

Between and Within Sexual Identity-Group Differences in Asthma Prevalence in the United States

David Adzrago, Samuel H Nyarko, Nnenna Ananaba, Matt Asare, Emmanuel Odame, Antwan Jones, Timir K Paul, and Hadii M Mamudu

BACKGROUND: Although prior studies have established the association of asthma with smoking and obesity, literature on difference-in-differences analyses involving sexual identity is sparse. Therefore, this study aimed to examine the between and within sexual identity-group differences in asthma prevalence among individuals who smoke and are obese. **METHODS:** We aggregated the 2017–2019 National Survey on Drug Use and Health data on adults ($N = 128,319$) to perform weighted multivariable logistic regression analysis and marginal estimates and marginsplot to determine asthma prevalence by sexual identity and the status of smoking and obesity. **RESULTS:** About 66% of the study population reported having asthma. Among the individuals with asthma, 42% were obese, 10% were daily cigarette smokers, and 6% identified as bisexual persons. Lesbian/gay daily smokers (86%) or former smokers (75%) had a higher probability of having asthma than bisexual (daily smokers = 78% vs former smokers = 72%) and heterosexual (daily smokers = 68% vs former smokers = 65%) persons. Within each sexual identity subgroup, daily smokers (68–86%) had the highest probability of asthma. Obese bisexual (73%) or lesbian/gay (72%) persons had higher probabilities of having asthma than heterosexual persons (69%). Obese (73%) or overweight (72%) bisexual (compared to normal weight = 70% or underweight = 51%) and obese (69%) or overweight (65%) heterosexual (compared to normal weight = 62% or underweight = 57%) persons had the highest probabilities of having asthma within their groups, whereas overweight persons (overweight = 81% vs underweight = 79%, normal weight = 78%, and obese = 72%) had the highest probabilities within lesbian/gay persons. **CONCLUSIONS:** Smoking and obesity show heightened odds for asthma, with significant odds for sexual minorities in asthma diagnosis relative to heterosexuals. These findings provide formative information for future longitudinal and experimental studies to explore these mechanisms of asthma risks among sexual and gender minorities. *Key words:* asthma; sexual and gender minorities; smoking; obesity. [Respir Care 2022;67(3):331–338. © 2022 Daedalus Enterprises]

Introduction

Asthma is a chronic disease of the lungs with no known cure and a major cause of morbidity and mortality in the United States.^{1–3} It is characterized by repeated episodes of wheezing, breathlessness, chest tightness, and coughing. Between 2001–2019, the prevalence of asthma in the United States increased from 7.4% to 8% among adults age ≥ 18 y, which implies the critical need for initiatives to curtail this trend.^{1,4} Asthma can result in frequent emergency department (ED) visits, hospitalizations, and premature deaths. In 2018, about 1.6 million ED visits were asthma related.^{1,3,4} More than 11.4 million individuals with asthma reported having had one or more asthma episodes or attacks

in 2017, whereas 3,524 deaths were associated with the disease.^{1,3,4} The economic costs of asthma were estimated at \$81.9 billion in 2013³ and were projected at \$963.5 billion in 20 years.²

Although limited, some literature suggests that people who either smoke cigarettes and/or are obese have elevated risks of impaired or irritated airways that trigger asthma.^{5–15} Hence, people including sexual identity subgroups who smoke and/or are obese may have an elevated likelihood of developing asthma.^{16–19} Cigarette smoking increases the risk of developing more severe pulmonary symptoms for asthma attacks and asthma-related mortality.^{11–13} Similarly, obesity increases inflammatory cytokines or substances that impair lung functioning and airway changes that lead to

asthma.^{14,15} Previous studies have documented that sexual and gender minorities such as lesbian, gay, and bisexual individuals have elevated risks of asthma, smoking, and obesity than heterosexual persons across all racial/ethnic groups.¹⁶⁻²² There is a dearth of literature on difference in differences in asthma among lesbian, gay, bisexual, and heterosexual persons by the status of cigarette smoking and obesity. In this regard, Veldhuis et al¹⁶ indicated in their systematic review of literature that there is unclear information about differences in asthma-related factors among sexual identity subgroups and suggested the need for further research to highlight the differences, hence this study. Also, the existing studies on the association between asthma and the status of cigarette smoking and obesity did not use nationally representative data^{6,23} or include sexual minority groups.²⁴ This study used a nationally representative sample of adults aged ≥ 18 y to (1) assess the prevalence of asthma among sexual identity subgroups, (2) examine the association between asthma and sexual identity, and (3) evaluate differences in asthma between and within sexual identity groups by cigarette smoking and obesity status.

