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Asthma Remission Disparities among U.S. Youth by Sexual Identity and Race/Ethnicity, 2009–2017

Caleb W. Curry^{1,2,3,6}, Dylan Felt, BA^{1,2,7}, Kristin Kan, MD, MPH, MSc^{4,5,8}, Megan Ruprecht, BA^{1,2,9}, Xinzi Wang, MA^{1,2,10}, Gregory Phillips II, PhD, MS^{1,2,11}, Lauren B. Beach, JD/PhD^{1,2}

¹Evaluation, Data Integration, and Technical Assistance (EDIT) Research Program, Institute for Sexual and Gender Minority Health and Wellbeing, Northwestern University, Chicago, IL

²Department of Medical Social Sciences, Northwestern University Feinberg School of Medicine, Chicago, IL

³College of Arts and Sciences, Case Western Reserve University, Cleveland, OH

⁴Department of Pediatrics, Northwestern University Feinberg School of Medicine, Chicago, IL

⁵Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

⁶caleb.curry@case.edu

⁷dylan.felt@northwestern.edu

⁸kkan@luriechildrens.org

⁹megan.ruprecht@northwestern.edu

¹⁰xinzi.wang@northwestern.edu

¹¹glp2@northwestern.edu

Abstract

¹²Corresponding Author Lauren B. Beach, 625 N Michigan Ave #15-5427, Chicago, IL, USA, 60611, Phone: +1 312-503-3447; Fax: 312-503-6700, lauren.beach@northwestern.edu.

Author Contributions

CWC conceived and led the study. CWC initiated the study design. DF and LBB further developed the study design. GLP and XW conducted all statistical analyses. All authors drafted and approved the final version of this manuscript. Authors equally contributed to critical analyses, interpretation, and all other aspects of the manuscript.

Disclaimer

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We declare no competing interests.

Human Participant Protection

All current study activities were classified as non-human participant research by the institutional review board at Northwestern University.

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Background: Sexual minority and racial/ethnic minority youth experience a higher burden of asthma. The frameworks of minority stress theory and intersectionality suggest sexual minority and racial/ethnic minority youth may experience disparities in non-remitting asthma.

Objective: To examine adjusted odds of non-remitting asthma by sexual identity, race/ethnicity, and their intersections, along with their relationship with traditional non-remitting asthma risk factors (weight status and smoking) and victimization (bullying, cyberbullying, and forced sex).

Method: We utilized data from the Youth Risk Behavior Survey (YRBS) pooled across 41 jurisdiction-years (biennially, 2009–2017), resulting in a sample of 21,789 U.S. youth. The prevalence of non-remitting asthma was examined by sexual identity, race/ethnicity, and their intersections, stratified by sex. Bivariate associations and backward logistic regression models, stratified by sex, were built to examine non-remitting asthma disparities and the effects of selected traditional correlates and victimization variables.

Results: At the intersections, 8 sexual minority and racial/ethnic minority subpopulations were significantly more likely to have non-remitting asthma compared with White heterosexual sex-matched peers. White gay males and Black lesbian females had the highest odds of non-remitting asthma. Traditional risks of non-remitting asthma and victimization were associated with attenuated odds of non-remitting asthma.

Conclusion: Many sexual minority and racial/ethnic youth sub-populations are more likely to have non-remitting asthma. Evidence suggests traditional non-remitting asthma risk factors and victimization may partly explain disparities in non-remitting asthma. Asthma management guidelines should be updated to include population health disparities of sexual and racial/ethnic minorities.

Keywords

Asthma; Asthma Remission; Non-remitting Asthma; Disparities; Sexual Minorities; Sexual Identity; Race/Ethnicity; Minority Stress; Intersectionality; Victimization; YRBS; Youth; United States

INTRODUCTION

Asthma is the most common chronic condition among children, affecting 8.4% of youth under 18 years.^{1,2} Among youth, asthma is a leading cause of hospitalization and is associated with an increased risk for developing diabetes and coronary heart disease in adulthood.^{3,4} Youth asthma management and surveillance, therefore, remains a top public health priority.^{2,5,6} Previous asthma surveillance reveals asthma prevalence disparities among youth and adults by sex, sexual identity, and race/ethnicity, as well as those multiply-marginalized by sexual identity and race/ethnicity.^{1,7–16}

Despite growing asthma surveillance research, non-remitting asthma is still not well understood. Clinical asthma remission is typically considered as the absence of asthma symptoms without the use of an asthma medication over a period of time (varying from 6 months to 5 years).^{17,18} In the present study, asthma remission was defined as the self-reported absence of asthma symptoms among those with a prior history of asthma. Most cases of asthma remission occur between ages 14 to 21, and the prevalence of

remission has been estimated to be between 33% and 53% among youth under 18.^{17–19} Among youth and adult populations, there are sex-based differences in asthma remission with more males entering remission than females.¹⁸ Correlates of non-remitting asthma have also been identified: persons who smoke, have a body mass index percentile (BMI_p) greater than 85, or have more severe asthma tend to have lower rates of remission.¹⁸ Notably, sexual minority and/or racial/ethnic minority (SM/REM) youth report a higher prevalence of smoking and elevated weight.^{20,21} Additionally, although no studies have investigated asthma severity among sexual minority youth, asthma symptoms have been found to be more severe among racial/ethnic minority youth compared to their White counterparts.^{18,22} Taken together, the higher prevalence of non-remitting asthma risk factors among SM/REM youth suggests they may experience less asthma remission. Despite the evidence, though, no studies have investigated if such disparities exist by sexual identity. Only one study among youth has examined asthma remission by race/ethnicity, finding White individuals were more likely to experience asthma remission than non-White cohort members.²³ Thus, additional surveillance with more precise populations is needed.

Minority stress theory (MST) and intersectionality are theoretical frameworks that can be applied to investigate health disparities of multiply-marginalized populations.^{24–26} MST posits that marginalized populations are disparately burdened with stigmatization, discrimination, and oppression that contributes to an overall heightened burden of stress.²⁴ Minority stressors can take the form of proximal (e.g., internalized homophobia) or distal (e.g., prejudiced events such as victimization) stressors. The heightened chronic stress experienced can cause physiological changes, such as immune system dysregulation, which have been associated with the development of asthma.²⁷ Stress-related coping can also manifest as maladaptive health behaviors that increase the prevalence of traditional risks of asthma non-remission, such as smoking and disordered eating that increases risk for a BMI_p>95.^{18,24,28,29} Ultimately, the higher burden of chronic stress and stress-linked coping behaviors can exacerbate both mental and physical health conditions, potentially impacting the likelihood of asthma remission among marginalized populations.^{24,30,31}

Furthermore, applying an intersectional lens expands the contextual scope of MST by specifically considering the health impacts of multiple marginalization.^{32,33} Intersectionality—a Black feminist framework developed by Crenshaw²⁵ and Collins²⁶—highlights that marginalization can manifest distinctly at the intersections of multiply-marginalized identities. At the person level, the framework emphasizes that individuals hold multiple characteristics (e.g., race/ethnicity and sexual orientation) but experience the world living in a single body. Applied to the present study, marginalization may be manifesting as excess experiences of victimization among SM/REM youth and impacting both maladaptive-stress coping behaviors and physiological stress responses that may disparately drive asthma remission outcomes among SM/REM sub-populations.

