

The Association of Asthma, Sexual Identity, and Inhaled Substance Use among U.S. Adolescents

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Abstract

Rationale: Minority sexual identity appears to confer asthma risks. Although associations between inhaled substances and asthma are established, these have not been examined among sexual minority youths. Given sexual minority adolescents' disproportionately high rates of substance use, research is needed to fill this important gap.

Objectives: Using a representative sample of adolescents from the United States, we 1) examined associations among asthma, sexual identity, and inhaled substance use and tested 2a) whether sexual identity moderates relationships between asthma and inhaled substance use and 2b) whether inhaled substance use mediates associations between sexual identity and asthma.

Methods: Data are from the 2015 and 2017 Youth Risk Behavior Surveillance Survey. Adolescents ($n = 30,113$) reported if they were ever diagnosed with asthma, current use of cigarettes, cigars and/or cigarillos, marijuana, and electronic vapor products and if they ever used inhalants or synthetic marijuana. We used logistic regression to examine associations between asthma, sexual identity, and inhaled substance use controlling for age, race or ethnicity, and body mass index percentile, stratified by sex.

Results: Lesbian, gay, and bisexual respondents had higher relative risks for asthma than heterosexual youth. Sexual minority female youths had significantly higher relative risks than heterosexual female youths for use of every inhaled substance. There were few sexual identity differences in inhaled substance use among male youths. Inhaled substance use was significantly associated with higher risks for asthma. In general, associations between each individual inhaled substance and asthma did not differ between sexual minority and heterosexual youths. However, when all inhaled substances were added into the models concurrently, inhaled substance use appeared to mediate associations with asthma among lesbian and bisexual female youths, and partially mediated these associations among sexual minority male youths.

Conclusions: Sexual identity and inhaled substance use appear to play important roles in asthma risk. However, these variables do not fully explain the risk, suggesting that other unmeasured variables (e.g., stress and victimization) may be implicated in risks for both inhaled substance use and asthma. It is important that clinicians providing care to adolescents ask about sexual identity and inhaled substance use. Effective approaches to reducing inhaled substance use among adolescents, especially sexual minorities, are needed.

Keywords: lesbian; gay; bisexual; health risks; youth

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Asthma, the most common pediatric chronic illness, has high prevalence among adolescents (1, 2). Uncontrolled asthma results in frequent school absences, reduced quality of life, and higher healthcare costs as well as increased risk of comorbidities (e.g., depression, obesity) and mortality (3–5). Vulnerability to asthma varies by age; adolescents have a higher prevalence of diagnosed asthma (1) and greater asthma-related morbidity and mortality (6) than elementary school-age youths. Although exposure to smoke increases risk of asthma (7), adolescents with asthma have higher odds of smoking cigarettes and marijuana than those without asthma (8, 9). Additionally, compared with their peers without asthma, adolescents with asthma have higher prevalence of e-cigarette use (10), and this association is independent of cigarette and marijuana use (9, 11). This is particularly concerning given that adolescent e-cigarette use has eclipsed cigarette smoking (12, 13); however, whether this may increase asthma risks is still unknown.

Available research suggests that compared with heterosexual adults, rates of asthma are higher among sexual minority (SM; e.g., people who identify as lesbian, gay, or bisexual) adults, particularly SM women (e.g., lesbian, bisexual) (14). Much less is known about asthma among SM youths (SMY), despite the relatively high prevalence of asthma among adolescents (1, 2). The limited available data suggest that SMY have a higher prevalence of lifetime asthma than heterosexual youths (15, 16) and that the relationship between minority sexual identity and asthma is partially mediated by obesity, lifetime cigarette smoking, and bullying (16). Compared with their heterosexual counterparts, SMY are more likely to engage in risky health behaviors, such as cigarette smoking (14), and use of other inhaled substances, including marijuana and “emerging drugs” (17–19). However, other than cigarette smoking, to date no research has examined whether use of inhaled substances including “emerging drugs” such as e-cigarettes and synthetic marijuana among SMY might contribute to their higher asthma prevalence.