Methods

Study Design

This study utilized aggregated de-identified public use data for 2017, 2018, and the 2019 National Survey on Drug Use and Health (NSDUH) to perform the analyses. The NSDUH is an annual cross-sectional survey in the United States supported by the Substance Abuse and Mental Health Services Administration (SAMHSA), and it uses a complex, multistage area probability sample of United

Mr Adzrago and Dr Ananaba are affiliated with Center for Health Promotion and Prevention Research, School of Public Health, University of Texas Health Science Center at Houston, Houston, Texas. Dr Nyarko is affiliated with Department of Epidemiology, Human Genetics and Environmental Sciences, UTHealth School of Public Health, Houston, Texas. Dr Asare is affiliated with Department of Public Health, Robbins College of Health and Human Sciences, Baylor University, Waco, Texas. Dr Odame is affiliated with Department of Environmental Health Sciences, University of Alabama at Birmingham, Birmingham, Alabama. Dr Jones is affiliated with Department of Sociology and Department of Epidemiology, The George Washington University, Washington, District of Columbia. Dr Paul is affiliated with University of Tennessee at Nashville, Nashville, Tennessee. Dr Mamudu is affiliated with Department of Health Services Management and Policy, College of Public Health, East Tennessee State University, Johnson City, Tennessee.

The authors have disclosed no conflicts of interest.

Correspondence: David Adzrago MPhil MSW, 7000 Fannin, Suite 2502A, Houston, TX 77030. E-mail: David.Adzrago@uth.tmc.edu.

DOI: 10.4187/respcare.09258

QUICK LOOK

Current knowledge

Asthma prevalence rates are associated with cigarette smoking and obesity in the general United States population. Cigarette smoking increases the risk of developing more severe pulmonary disease symptoms, including symptoms of asthma attacks and asthma-related mortality. Obesity increases inflammatory cytokines that impair lung functioning and airway changes that lead to asthma. However, between- and within-group differences in asthma prevalence among sexual and gender identity subgroups who smoke and are obese are sparse.

What this paper contributes to our knowledge

Although sexual minority individuals had higher odds of having asthma than heterosexual individuals, there were significant differences in odds between and within sexual identity subgroups. Cigarette smoking or obesity was associated with increased odds of having asthma, with daily smoking or being obese associated with a higher likelihood of having asthma between and within lesbian/gay, bisexual, and heterosexual individuals. Lesbian/gay and bisexual individuals had higher odds of asthma than heterosexual individuals.

States civilian, noninstitutionalized population in each of the 50 states and the District of Columbia. Details of the construction of the samples and survey questions and survey administration can be found in the Center for Behavioral Health Statistics and Quality²⁵ and SAMHSA.²⁶ The aggregated data for the 3 surveys for this study consist of 168,725 individuals aged ≥ 12 y. However, our analysis was restricted to 128,319 adults aged ≥ 18 y to assess asthma risk factors among adults. This study was limited to a secondary analysis of the NSDUH de-identified data and, therefore, did not require a review from the authors' institutional review board.

Measures

The outcome variable was current asthma status and was assessed by asking participants to indicate whether they have ever been told by a doctor or other health care professional that they had asthma (yes/no). Those who reported that they have had asthma before were further asked whether they still have asthma (yes/no). Combining these 2 questions, the current asthma status was obtained and categorized as "0" (not currently having asthma) and "1" (currently having asthma).

This study examined 2 main exposure variables: (1) cigarette smoking status and (2) obesity status. Cigarette

smoking status was ascertained by asking the participants whether they had ever smoked at least 100 cigarettes in their lifetime (yes/no). Participants were further asked if they smoked daily in the past month. Combining these 2 questions, the participants were categorized into 3 groups: daily smoker, former smoker, and never smoker.^{27,28} Whereas daily smokers were those who have ever smoked at least 100 cigarettes in their lifetime and now smoked daily in the past month, former smokers were those who have ever smoked at least 100 cigarettes in their lifetime but had quit smoking at the time of the interview. Never smokers were those who have smoked fewer than 100 cigarettes in their lifetime and had not smoked in the past month.

Obesity status was categorized based on the participants' body mass index (BMI). Based on the scale by the United States Centers for Disease Control and Prevention, the participants were categorized into 4 groups: normal weight (BMI 18.5–25.0), underweight (BMI < 18.5), overweight (BMI 25.0–30.0), and obese (BMI > 30.0).^{17,29}

Based on existing literature,^{17,30,31} self-reported sociodemographic characteristics were adjusted for in the analyses. These sociodemographic variables included age (18–25, 26–34, 35–49, 50–64, ≥ 65 y), sex (male/female), sexual identity (heterosexual, lesbian or gay, and bisexual), race/ethnicity (non-Hispanic white, non-Hispanic Black, Hispanic, and Other race [non-Hispanic Native American/Alaskan Native, non-Hispanic Asian American, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic more than one race]), level of education completed (12th grade or less, high school diploma/GED, some college credit but no degree, associate degree, and college graduate or higher), total family income (< \$20,000, \$20,000–\$49,999, \$50,000–\$74,999, and ≥ \$75,000), and whether the respondent lived in a large metro, small metro, or nonmetro/county metro. These variables were analyzed as categorical variables in this current study.