Neither the epidemiology of non-remitting asthma among SM/REM youth nor the association between non-remitting asthma and minority stress-related factors have ever been described. In the present study, we aim to advance the field of pediatric asthma remission research by describing patterns of non-remitting asthma within a large and geographically diverse dataset of high school-aged youth. Specifically, we aim to: (1)

examine non-remitting asthma disparities among youth by sexual identity, race/ethnicity, and their intersections and (2) explore the impact of selected traditional asthma non-remission factors (weight status and smoking) and—based on MST—victimization (bullied, cyberbullied, and forced sex) on odds of non-remitting asthma.³⁴ Informed by theory and the related background literature, we hypothesize differential prevalence of non-remitting asthma among SM/REM youth. We also expect traditional correlates of non-remitting asthma, as well as experiences of victimization to be associated with increased odds of non-remitting asthma.

METHODS

Data Source

The Youth Risk Behavior Survey (YRBS) is a biennial survey conducted by the Centers for Disease Control and Prevention (CDC) to collect health data on students in grades 9–12.³⁵ We utilized local administrations of the YRBS, pooling data across jurisdictions of states and large, urban school districts. Jurisdictions use a two-stage cluster sample design to identify a representative sample of students.³⁵ A new sample is selected each year the survey is administered. The YRBS data weights adjust for student non-response and distribution of students by grade, sex, and race/ethnicity in each jurisdiction.

Study Design

Local YRBS data were pooled across multiple jurisdictions and years (biennially, 2009–2017). Only jurisdiction-years including sexual identity, lifetime asthma, and current asthma measures were included in the sample, representing 137,107 students. For the present analyses, students were excluded if they were missing any of the primary demographic variables of interest (Sexual Identity, Race/Ethnicity, Age, Region), resulting in 129,196 participants. Finally, only individuals who reported having lifetime asthma and who answered “yes” or “no” to still having asthma were included, leaving a final analytic sample of 21,789 youth across 41 jurisdiction-years.

Measures

The following measures were used: Demographics (Sex, Sexual Identity, Race/Ethnicity, SM/REM Sub-Populations, Age, Region); Traditional Non-remitting Asthma Risk Factors (Obese and Overweight, Smoking Status); the Primary Outcome (Non-remitting Asthma); and Victimization Indicators (Bullied, Cyberbullied, Forced Sex). These victimization variables were selected because prior research has used victimization variables to represent manifestations of stigma that contribute to excess minority stress levels among SM/REM youth.^{34,36} These specific variables cover a range of social settings (school and non-school), and bullying is the most common form of victimization among SMY.^{7,34,36–38} Moreover, besides bullying, forced sex is the most common type of victimization experienced by sexual minority females, particularly bisexual women and women of color.^{7,38} For information on survey questions and classification for measures, see Table I.

The primary outcome of non-remitting asthma was formed by first asking, “*Has a doctor or nurse ever told you that you have asthma?*” Response options: yes; no; and not sure.

Participants were then asked, “*Do you still have asthma?*” Response options: I have never had asthma; yes; no; and not sure. For our analyses, those who responded yes to both questions were considered to have non-remitting asthma. Those who responded yes to the first question but no to the second were classified as in asthma remission. Participants responding differently from above were dropped from all models.

Statistical Analyses

All data cleaning and recoding was conducted in SAS Version 9.4 (SAS Institute, Cary, NC). SAS-Callable SUDAAN Version 11.0.1 (RTI International, Research Triangle Park, NC) was used to appropriately weight estimates and account for the complex sampling design of the YRBS. First, bivariate logistic regressions with traditional non-remitting asthma risk factors and experiences of victimization, stratified by sex, were conducted. Multivariate logistic regressions were used to assess any potential correlates of asthma remission. Predictors were removed in a stepwise manner until only those with $p < 0.10$ (to capture any potential correlate) remained in the model. All adjusted models contained demographics (age, region, race/ethnicity, and sexual identity) and survey year.

RESULTS

The analytic sample ($n=21,789$) consisted of nearly equal proportions of males (49.2%) and females (50.8%; Table II). The sample predominately identified as heterosexual (87.4%), followed by bisexual (6.9%), not sure (3.2%), and lesbian or gay (2.4%). Slightly over half were White (51.2%)—followed by Black (24.0%), Hispanic or Latinx (17.7%), and additional-race (7.1%). Approximately one-third (33.3%) of respondents had experienced asthma remission. By sex, 40.5% of males experienced remission compared with 26.3% of females ($p < 0.001$), corresponding with prior literature.^{7,18,19}

Bivariate Associations with Non-remitting Asthma

Across sexual identity and race/ethnicity separately, gay (odds ratio [OR]: 2.71; 95% confidence interval [CI]: 1.51–7.84), Black (OR: 1.80; 95% CI: 1.38–2.34), and additional-race (OR: 1.30; 95% CI: 1.01–1.69) male students were significantly more likely to have non-remitting asthma compared with heterosexual or White, sex-matched students (Table III). Among females, only Black respondents (OR: 1.52; 95% CI: 1.20–1.92) were significantly more likely to have non-remitting asthma compared with White female respondents. Hispanic/Latinx females were less likely to have non-remitting asthma (OR: 0.68; 95% CI: 0.56–0.83) than White females.

Among males, a BMI >95 (OR: 1.29; 95% CI: 1.03–1.61) and being bullied (OR: 1.29; 95% CI: 1.03–1.62) were significantly associated with increased odds of non-remitting asthma. Among females, being a former smoker (OR: 1.30; 95% CI: 1.01–1.66), being bullied (OR: 1.54; 95% CI: 1.23–1.92), being cyberbullied (OR: 1.39; 95% CI: 1.10–1.76), and experiencing forced sex (OR: 1.49; 95% CI: 1.13–1.97) were associated. Unadjusted models for SM/REM subpopulations across males and females are included in Table III.

