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Repeated Changes in Reported Sexual Orientation Identity Linked to Substance Use Behaviors in Youth

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Abstract

Purpose—Previous studies have found that sexual minority (e.g., lesbian, gay, bisexual) adolescents are at higher risk of substance use than heterosexuals, but few have examined how changes in sexual orientation over time may relate to substance use. We examined the associations between change in sexual orientation identity and marijuana use, tobacco use, and binge drinking in U.S. youth.

Methods—Prospective data from 10,515 U.S. youth ages 12-27 years in a longitudinal cohort study were analyzed using sexual orientation identity mobility measure M (frequency of change from 0 [no change] to 1 [change at every wave]) in up to five waves of data. Generalized

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CONTRIBUTIONS

Mr. Ott conducted the statistical analyses, contributed to data interpretation, drafted portions of the manuscript, and critically reviewed the manuscript. Dr. Wypij oversaw statistical analyses, contributed to data interpretation, and critically reviewed the manuscript. Dr. Corliss and Dr. Rosario contributed to data interpretation and critically reviewed the manuscript. Mr. Reisner and Ms. Gordon drafted portions of the manuscript and critically reviewed the manuscript. Dr. Austin oversaw statistical analyses, contributed to data interpretation, drafted portions of the manuscript, and critically reviewed the manuscript.

CONFLICT OF INTEREST

None of the authors has a conflict of interest with this manuscript.

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estimating equations were used to estimate substance use risk ratios and 95% confidence intervals; interactions by sex and age group were assessed.

Results—All substance use behaviors varied significantly by sexual orientation. Sexual minorities were at higher risk for all outcomes, excluding binge drinking in males, and mobility score was positively associated with substance use in most cases ($p < .05$). The association between mobility and substance use remained significant after adjusting for current sexual orientation and varied by sex and age for selected substance use behaviors. This association had a higher positive magnitude in females than males and in adolescents than young adults.

Conclusions—In both clinical and research settings it is important to assess history of sexual orientation changes. Changes in reported sexual orientation over time may be as important as current sexual orientation for understanding adolescent substance use risk.

Keywords

Substance use; tobacco; alcohol; marijuana; sexual orientation; lesbian; gay; bisexual

INTRODUCTION

Substance use among U.S. adolescents continues to be an area of critical concern [1, 2]. Research in the past decade has found disparities in adolescent substance use by sexual orientation, suggesting that sexual minority adolescents (e.g., those who identify as lesbian, gay, or bisexual or who report same-sex attractions and/or relationships) are at disproportionate risk of substance use compared to heterosexual peers [3]. Sexual minority adolescents are more likely than heterosexuals to report smoking tobacco, drinking heavily, misusing prescription drugs, and using marijuana, cocaine and other illicit drugs, although findings are mixed and differences by subgroup remain under-researched [4-10]. A recent Institute of Medicine report called for redoubled efforts to reduce such disparities through improved research [11], underscoring the urgent need to understand the factors that heighten the vulnerability of sexual minority adolescents.

Most studies of sexual orientation and substance use rely on static assessments of sexual orientation identity that do not incorporate changes in sexual orientation identification over time. Reported sexual identity, attraction, and behavior have been shown to change substantially across adolescence and young adulthood [12-16]. Yet a dearth of research has examined the relationship between reported sexual orientation identity change and health-related behaviors. Even fewer studies have examined whether the effects of reported sexual orientation identity on substance use differ across subgroups of adolescents (e.g., male and female, younger and older adolescents). Prior research has found sexual orientation disparities in substance use to be larger in girls than boys and in younger than older adolescents [4, 5].

Changes in sexual orientation identity, like many components of identity development, can be a crucial part of positive transformation and growth during adolescence [17, 18]. Yet, in the case of sexual orientation identity, such change can also be destabilizing when stigma and discrimination result in loss of community, family support and/or social status. Such losses are well-documented in relation to movement toward a sexual minority identity [19, 20]. Thus, changes in self-reported sexual orientation may be an indicator of psychological stress, which can heighten risk of maladaptive coping behaviors [21].