Statistical Analyses

We performed descriptive analyses to describe the weighted percentages of the participants' sociodemographic characteristics and the prevalence of current asthma, cigarette smoking, and obesity (see Table 1). We also conducted bivariate analyses to determine the association between current asthma and sociodemographic characteristics, cigarette smoking, and obesity using chi-square tests (see Table 1). The significant variables at the bivariate analysis level ($P < .05$) were entered into the weighted multivariable logistic regression model (see Table 2). We further examined the interaction between cigarette smoking and sexual identity and found a significant result ($P = .001$); in Figure 1, using marginal estimates/predicted values and marginsplot, we examined differences in current

asthma between and within cigarette smoking and sexual identity. Additionally, we found a significant interaction ($P < .001$) between obesity status and sexual identity; and we, therefore, used marginal estimates and marginsplot to determine the differences in current asthma between and within obesity status and sexual identity (see Fig. 2). The marginal estimates/predicted values and marginsplot helped to determine the interaction effects on asthma by providing between- and within-group effects on asthma status.³²⁻³⁴ Our statistical analyses were weighted using the NSDUH survey weight to achieve nationally representative estimates and interpretations. Weighting and clustering effects such as unequal probabilities of sampling, nonresponse, and post-stratification adjustments were achieved using the survey weight. We also used the NSDUH nesting variables to capture explicit stratification and to ascertain clustering with the data as well as to obtain accurate variance estimates.²⁵ We used the NSDUH imputed variables when applicable to our study and based on the NSDUH statistical analytical recommendations for subpopulation analysis to establish accurate estimates and associations.²⁵ All statistical analyses were conducted at 2-tailed, an alpha level of 0.05, 95% CIs, and adjusted odds ratios. The data were analyzed with Stata/SE, version 16.1 (StataCorp, College Station, Texas).³⁵

Results

Descriptive and Bivariate Statistics

Table 1 shows that the majority of the population was within ages 35–49 (23.83%), females (58.76%), non-Hispanic whites (65.14%), heterosexuals (91.42%), had college graduate or higher degrees (30.31%), earned \$75,000 or more (40.03%), and resided in a large metropolitan area (56.28%). Important proportions of the population had current asthma (66.38%), were obese (39.20%), and were daily smokers (9.31). The majority of the population proportions who had current asthma was within ages 35–49 (24.11%) and 50–64 (24.05%), females (66.03%), non-Hispanic whites (65.84%), heterosexual (90.62%), had college graduate or higher degree (28.62%), earned \$75,000 or more (38.19%), and resided in a large metropolitan area (55%). Significant proportions of the population who had current asthma were obese (42.20%) and daily cigarette smokers (10.15%). The bivariate analysis results showed that age, sex, race/ethnicity, sexual identity, education, total family income, county metropolitan area, obesity status, and cigarette smoking status were associated with current asthma status.

Multivariable Logistic Regression Analysis

As shown in Table 2, the weighted multivariable logistic regression analysis results showed that being obese was

SEXUAL IDENTITY-GROUP DIFFERENCES IN ASTHMA

Table 1. Current Asthma Status Across Participants' Sociodemographic Characteristics, Cigarette Smoking Status, and Obesity Status: A Weighted Sample of United States Adults