Sex-Stratified SM/REM Analyses

Among males and in models adjusted for demographics (Table IV Model I; Figure 1), all four sub-populations with significantly elevated odds of non-remitting asthma from unadjusted models remained—Black heterosexual (adjusted OR [AOR] 2.05; 95% CI: 1.52–2.75), additional-race heterosexual (AOR 1.40; 95% CI: 1.06–1.86), White gay (AOR 11.56; 95% CI: 4.29–31.14), and additional-race gay (AOR 1.99; 95% CI: 1.79–13.95) males.

Among females and in models adjusted for demographics (Table V Model I; Figure 2), compared with unadjusted models, all four previous significant associations with non-remitting asthma remained—Black lesbian (AOR 7.13; 95% CI: 2.10–24.17), Black bisexual (AOR 2.35; 95% CI: 1.12–4.92), Hispanic/Latinx heterosexual (AOR 0.61; 95% CI: 0.48–0.76), and additional-race heterosexual (AOR 0.63; 95% CI: 0.47–0.86) females. A higher chance of non-remitting asthma among Black heterosexual (AOR 1.43; 95% CI: 1.09–1.87) and Black not sure females (AOR 3.89; 95% CI: 1.17–12.97) compared with White heterosexual females emerged.

Adjusting for Correlates

Among males, being cyberbullied (AOR 1.39; 95% CI: 0.96–2.02) and having a BMI_p>95 (AOR 1.31; 95% CI: 1.02–1.68) were the most robustly associated with non-remitting asthma (Table IV). Their inclusion in models reduced odds of non-remitting asthma for 9 subpopulations compared with models only adjusted for demographics. Most significant disparities in non-remitting asthma remained in the fully adjusted model; however, additional-race gay males (AOR: 3.06; 95% CI: 1.00–9.39; *p*=0.0504) lost significance.

Among females, being bullied (AOR 1.49; 95% CI: 1.16–1.92) and experiencing forced sex (AOR 1.53; 95% CI: 1.10–2.13) were the most robustly associated with non-remitting asthma (Table V). Their inclusion in models reduced the odds of non-remitting asthma for 12 subpopulations. Only Black lesbian females maintained significantly greater odds of asthma non-remission (AOR 4.62; 95% CI: 1.18–18.08). Four subpopulations (Hispanic/Latinx heterosexual, additional-race heterosexual, White lesbian, and White not sure) were significantly less likely than White heterosexual females to experience non-remitting asthma.

DISCUSSION

Consistent with prior work, we report differences in asthma remission by sex, with males having a higher prevalence than females.¹⁸ In partial agreement with the previous study on differences by race/ethnicity,²³ we found significantly elevated rates of non-remitting asthma among Black males and females, as well as among additional-race males. Hispanic/Latinx females, however, experienced significantly lower rates of non-remitting asthma than White females. By sexual identity, only gay males were significantly more likely than their sex-matched heterosexual peers to have non-remitting asthma.

Furthermore, using an applied intersectional lens, we report disparities in asthma remission among SM/REM youth. Understanding that each subpopulation experiences distinct overlapping stigmatization helps to explain the varying magnitudes of disparities we

report.^{24,25,30} Overall, 8 SM/REM minority subpopulations experienced significantly increased odds of non-remitting asthma compared with White heterosexual, sex-matched peers. There were no significant disparities among females by sexual identity alone; however, among SM/REM youth, significant disparities were found among Black heterosexual, lesbian, bisexual, and not sure females compared with White heterosexual females. Moreover, black females with a minority sexual identity, particularly lesbian and not sure identities, had higher odds of non-remitting asthma than did Black heterosexual females. These findings highlight the value of intersectionality-informed analyses, as worsened disparities among sexual minority females of color were not seen when examining only sexual identity, indicating that interlocking oppressions experienced by these subpopulations may be driving their distinct asthma outcomes.

For males, being cyberbullied or having a BMI_p>95 tended to attenuate odds of non-remitting asthma among sub-populations, with additional-race gay males losing statistically significant increased odds of non-remitting asthma in fully adjusted models. The evidence suggests victimization and traditional risk factors like BMI may partially moderate disparities in asthma remission among marginalized populations. As described above, victimization may increase levels of minority stress among marginalized populations, initiating physiological (e.g., immune system dysregulation) and stress-linked coping behaviors (e.g., disordered eating that increases BMI_p) that increase the risk for non-remitting asthma.^{24,30,31} Addressing the levels of stigmatization and minority stress that lead to such correlates could prove efficacious in reducing asthma remission disparities among male youth. Based on significantly elevated disparities, Black heterosexual; additional-race heterosexual; White gay; and additional-race gay male youth should receive special consideration in future asthma remission research and intervention.

For females, including being bullied and experiencing forced sex in fully adjusted models reduced the odds of non-remitting asthma for all subpopulations except additional-race heterosexual, lesbian, and not sure females. These variables eliminated the significantly higher odds of non-remitting asthma among Black heterosexual, bisexual, and not sure females. Of considerable note is the loss of statistical significance for increased odds of non-remitting asthma among Black bisexual females in the model including forced sex. Nationally, experiencing forced sex is most common among bisexual women and women of color.³⁹ While the reasons for these higher levels of sexual victimization remain poorly studied, scholars have posited that such violence is linked directly to stereotypes and stigmatization of women of color and bisexual women (as well as among bisexual women of color).⁴⁰ The evidence, then, in line with MST suggests that reducing occurrences of victimization and stigmatization may reduce risk for non-remitting asthma among marginalized female youth. Research into asthma remission among Black female youth, particularly those with a sexual minority identity, should be prioritized.

Interestingly, smoking status did not meet the significance cut-off for either fully-adjusted model. The lack of correlation may be explained by youth having not smoked long enough to see the observed patterns common in adults of smoking as a risk factor for non-remitting asthma.¹⁸ Having a BMI_p>95%, however, was significantly associated with non-remission for males, indicating its potential role in pediatric non-remitting asthma.

