persons of the opposite sex)”; “mostly heterosexual”; “bisexual (attracted equally to men and women)”; “mostly homosexual”; “completely homosexual (gay/lesbian, attracted to persons of the same sex)”; and “not sure”. Respondents who were unsure about their sexual orientation, or who had missing information on sexual orientation were excluded from analyses from that wave. “Mostly homosexual” and “completely homosexual” responses were grouped together due to low prevalence and to enhance statistical power. Thus, the sexual orientation variable was categorized into four groups: completely heterosexual (CH), mostly heterosexual (MH), bisexual (BI), and completely/mostly gay/lesbian (GL). In analyses, sexual orientation was modeled as time-varying to account for changes in reports over the waves.

2.3.2. Polysubstance use outcomes—Past 12-month substance use was assessed on the five waves. The following variables assessing any report of past 12-month use, all coded as yes vs. no, were used to create the concurrent polysubstance use outcome: (1) cigarette smoking (in 1999 and 2001 cigar smoking and tobacco chewing were also included); (2) heavy episodic use of alcohol as drinking five (for males) or four (for females) or more alcoholic beverages over a few hours (3) marijuana; (4) ecstasy; (5) cocaine; (6) heroin; (7) lysergic acid diethylamide, LSD; (8) crystal methamphetamine, or other amphetamines; (9) misuse (defined as use without a doctor’s prescription) of prescription tranquilizers, i.e. Valium/Xanax/Librium; (10) prescription opioids, i.e. Percodan/Codeine; (11) prescription sleeping pills, i.e. Rophynol; (12) prescription stimulants, i.e. Ritalin/Adderall. We initially summed the number of substances used (from 0–12) at each wave, and then created a binary variable for polysubstance use. Similar to previous studies (39–41), concurrent polysubstance use was defined as use of three or more substances over 12 months prior to completing the survey (0=0–2; 1=3+ substances). Polysubstance use was also modeled as time varying.

2.3.3. Mediators—To assess age at first smoking and drinking, on the earlier waves (1996–1998) participants were asked to indicate whether and at what age they smoked their first cigarette or first drank a whole glass of alcohol, respectively. Beginning in 1999, specific ages of smoking and drinking initiation were determined by crossing participants' age and their change in smoking or drinking status from the prior wave (i.e., going from never to past year users). Early onset of alcohol use and cigarette smoking were defined as initiation before or at age 14 years (1=Yes; 0=No).

2.3.4. Covariates—Covariates included gender at birth (0=male; 1=female), race/ethnicity (0=non-Hispanic white; 1=other), age (modeled as a continuous variable) and region of residence (0=Midwest/South, 1=West, and 2=Northeast), and report of an adult or sibling living in the household who drinks alcohol and/or smokes tobacco (0=no; 1=yes).

2.4. Data analyses

To investigate sexual-orientation patterns in polysubstance use, we conducted longitudinal repeated measures analyses using data from 5 survey waves. We used multivariable generalized estimating equations (GEE) modified Poisson regression (65) with SAS Version 9.3 PROC GENMOD (66) to estimate adjusted risk ratios (RR) and 95% confidence intervals (CI) for past 12-month polysubstance use comparing sexual minority groups to same-gender heterosexuals. In the GEE repeated measures regressions, all variables in the model were updated for each wave and measured concurrently whenever possible. All test statistics presented were derived from GEE models. The working variance-covariance structure was specified as exchangeable (compound symmetry). GEE variance estimates accounted for the non-independent repeated measures from the same individual and siblings within a family (66).

We also estimated gender-specific age-standardized prevalences of past 12-month polysubstance use for each sexual orientation group. Subanalyses were conducted to test for differences in polysubstance use between the sexual minority groups. To formally test whether age was an effect modifier in the relationship between sexual orientation and polysubstance use, we constructed statistical models that included sexual orientation-by-age interaction terms. Analyses were stratified by gender due to gender differences commonly found in substance use (27,43,45) with the exception of models including sexual-orientation-by-gender interaction terms to test statistically whether gender modified relationships between sexual orientation and polysubstance use. All multivariable models controlled for potential confounding by age, race/ethnicity, region of residence, and family substance use. Statistical significance was set at $p < 0.05$ criterion.

To examine if younger age (i.e., before or at age 14 years) of first smoking cigarettes and/or first drinking alcohol mediated relationships between sexual orientation and polysubstance use, we compared sexual orientation specific estimates from models that included (mediation models) and excluded (base models) younger age at first smoking/drinking to assess for changes in model parameter estimates. We calculated the mediation proportion and its associated p-value (67) using the publicly available Mediate macro available at <http://www.hsph.harvard.edu/faculty/spiegelman/mediate.html>. The mediation proportion is the

excess polysubstance use in sexual minorities relative to same-gender heterosexuals attributable to sexual minorities' greater risk of younger age at first smoking and/or drinking. Mediation analyses were restricted to responses at age 14 years or older to account for temporal ordering.