	Overall <i>n</i> (%)	No Current Asthma <i>n</i> (%)	Current Asthma <i>n</i> (%)	<i>P</i>
	26,641,428 (100%)	8,957,326 (33.62)	17,684,102 (66.38)	
Age, y				< .001
18–25	4,235,216 (18.02)	1,748,216 (22.27)	2,487,001 (15.89)	
26–34	4,349,601 (18.51)	1,723,613 (21.95)	2,625,987 (16.78)	
35–49	5,600,030 (23.83)	1,825,736 (23.25)	3,774,294 (24.11)	
50–64	5,197,496 (22.11)	1,433,256 (18.25)	3,764,240 (24.05)	
≥ 65	4,121,631 (17.54)	1,121,143 (14.28)	3,000,488 (19.17)	
Sex				< .001
Male	10,987,928 (41.24)	4,980,278 (55.60)	6,007,651 (33.97)	
Female	15,653,500 (58.76)	3,977,048 (44.40)	11,676,452 (66.03)	
Race/Ethnicity				< .001
Non-Hispanic white	17,354,453 (65.14)	5,711,709 (63.77)	11,642,744 (65.84)	
Non-Hispanic Black	3,292,701 (12.36)	929,290 (10.38)	2,363,411 (13.37)	
Hispanic	3,933,760 (14.77)	1,512,218 (16.88)	2,421,542 (13.69)	
Other	2,060,514 (7.73)	804,109 (8.98)	1,256,405 (7.10)	
Sexual identity				.003
Heterosexual	21,271,859 (91.42)	7,248,024 (93.01)	14,023,836 (90.62)	
Lesbian or gay	654,965 (2.81)	165,766 (2.13)	489,199 (3.16)	
Bisexual	1,342,006 (5.77)	378,671 (4.86)	963,334 (6.22)	
Level of education completed				< .001
12th grade or less	5,274,629 (19.80)	1,610,044 (17.98)	3,664,585 (20.72)	
High school diploma/GED	4,975,607 (18.68)	1,516,670 (16.93)	3,458,937 (19.56)	
Some college but no degree	5,942,587 (22.31)	2,072,952 (23.14)	3,869,635 (21.88)	
Associate degree	2,374,509 (8.91)	744,137 (8.31)	1,630,372 (9.22)	
College graduate or higher	8,074,096 (30.31)	3,013,523 (33.64)	5,060,573 (28.62)	
Total family income				< .001
< \$20,000	4,368,316 (16.40)	1,169,453 (13.06)	3,198,863 (18.09)	
\$20,000–\$49,999	7,315,884 (27.46)	2,425,253 (27.08)	4,890,631 (27.66)	
\$50,000–\$74,999	4,292,031 (16.11)	1,450,888 (16.20)	2,841,142 (16.07)	
≥ \$75,000	10,665,197 (40.03)	3,911,732 (43.67)	6,753,465 (38.19)	
County metro/nonmetro area				.01
Large metro	14,994,621 (56.28)	5,267,921 (58.81)	9,726,699 (55.00)	
Small metro	7,985,334 (29.97)	2,561,519 (28.60)	5,423,814 (30.67)	
Nonmetro	3,661,473 (13.74)	1,127,885 (12.59)	2,533,588 (14.33)	
Obesity status				< .001
Normal	8,014,299 (30.08)	3,046,482 (34.01)	4,967,817 (28.09)	
Underweight	804,187 (3.02)	312,462 (3.49)	491,725 (2.78)	
Overweight	7,380,117 (27.70)	2,618,619 (29.23)	4,761,498 (26.93)	
Obese	10,442,825 (39.20)	2,979,764 (33.27)	7,463,062 (42.20)	
Cigarette smoking status				.001
Nonsmoker	17,648,011 (66.81)	6,110,817 (68.82)	11,537,194 (65.79)	
Former smoker	6,310,481 (23.89)	2,091,069 (23.55)	4,219,412 (24.06)	
Daily smoker	2,458,539 (9.31)	677,755 (7.63)	1,780,784 (10.15)	

Data source: National Survey on Drug Use and Health 2017–2019; weighted *n* = 26,641,428.

Statistical significance at *P* < .05.

All *P* values are based on chi-square tests for the categorical variables.

associated with higher odds (odds ratio [OR] 1.34 [95% CI 1.15–1.56]) of having current asthma compared to normal weight. Being a daily smoker was associated with higher odds (OR 1.17 [95% CI 1.01–1.37]) of having current asthma. Individuals who were within ages 35–49 (OR 1.51

[95% CI 1.32–1.73]), 50–64 (OR 1.82, [95% CI 1.45–2.28]), and 65 or older (OR 1.88 [95% CI 1.53–2.31]) had higher odds of having current asthma compared to individuals age 18–25 y. Compared to females, males had lower odds (OR 0.42 [95% CI 0.37–0.47]) of having current

SEXUAL IDENTITY-GROUP DIFFERENCES IN ASTHMA

Table 2. Adjusted Odds Ratios of Current Asthma Status Associated With Sociodemographic Characteristics, Cigarette Smoking Status, and Obesity Status

	AOR	95% CI
Age, y		
18–25	Ref	
26–34	1.12	0.98–1.28
35–49	1.51***	1.32–1.73
50–64	1.82***	1.45–2.28
65 or older	1.88***	1.53–2.31
Sex		
Female	Ref	
Male	0.42***	0.37–0.47
Race/Ethnicity		
Non-Hispanic white	Ref	
Non-Hispanic Black	1.19*	1.01–1.41
Hispanic	0.80**	0.69–0.93
Other race	0.89	0.71–1.11
Sexual identity		
Heterosexual	Ref	
Lesbian or gay	1.86***	1.29–2.68
Bisexual	1.33**	1.10–1.62
Level of education completed		
College graduate or higher	Ref	
12th grade or less grade	1.86***	1.44–2.39
High school diploma/GED	1.30**	1.07–1.57
Some college credit but no degree	1.11	0.95–1.30
Associate degree	1.21	0.95–1.54
Total family income		
< \$20,000	Ref	
\$20,000–\$49,999	0.78**	0.66–0.91
\$50,000–\$74,999	0.80*	0.65–0.97
≥ \$75,000	0.80*	0.66–0.96
County metro/nonmetro area		
Large metro	Ref	
Small metro	1.07	0.92–1.25
Nonmetro	1.01	0.86–1.19
Obesity status		
Normal	Ref	–
Underweight	0.76	0.53–1.09
Overweight	1.13	0.96–1.34
Obese	1.34***	1.15–1.56
Cigarette smoking status		
Nonsmoker	Ref	–
Former smoker	0.96	0.85–1.08
Daily smoker	1.17*	1.01–1.37