Regarding the formulation of the asthma remission measure, we cannot confirm that a greater than 6 month period of symptom remission without medication occurred due to the wording of the questions in the YRBS. Thus, some respondents considered in our analyses to have entered asthma remission may not meet the clinical definition for this diagnosis. The term “asthma remission” has been used by many previous cross-sectional studies without a defined period of symptom remission.¹⁸ Additionally, the clinical definition of asthma remission is imprecise, with periods of no symptoms ranging from 6 months to 5 years to be considered in remission.^{17,18} The term “current asthma” has been used previously in epidemiological literature; however, current asthma studies use a different methodological approach.^{41–43} Studies using the term current asthma include respondents who have never had lifetime asthma. Thus, the term current asthma is in response to among the general population, how many youths have had asthma and still do. These studies estimate between 10–15% of youth have current asthma. Our study, however, along with other cross-sectional studies of asthma remission explore the absence of symptoms among lifetime asthmatics.¹⁸ Thus, the term asthma remission is in response to among people who have had asthma, how many of them no longer have asthma. The literature have estimated between 33% to 53% of youth asthmatics under 18 years have entered asthma remission, in line with our present estimate of 33.3%. Additionally, for adults with non-remitting asthma that began before age 16 years, the mean age of onset is at 7 years which is well below the age of the present analytic sample.⁴⁴

Informing Clinical Practice and Asthma Management Guidelines

Asthma, unlike chronic conditions such as diabetes or cardiovascular disease, is not responsive to primary prevention or early intervention.⁴⁵ However, similar to other chronic conditions, there are notable population-level health disparities impacting SM/REM populations.⁴⁶ Despite the well-documented disparities, clinical guidelines of chronic conditions often do not include their mention.^{47–50} Included are the most referenced clinical guidelines for asthma—the Global Initiative for Asthma (GINA) and the Expert Panel Report (EPR) 3 Guidelines from the National Heart, Lung, and Blood Institute (NHLBI) published in 2007—which do not include considerations of the health inequalities among sexual or racial/ethnic minority populations.^{49,50} These considerations are similarly omitted from the recent focused updates to the EPR-3.^{51,52} Accordingly, we recommend GINA and future EPRs to include a section in their upcoming guidelines for the established disparities in asthma outcomes by marginalized status. The effects of structural issues such as stigmatization, discrimination, and oppression of marginalized persons on health disparities must be conceptualized by providers to begin combating their effects. To realize this goal, we recommend clinical asthma guidelines to include further research on the relation between social determinants of health, structural-level factors, and health disparities.⁵³ The guidelines should specifically encourage health systems and providers to implement the National Standard for Culturally and Linguistically Appropriate Services (CLAS) in Health and Health Care from the U.S. Department of Health and Human Services.⁵⁴ GINA and the EPR should consider adding the stigmatization of SM/REM populations to be assessed and addressed along with environmental factors, education, and comorbidities in the management of asthma.^{49,51} Further, culturally-tailored asthma practices from the peer-reviewed literature predominantly focus on race/ethnicity.^{55–62} We

posit the need for the development of culturally-tailored asthma interventions for SM/REM youth; hence, these guidelines must be expanded to also include sexual identity and the impacts of multiple-marginalization.

Along with additional considerations for clinical asthma guidelines, we encourage providers, researchers, and health care systems to adopt a systematic approach for identifying and ameliorating disparities on the basis of marginalization.^{24,25,53} Such approaches include the examination of culturally-tailored interventions designed to impact health systems and patient- provider interaction, as well as ways to increase provider conceptualization of the structural issues at hand.

Limitations

The present study is not without limitations. All data were self-reported, and secondary data analyses of a cross-sectional dataset do not allow for any commentary on causality or control over the questions asked. Moreover, the “not sure” response to sexual identity could have meant students were unsure of the question—not necessarily that they were unsure of their sexual identity. The YRBS only includes adolescents who attend high school; results may not be representative of students who are home-schooled or do not attend school. The use of clinician-diagnosed asthma could have led to an underestimation of asthma among marginalized youth populations, as engaging with physicians to receive a diagnosis is less likely among these groups.⁶³ The asthma remission variable had to be constructed using self-report measures with no specific time period mentioned, which could have introduced symptom perception bias.¹⁸ As most remission occurs between the ages of 14 and 21 years of ages and our sample falls toward the early part of this range, there could be an underestimation of asthma remission.¹⁹ Moreover, due to wording of the asthma questions, we cannot define the length of symptom remission or medication use. Thus, some respondents considered to have enter remission in the present study may not meet the clinical definition.

Adjusting for all known traditional correlates was also not possible.¹⁸ The small sample size of many sub-populations likely contributed to their not reaching significance. Specifically, the sample size for Black not sure males was fewer than 30 individuals and should be interpreted with caution.⁶⁴ Finally, we used SM/REM youth sub-populations as proxies for intersectional oppression. Despite these limitations, our study is the first to explore and introduce inequalities in asthma remission by sexual identity and at the intersections of sexual identity and race/ethnicity. Our study is also the first to frame remission based on MST and intersectionality frameworks, which are critical to population health studies. Finally, we identified potential factors for non-remitting asthma among male and female SM/REM youth and, for the first time, suggested the role that victimization may play.

In total, asthma remission disparities exist by sexual identity, race/ethnicity, or both with those of marginalized status generally being more likely to experience non-remitting asthma. Viewed through the lens of intersectionality and MST, our findings provide empirical support that victimization may be associated with asthma non-remission. The construction of an asthma remission variable allowed for an innovative and comprehensive examination of the disparity subpopulations and correlates of non-remitting asthma among U.S. youth.

Correlates such as being cyberbullied or BMI_p>95% for males and being bullied or forced to engage in sex for females may partly explain the disparities in asthma remission observed in our study. The present study, along with previously published literature on asthma prevalence and remission disparities experienced by marginalized persons, should be used to set a research agenda designed to improve asthma management.^{1,7–16,18}

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Abbreviations:

(CDC)	Centers for Disease Control and Prevention
(SM/REM)	Sexual Minority and/or Racial/Ethnic Minority
(YRBS)	Youth Risk Behavior Survey
(BMI_p)	Body Mass Index Percentile
(GINA)	Global Initiative for Asthma
(NHLBI)	National Heart, Lung, and Blood Institute
(EPR)	Expert Panel Report

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HIGHLIGHTS BOX**1. What is already known about this topic?**