Our approach to handling missing data was not to impute information for the main independent and dependent variables (i.e., sexual orientation and polysubstance use), and to use the missing-indicator method for missing covariate information (68). Missing data for sexual orientation and polysubstance use occurred principally because of nonresponse to a survey wave. Missing covariate information in GUTS was small (between 0–1.6%) and covariates examined were not strong confounders; under these conditions, the missing covariate indicator approach is considered valid (69).

3. Results

In Table 1, we present gender-specific distributions of sexual orientation in GUTS calculated from the repeated measures observations. Over all repeated measures, the prevalence of past-year concurrent polysubstance use in the cohort was 18.6%. In Table 2, we present the age-standardized and the age-specific prevalences and their corresponding adjusted RRs of past-year concurrent polysubstance use by sexual orientation among male and female youth in GUTS. In all but one instance (gay men aged 18–20 years), the overall and the age-specific prevalences and RRs indicated elevated risk for concurrent polysubstance use for sexual minority groups compared to CH. Additional analyses indicated that BI females were at higher risk for concurrent polysubstance use than MH females (Table 2 footnote b); no differences in polysubstance use were found between subgroups of sexual minority males. Age-by-sexual orientation interactions indicated that differences between sexual minorities and CH were larger during younger (i.e., adolescence) than during later ages for all groups except BI males (Table 2 footnote c). Gender-by-sexual orientation interactions indicated that differences between sexual minorities and CH were larger in females than males (Table 2 footnote d).

Over the repeated measures, 33.8% reported drinking their first whole glass of alcohol by age 14 years, while early use of tobacco was endorsed by 19.5%. Prevalence of past-year polysubstance use (among observations at ages 14 or older) was positively associated with earlier vs. later initiation of alcohol (34.5% vs. 12.1%) and tobacco (42.1% vs. 13.9%) use. Analyses conducted to examine contributions of younger age at first smoking and drinking to sexual orientation disparities in subsequent polysubstance use are shown in Table 3. The estimated percent (i.e., mediation proportion) of sexual minorities' excess polysubstance use attributable to their early initiation of smoking was larger for females (9.4–18.5%) than for males (0–11.5%). Younger age at first drinking mediated the positive relationship between minority sexual orientation and polysubstance use for mostly heterosexual (12.1%) and bisexual (22.7%) males, but not for gay males. Younger age at first drinking explained between 11.9–17.4% of sexual minority females' excess risk for engaging in polysubstance use. When early initiation of smoking and drinking were considered simultaneously as mediators, up to 24.3% of the relationship between minority sexual orientation and polysubstance use was explained by these variables.

4. Discussion

The present study further corroborates the evidence that concurrent polysubstance use is common among adolescents and young adults. The overall prevalence of concurrent polysubstance use in GUTS was similar to comparable samples (12,13,16). However, we also observed that sexual minorities of both genders had significantly higher prevalence of concurrent polysubstance use than heterosexuals. Our study found that on average, across adolescence and young adulthood, sexual minorities had between 60% to more than two times greater risk for polysubstance use compared to their same-gender, CH peers. When compared to other demographic correlates of polysubstance use (e.g., race/ethnicity, socioeconomic position, gender, age) (37,70), the sexual orientation disparities we observed were quite large. Consistent with previous literature, individuals identifying as MH reported higher substance use than CHs, and were more similar to other sexual minority groups (49). While previous studies of the GUTS cohort have found sexual orientation disparities in the use of individual substances (23,24,27), this study quantified sexual orientation disparities associated with concurrent polysubstance use making a unique contribution to the field.

It is important to note that compared to CHs, sexual minorities in GUTS reported higher overall rates of substance use, which suggests that their higher rates of concurrent polysubstance use are, in part, a function of their higher overall substance use. The most common explanations for higher substance use among sexual minorities include minority stress (71,72), social anxiety related to coming out processes (73), and social norms and network characteristics supportive of substance use (74). In addition, elevated risk for substance use among non-gay identified sexual minorities (e.g., MH, BI) is explained as a consequence of discrimination from both heterosexuals and lesbians and gay men (75).