Note: Weighted $n = 26,641,428$

* $P \leq .05$, ** $P \leq .01$, *** $P \leq .001$

AOR = adjusted odds ratio

Ref = reference group

asthma. Non-Hispanic Black individuals had higher odds (OR 1.19 [95% CI 1.01–1.41]), whereas Hispanics had lower odds (OR 0.80 [95% CI 0.69–0.93]) of having current asthma compared to non-Hispanic whites. Lesbians or gays (OR 1.86 [95% CI 1.29–2.68]) and bisexuals (OR 1.33

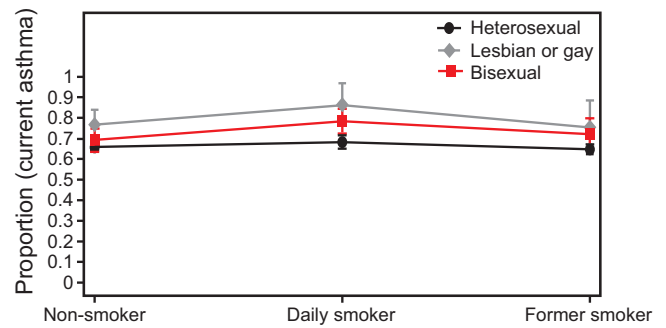


Fig. 1. Differences in current asthma between and within cigarette smoking status and sexual identity.

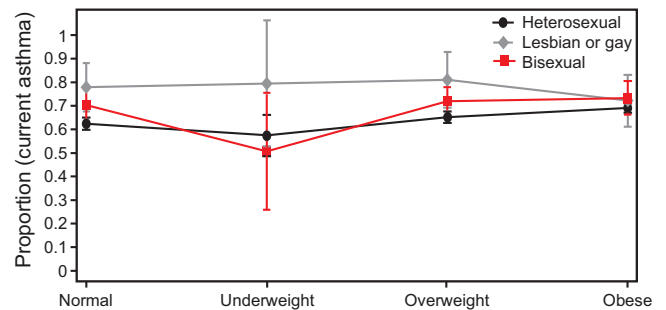


Fig. 2. Differences in current asthma between and within cigarette obesity status and sexual identity.

[95% CI 1.10–1.62]) had higher odds of having current asthma compared to heterosexuals. Individuals who had completed 12th grade or less (OR 1.86 [95% CI 1.44–2.39]) and high school diploma/GED (OR 1.30 [95% CI 1.07–1.57]) versus college graduate or higher had higher odds of having current asthma. Those who had total family income of \$20,000–\$49,999 (OR 0.78 [95% CI 0.66–0.91]), \$50,000–\$74,999 (OR 0.80 [95% CI 0.65–0.97]), and ≥ \$75,000 (OR 0.80 [95% CI 0.66–0.96]) had lower odds of having current asthma compared to those who had < \$20,000.

Between- and Within-Group Analysis

Figure 1 presents the differences in current asthma between and within cigarette smoking and sexual identity groups. Individuals who self-identified as lesbians/gays and were daily cigarette smokers (86%) had the highest probability of having current asthma compared to bisexual (78%) and heterosexual (68%) persons who were also daily cigarette smokers. Lesbian/gay persons who were former cigarette smokers (75%) had the highest probability of having current asthma compared to bisexual (72%) and heterosexual (65%) persons who were also former cigarette smokers. The probability of having current asthma was higher for lesbian/gay persons who were daily cigarette smokers

(86%) than for lesbian/gay persons who were former smokers (75%) and nonsmokers (77%). Bisexual persons who were daily smokers (78%) had a higher probability of having current asthma than bisexual persons who were former smokers (72%) and nonsmokers (69%). The probability of having asthma was marginally higher for heterosexual persons who were daily cigarette smokers (68%) than for heterosexual persons who were former smokers (65%) and nonsmokers (66%).

The differences in current asthma between and within obesity status and sexual identity are presented in Figure 2. Those who self-identified as bisexuals and were obese (73%) had marginally the highest probability of having current asthma compared to lesbian/gay (72%) and heterosexual (69%) persons who were also obese. Lesbian/gay persons who were overweight (81%) had the highest probability of having asthma compared to bisexual (72%) and heterosexual (65%) persons who were also overweight. Lesbian/gay persons who were underweight (79%) had the highest probability of having current asthma compared to heterosexual (57%) and bisexual (51%) persons who were also underweight. Within lesbian/gay persons, those who were overweight (81%) had marginally the highest probability of having current asthma compared to those who were underweight (79%), normal weight (78%), and obese (72%). Bisexual persons who were obese (73%) had fairly the highest probability of having current asthma compared to bisexual persons who were overweight (72%), normal weight (70%), and underweight (51%). For heterosexual persons, those who were obese (69%) had the highest probability of having current asthma compared to those who were overweight (65%), normal weight (62%), and underweight (57%).