We used data from a representative sample of high school students in the United States to test three aims: 1) to examine associations among asthma, sexual identity, and inhaled substance use and to test 2a)

whether sexual identity moderates the relationship between asthma and inhaled substances and 2b) whether inhaled substance use mediates the association between sexual identity and asthma.

Methods

Data Source

We analyzed data from the Centers for Disease Control and Prevention’s (CDC) 2015 and 2017 Youth Risk Behavior Surveillance Survey (YRBS) data sets; in the national YRBS survey, only years 2015 and 2017 included questions about sexual identity. The national YRBS is a biennial study of adolescent health and health behavior using a three-stage cluster design to obtain a representative sample of students in grades 9 through 12 in private and public high schools in the 50 states and the District of Columbia (20, 21). Student participation is anonymous and voluntary, and local parental permission and student assent procedures are used (20, 21). Using a standardized protocol, trained data collectors, who travel to each school, proctor the survey. Students complete a self-administered survey during the school day; absent students complete the survey on later dates. The CDC Institutional Review Board reviewed and approved the national YRBS procedures; the Columbia University Irving Medical Center Institutional Review Board determined that the current study was exempt.

Measures

In 2015 and 2017, the primary outcome *asthma status* was assessed by asking, “Has a doctor or nurse ever told you that you have asthma”? Adolescents reported *sexual identity* by indicating whether they were heterosexual, lesbian, gay, bisexual, or unsure or unknown. Gender identity was not assessed in the national data set (22) and thus could not be included. For *use of inhaled substances*, adolescents reported the number of days in the past 30 days they used cigarettes, cigars or cigarillos, marijuana, or “electronic vapor products” (e.g., electronic cigarettes, vaping pens, e-hookahs, and hookah pens), and if they ever used inhalants (i.e., sniffed glue, breathed the contents of spray cans, or inhaled any paints or sprays to get high) or synthetic marijuana. Consistent with previous research on asthma and substance use

(23–25), we dichotomized responses to reflect use or not of each substance. Youths also reported their sex, age, and race or ethnicity, as well as their height and weight without shoes, which the CDC uses to calculate age- and sex-specific body mass index (BMI) percentile (26).

Statistical Analyses

We excluded from analyses cases that had missing data on sex or age ($n = 276$; 0.09%), resulting in a final sample size of 30,113. To make full use of the data, for any variable with an “unsure” category or with any missing observations, we created an “unsure or unknown” category. For example, 1,244 respondents reported they were “unsure” if they had ever been diagnosed with asthma and 2,515 had missing values for this variable, giving us 3,739 respondents in the “unsure or unknown” category for the final asthma outcome variable.

Combining the 2015 and 2017 YRBS data yielded a large enough sample of SMY to permit subgroup analyses (i.e., by sex and sexual identity). Given established sex differences in asthma and substance use (2, 27, 28), analyses were stratified by sex. We calculated descriptive statistics (i.e., counts and percentages) to characterize the study sample and to examine asthma prevalence by sexual identity (heterosexual, lesbian, gay, bisexual, unsure or unknown). We tested associations between use of each specific inhaled substance and sexual identity, controlling for covariates (i.e., age, race or ethnicity, and BMI percentile). Separate multinomial logistic regression models were tested for each substance use variable.

To examine whether the association between each substance and asthma was moderated by sexual identity, we first tested models separately among female and male youths that included the interaction term for each inhaled substance variable by sexual identity with asthma status as the outcome. If there was a significant interaction effect, we then examined the interaction effect by stratifying the association between substance use and asthma by sexual identity. Otherwise, we refit the model for each substance by removing the interaction term and examining only the main effect of the corresponding substance on asthma.

Finally, to test whether inhaled substance use mediated associations between sexual identity and asthma, we used multivariable models that included the

inhaled substance use variables, controlling for covariates, in separate models for female and male youths. We first built multinomial regression models that included only sexual identity and covariates; the final models included all six substance use variables in addition to sexual identity and covariates. We compared the coefficients for sexual identity across models and calculated the mediation proportion (the proportion of asthma among SMY relative to heterosexual youths that was attributable to use of inhaled substances) (29). Mediation is supported if the effect of the mediator is significant in the final multivariable models and when the association between the predictor and the outcome are no longer significant with the addition of the potential mediator to the model (30).