Our results reinforce the importance of analyzing data separately by gender and sexual minority subgroups when examining polysubstance use (22). Among CHs, males had higher past-year polysubstance use than females, while among sexual minorities females reported higher prevalence of past-year polysubstance use than males. Smaller sexual-orientation differences in males than females can be partly explained by the higher rates of substance use among males in general (76). These findings of larger differences in females than males are consistent with other studies suggesting that sexual minority females are at disproportionate risk for substance use (21,27,77). It is possible that sexual minority females are at elevated risk for polysubstance use because of cultural and environmental factors associated with gender and sexual orientation. While some researchers suggest that sexual minority females may express a masculine role through substance use (77), we observed that bisexual females reported the highest relative risk of past-year polysubstance, suggesting that factors besides gender expression may contribute to sexual minority females' elevated substance use. Future research is warranted to explore the mechanisms that produce and maintain disparities among different categories of sexual minority female youth.

In this study, we examined age as a potential modifier of relationships between sexual orientation and polysubstance use. Among both genders, sexual orientation disparities existed during all developmental stages investigated, confirming previous findings that a significant proportion of sexual minorities are on an elevated substance use trajectory that

extends into adulthood and is different from the trajectories of heterosexuals (47). Similar to other research (47,60), we also observed a reduction in relative risks as participants aged, which suggests that sexual-orientation disparities may be largest during adolescence compared to older developmental periods. Adolescence may represent a key vulnerability period for substance use among sexual minority youth because of a confluence of factors during this period including subcultural norms and perceived drug availability (78), intensification of sexual orientation and identity development processes (79,80), social contextual factors (e.g., intensification of gender roles and norms) (81), and cognitive developmental factors (25,26).

This study found positive associations between early initiation of tobacco and alcohol use and polysubstance use, providing additional support for the developmental patterning of substance use behavior, which is frequently referred to as the gateway hypothesis. This hypothesis suggests that adolescents initially use substances that are more readily available and socially acceptable, such as alcohol or tobacco, and then some of these adolescents progress to using other illicit substances (82,83). In addition, we present evidence that earlier initiation of cigarette smoking and alcohol use among sexual minorities contributed to their subsequent elevated risk of polysubstance use when compared to same-gender heterosexuals, with the exception of gay males. Taken together, these findings suggest heterogeneity across sexual orientation subgroups and gender in the degree to which age of initiation into tobacco or alcohol use contributes to disparities in polysubstance use. While previous studies suggest that sexual minority females are more likely to meet criteria for substance use disorders than heterosexual females (84), it is possible that, among sexual minorities, early use of alcohol and tobacco might directly contribute distinct patterns of later substance use. Results from this study suggest that smoking and drinking prevention interventions might specifically target adolescent females as a group at elevated risk.

The study has limitations. GUTS is not representative of the U.S. population; participants' mothers were Nurses' Health Study II participants. Therefore, the generalizability of findings to more diverse samples of young people (e.g., heterogeneous socioeconomic positions) remains to be determined. The sample is predominantly non-Hispanic white, requiring caution in generalizing findings to more ethnically or racially diverse populations. However, participants were enrolled in GUTS regardless of their sexual orientation. Because some sexual orientation categories had small sample sizes, sexual orientation was collapsed into four groups to enhance statistical power, precluding more fine-grained comparisons of sexual orientation. Furthermore, because this study used a sexual orientation question that combined attractions and identity, we were unable to examine different dimensions of sexual orientation. Results are based on self-reports of substance use, and due to the limitations of the questionnaire, we were unable to examine simultaneous coingestion of substances. Longitudinal studies are subject to potential attrition bias. Finally, it is difficult to operationalize mediation analyses when the main predictor (i.e. sexual orientation) is a marker of developmental processes and experiences that occur over time (85). However, we restricted our mediation analyses to responses at age 14 years or older to account for temporal ordering. Despite these limitations, findings from this research offer important and unique information about sexual orientation differences in patterns of polysubstance use over time in a national sample of youth.

Future research would benefit from moving beyond binary measures of drug use to considering polysubstance use profiles by incorporating measures of frequency and severity (2,17). Although the prevalence of sexual orientation subgroups were similar to other studies (18,86), polysubstance use patterns should be examined further in relation to multiple dimensions of sexual orientation. Extant literature shows that risk for substance use might vary depending on sexual identity, sexual behavior and sexual attraction, pointing to the need for comprehensive assessment of sexual orientation in research and clinical practice (79,87). While the repeated measures accounted for changes in sexual orientation, additional research is needed to understand how the development of sexual orientation over time is related to polysubstance use. Relatedly, prior research with GUTS found that sexual orientation mobility, or changing from one sexual orientation category to another, was common during adolescence and emerging adulthood (88), and was a marker of greater substance use (80). Future research is needed to explicate key mechanism during different developmental periods responsible for sexual minorities' greater burden of polysubstance use. Understanding risk and protective factors for polysubstance use in different subgroups of sexual minority youth can aid in developing interventions and policies aimed at reducing the disparities observed in this study. While prevention efforts should emphasize delayed use of alcohol and tobacco for all adolescents, additional research is needed to understand how to reduce sexual-orientation disparities in early initiation of substance use.