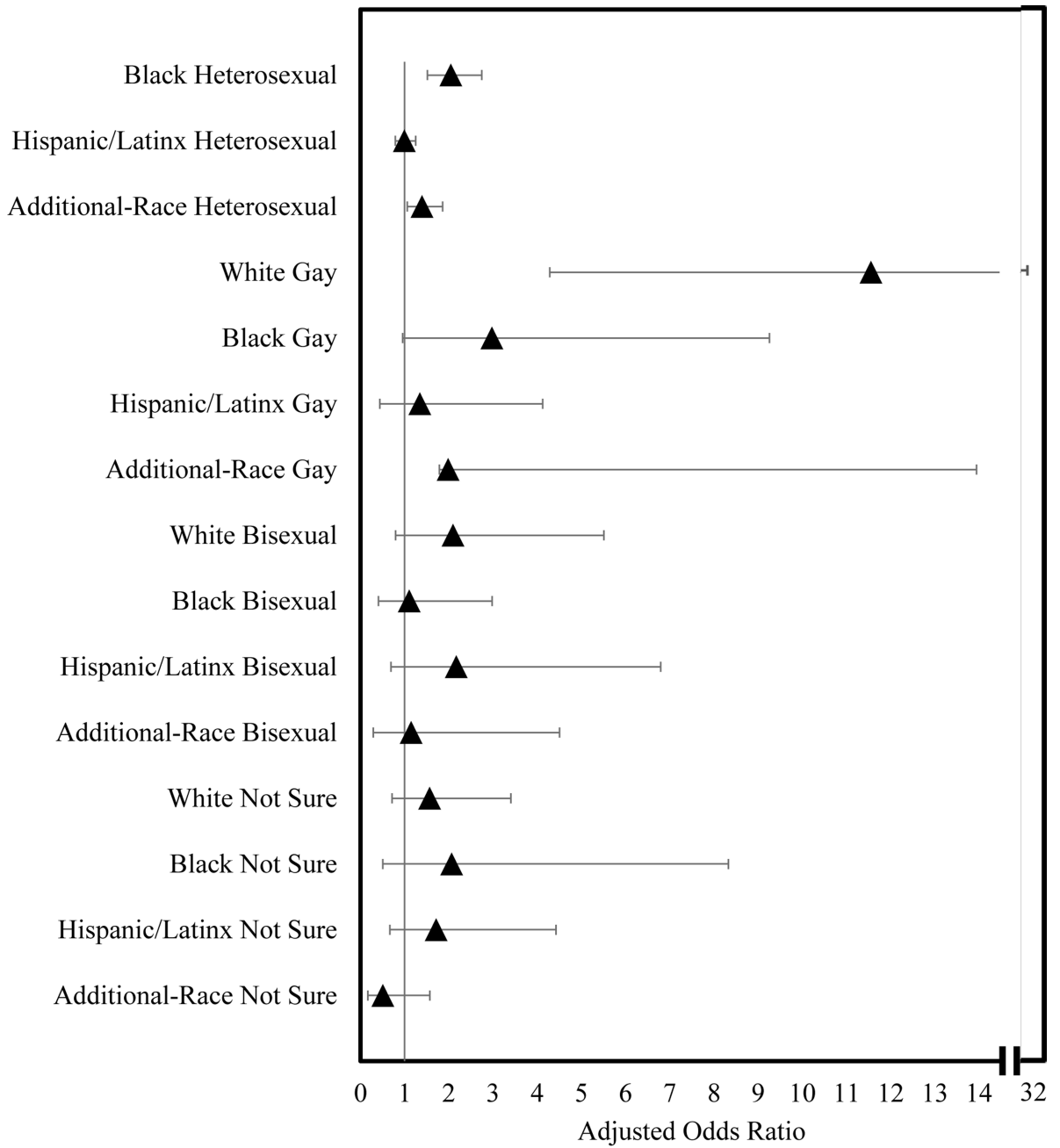
1.1. There are reported disparities in asthma remission by sex and race/ethnicity. Asthma remission negatively associates with asthma severity, smoking, and increased weight. Minority stress theory and intersectionality are imperative frameworks to study population health.

2. What does this article add to our knowledge?

2.1 Sexual minority and/or racial/ethnic minority youth tend to be at higher risk for non-remitting asthma. Traditional risk factors and victimization are associated with increased odds of non-remitting asthma among these populations.

3. How does this study impact current management guidelines

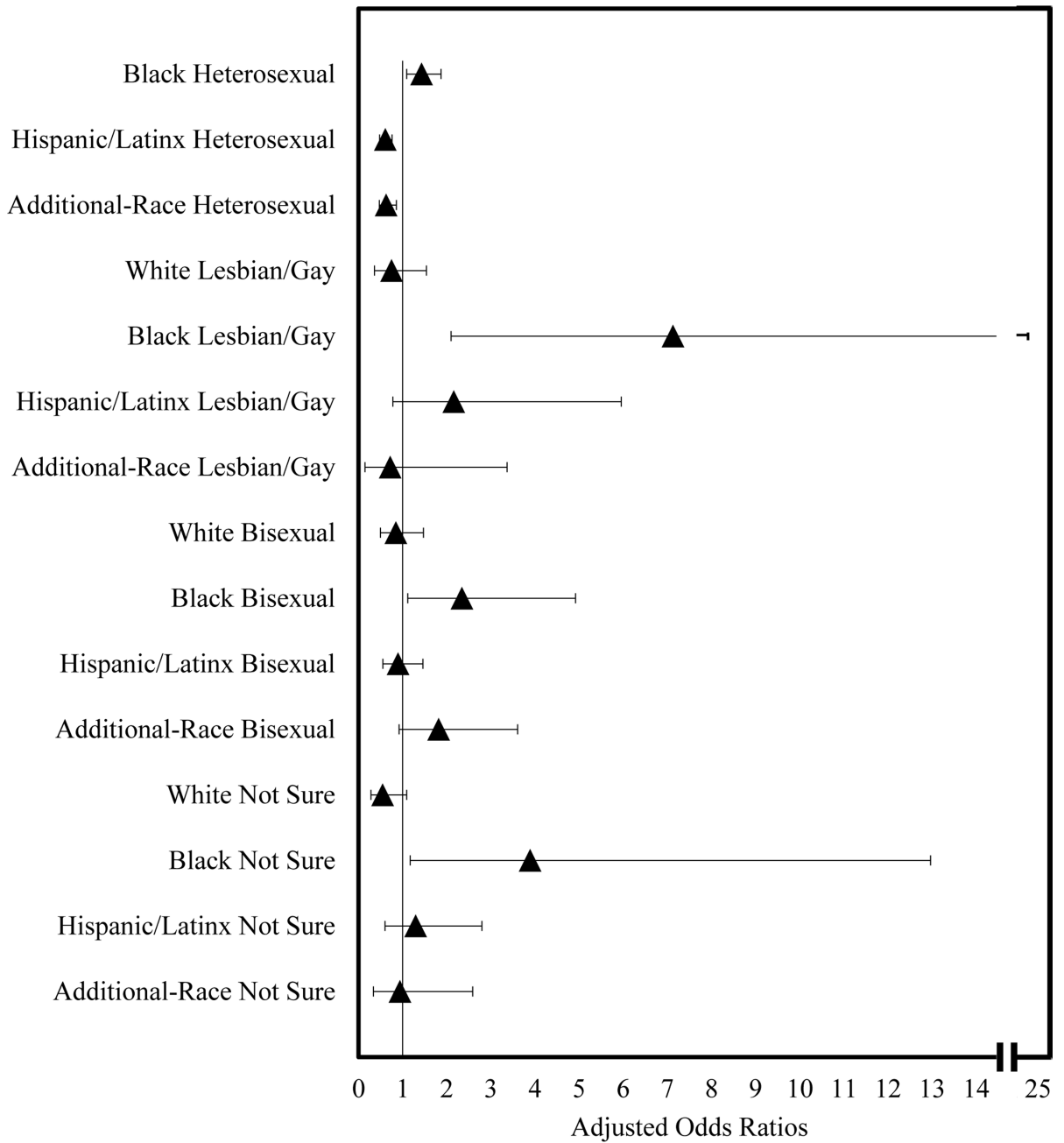
3.1. Asthma management guidelines should include population-level disparities on the basis of marginalization. Clinicians should stay up-to-date on cultural responsiveness training and implement the National Standard for Culturally and Linguistically Appropriate Services (CLAS) in practice.