Data analyses were performed using SAS 9.4 (SAS Institute) and accounted for the complex YRBS survey design (strata and cluster) and population weights using PROC SURVEYLOGISTIC or PROC SURVEYFREQ procedures. We converted results from multinomial logistic regressions into relative risk ratios (RRRs) for easier interpretation and report 95% confidence intervals (95% CIs) to assess the direction and strength of the associations. Consistent with guidance provided by the CDC for combining multiple national YRBS data sets, we used the original weights from the YRBS data (31). Significance was evaluated at a two-sided α level of 0.05.

Results

Sample Description

The sample included 30,113 youths (grades 9–12); 50.7% identified as female. The majority (88.2%) identified as heterosexual, 1.9% as lesbian or gay, 6.6% as bisexual, and 3.2% as unsure or unknown. Most (55.9%) identified their race or ethnicity as white, 22.3% Latina or Latino, 12.2% Black, and 9.7% as another race or ethnicity. Overall, 21.0% of the weighted sample (21.4% of female and 20.6% of male youths) reported ever having been diagnosed with asthma. There were no differences in asthma status by sex.

Prevalence of Asthma by Sexual Identity

Table 1 presents the weighted prevalence estimates of asthma by sexual identity. Prevalence rates were higher among lesbian or gay (28.1%) and bisexual (26.2%) youths

than heterosexual (21.0%) and unsure or unknown (16.1%) youths. Controlling for age, race or ethnicity, and BMI percentile, SMY had significantly higher relative risk for asthma than their heterosexual counterparts (*see* Model 1, Table 4). Lesbian and bisexual female youths had 42% and 26% times higher relative risk of asthma, respectively. Among male youths, gay and bisexual youths had 74% and 68% higher relative risk of asthma than their heterosexual counterparts. Unsure or unknown youths' relative risk for asthma did not differ from heterosexual youths.

Use of Inhaled Substances by Sex and Sexual Identity

Table 2 presents results of the adjusted associations between sexual identity and use of each inhaled substance separately for female and male youths (Models 1 and 2 in Table 2, respectively). Adjusting for covariates, lesbian and bisexual female youths had higher relative risks than their heterosexual peers of using every inhaled substance, whereas we found few sexual identity differences among male youths. Lesbian female youths had 61–171% higher relative risk of reporting use of every inhaled substance. Relative risk of each inhaled substance was highest among bisexual female youths compared with heterosexual female youths (range = 79–189%). Female youths whose sexual identity was unsure or unknown reported higher relative risks of cigar smoking (41% higher) and inhalant use (71% higher).

Gay male youths had 301% and 104% higher relative risks of reporting inhalant use and synthetic marijuana use, respectively, than heterosexual male youths. Bisexual male youths had higher relative risks of reporting cigarette smoking (82% higher) and inhalant use (204% higher). Male youths with unsure or unknown sexual identity had 163% and 53% higher relative risks of inhalant and synthetic marijuana use, respectively.

Moderation Analyses

We tested the interactions between sexual identity and each inhaled substance separately for female and male youths adjusting for key covariates. None of the interaction terms were significant with the exception of synthetic marijuana use among female youths (RRR [ever synthetic marijuana \times lesbian] = 4.26; 95% CI, 1.52–4.56). For female heterosexual youths, there

was a positive relationship between asthma and synthetic marijuana use (RRR = 1.38; 95% CI, 1.02–1.87). However, among lesbian youths, the positive relationship between asthma and synthetic marijuana was stronger (RRR = 5.88; 95% CI, 2.10–16.60). There were no other significant moderation effects. As detailed in Table 3, there were positive associations between asthma and each substance use variable among both female and male youths.

Mediation Analyses

Table 4 presents the results from sex-stratified multivariable models used to test associations between asthma and sexual identity, adjusting for age, race or ethnicity, and BMI (Model 1); Model 2 adds inhaled substance use as a potential mediator. For both females and males, the use of inhaled substance variables was significant in the final multivariable regression models, suggesting mediation.