The potential links between stress processes and sexual orientation identity change can be considered in several ways. One, greater change in sexual orientation identity may increase exposure to social stressors including antigay or antibisexual prejudice. According to

Minority Stress Theory [22, 23], these stressors disproportionately affect those with or moving toward sexual minority identities. Two, change in identity for youth moving toward bisexuality or heterosexuality is not inherently stress-free [17, 21]. Such change could be associated with loss of sexual minority community, increasing stress and decreasing access to social or emotional resources [24]. This area remains undertheorized but can be informed by the extensive literature on multiracial identity development, demonstrating that bi/multiracial youth frequently face the monoracial expectations and demands of peers, teachers, and strangers; thus, while being multiracial carries no inherent harm, these social pressures can require additional coping resources on the part of youth [25]. Youth with a sexual orientation identity that is mobile or otherwise does not fit expectations of a fixed sexual identity at one end of the spectrum may similarly be subject to negative social reactions. Moreover, as adolescents have yet to develop the coping resources of adults, they may be particularly vulnerable to such social stressors [26] and thus at elevated risk of engaging in substance use as a coping strategy. Three, identity change may be a proxy for intrapersonal factors, such as underlying psychological distress that may independently drive substance use behaviors.

The primary aim of this study was to describe the associations between substance use and change in self-reported sexual orientation identity, measured as *mobility* and *trajectory*, in a national sample of over 8,000 adolescents. *Mobility* (“M”) is used to quantify the occurrence of change in a particular characteristic—in this case, reported sexual orientation identity—within a population over time. *Trajectory* is used to describe the direction of changes in self-reported sexual orientation identity over time. We hypothesized that adolescents with more mobility in reported sexual orientation identity would be more likely to engage in substance use than those with fewer changes in self-reported sexual orientation. We also hypothesized that adolescents who changed their sexual orientation reports in a single direction (either toward heterosexual or toward homosexual) would be more likely to engage in substance use than those who reported the same sexual orientation for each wave. As this is an emerging field and there is scant literature to indicate whether direction of trajectory could be linked with health outcomes, we designed our analysis to estimate effects separately for each category of trajectory. We further hypothesized that youth who changed in a single direction would be less likely to engage in substance use than those who changed their self-reported sexual orientation multiple times and in no clear direction. We also hypothesized that the associations between both measures of mobility and health risk behavior would be of higher magnitude in females vs. males and in younger vs. older youth.

METHODS

Study Sample

The Growing Up Today Study (GUTS) is a longitudinal cohort of the children of women participating in the Nurses’ Health Study II (NHSII), a prospective cohort study of over 116,000 female registered nurses. Invitations were sent to mothers in NHSII to enroll their children ages 9 to 14 years into the GUTS cohort. In 1996 the children were sent a questionnaire encompassing a broad range of health topics, which they were asked to return if they wanted to participate in the study. At the beginning of the study 7,843 boys and 9,039 girls throughout the United States were enrolled into the GUTS cohort [27]. Participants in the GUTS cohort are 93.3% white, 1.5% Asian, 0.9% African American, 1.5% Hispanic, 0.8% American Indian, and 2.2% of other ethnicity.

GUTS began collecting sexual orientation identity information biennially in 1999. For the present study, adolescent and young adult males and females were included if they reported sexual orientation identity in three or more of five waves of data collection (1999, 2001, 2003, 2005, and 2007). Participants included in analyses ranged in age from 12 (1999 wave)

to 27 (2007 wave) years at the time of questionnaire return. The institutional review board at Brigham and Women's Hospital approved the study.

Sexual Orientation Identity Measure

Beginning in 1999, an item adapted from the Minnesota Adolescent Health Survey [28] was introduced to assess sexual orientation identity in the GUTS cohort: "Which of the following best describes your feelings? (1) completely heterosexual (attracted to persons of the opposite sex), (2) mostly heterosexual, (3) bisexual (equally attracted to men and women), (4) mostly homosexual, (5) completely homosexual (gay/lesbian, attracted to persons of the same sex), (6) not sure." Sexual orientation identity was categorized as either completely heterosexual, mostly heterosexual, bisexual, or lesbian/gay (LG). The mostly homosexual and completely homosexual categories were collapsed to form the LG category due to small sample sizes in these subgroups. Youth who reported "not sure" were excluded.

Measures of Change in Reported Sexual Orientation Identity

Two measures of change in self-reported sexual orientation identity were calculated for each study participant who reported sexual orientation identity on at least three survey waves. The first, mobility, "M," is equal to the number of changes in self-reported sexual orientation identity divided by the total opportunities for a change [14]. For example, a hypothetical participant could report her/his sexual orientation as completely heterosexual in the 1999 survey wave, completely heterosexual in the 2001 wave, mostly heterosexual in both the 2003 and 2005 waves, and finally completely heterosexual in the 2007 wave. As this participant reported sexual orientation in five waves, there were four opportunities for a change in reported sexual orientation identity and two actual changes were observed; thus, $M=0.5$ for this participant. M can range between zero (no changes in self-reported sexual orientation) and one (changes at all possible times). M does not distinguish between changes with different magnitudes or directions, as all changes in self-reported sexual orientation identity are considered equivalent for the calculation of M.