▲ Non-remitting

Figure 1. Non-remitting Asthma Forest Plot Odds Ratios for SM/REM vs White Heterosexual Male Youths.

Forest Plot of Table IV Model I. Model is adjusted for year of survey administration, age, and region.



▲ Non-remitting

Figure 2. Non-remitting Asthma Forest Plot Odds Ratios for SM/REM vs White Heterosexual Female Youths.

Forest Plot of Table V Model I. Model is adjusted for year of survey administration, age, and region.

Table I:

Measures, Question Wording, Response Options, and Classification, YRBS, 2009–2017

Measures	Question Wording, Response Options, and Classification
Demographics	
<i>Sex</i>	Assessed by asking participants, “ <i>What is your sex?</i> ” Response options: male and female.
<i>Sexual Identity (SI)</i>	Assessed by asking participants, “ <i>Which of the following best describes you?</i> ” Response options: heterosexual (straight); gay or lesbian; bisexual; and not sure.
<i>Race/Ethnicity (RE)</i>	Participants were asked if they identified as Hispanic or Latino (yes or no) and to then select all races that applied to them: American Indian or Alaska Native; Asian; Black or African American; Native Hawaiian or Other Pacific Islander; and White. For our analyses, these were joined into 4 racial/ethnic groups: White; Black; Hispanic; and an Additional-race (including multiple-races).
<i>SM/REM Sub-Populations</i>	Participants who responded to both sexual identity and race/ethnicity questions were placed into 1 of 16 categories—a combination of (1) heterosexual; (2) gay or lesbian; (3) bisexual; and (4) not sure with (1) White; (2) Black; (3) Hispanic/Latinx; and (4) additional-race.
<i>Age</i>	Assessed by asking participants, “ <i>How old are you?</i> ” Response options ranged from 12 to 18 years old. Students selecting between 12 and 14 years old options were collapsed into “14 years old or younger.”
<i>Region</i>	Assessed by grouping jurisdictions together based on U.S. Census regions: Northeast; Midwest; South; and West.
Traditional Non-remitting Asthma Correlates¹⁸	
<i>Obese and Overweight</i>	Respondents were classified as obese or overweight based on body-mass index (BMI) calculated using participant-reported age, sex, height, and weight. Individuals with a BMI ≥95 th percentile were classified as obese, while individuals with a BMI ≥85 th percentile and <95 th percentile were classified as overweight. ⁶⁵
<i>Smoking Status</i>	Participants were first asked, “ <i>Have you ever tried cigarette smoking, even one or two puffs?</i> ” Response options: yes and no. Students responding no were classified as (1) never smoked. Participants were then asked, “ <i>During the past 30 days, on how many days did you smoke cigarettes?</i> ” Response options ranged from 0 to 30 days. Students who selected yes to the first question and 0 days to the second were classified as (2) former smoker; those selecting yes to the first and more than 0 days to the second were classified as (3) current smoker.
Victimization Indicators	
<i>Bullied</i>	Assessed by asking participants, “ <i>During the past 12 months, have you ever been bullied on school property?</i> ” Response options: yes and no.
<i>Cyberbullied</i>	Assessed by asking participants, “ <i>During the past 12 months, have you ever been electronically bullied? (Include being bullied through e-mail, chat rooms, instant messaging, Web sites, or texting.)</i> ” Response options: yes and no.
<i>Forced Sex</i>	Assessed by asking “ <i>Have you ever been physically forced to have sexual intercourse when you did not want to?</i> ” Response options: yes and no.

Table II

Participant Demographics and Non-remitting Asthma among High School Youth, YRBS, 2009–2017

	Total		Male		Female	
	n	%	n	%	n	%
Demographics	21,789	--	10,323	49.21	11,466	50.79
<i>Sexual Identity (SI)</i>						
Heterosexual	19,076	87.43	9,521	92.62	9,555	82.41
Lesbian/Gay	533	2.43	236	1.93	297	2.92
Bisexual	1,494	6.91	282	2.54	1,212	11.15
Not Sure	686	3.22	284	2.91	402	3.52
<i>Race/Ethnicity (RE)</i>						
White	11,100	51.15	5,198	50.98	5,902	51.31
Black	2,920	24.02	1,376	23.91	1,544	24.12
Hispanic/Latinx	4,105	17.73	1,944	17.97	2,161	17.5
Additional-Race	3,664	7.10	1,805	7.14	1,859	7.07
<i>Age, years</i>						
14 or younger	2,941	10.55	1,342	10.63	1,599	10.47
15	5,627	24.89	2,637	25.03	2,990	24.76
16	5,732	26.98	2,762	26.93	2,970	27.04
17	5,077	24.14	2,363	22.83	2,714	25.1
18 or older	2,412	13.44	1,219	14.58	1,193	12.33
<i>Region</i>						
Northeast	9,306	5.49	4,354	5.48	4,952	5.5
Midwest	3,169	32.52	1,469	31.58	1,700	33.43
South	4,928	51.90	2,376	52.81	2,552	51.01
West	4,386	10.09	2,124	10.13	2,262	10.05
SI and RE Intersections						
<i>Heterosexual</i>						
White	9,906	45.52	4,871	47.95	5,035	42.97
Black	2,546	20.88	1,265	22.03	1,281	19.76
Hispanic/Latinx	3,484	15.17	1,757	16.27	1,727	14.1
Additional-Race	3,140	5.97	1,628	6.37	1,512	5.58
<i>Lesbian/Gay</i>						
White	208	0.92	89	0.65	119	1.19
Black	103	0.8	41	0.56	62	1.04
Hispanic/Latinx	124	0.55	54	0.56	70	0.55
Additional-Race	98	0.16	52	0.17	46	0.14
<i>Bisexual</i>						
White	691	3.14	116	0.92	575	5.3
Black	184	1.74	42	0.86	142	2.59
Hispanic/Latinx	339	1.34	63	0.37	276	2.28
Additional-Race	280	0.69	61	0.39	219	0.98