Overall, findings suggest that use of substances among U.S. adolescents and young adults often occur in the context of multiple types of drug use. This study provides additional and compelling evidence that sexual minorities are at higher risk for substance use during adolescence and early adulthood by highlighting that these disparities are also applicable to polysubstance use. Given evidence that sexual minorities may have challenges accessing substance abuse services (89) and experiences with these services may not be ideal (90), reducing polysubstance use among sexual minorities should be a focus of prevention efforts. We suggest focusing specifically on sexual minority adolescents because of their increased vulnerability to polysubstance use during this developmental period.

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Table 1

Distribution of Sexual Orientation by Repeated Measures Observations among Male and Female Adolescent Participants in Polysubstance Use Analysis in the Growing Up Today Study (1999–2010).

	N (%)	
	Males	Females
Repeated Measures Observations of Sexual Orientation *		
<i>Total Number of Observations</i>	16018 (100.0)	27535 (100.0)
Completely Heterosexual (CH)	14731 (92.0)	23681 (86.0)
Mostly Heterosexual (MH)	852 (5.3)	3116 (11.3)
Bisexual (BI)	104 (0.6)	508 (1.8)
Gay/Lesbian (GL)	331 (2.1)	230 (0.8)

* Over the repeated measures, using Generalized Estimating Equations (GEE), females were significantly more likely than males to self-identify as MH ($p<0.001$) and BI ($p<0.001$), but less likely to identify as CH ($p<0.001$) and GL ($p=0.001$).

Age-Standardized and Age-Specific Prevalence of Past-Year Polysubstance Use by Sexual Orientation among Male and Female Youth in The Growing-Up Today Study (1999–2010).

Table 2

Polysubstance Use by Gender and Age (years)					
	Total Sample	Completely Heterosexual (CH)	Mostly Heterosexual (MH)	Bisexual (BI)	Gay/Lesbian (GL)
Males					
Age-Standardized Prevalence (%)	20.0	18.5	35.8	37.1	32.3
RR (95% CI) ^a		Ref	2.07 (1.59–2.71) ^{***}	1.63 (1.35–1.95) ^{***}	1.69 (1.53–1.88) ^{***}
Ages 12–17 (%)	9.7	9.0	23.1	29.7	23.2
RR (95% CI)		Ref.	2.21 (1.74–2.81) ^{***}	2.39 (1.52–3.76) ^{***}	1.83 (1.16–2.88) ^{**}
Ages 18–20 (%)	26.2	25.1	41.7	46.2	33.8
RR (95% CI)		Ref.	1.58 (1.27–1.97) ^{***}	1.87 (1.25–2.79) ^{**}	1.26 (0.88–1.80)
Ages 21–24 (%)	29.7	27.2	51.4	44.8	45.6
RR (95% CI)		Ref.	1.76 (1.54–2.00) ^{***}	1.80 (1.25–2.60) ^{**}	1.63 (1.31–2.02) ^{***}
Ages 25–29 (%)	25.6	23.9	40.0	33.3	35.4
RR (95% CI)		Ref.	1.52 (1.22–1.89) ^{***}	2.06(1.04–4.06) [*]	1.50 (1.09–2.07) ^{**}
Females					
Age-Standardized Prevalence (%)	17.9	14.1	38.7	52.3	43.8
RR (95% CI)		Ref	2.91 (2.62–3.23) ^{***}	2.46 (2.01–3.01) ^{***}	2.18 (2.04–2.33) ^{***}
Ages 12–17 (%)	10.1	8.1	29.6	50.0	37.5
RR (95% CI)		Ref.	2.75 (2.41–3.15) ^{***}	4.04 (3.28–4.97) ^{***}	2.70 (1.27–5.75) ^{**}
Ages 18–20 (%)	24.3	20.5	48.8	56.0	56.1
RR (95% CI)		Ref.	2.10 (1.90–2.34) ^{***}	2.54 (2.13–3.02) ^{***}	2.24 (1.62–3.11) ^{***}
Ages 21–24 (%)	24.7	18.8	46.6	58.4	49.0
RR (95% CI)		Ref.	2.24 (2.05–2.44) ^{***}	2.62 (2.24–3.05) ^{***}	2.58 (2.06–3.23) ^{***}
Ages 25–29 (%)	16.5	12.0	33.9	42.7	33.3
RR (95% CI)		Ref.	2.58 (2.22–3.00) ^{***}	3.34 (2.58–4.32) ^{***}	2.76 (1.93–3.94) ^{***}

RR - Risk ratio; CI - Confidence Intervals

^bBased on repeated measures observations, RR from multivariable GEE models adjusted for age, race/ethnicity, region of residence, and family alcohol/tobacco use.