The second change measure, "Trajectory," is calculated by categorizing the direction of changes in self-reported sexual orientation identity [14]. Each participant with three or more reports of sexual orientation is classified as either "Immobile" (no changes in self-reported sexual orientation, this coincides with $M=0$), "Toward Completely Heterosexual," "Toward Completely Homosexual," and "Multidirectional." For example, the Trajectory category for the hypothetical participant described above would be Multidirectional.

Substance Use Behaviors

Three substance use behaviors were assessed during the 1999, 2001, 2003, 2005, and 2007 waves of data collection and were treated as binary. These behaviors were: (1) any marijuana use in the past year, (2) any cigarette smoking in the past month, and (3) binge drinking 12 or more times in the past year. For males binge drinking was defined as drinking five or more drinks in a few hours; initially, the definition was the same for females, but was changed in the 2001 wave to four or more drinks.

Analysis

The association between each of the three health outcomes and M were explored in two ways. First, three sex-stratified regression models exploring the association between M modified by age-group and the three substance use behaviors were constructed, which is to say that an M-by-age-group interaction term was included in the models. Age group for all analyses was defined as a binary variable wherein participants were categorized as either adolescents (ages 12-17 years at time of survey return) or young adults (ages 18-27 at time

of survey return). Second, an M-by-sex interaction term was included in models to determine if the association between M and each of the three substance use behaviors was different for males and females.

Associations between Trajectory category modified by age group and the three substance use risk behaviors were first explored in sex-stratified models. Next, models were constructed to assess for different levels of association between Trajectory category and each of the three substance use behaviors for males as opposed to females by introducing a Trajectory-by-sex interaction term.

All models used a modified Poisson method to generate risk ratios (RR) rather than odds ratios because the prevalence of the outcomes exceeded 10% in most cases and therefore violated the rare-outcomes condition for use of odds ratios to estimate risk.[29] Models were adjusted for age group at the time of return of the survey and race/ethnicity. Additionally, all models adjusted for sexual orientation identity as reported at the time of survey return, as we are interested in the effect of M and Trajectory above and beyond current sexual orientation identity report. All analyses were performed using SAS version 9.2. Generalized estimating equations (GEEs) [30] were utilized in all regression models to account for intra-cluster correlation resulting from siblings nested within families in the GUTS cohort and correlation between the repeated measures from individuals.

To investigate whether missing data might serve as a confounder in these analyses, we tested for an association between the number of waves that were missing and the substance use outcomes stratified by sex, again using GEEs. We also tested for an association between the number of missing waves and M and Trajectory stratified by gender. To account for the potential confounding effect of missing waves, all models with repeated measures were adjusted for the number of missing waves.

RESULTS

From the original cohort, 3980 males and 6535 females (62.3%) reported a sexual orientation in at least 3 survey waves and were included in the analysis. Of the 388 males and 363 females who provided sexual orientation information in 2007 but were not included in the final analyses (due to ever reporting unsure and/or reporting sexual orientation information fewer than three times) there were no significant differences ($p > 0.05$) in sexual orientation, race/ethnicity, or binge drinking compared to those included in analyses; however, those included were younger, more likely to be female, and less likely to have smoked in the past month or used marijuana in the past year ($p < 0.05$).

Demographic and sexual orientation identity mobility information on the sample of 3,067 males and 5,585 females who responded to the most recent wave included in the present analysis (2007) is provided in Table 1. The prevalence of substance use stratified by sex and self-reported sexual orientation identity for each wave of data collection is detailed in Table 2. All substance use behaviors varied significantly by sexual orientation ($p < 0.05$) except for binge drinking in males. In most cases, completely heterosexuals reported the lowest rates of substance use behaviors compared to same-sex sexual minority peers.

The number of missing waves was found to be positively associated with marijuana use in females, and smoking in both males and females (p 's < 0.01), but was not associated with marijuana use in males or with binge drinking for either females or males ($p = 0.56, 0.72, 0.86$, respectively). The number of missing waves was not found to be associated with mobility for females nor males (p -values = 0.11, 0.30, respectively), though the number of missing waves was associated with Trajectory for both males and females (p -values < 0.01).