Panel A presents results for female youths. Use of inhaled substances accounted for 12% of the higher relative risks for asthma for lesbian youths (calculated by the change in relative risk ratio from Model 1 to Model 2; e.g., RRR 1.42 in Model 1 minus RRR 1.30 in Model 2 = 0.12 or 12%) and 9% of the higher relative risks for bisexual female youths compared with heterosexual female youths. Notably, however, when inhaled substances were added in Model 2, the associations between asthma and sexual identity for lesbian and bisexual women were no longer significant. This suggests that when inhaled substance use was added to the model, the disparities between SM and heterosexual female youths is reduced because inhaled substances explain at least some of the higher risks among lesbian and bisexual female youths compared with their heterosexual peers.

Inhaled substance use accounted for 12% of the higher relative risks of asthma among gay male youths and 7% of the higher relative risks among bisexual male youths (Panel B). Thus, when inhaled substances were added to the model for male youths, the associations between asthma and sexual identity remained significant for gay and bisexual youths, suggesting partial mediation.

Discussion

Despite their higher prevalence of asthma, to our knowledge, this is the first study to

Table 1. Unadjusted weighted prevalence estimates of asthma and inhaled substance use variables by sexual identity among all youths and separately by sex

	All Youths (N = 30,113) (%)					Female Youths (n = 14,970) (%)					Male Youths (n = 15,161) (%)				
	Total	Heterosexual (n = 24,711)	Lesbian or Gay (n = 609)	Bisexual (n = 1,966)	Unsure or Unknown (n = 2,845)	Total	Heterosexual (n = 11,440)	Lesbian (n = 301)	Bisexual (n = 1,594)	Unsure or Unknown (n = 1,635)	Total	Heterosexual (n = 13,271)	Gay (n = 308)	Bisexual (n = 372)	Unsure or Unknown (n = 1,210)
	Asthma	21.0	21.0	28.1	26.2	16.1	21.4	21.5	28.0	25.7	15.8	20.6	28.2	28.2	28.2
Inhaled substances	9.5	8.7	14.3	17.3	9.7	8.6	7.1	15.1	17.4	8.9	10.4	13.6	16.8	10.9	
Cigarettes	8.8	8.5	13.6	10.5	8.7	5.7	4.8	13.2	9.7	6.2	11.9	14.0	14.0	12.2	
Cigars	20.3	19.7	29.0	30.3	17.1	19.5	17.8	34.6	32.1	16.8	21.1	23.5	22.8	17.6	
Marijuana	17.5	17.4	18.4	21.2	15.2	15.5	14.7	21.6	21.8	13.9	19.4	15.3	18.6	16.9	
Electronic vapor products	6.2	5.1	14.0	12.0	9.9	6.1	4.9	10.4	11.6	8.2	6.2	17.6	13.7	12.2	
Inhalants	7.8	7.2	14.1	12.3	8.4	7.0	6.1	12.8	12.6	6.7	8.6	15.3	11.2	10.8	
Synthetic marijuana															

All data are weighted to account for the complex Youth Risk Behavior Surveillance Survey design and population weighting.

examine associations between asthma and inhaled substance use among SMY. Consistent with previous research (16), SMY in the current study evidenced higher rates of asthma than heterosexual youths. Compared with heterosexual female youths, rates of each inhaled substance were higher among lesbian and bisexual female youths than among their heterosexual peers. Relative to heterosexual male youths, inhalant use was more prevalent among gay, bisexual, and unsure or unknown male youths and synthetic marijuana use was more prevalent among gay and unsure male youths.

Overall, inhaled substance use was associated with increased risk of asthma, particularly among female SMY. Although SMY have higher rates of inhaled substance use and higher rates of asthma, there were few sexual identity differences in the associations between asthma and use of specific types of inhaled substances. For example, the association between synthetic marijuana and asthma was significant for heterosexual female youths but stronger for lesbian female youths. However, when all inhaled substances were added to the model, use of inhaled substances mediated the associations between asthma and substance use among both lesbian and bisexual female youths and among gay and bisexual male youths. This suggests that lesbian and bisexual female youths' greater use of inhaled substances may account for their increased asthma risks. However, for gay and bisexual male youths, there was still a significant association between sexual identity and asthma risks, even when inhaled substance use was added to the model. This suggests that other unmeasured variables may partially account for gay and bisexual male youths' higher asthma risks. Below we highlight the potential roles of stress and victimization in higher risks for both inhaled substances and asthma.