^hDifferences in prevalence of polysubstance use were observed between MH (Ref.) vs BI females: Age-standardized: RR=1.34 (95% CI: 1.21–1.49)***, and in Age-specific: Ages 12–17 [RR=1.47 (95% CI: 1.17–1.83)***]; Ages 18–20 [RR=1.21 (95% CI: 1.00–1.45)*]; Ages 21–24 [RR=1.17 (95% CI: 1.01–1.37)*]; Ages 25–29 [RR=1.32 (95% CI: 1.03–1.68)*]

^cAge-by-sexual orientation interactions were significant for all sexual minority categories (all $p < 0.001$) except BI males.

^dGender-by-sexual orientation interactions were significant for MH ($p = 0.003$) and BI ($p = 0.03$) categories.

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$

Table 3

Results of Analyses Testing the Mediating Effects of Age of First Cigarette and First Alcohol Drink (Before Age 14) on Differences between Sexual Minority and Completely Heterosexual Youth in Past-Year Polysubstance Use by Gender among Participants (Age 14) in The Growing-Up Today Study (1999–2010).^a

Polysubstance Use, OR (95% CI)	Mostly Heterosexual (MH)			Bisexual (BI)			Gay/Lesbian (GL)		
	Base Model +	Mediation Model ^a adjusted for early smoking/drinking initiation	% of effect explained by hypothesized mediators (p-value)	Base Model	Mediation Model adjusted for early smoking/drinking initiation	% of effect explained by hypothesized mediators (p-value)	Base Model unadjusted for the hypothesized mediators	Mediation Model adjusted for early smoking/drinking initiation	% of effect explained by hypothesized mediators (p-value)
Mediator: Smoking (14 years)									
Males	1.80 (1.62–1.99)	1.68 (1.51–1.86)	11.5 (0.005)	1.99 (1.52–2.61)	1.86 (1.38–2.53)	9.5 (0.160)	1.55 (1.28–1.88)	1.58 (1.30–1.93)	0.0
Females	2.56 (2.41–2.75)	2.18 (2.05–2.34)	17.0 (<0.001)	3.29 (2.97–3.67)	2.64 (2.36–2.94)	18.5 (<0.001)	2.75 (2.23–3.39)	2.51 (2.05–3.03)	9.4 (0.041)
Mediator: Drinking (14 years)									
Males	1.80 (1.62–1.99)	1.68 (1.51–1.86)	12.1 (<0.001)	1.99 (1.52–2.61)	1.70 (1.28–2.25)	22.7 (0.001)	1.55 (1.28–1.88)	1.60 (1.31–1.93)	0.0
Females	2.56 (2.41–2.75)	2.18 (2.05–2.32)	17.4 (<0.001)	3.29 (2.97–3.67)	2.75 (2.48–3.06)	15.2 (<0.001)	2.75 (2.23–3.39)	2.44 (1.97–3.00)	11.9 (0.006)
Mediators: Drinking and Smoking (14 years)									
Males	1.80 (1.62–1.99)	1.61 (1.45–1.79)	18.2 (<0.001)	1.99 (1.52–2.61)	1.77 (1.35–2.34)	16.8 (0.010)	1.55 (1.28–1.88)	1.60 (1.31–1.97)	0.0
Females	2.56 (2.41–2.75)	2.03 (1.92–2.18)	24.3 (<0.001)	3.29 (2.97–3.67)	2.46 (2.20–2.75)	24.2 (<0.001)	2.75 (2.23–3.39)	2.34 (1.90–2.86)	16.1 (0.007)

^aReferent is completely heterosexual. All analyses restricted to observations from participants when they were 14 years and older in order to make certain the outcome of polysubstance use in the past year occurred temporally after the mediating factor (i.e., age of smoking and drinking before age 14 years).

⁺Base models adjusted for age, race, region of residence, family substance use.

[^]Mediation models adjusted for variables in the base model and age at first smoking cigarette and/or age of first alcohol drink.

* p < 0.05;

** p < 0.01;

*** p < 0.001