Discussion

Although the association between cigarette smoking and asthma^{6,8-10} and obesity and asthma^{14,15} has been established, there is a paucity of studies on the extent of these associations in population subgroups, particularly in sexual and gender minority groups. Furthermore, the results from these prior studies are mixed or unclear.¹⁶ As such, the use of nationally representative data in this study will contribute to research to close such gaps in the literature. This current study assessed the prevalence of current asthma among sexual identity subgroups (ie, lesbian/gay, bisexual, and heterosexual persons), cigarette smoking status (ie, never smoker, former smoker, and daily smoker), and obesity categories (ie, normal weight, underweight, overweight, and obese). The findings of this study revealed that about two-thirds of the study participants currently has asthma, whereas approximately one in 10 and 2 in 5 people with asthma were daily cigarette smokers and obese, respectively. These results suggest the continuous need for public

health interventions and research on asthma, with a focus on behavioral/lifestyle modifications.

In the overall population, the results of the multiple variable analyses showed that being a daily smoker was significantly associated with higher odds of current asthma by 1.17 times. This supports previous studies that have strongly linked smoking to higher odds of asthma diagnosis,^{6,17} reinforcing the evidence that cigarette smoking has severe public health implications. Similarly, being obese is significantly associated with higher odds for asthma by 1.34 times. Evidence of the link between obesity status and asthma diagnosis has also been documented by several studies among adults in the United States.^{17,36} Consequently, obesity has been shown to increase the severity of asthma, leading to poorer control of the disease and quality of life, possibly owing to chronic systemic inflammation.³⁷⁻⁴⁰

In the analyses involving sexual and gender minority individuals, considerable differences have been found in current asthma risks concerning cigarette smoking status, obesity status, and sexual identity groups. There are elevated asthma odds among lesbian/gay and bisexual persons irrespective of their smoking status. However, the greatest current asthma likelihoods are found among lesbian/gay and bisexual daily smokers, which highlights the severe implications of daily smoking and sexual minority status for asthma diagnosis. Studies have shown that sexual minorities are significantly more likely to smoke and be diagnosed with asthma than heterosexuals.^{31,41-43} Similarly, we found that lesbian/gay and bisexual persons are linked to increased asthma likelihoods across obesity status except for underweight status. In effect, overweight lesbian/gay persons show the greatest likelihoods for current asthma diagnosis relative to normal weight, underweight, and obese persons. In this regard, previous research has also pointed to the evidence that sexual minority women are likely to be overweight,⁴⁴ whereas same-sex relationship status is significantly linked to asthma diagnosis.⁴¹ Myriad studies have indicated that these notable health disparities can be attributable to limited access to health care services among sexual minorities, possibly owing to poor quality of care, unfair treatment, and discrimination against these persons when receiving medical care,⁴⁵⁻⁴⁸ which have severe implications for the promotion of health equity. In this respect, achieving the Healthy People 2030 goal to eliminate health disparities in the United States⁴⁹ will require more research into smoking and obesity in population subgroups, including sexual and gender minorities.

This study is not without a few limitations. This study is a cross-sectional study; therefore, we were unable to examine the biological or longitudinal mechanisms of the associations between sexual orientation and asthma. Also, we were unable to assess temporal sequence or causal relationships to determine the triggers to initiate the inflammatory process to cause secretion and bronchospasm. As such, we did not

make causal inferences in this study; instead, we reported associations. This current study provides formative information for longitudinal and experimental studies to explore these mechanisms. The data were based on self-reported information such as current asthma status (yes/no), which may be prone to bias including recall and social desirability biases. This may result in underreporting, which could lead to the underestimation of results. However, the NSDUH questions used to assess the self-reported responses such as asthma status have been widely adopted and sensitive to apply.^{25,26} Additionally, our study did not include other factors (eg, neighborhood characteristics, family history of asthma) that may explain differences in asthma between and within subgroups (eg, sexual identity groups). Nevertheless, this study makes an invaluable contribution to the literature by providing between- and within-group analysis of asthma diagnosis among sexual and gender minority and subgroups by their status of cigarette smoking and obesity in the United States. Further, the study utilized a large nationally representative sample to enhance accurate statistical estimations and generalizability of our findings to the general United States population.

Conclusions

Asthma is a major cause of morbidity and mortality in the United States, and this study confirms findings in the extant literature that cigarette smoking and obesity are important risk factors for asthma diagnosis across the general population. Additionally, this study suggests that there is evidence of considerable disparities by sexual identity group with sexual and gender minority individuals being disproportionately burdened with asthma relative to heterosexual adults across cigarette smoking and obesity. As such, identifying between- and within-group differences in asthma-related risk factors by this study can help to determine the number of public health resources needed for specific population subgroups. These findings also provide formative information for future longitudinal and experimental studies to explore the mechanisms of these asthma risks, especially among sexual and gender minorities.