Results from multivariable sex-stratified GEE models, controlling for concurrent sexual orientation identity, age group, race/ethnicity, and number of missing waves, and including an M-by-age-group interaction term, indicated that higher M was significantly associated with higher risk of past year marijuana use and past month smoking in both males and females (Table 3), regardless of age group. For example, a male adolescent with an M score of 1 had 1.9 times the risk of marijuana use than a male adolescent with an M score of 0 after controlling for current sexual orientation identity, race/ethnicity, and the number of missing waves. Whereas a female adolescent with an M score of 1 had 3.2 times the risk of marijuana use than a female adolescent with an M score of 0 after controlling for current sexual orientation identity, race/ethnicity, and the number of missing waves. Making use of the M-by-age-group interaction term, age group-specific risk ratios and their 95% confidence intervals are presented for the effect of M on each of the three substance use behaviors (Table 3). The effect of M varied significantly by age group for past year marijuana use in both males ($p = 0.02$) and females ($p < 0.01$) and for past month smoking in females ($p < 0.01$). In all cases where the effect of M varied by age group, M's effect was of a larger magnitude for those in adolescence as opposed to young adulthood.

The effect of M varied by sex for marijuana use ($p < 0.01$), smoking ($p < 0.01$), and binge drinking ($p < 0.01$) (Figure 1). Females experienced a higher magnitude positive association between M and each of the three substance use behaviors than did males, regardless of age.

Results from the sex-stratified models testing the associations between age-specific Trajectory group and substance use indicated that after adjusting for sexual orientation, race/ethnicity, and the number of missing waves, age-specific Trajectory group was significantly associated with all substance use outcomes, excluding binge drinking in adolescent females, binge drinking in both age categories for males, and smoking for adolescent males (Table 4). For example, for smoking among males regardless of age, those in the Toward Completely Homosexual group had a greater risk of smoking in past month than the Immobile group, whereas those classified as Toward Completely Heterosexual did not have a significantly different risk of smoking than the Immobile group. Further, we tested the effect of age on Trajectory for each substance use behavior, and found no evidence of effect modification (p -values > 0.05) except for past-month smoking among females ($p = 0.049$).

Models testing interactions of sex with age-specific Trajectory group indicated that the effect of age-specific Trajectory group varied significantly by sex for all substance use behaviors (all p -values < 0.01). For example, when considering binge drinking 12 or more times in the past year, females who were in the Toward Completely Heterosexual group had a higher risk of binge drinking as compared to females in the Immobile category; however, males in the trajectory Toward Completely Heterosexual had a risk of binge drinking that did not significantly differ from males in the Immobile category.

DISCUSSION

In this analysis of a prospective cohort of U.S. youth, higher levels of reported sexual orientation identity mobility were associated with higher levels of substance use regardless of age, sex, or current sexual orientation identity, with only one exception (binge drinking). In addition, in most cases, being categorized as having an orientation trajectory of Toward Completely Heterosexual, Toward Completely Homosexual, or Multidirectional, compared to the Immobile group, was associated with elevated substance use regardless of age or sex, even after adjusting for current sexual orientation. However, contrary to our hypotheses, no specific trajectory group appeared to be at consistently greater risk than the others relative to the Immobile group. Notably, a substantial proportion of participants were not reporting substance use, regardless of sexual orientation identity, mobility, or trajectory.

This analysis revealed sex differences in the association between self-reported sexual orientation identity mobility (both M and Trajectory measures) and each of the substance use behaviors. Females with some degree of sexual minority experience appeared to be at particularly heightened substance use risk, regardless of age. This is consistent with prior research suggesting that the effect of minority sexual orientation on the risk of substance use is larger for females than for males [3-5]. Possible explanations for these differences may include factors related to gender expression, biological factors, gender differences in how young people cope with stress related to a stigmatized identity, or some combination of these [4, 31].

Our finding that the effect of both mobility measures varied significantly by age, with larger magnitude effects for adolescents as opposed to young adults, extends recent findings within this same cohort that substance use disparities by current sexual orientation identity are larger in early adolescence than later adolescence [4, 5]. Research has indicated that psychosocial stress due to antigay prejudice may increase risk of psychiatric disorders, including substance use disorders, in sexual minority populations, compared to heterosexuals [22, 32]. In sexual minority youth, success with the developmental process of identity integration [17], measured as positive attitudes about homosexuality/bisexuality and comfort with sexual orientation disclosure, is negatively associated with risk of mental disorders [33, 34]. Younger adolescents may be more affected by social stressors related to antigay prejudice than young adults because they have not achieved identity integration or developed necessary coping resources [26]; this could drive both higher mobility and higher levels of substance use.

Mobility measures may also be a proxy for general psychological distress that is associated with both sexual orientation changes and greater substance use risk across age groups. An individual's ability to effectively regulate emotion could impact both changing reported sexual identities and unhealthy coping-related behaviors. Deficits in emotion regulation strategies have been shown to increase psychiatric symptoms among adolescents, including depression and anxiety disorders [35-38]. In a longitudinal study of middle school students, emotion regulation deficits mediated the relationship between sexual minority status and depressive and anxious symptomatology [36]. Current neurocognitive research suggests that adolescents are less capable than children or adults of emotion regulation and impulse control, which may bias them towards coping strategies that involve risk taking, such as substance use [39]. Because sexual minority adolescents may have few external supports (e.g., from parents or schools) to guide them, they may be more vulnerable than heterosexual youth to adopting unhealthy coping strategies.