	Total		Male		Female	
	n	%	n	%	n	%
<i>Not Sure</i>						
White	295	1.66	122	1.47	173	1.86
Black	87	0.6	28	0.47	59	0.73
Hispanic/Latinx	158	0.67	70	0.77	88	0.58
Additional-Race	146	0.28	64	0.21	82	0.36
OUTCOME						
<i>Non-remitting Asthma</i>						
Yes	14,849	66.71	6,323	59.5	8,526	73.69
No	6,940	33.29	4,000	40.5	2,940	26.31

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Table III:

Prevalence and Unadjusted Odds Ratios for Non-remitting Asthma by Sexual Identity (SI), Race/Ethnicity (RE), and their Intersections, YRBS, 2009–2017.

	Non-remitting Asthma (weighted %)	Male			Non-remitting Asthma (weighted %)	Female		
		N/Total	OR	95% CI		N/Total	OR	95% CI
Selected Demographics								
<i>Sexual Identity</i>								
Heterosexual	58.80	5776/9521	REF	--	73.19	7026/9555	REF	--
Lesbian/Gay	78.63	162/236	2.71	(1.51, 4.84)	80.66	236/297	1.37	(0.87, 2.18)
Bisexual	63.68	192/282	1.17	(0.66, 2.06)	75.84	956/1212	1.09	(0.78, 1.52)
Not Sure	65.39	193/284	1.48	(0.85, 2.58)	72.72	308/402	0.99	(0.61, 1.61)
<i>Race/Ethnicity</i>								
White	55.94	3159/5198	REF	--	73.68	4471/5902	REF	--
Black	69.44	949/1376	1.80	(1.38, 2.34)	81.14	1237/1544	1.52	(1.20, 1.92)
Hispanic/Latinx	55.37	1127/1944	0.97	(0.80, 1.17)	65.68	1483/2161	0.68	(0.56, 0.83)
Additional-Race	62.06	1088/1805	1.30	(1.01, 1.69)	68.18	1335/1859	0.81	(0.61, 1.06)
<i>Age, years</i>								
14 or younger	68.46	898/1342	REF	--	76.96	1215/1599	REF	--
15	60.07	1681/2637	0.86	(0.63, 1.16)	74.09	2247/2990	0.86	(0.63, 1.16)
16	59.50	1680/2762	0.93	(0.68, 1.26)	75.61	2217/2970	0.93	(0.68, 1.26)
17	56.91	1388/2363	0.79	(0.59, 1.05)	72.41	1980/2714	0.79	(0.59, 1.05)
18 or older	56.07	676/1219	0.65	(0.46, 0.93)	68.52	867/1193	0.65	(0.46, 0.93)
<i>Region</i>								
Northeast	63.04	2758/4353	REF	--	76.48	3811/4952	REF	--
Midwest	62.58	943/1469	0.98	(0.82, 1.17)	76.05	1313/1700	0.98	(0.82, 1.16)
South	57.18	1367/2376	0.78	(0.67, 0.92)	72.01	1798/2552	0.79	(0.67, 0.94)
West	60.1	1255/2124	0.88	(0.70, 1.12)	72.83	1604/2262	0.82	(0.67, 1.01)
SI and RE Intersections								
<i>Heterosexual</i>								
White	54.82	2922/4871	REF	--	74.62	3790/5035	REF	--
Black	69.75	876/1265	1.94	(1.48, 2.54)	79.36	1012/1281	1.27	(0.98, 1.64)
Hispanic/Latinx	50.24	999/1757	0.97	(0.79, 1.18)	63.41	1156/1727	0.58	(0.46, 0.72)
Additional-Race	62.62	979/1628	1.40	(1.07, 1.83)	65.10	1068/1512	0.66	(0.49, 0.88)
<i>Lesbian/Gay</i>								
White	93.36	68/89	17.65	(6.98, 44.67)	67.7	93/119	0.60	(0.31, 1.16)
Black	76.77	28/41	2.67	(0.98, 7.24)	95.07	55/62	7.07	(2.01, 24.77)
Hispanic/Latinx	61.31	33/54	1.20	(0.46, 3.14)	84.86	53/70	1.79	(0.63, 5.11)
Additional-Race	85.61	33/52	4.79	(1.74, 13.18)	67.89	35/46	0.75	(0.17, 3.38)
<i>Bisexual</i>								
White	71.44	76/116	1.95	(0.76, 5.01)	71.21	456/575	0.77	(0.46, 1.29)
Black	55.40	28/42	0.95	(0.35, 2.63)	86.04	118/142	2.03	(1.03, 4.01)

	Non-remitting Asthma (weighted %)	Male			Non-remitting Asthma (weighted %)	Female		
		N/Total	OR	95% CI		N/Total	OR	95% CI
Hispanic/Latinx	71.83	44/63	1.80	(0.61, 5.32)	71.58	211/276	0.83	(0.52, 1.34)
Additional-Race	56.00	44/61	1.01	(0.33, 3.15)	83.76	171/219	1.84	(0.92, 3.68)
<i>Not Sure</i>								
White	66.27	93/122	1.86	(0.83, 4.15)	62.94	132/173	0.57	(0.29, 1.14)
Black	71.80	17/28*	1.61	(0.39, 6.71)	91.94	52/59	3.52	(0.96, 12.92)
Hispanic/Latinx	67.44	51/70	2.16	(0.91, 5.16)	79.42	63/88	1.45	(0.66, 3.19)
Additional-Race	36.87	32/53	0.61	(0.19, 1.98)	73.41	61/82	0.91	(0.34, 2.42)
Selected Variables								
<i>Smoking Status</i>								
Never smoked	61.39	2265/3629	REF	--	75.18	3199/4274	REF	--
Former smoker	59.66	673/1134	0.93	(0.70, 1.24)	79.71	1047/1366	1.30	(1.01, 1.66)
Current smoker	58.78	448/705	0.90	(0.65, 1.25)	79.46	542/685	1.28	(0.83, 1.96)
<i>Obese</i>								
Yes	64.07	1232/1893	1.29	(1.03, 1.61)	77.51	1019/1288	1.28	(0.95, 1.72)
No	58.08	4730/7882	REF	--	72.97	6891/2473	REF	--
<i>Overweight</i>								
Yes	55.87	931/1563	0.85	(0.67, 1.08)	74.46	1479/1967	1.06	(0.83, 1.35)
No	59.82	5031/8212	REF	--	73.35	6431/8685	REF	--
<i>Bullied</i>								
Yes	64.34	1261/1868	1.29	(1.03, 1.62)	79.55	2199/2754	1.54	(1.23, 1.92)
No	58.3	4937/8258	REF	--	71.65	6153/8494	REF	--
<i>Cyberbullied</i>								
Yes	65.25	699/1017	1.34	(0.95, 1.88)	78.28	1818/2295	1.39	(1.10, 1.76)
No	58.34	4602/7736	REF	--	72.12	5348/7362	REF	--
<i>Forced Sex</i>								
Yes	65.93	381/524	1.30	(0.88, 1.90)	79.97	990/1244	1.49	(1.13, 1.97)
No	59.9	4912/8026	REF	--	72.82	6016/8149	REF	--