REFERENCES

1. Asthma and Allergy Foundation of America. Asthma facts and figures. Available at: <https://www.aafa.org/asthma-facts>. Accessed July 8, 2021.
2. Yaghoubi M, Adibi A, Safari A, FitzGerald JM, Sadatsafavi M. The projected economic and health burden of uncontrolled asthma in the United States. *Am J Respir Crit Care Med* 2019;200(9):1102-1112.
3. Nurmagambetov T, Kuwahara R, Garbe P. The economic burden of asthma in the United States, 2008–2013. *Ann Am Thorac Soc* 2018;15(3):348-356.
4. Centers for Disease Control and Prevention. Asthma surveillance data. Available at: <https://www.cdc.gov/asthma/asthmadata.htm>. Accessed July 8, 2021.
5. Belachew SA, Erku DA, Yimenu DK, Gebresillassie BM. Assessment of predictors for acute asthma attack in asthmatic patients visiting an Ethiopian hospital: are the potential factors still a threat? *Asthma Res Pract* 2018;4(1):1-7.
6. Coogan PF, Castro-Webb N, Yu J, O'Connor GT, Palmer JR, Rosenberg L. Active and passive smoking and the incidence of asthma in the black women's health study. *Am J Respir Crit Care Med* 2015;191(2):168-176.
7. McLeish AC, Zvolensky MJ. Asthma and cigarette smoking: a review of the empirical literature. *J Asthma* 2010;47(4):345-361.
8. US Department of Health and Human Services, US Public Health Service. Smoking cessation: a report of the surgeon general. Available at: <https://www.hhs.gov/sites/default/files/2020-cessation-sgr-full-report.pdf>. Accessed July 8, 2021.
9. Polosa R, Thomson NC. Smoking and asthma: dangerous liaisons. *Eur Respir J* 2013;41(3):716-726.
10. Stapleton M, Howard-Thompson A, George C, Hoover RM, Self TH. Smoking and asthma. *J Am Board Fam Med* 2011;24(3):313-322.
11. Self TH, Shah SP, Mar KL, Sands CW. Asthma associated with the use of cocaine, heroin, and marijuana: a review of the evidence. *J Asthma* 2017;54(7):714-722.
12. Chatkin JM, Zani-Silva L, Ferreira I, Zamel N. Cannabis-associated asthma and allergies. *Clin Rev Allergy Immunol* 2019;56(2):196-206.
13. Caponnetto P, Auditore R, Russo C, Alamo A, Campagna D, Demma S, Polosa R. Dangerous relationships": asthma and substance abuse. *J Addict Dis* 2013;32(2):158-167.
14. Peters U, Dixon AE, Forno E. Obesity and asthma. *J Allergy Clin Immunol* 2018;141(4):1169-1179.
15. Baffi CW, Winnica DE, Holguin F. Asthma and obesity: mechanisms and clinical implications. *Asthma Res Pract* 2015;1(1):1-7.
16. Veldhuis CB, Bruzzese J-M, Hughes TL, George M. Asthma status and risks among lesbian, gay, and bisexual adults in the United States: a scoping review. *Ann Allergy Asthma Immunol* 2019;122(5):535-536.e1.
17. Landers SJ, Mimiaga MJ, Conron KJ. Sexual orientation differences in asthma correlates in a population-based sample of adults. *Am J Public Health* 2011;101(12):2238-2241.
18. Dilley JA, Simmons KW, Boysun MJ, Pizacani BA, Stark MJ. Demonstrating the importance and feasibility of including sexual orientation in public health surveys: health disparities in the Pacific Northwest. *Am J Public Health* 2010;100(3):460-467.
19. Heslin KC, Hall JE. Sexual orientation disparities in risk factors for adverse COVID-19-related outcomes by race/ethnicity — behavioral risk factor surveillance system, United States, 2017–2019. *Mmwr Morb Mortal Wkly Rep* 2021;70(5):149-154.
20. Timmins L, Rimes KA, Rahman Q. Minority stressors, rumination, and psychological distress in lesbian, gay, and bisexual individuals. *Arch Sex Behav* 2020;49(2):661-680.
21. Flentje A, Heck NC, Brennan JM, Meyer IH. The relationship between minority stress and biological outcomes: a systematic review. *J Behav Med* 2020;43(5):673-694.
22. Bulatao RA, Anderson NB, eds. National Research Council. Understanding Racial and Ethnic Differences in Health in Late Life: A Research Agenda. Washington, DC: The National Academies Press; 2004.
23. Han Y-Y, Rosser F, Forno E, Celedón JC. Electronic vapor products, marijuana use, smoking, and asthma in US adolescents. *J Allergy Clin Immunol* 2020;145(3):1025-1028.e6.
24. Yawn BP, Rank MA, Bertram SL, Wollan PC. Obesity, low levels of physical activity, and smoking present opportunities for primary care asthma interventions: an analysis of baseline data from the asthma tools study. *NPJ Prim Care Respir Med* 2015;25(1):1-7.
25. US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration. 2019 National