Several limitations of this study should be considered. The measures we used to quantify the changes in reported sexual orientation did not take into account magnitude of changes. Missingness in GUTS may affect the data analysis, as not all participants participated in the survey in all five waves of data collection. Finally, the sample is composed of the children of professional nurses, limiting socioeconomic variability within the cohort; this, coupled with the racial/ethnic homogeneity of the sample, may limit generalizability of results.

The results of our study represent an important contribution to adolescent substance use research, which has typically used only static measures of sexual orientation [16]. Moreover, our findings have relevance for clinical practice: Clinicians should consider assessing sexual orientation at multiple time points both to provide patients with the opportunity to most accurately represent themselves and to explore whether repeated changes in self-reported sexual orientation may be an indicator of vulnerability to health risk behaviors. Research is needed assessing factors underlying repeated changes in reported sexual orientation identity and the heightened vulnerability to substance use. This research is especially critical given

that adolescent substance use is a strong predictor of later substance use dependence [40]. Investigations that address the methodological challenges of measuring the dynamic facets of sexual orientation in relation to substance use behaviors and psychiatric disorders represent an important step in understanding and eliminating health inequalities experienced by sexual minority adolescents.

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IMPLICATIONS AND CONTRIBUTION

Repeated changes in reported sexual orientation in adolescence and young adulthood is positively associated with substance use, independent of current sexual orientation, and is more pronounced in females than males and in adolescents than young adults. Repeated changes in reported sexual orientation may indicate underlying distress and substance use risk.

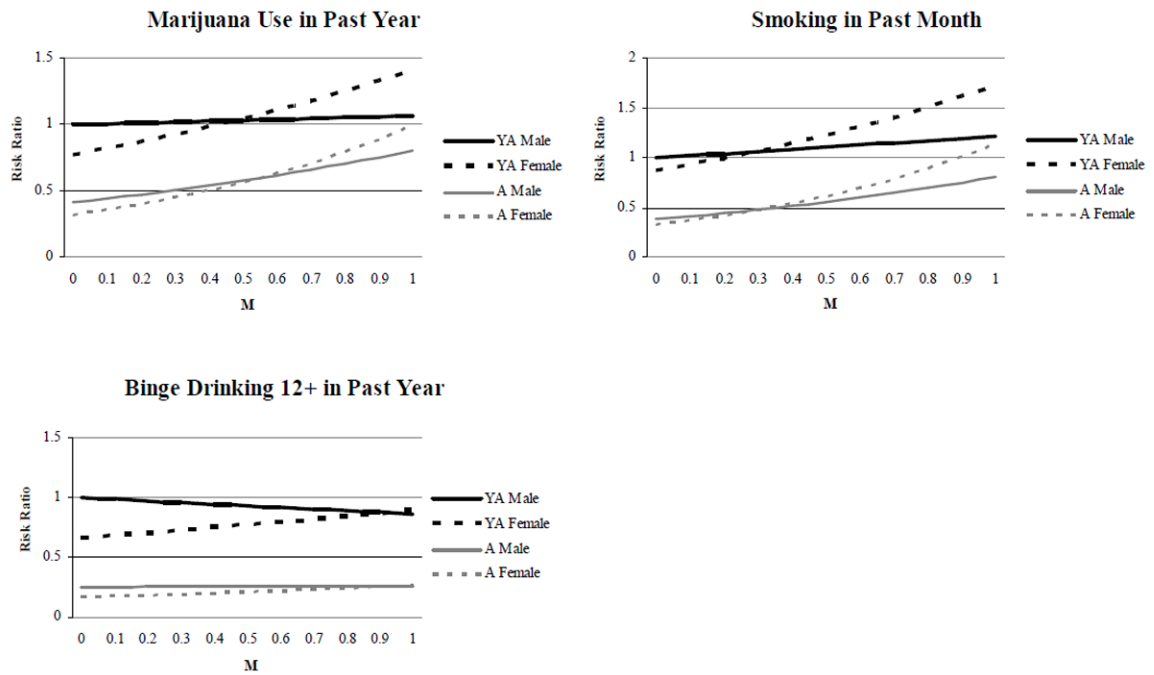


Figure 1. Estimated Risk Ratios from Multivariable Risk Ratios of M-by-sex interactions for three substance use behaviors controlling for sex, age-group, race/ethnicity, and including an M-by-age-group interaction

P-values for all interactions are <.01 Solid lines are for males, dotted lines are for females. Black lines indicate Young Adulthood (YA), and gray lines indicate Adolescence (A).