Our findings of higher prevalence of inhaled substances among SM female youths is consistent with the literature. Despite national declines in cigarette smoking rates, SM people are more likely than heterosexuals to smoke (32–34); SMY start smoking earlier and smoke more heavily than heterosexual youths (32). Sexual orientation–related disparities in tobacco use have not changed over time among male youths (32). However, such disparities are widening among female youths; use of tobacco among female SMY

Table 2. Main effects of sexual identity on use of each inhaled substance stratified by sex adjusting for BMI, race or ethnicity, and age (N = 30,113)

	Inhaled Substance Use					
	Cigarette Smoking RRR (95% CI)	Cigars RRR (95% CI)	Marijuana RRR (95% CI)	Electronic Vapor Products RRR (95% CI)	Inhalants RRR (95% CI)	Synthetic Marijuana RRR (95% CI)
Model 1. Among female youths (ref heterosexual) (n = 15,275)						
Lesbian	2.70 (1.75–4.17)	2.71 (1.72–4.26)	2.42 (1.81–3.25)	1.61 (1.11–2.34)	2.25 (1.34–3.79)	2.25 (1.48–3.42)
Bisexual	2.89 (2.34–3.57)	2.05 (1.64–2.56)	2.25 (1.86–2.72)	1.79 (1.46–2.21)	2.48 (1.93–3.18)	2.21 (1.77–2.77)
Unsure or Unknown	1.27 (0.71–2.25)	1.41 (0.93–2.15)	1.03 (0.62–1.70)	1.02 (0.59–1.75)	1.71 (1.21–2.47)	1.15 (0.69–1.91)
Model 2. Among male youths (ref heterosexual) (n = 14,838)						
Gay	1.55 (0.98–2.47)	1.28 (0.73–2.26)	1.26 (0.80–1.99)	0.82 (0.55–1.24)	4.01 (2.21–7.31)	2.04 (1.25–3.35)
Bisexual	1.82 (1.19–2.80)	1.27 (0.86–1.86)	1.17 (0.82–1.67)	0.99 (0.55–1.24)	3.04 (1.97–4.68)	1.48 (0.93–2.38)
Unsure or Unknown	1.17 (0.83–1.64)	1.21 (0.92–1.59)	0.92 (0.73–1.17)	1.00 (0.74–1.35)	2.63 (2.03–3.41)	1.53 (1.13–2.06)

Definition of abbreviations: BMI = body mass index; CI = confidence interval; ref = reference; RRR = relative risk ratio.

(and adult SM women) has increased over time, and rates of smoking at an early age among these groups have also increased (35).

Although multiple studies have assessed cigarette smoking among SMY, there is limited information about SMY’s use of marijuana or alternative tobacco products, such as e-cigarettes, cigars, or hookahs (17, 18). SM adults are more likely than heterosexual adults to have ever used alternative tobacco products such as these (36); however, asthma-related risk associated with use of these products is poorly understood. Given higher rates of use of marijuana and alternative tobacco products (19, 34, 37–39) as well as higher rates of inhalant use (34) among SMs, additional research is needed to understand their contributions to asthma risk.

One possible contributor to both the higher rates of inhaled substance use and

higher asthma prevalence among SMY is stress. Inhaled substances may be a marker for higher rates of stress and other unmeasured variables that may increase risks for asthma. Chronic psychosocial stress due to racism, poverty, stigma, adverse childhood events, and exposure to neighborhood violence have been linked to higher risks for substance use (29, 37, 40, 41), as well as to asthma diagnosis and to greater asthma morbidity (42–44). A potential mechanism for this association is related to changes in the methylation and expression of genes that respond to stress. In addition, some research has suggested chronically stressed individuals are predisposed to asthma (45). Stressful life events—such as victimization, discrimination, bullying, and homophobia—increase wear and tear on the body, which can lead to negative health

outcomes (46). Stress increases the likelihood of engaging in unhealthy behaviors (37), such as inhaled substance use, that may also increase risk of asthma.