- Survey on Drug Use and Health: Methodological summary and definitions. Available at: <https://www.samhsa.gov/data/sites/default/files/reports/rpt29395/2019NSDUHMethodsSummDefs/2019NSDUHMethodsSummDefs082120.htm>. Accessed July 8, 2021.
26. US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration. 2019 National Survey on Drug Use and Health Detailed Tables. Available at: <https://www.samhsa.gov/data/report/2019-nsduh-detailed-tables>. Accessed July 8, 2021.
 27. Centers for Disease Control and Prevention. National Health Interview Survey - Adult tobacco use glossary. Available at: https://www.cdc.gov/nchs/nhis/tobacco/tobacco_glossary.htm. Accessed July 8, 2021.
 28. Jones A, Gulbis A, Baker EH. Differences in tobacco use between Canada and the United States. *Int J Public Health* 2010;55(3):167-175.
 29. Centers for Disease Control and Prevention. Defining adult overweight & obesity. Available at: <https://www.cdc.gov/obesity/adult/defining.html>. Accessed July 8, 2021.
 30. Toskala E, Kennedy DW. Asthma risk factors. *International Forum of Allergy and Rhinology* 2015;5(S1):S11-S16.
 31. Conron KJ, Mimiaga MJ, Landers SJ. A population-based study of sexual orientation identity and gender differences in adult health. *Am J Public Health* 2010;100(10):1953-1960.
 32. Williams R. Using the margins command to estimate and interpret adjusted predictions and marginal effects. *Stata J* 2012;12(2):308-331.
 33. A categorical can of worms III. The detective's handbook. Available at: <https://thedetektiveshandbook.wordpress.com/2018/10/15/a-categorical-can-of-worms-iii/>. Accessed July 9, 2021.
 34. Connelly R, Gayle V, Lambert PS. Statistical modelling of key variables in social survey data analysis. *Methodol Innov* 2016;9:205979911663800.
 35. StataCorp. Why Stata. Available at: <https://www.stata.com/why-use-stata/>. Accessed July 8, 2021.
 36. Ford ES, Mannino DM, Redd SC, Mokdad AH, Mott JA. Body mass index and asthma incidence among USA adults. *Eur Respir J* 2004;24(5):740-744.
 37. Juel CT-B, Ulrik CS. Obesity and asthma: impact on severity, asthma control, and response to therapy. *Respir Care* 2013;58(5):867-873.
 38. Maalej S, Yaacoub Z, Fakhfekh R, Yaalaoui S, Ben KA, Drira I. Association of obesity with asthma severity, control, and quality of life. *Tanaffos* 2012;11(1):38-43.
 39. Taylor B, Mannino D, Brown C, Crocker D, Twum-Baah N, Holguin F. Body mass index and asthma severity in the national asthma survey. *Thorax* 2008;63(1):14-20.
 40. Akerman MJH, Calacanis CM, Madsen MK. Relationship between asthma severity and obesity. *J Asthma* 2004;41(5):521-526.
 41. Blossnich JR, Lee JGL, Bossarte R, Silenzio VMB. Asthma disparities and within-group differences in a national, probability sample of same-sex partnered adults. *Am J Public Health* 2013;103(9):e83-e87.
 42. Gruskin EP, Greenwood GL, Matevia M, Pollack LM, Bye LL. Disparities in smoking between the lesbian, gay, and bisexual population and the general population in California. *Am J Public Health* 2007;97(8):1496-1502.
 43. Tang H, Greenwood GL, Cowling DW, Lloyd JC, Roeseler AG, Bal DG. Cigarette smoking among lesbians, gays, and bisexuals: how serious a problem? (United States). *Cancer Causes Control* 2004;15(8):797-803.
 44. Azagba S, Shan L, Latham K. Overweight and obesity among sexual minority adults in the United States. *Int J Environ Res Public Health* 2019;16(10):1828.
 45. Jennings L, Barcelos C, McWilliams C, Malecki K. Inequalities in lesbian, gay, bisexual, and transgender (LGBT) health and health care access and utilization in Wisconsin. *Prev Med Rep* 2019;14:100864.
 46. Albuquerque GA, de Lima Garcia C, da Silva Quirino G, Alves MJ, Belem JM, dos S, Figueiredo FW. Access to health services by lesbian, gay, bisexual, and transgender persons: systematic literature review. *BMC Int Heal Hum Rights* 2016;16(1):1-10.
 47. Logie C. The case for the World Health Organization's commission on the social determinants of health to address sexual orientation. *Am J Public Health* 2012;102(7):1243-1246.
 48. Heck JE, Sell RL, Gorin SS. Health care access among individuals involved in same-sex relationships. *Am J Public Health* 2006;96(6):1111-1118.
 49. Pronk NP, Kleinman DV, Richmond TS. Healthy People 2030: moving toward equitable health and well-being in the United States. *EClinicalMedicine* 2021;33:100777.