Table 1

Sample characteristics and M and Trajectory group in a prospective cohort of U.S. youth of the Growing Up Today Study (N=8652*) from the 2007 wave of data collection

	Male N = 3067*						Female N = 5585*					
	Sexual orientation reported in 2007			Sexual orientation reported in 2007			Sexual orientation reported in 2007			Sexual orientation reported in 2007		
	Completely Heterosexual n=2697 (87.9%)	Mostly Heterosexual n=254 (8.3%)	Mostly or Completely Homosexual n=93 (3.0%)	Completely Heterosexual n=4373 (78.3%)	Mostly Heterosexual n=1008 (18.1%)	Mostly or Completely Homosexual n=78 (1.4%)	Completely Heterosexual n=4373 (78.3%)	Mostly Heterosexual n=1008 (18.1%)	Mostly or Completely Homosexual n=78 (1.4%)	Completely Heterosexual n=4373 (78.3%)	Mostly Heterosexual n=1008 (18.1%)	Mostly or Completely Homosexual n=78 (1.4%)
Non-Hispanic white 2007 Mean age (SD)	94.0% 23.0 (1.7)	91.7% 23.1(1.6)	91.3% 22.6 (1.6)	93.9% 23.1 (1.6)	92.9% 23.1 (1.6)	88.1% 23.0 (1.6)	93.9% 23.1 (1.6)	92.9% 23.1 (1.6)	88.1% 23.0 (1.6)	93.9% 23.1 (1.6)	92.9% 23.1 (1.6)	88.1% 23.0 (1.6)
Number of waves reporting sexual orientation												
5	53.7%	54.7%	56.5%	66.7%	61.6%	57.1%	66.7%	61.6%	57.1%	66.7%	61.6%	57.1%
4	29.5%	31.5%	26.1%	24.0%	26.2%	29.4%	24.0%	26.2%	29.4%	24.0%	26.2%	29.4%
3	16.8%	13.8%	17.4%	9.3%	12.2%	13.5%	9.3%	12.2%	13.5%	9.3%	12.2%	13.5%
M												
0	93.4%	9.8%	8.7%	91.2%	8.2%	7.9%	91.2%	8.2%	7.9%	91.2%	8.2%	7.9%
1/4	1.2%	33.9%	17.4%	2.2%	37.2%	19.8%	2.2%	37.2%	19.8%	2.2%	37.2%	19.8%
1/3	0.8%	21.7%	0.0%	0.6%	18.4%	16.7%	0.6%	18.4%	16.7%	0.6%	18.4%	16.7%
1/2	2.6%	19.3%	26.1%	4.1%	17.7%	26.2%	4.1%	17.7%	26.2%	4.1%	17.7%	26.2%
2/3	1.2%	3.9%	13.0%	1.0%	4.2%	5.6%	1.0%	4.2%	5.6%	1.0%	4.2%	5.6%
3/4	0.2%	9.8%	21.7%	0.6%	10.5%	11.9%	0.6%	10.5%	11.9%	0.6%	10.5%	11.9%
1	0.6%	1.6%	13.0%	0.4%	3.9%	15.4%	0.4%	3.9%	15.4%	0.4%	3.9%	15.4%
Trajectory group												
Immobile	93.4%	9.8%	8.7%	91.2%	8.2%	7.9%	91.2%	8.2%	7.9%	91.2%	8.2%	7.9%
Multidirectional	4.3%	22.4%	39.1%	5.8%	27.3%	27.8%	5.8%	27.3%	27.8%	5.8%	27.3%	27.8%
Toward completely heterosexual	2.3%	0.0%	0.0%	3.0%	1.8%	0.0%	3.0%	1.8%	0.0%	3.0%	1.8%	0.0%
Toward completely homosexual	0.0%	67.7%	52.2%	0.0%	62.7%	64.3%	0.0%	62.7%	64.3%	0.0%	62.7%	64.3%

* Restricted to those who provided sexual orientation identity data on three or more waves

Table 2
Prevalence of health risk behaviors stratified by gender and sexual orientation in a prospective cohort of U.S. youth (N=10515) from GEE models