SMY experience the typical stresses and strains of adolescence as well as stress associated with their minority sexual identity (40, 47, 48), which, coupled with the higher rates of inhaled substances, may put them at higher risk of developing asthma. This may be particularly true for female SMY as limited research shows that they have higher rates of life stressors (49), higher rates of bullying (48), and higher rates of dating violence (50) than do heterosexual female youths, putting them at increased risk for inhaled substances. These same studies, however, show minimal to no differences between the stressors experienced by female and male SMY. Thus, the reasons that female SMY use inhaled substances, as well as other substances such as alcohol, at higher rates than do male SMY are poorly understood. Differences in substance use may be explained by positive expectancies, peer norms, and gender expression (48). Sexual identity and sex differences in substance use may also be explained by differences in coping (41) and levels of sexual identity disclosure (51).

Perceived acceptability of substance use, which may be influenced by peers and peer groups, may additionally be associated with increased risks among SMY (52, 53). Acceptability of tobacco use may be related to tobacco companies’ having designed vaping products and advertisements that appeal directly to youths (54). Just as

Table 3. Main effects of each inhaled substance use on asthma stratified by sex adjusting for sexual identity, age, race or ethnicity, and BMI

	Model 1. Among Females (n = 15,275) RRR (95% CI)	Model 2. Among Males (n = 14,838) RRR (95% CI)
Cigarettes	1.41 (1.61–1.72)	1.35 (1.10–1.65)
Cigars	1.58 (1.28–1.96)	1.35 (1.14–1.62)
Electronic vapor products	1.46 (1.21–1.77)	1.28 (1.12–1.45)
Inhalants	1.51 (1.24–1.84)	1.88 (1.36–2.59)
Synthetic marijuana	—*	1.66 (1.32–2.08)

Definition of abbreviations: BMI = body mass index; CI = confidence interval; RRR = relative risk ratio. To be parsimonious, results from those whose asthma diagnosis is unknown unsure are not presented in the table but were included in the model. Data available upon request.

*Main effect for synthetic marijuana not reported owing to significant interaction term; see RESULTS section.

Table 4. Associations between sexual identity and asthma adjusting for inhalant use, age, race or ethnicity, and BMI to determine effects of inhaled substance use on the association of sexual identity and asthma stratified by sex (mediation models)

	A. Among Female Youths (n = 15,275)		B. Among Male Youths (n = 14,838)	
	Model 1* RRR (95% CI)	Model 2*† RRR (95% CI)	Model 1* RRR (95% CI)	Model 2*† RRR (95% CI)
Sexual identity (ref heterosexual)				
Heterosexual	—	—	—	—
Lesbian or Gay	1.42 (1.00–2.02)	1.30 (0.91–1.86)	1.74 (1.27–2.39)	1.62 (1.19–2.22)
Bisexual	1.26 (1.04–1.53)	1.17 (0.96–1.42)	1.68 (1.19–2.40)	1.61 (1.13–2.31)
Unsure	0.81 (0.53–1.23)	0.80 (0.54–1.18)	1.02 (0.82–1.28)	0.99 (0.77–1.26)
Inhaled substance				
Cigarette smoking	—	1.03 (0.83–1.28)	—	0.99 (0.80–1.22)
Cigar or cigarillos	—	1.21 (0.98–1.49)	—	1.00 (0.88–1.29)
Marijuana	—	1.16 (1.00–1.36)	—	1.11 (0.95–1.30)
Electronic vapor products	—	1.26 (1.02–1.55)	—	1.07 (0.93–1.23)
Inhalant	—	1.36 (1.11–1.67)	—	1.59 (1.17–2.17)
Synthetic marijuana	—	1.07 (0.81–1.41)	—	1.35 (1.07–1.71)

Definition of abbreviations: BMI = body mass index; CI = confidence interval; ref = reference; RRR = relative risk ratio.