Boldface indicates statistical significance (p<0.05)

* Analyses performed with small sub-population

Table IV:

Stepwise Adjusted Odds Ratios for Non-remitting Asthma by Sexual Identity (SI) and Race/Ethnicity (RE) Intersections among Males, YRBS, 2009–2017.

	Model I: Demographics N = 10,323			Model II: Model I + Selected Factors N = 8,293		
	n	AOR	95% CI	n	AOR	95% CI
SI and RE Intersections						
<i>Heterosexual</i>						
White	4871	REF	--	4871	REF	--
Black	1265	2.05	(1.52,2.75)	1265	2.01	(1.47, 2.75)
Hispanic/Latinx	1757	1.00	(0.79,1.25)	1757	1.02	(0.80, 1.31)
Additional-Race	1628	1.40	(1.06,1.86)	1628	1.44	(1.04, 2.00)
<i>Gay</i>						
White	89	11.56	(4.29,31.14)	89	11.09	(3.58, 34.38)
Black	41	2.98	(0.96,9.26)	41	2.95	(0.66, 13.14)
Hispanic/Latinx	54	1.35	(0.44,4.13)	54	1.03	(0.37, 2.85)
Additional-Race	52	1.99	(1.79,13.95)	52	3.06	(1.00, 9.39)
Bisexual						
White	116	2.10	(0.80,5.51)	116	2.64	(0.91, 7.70)
Black	42	1.11	(0.41,2.98)	42	1.11	(0.36, 3.41)
Hispanic/Latinx	63	2.17	(0.69,6.80)	63	1.96	(0.45, 8.53)
Additional-Race	61	1.15	(0.29,4.51)	61	1.08	(0.21, 5.50)
<i>Not Sure</i>						
White	122	1.57	(0.72,3.41)	122	1.3	(0.59, 2.88)
Black	28*	2.07	(0.51,8.33)	28*	1.23	(0.23, 6.66)
Hispanic/Latinx	70	1.72	(0.67,4.43)	70	1.65	(0.52, 5.22)
Additional-Race	64	0.51	(0.17,1.57)	64	0.93	(0.26, 3.35)
Selected Demographics *						
<i>Region</i>						
Northeast	4354	REF	--	4354	REF	--
Midwest	1469	0.92	(0.77,1.11)	1469	1.05	(0.84, 1.31)
South	2379	0.66	(0.54,0.82)	2379	0.73	(0.58, 0.91)
West	2124	0.81	(0.62,1.06)	2124	0.74	(0.56, 0.99)
Selected Variables						
<i>Cyberbullied</i>						
Yes	--	--	--	1017	1.39	(0.96, 2.02)
No	--	--	--	7736	REF	--
<i>Obese</i>						
Yes	--	--	--	1893	1.31	(1.02, 1.68)
No	--	--	--	7882	REF	--

Models were also adjusted for year of survey administration and age of respondent

Boldface indicates statistical significance (p<0.05)

* Analyses performed with small sub-population

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Table V:

Stepwise Adjusted Odds Ratios for Non-remitting Asthma by Sexual Identity (SI) and Race/Ethnicity (RE) Intersections among Females, YRBS, 2009–2017.

	Model I: Demographics N = 11,466			Model II: Model I + Selected Factors N = 9,206		
	n	AOR	95%CI	n	AOR	95%CI
SI and RE Intersections						
<i>Heterosexual</i>						
White	5035	REF	--	5035	REF	--
Black	1281	1.43	(1.09,1.87)	1281	1.31	(0.99, 1.73)
Hispanic/Latinx	1727	0.61	(0.48,0.76)	1727	0.57	(0.45, 0.73)
Additional-Race	1512	0.63	(0.47,0.86)	1512	0.63	(0.45, 0.88)
<i>Lesbian/Gay</i>						
White	119	0.75	(0.36,1.54)	119	0.32	(0.14, 0.72)
Black	62	7.13	(2.10,24.17)	62	4.62	(1.18, 18.08)
Hispanic/Latinx	70	2.16	(0.78,5.96)	70	1.32	(0.49, 3.51)
Additional-Race	46	0.72	(0.15,3.37)	46	3.79	(0.88, 16.34)
Bisexual						
White	575	0.85	(0.50,1.47)	575	0.55	(0.28, 1.08)
Black	142	2.35	(1.12,4.92)	142	2.02	(0.86, 4.75)
Hispanic/Latinx	276	0.90	(0.55,1.46)	276	0.66	(0.39, 1.10)
Additional-Race	219	1.82	(0.92,3.61)	219	1.70	(0.71, 4.05)
<i>Not Sure</i>						
White	173	0.55	(0.28,1.09)	173	0.38	(0.16, 0.91)
Black	59	3.89	(1.17,12.97)	59	3.52	(0.84, 14.71)
Hispanic/Latinx	88	1.30	(0.60,2.80)	88	1.05	(0.46, 2.41)
Additional-Race	82	0.94	(0.34,2.59)	82	1.53	(0.57, 4.13)
Selected Demographics*						
<i>Region</i>						
Northeast	4952	REF	--	4952	REF	--
Midwest	1700	0.94	(0.78,1.13)	1700	0.97	(0.78, 1.20)
South	2552	0.71	(0.56,0.89)	2552	0.73	(0.55, 0.95)
West	2262	0.95	(0.75,1.20)	2262	0.81	(0.62, 1.07)
Selected Variables						
<i>Bullied</i>						
Yes	--	--	--	2754	1.49	(1.16, 1.92)
No	--	--	--	8494	REF	--
<i>Forced Sex</i>						
Yes	--	--	--	1244	1.53	(1.10, 2.13)
No	--	--	--	8149	REF	--

Models were also adjusted for year of survey administration and age of respondent

Boldface indicates statistical significance (p<0.05)