Substance Use Behavior	Male (N = 3980 [*])						Female (N = 6535 [*])								
	Sexual orientation			p-value	Mostly or Completely Homosexual	p-value	Sexual orientation			p-value	Mostly or Completely Homosexual				
	Completely Heterosexual	Mostly Heterosexual	Bisexual				Completely Heterosexual	Mostly Heterosexual	Bisexual						
1999															
Marijuana use in past year	9.6% ¹	30.0% ²	26.7% ²	<0.01	10.5% ^{1,2}	8.3% ¹	27.9% ²	62.5% ³	42.8% ^{2,3}	<0.01					
Smoking in past month	7.5% ¹	16.7% ²	20.0% ^{1,2}	0.04	10.5% ^{1,2}	8.4% ¹	25.0% ²	39.6% ³	14.3% ^{1,2,3}	<0.01					
Binge drinking 12 or more times in past year	9.00%	4.00%	0.00%	[‡]	10.00%	5.30%	10.40%	20.00%	0.00%	[‡]					
2001															
Marijuana use in past year	21.0% ¹	44.7% ²	33.3% ^{1,2}	<0.01	34.2% ^{1,2}	20.2% ¹	47.7% ²	67.8% ³	73.3% ^{2,3}	<0.01					
Smoking in past month	12.1% ¹	24.0% ²	36.8% ²	<0.01	31.8% ²	13.7% ¹	30.8% ²	51.4% ³	50.0% ^{2,3}	<0.01					
Binge drinking 12 or more times in past year	20.6%	18.3%	41.2%	0.33	25.7%	16.3% ¹	19.3% ¹	29.5% ²	26.7% ^{1,2}	0.02					
2003															
Marijuana use in past year	27.0% ¹	49.1% ²	53.8% ²	<0.01	43.5% ²	24.2% ¹	57.9% ²	63.1% ²	48.6% ²	<0.01					
Smoking in past month	18.1% ¹	35.6% ²	30.8% ^{1,2}	<0.01	38.6% ²	-1.5123	39.9% ²	52.8% ³	37.5% ^{2,3}	<0.01					
Binge drinking 12 or more times in past year	27.40%	23.70%	25.00%	0.74	24.60%	20.1% ¹	30.4% ²	23.5% ^{1,2}	28.9% ^{1,2}	<0.01					
2005															
Marijuana use in past year	33.1% ¹	49.5% ²	47.4% ^{1,2}	<0.01	47.6% ²	24.9% ¹	55.7% ²	65.4% ³	59.3% ^{2,3}	<0.01					
Smoking in past month	24.3% ¹	34.5% ²	50.0% ²	<0.01	44.2% ²	8.2% ¹	15.8% ²	21.5% ²	22.0% ²	<0.01					
Binge drinking 12 or more times in past year	41.9% ¹	37.8% ¹	37.5% ^{1,2}	<0.01	24.0% ²	25.8% ¹	32.2% ²	28.3% ^{1,2}	33.9% ^{1,2}	0.01					
2007															
Marijuana use in past year	32.8% ¹	58.2% ²	39.1% ^{1,2}	<0.01	47.3% ^{1,2}	20.9% ¹	50.1% ²	60.3% ³	55.1% ^{2,3}	<0.01					
Smoking in past month	24.5% ¹	37.0% ²	43.5% ²	<0.01	40.9% ²	15.8% ¹	34.2% ²	45.2% ³	37.2% ^{2,3}	<0.01					
Binge drinking 12 or more times in past year	41.2%	39.1%	30.4%	0.68	40.0%	26.7% ¹	32.3% ²	36.4% ²	34.2% ^{1,2}	<0.01					

* This is the maximum sample size as missingness varies for different health risk behaviors

[‡] Zero count cells prohibited us from conducting a statistical test

Superscripts denote which groups are statistically different (p<0.05) and are displayed when the overall test for sexual orientation differences have p<0.05

Table 3

Multivariable risk ratios and 95% confidence intervals of health risk behaviors predicted by age-group-specific sexual orientation mobility measure M, and self-reported sexual orientation