To be parsimonious, results from those whose asthma diagnosis is unknown or unsure are not presented in the table but were included in the model. Data available upon request.

*Model adjusted for age, race or ethnicity, and BMI.

†Inhaled substance use is included as a potential mediator.

tobacco companies target cigarette ads to other vulnerable populations (e.g., menthol cigarettes in African American neighborhoods (55) and Camel cigarettes to youths), marketing efforts target the LGBTQ (lesbian, gay, bisexual, transgender, queer or questioning) community (56). There is some evidence that such marketing may play a role in SMY's risks for cigarette smoking, possibly by influencing social norms and perceptions of acceptability (53). Despite the associated health risks, restrictions have yet to be enacted and youths continue to be exposed to the dangers of nicotine addiction; youths who vape are four times as likely to start smoking cigarettes (57), and youths who use flavored products are more likely to report poly tobacco use (58).

Limitations

This study has several limitations to be considered in evaluating the findings, including limitations in the measurement of asthma. The national YRBS asked about sexual identity only in 2015 and 2017, and in these years, youths were only asked if they had ever been told by a healthcare professional that they had asthma. Current asthma was assessed only in 2007–2011. Respondents were asked about asthma symptom severity or about uncontrolled asthma only in 2003 and 2005. Furthermore, as the YRBS excludes youths who are not in

school, asthma prevalence and prevalence of inhaled substance use may be underestimated. SMY are at particularly high risk of missing school days, dropping out of school, and homelessness, suggesting particularly high-risk groups may be excluded (59). In 2017, several states and large urban school districts piloted a question about transgender identity in local YRBS surveys (22). However, the national survey does not include this question, precluding comparisons between transgender and cisgender youths. Transgender youth report significantly higher rates of inhaled substance use than their cisgender peers (22), making it important to consider the associations between asthma and inhaled substance use in this population (60). Synthetic marijuana and inhalant use were only assessed in terms of ever use; current use was not assessed. Given the cross-sectional study design, temporality or causality could not be determined; it is unclear whether the diagnosis of asthma occurred before or after the initiation of inhaled substance use. Future research should examine frequency and quantity of use of these substances to more fully understand their association with asthma risk.

This study represents an important early attempt to understand sexual identity-related asthma disparities. Our use of a large, representative sample afforded a

novel opportunity to examine how sexual identity may moderate the relationship between inhalant use and asthma, and how inhaled substances may explain observed sexual identity-related differences in asthma.

Conclusions

We used nationally representative data to examine associations among asthma, sexual identity, and inhaled substance use. We found that both asthma and inhaled substance use were positively associated with minority sexual identity, particularly among female youths. Our findings suggest that variables other than inhaled substance use may account for SMY's higher risk of asthma. However, evidence of the link between inhaled substance use and asthma among SM female youths is strong. We recommend that asthma researchers include assessment of sexual identity and inhaled substance use in their studies. Findings also highlight the importance of healthcare providers asking about sexual identity as health disparities are already present among high school youths—including among youths who are not yet sure of their sexual identities—and should be considered in assessments of health and health risk behaviors. Screening youths for inhaled substance use may provide little information about asthma risk if clinicians do not know (or ask about) the sexual identity of their

young patients. Providers should also be aware not only that female SMY are at higher risk for inhaled substance use but also that early initiation of smoking behaviors (and perhaps early initiation of other inhaled substances) is a strong contributor to adult smoking among SM women (61). Early interventions are critical to disrupt this pathway.

Although little is known about prevention and intervention of substance

use among SMY (62, 63), specialized programs tailored for LGBTQ adults are known to support smoking cessation (62). Healthcare providers working with SMY who use inhaled substances use should provide counseling and referral, preferably to programs that offer culturally sensitive care and specialized SMY-oriented interventions. School- and community-based interventions including Gay and Straight Alliance groups and programs such

as Safe Spaces, training educators to be more supportive, and antibullying programs may provide buffers and tools to reduce stress and improve health and wellbeing among SMY (64, 65). These may further decrease the potential root causes of sexual identity-related disparities in asthma and inhaled substance use, as well as other health concerns. ■

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