		Males n = 3980* RR [†] (95% CI)	Females n = 6535* RR [†] (95% CI)
Marijuana use in past year	M		
	M in Adolescence	1.9 (1.4, 2.6)[‡]	3.2 (2.7, 3.7)[‡]
	M in Young Adulthood	1.3 (1.1, 1.6)[‡]	1.7 (1.5, 1.9)[‡]
Sexual Orientation	Completely Heterosexual	1.0 (Ref)	1.0 (Ref)
	Mostly Heterosexual	1.6 (1.4, 1.8)	1.8 (1.7, 2.0)
	Bisexual	1.4 (1.1, 1.8)	2.2 (2.0, 2.5)
	Mostly or Completely Homosexual	1.3 (1.1, 1.6)	1.8 (1.5, 2.2)
Smoking in past month	M		
	M in Adolescence	1.8 (1.2, 2.5)	3.3 (2.7, 4.0)[‡]
	M in Young Adulthood	1.4 (1.1, 1.7)	2.0 (1.7, 2.3)[‡]
Sexual Orientation	Completely Heterosexual	1.0 (Ref)	1.0 (Ref)
	Mostly Heterosexual	1.5 (1.3, 1.7)	1.6 (1.4, 1.7)
	Bisexual	1.7 (1.2, 2.3)	2.0 (1.7, 2.3)
	Mostly or Completely Homosexual	1.6 (1.3, 2.05)	1.6 (1.3, 2.1)
Binge drinking 12 or more times in past year	M		
	M in Adolescence	1.3 (0.7, 2.4)	1.5 (0.97, 2.4)
	M in Young Adulthood	1.0 (0.8, 1.3)	1.2 (1.1, 1.5)
Sexual Orientation	Completely Heterosexual	1.0 (Ref)	1.0 (Ref)
	Mostly Heterosexual	0.9 (0.8, 1.3)	1.2 (1.1, 1.3)
	Bisexual	1.0 (0.7, 1.4)	1.2 (1.0, 1.5)
	Mostly or Completely Homosexual	0.8 (0.7, 1.1)	1.2 (0.9, 1.6)

Bold risk ratios indicate a statistically significant association with health risk behavior (p < 0.05).

* Represents the maximum possible sample size; sample sizes vary due to missingness for different substance behaviors.

[‡]Denote statistically significant age-group-by-M interactions ($p < 0.05$).

[†]Risk ratios of substance use behaviors adjusting for number of missing waves, age and race/ethnicity.

Table 4

Multivariable risk ratios of health risk behaviors predicted by age-group-specific Trajectory group, and sexual orientation adjusting for number of missing waves, race/ethnicity, and stratified by gender

	Trajectory Group			Sexual Orientation			
	Immobile RR* (95%CI)	Multi-directional RR* (95%CI)	Toward Completely Heterosexual RR* (95%CI)	Toward Completely Homosexual RR* (95%CI)	Completely Heterosexual RR* (95%CI)	Mostly Heterosexual RR* (95%CI)	Mostly or Completely Homosexual RR* (95%CI)
Males							
Marijuana use in past year					1.0	2.0 (1.6, 2.5)	1.4 (1.0, 2.0)
Adolescence	1.0	1.7 (1.3, 2.4)	1.1 (0.6, 2.0)	1.4 (0.99, 1.9)			
Young Adulthood	1.0	1.4 (1.1, 1.8)	1.5 (1.0, 2.3)	1.6 (1.2, 2.0)			
Smoking in past month					1.0	1.6 (1.3, 2.0)	2.0 (1.3, 2.9)
Adolescence	1.0	1.4 (0.98, 2.1)	1.4 (0.8, 2.5)	1.3 (1.0, 1.7)			
Young Adulthood	1.0	1.3 (1.0, 1.7)	1.4 (0.9, 2.2)	1.4 (1.0, 1.9)			
Binge drinking 12 or more times in past year					1.0	1.0 (0.8, 1.2)	0.8 (0.6, 1.2)
Adolescence	1.0	1.3 (0.8, 2.2)	0.4 (0.1, 1.6)	0.6 (0.3, 1.2)			
Young Adulthood	1.0	1.0 (0.8, 1.3)	0.7 (0.5, 1.2)	0.8 (0.6, 1.1)			
Females					1.0	2.3 (2.0, 2.6)	2.6 (1.7, 3.8)
Marijuana use in past year							
Adolescence	1.0	2.5 (2.1, 3.0)	1.7 (1.2, 2.3)	2.1 (1.7, 2.4)			
Young Adulthood	1.0	2.0 (1.7, 2.4)	1.8 (1.4, 2.3)	1.8 (1.6, 2.2)			
Smoking in past month					1.0	1.7 (1.5, 1.9)	2.1 (1.4, 3.1)
Adolescence	1.0	2.6 (2.1, 3.2)	2.0 (1.4, 2.9)	1.9 (1.5, 2.3)			
Young Adulthood	1.0	2.0 (1.7, 2.4)	2.2 (1.7, 2.9)	1.7 (1.5, 2.0)			
Binge drinking 12 or more times in past year					1.0	1.3 (1.1, 1.5)	1.3 (0.9, 2.1)
Adolescence	1.0	1.3 (0.9, 1.8)	0.9 (0.5, 1.8)	1.1 (0.7, 1.5)			
Young Adulthood	1.0	1.3 (1.1, 1.5)	1.4 (1.0, 1.8)	1.0 (0.9, 1.2)			

* Bold risk ratios indicate a statistically significant association between Trajectory group or sexual orientation and health risk behavior as compared to the immobile and completely heterosexual referent groups ($p < 0.05$).