

Demographic Disparities in Asthma Prevalence: A Focus on Gender, Socioeconomic Status, and Geographical Regions in the United States

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Abstract

Background: In the United States (US), the prevalence of asthma among adults is approximately 7.6%, but rates vary dramatically among different ethnic groups. In the US, asthma results in 439,000 hospitalizations, and more than 3,500 people die of asthma each year.

Objective: To assess factors associated with asthma among adults aged 18 years and older in the US.

Methods: Data were analyzed from the 2021 Behavioral Risk Factor Surveillance System (N=97,414). Bivariate and multivariable logistic regression analyses were conducted to assess factors associated with self-reported asthma. Analyses were conducted using SAS version 9.4.

Results: In 2021, the overall prevalence of asthma in US adults was 10.2%. After adjusting for sociodemographic and region of residence variables, factors associated with higher odds of reporting current asthma include being female (AOR=1.90; 95% CI=1.85, 1.95), being non-Hispanic Black (AOR=1.05; 95% CI=1.01, 1.10), American Indian or Alaska Native Non-Hispanic (AOR=1.10; 95% CI=1.01, 1.19), having grades 9 through 11 (some high school) level of education (AOR=1.24; 95% CI=1.17, 1.32), having college 1 year to 3 years (Some college or technical school) level of education (AOR=1.07; 95% CI=1.04, 1.10), and having low annual household income. Furthermore, as compared with respondents from the Midwest region of the U.S., those from the North (AOR=1.23; 95% CI=1.19, 1.27) and West (AOR=1.11; 95% CI=1.07, 1.15) had higher odds of reporting asthma.

Conclusion: Current asthma prevalence was highest among males, low income and education, and residents in the US-North and Western regions. Primary asthma prevention measures should focus on the populations at risk of developing asthma. Further research is needed on the role of exposure to certain environmental elements, which puts people at the most significant risk of developing asthma.

Keywords: Disparities, prevalence, asthma, adults, United States

1. INTRODUCTION

Asthma is a chronic respiratory disease that causes inflammation and narrowing of the airways, resulting in difficulty breathing, coughing, and wheezing[1]. It affects 26.5 million people in the United States (U.S.)[2]. In the U.S., each year, asthma accounts for more than 439,000 hospitalizations, 1.7 million emergency department visits, and 13.8 million missed school days[3]. Asthma costs the U.S. economy more than \$80 billion annually in medical expenses, days missed from work and school, and deaths[4].

Although the incidence of asthma in the United States has been increasing across all ages, sexes,

and races, disparities in asthma hospitalizations and mortality by race/ethnicity have been reported [5]. Compared to all other races, non-Hispanic Blacks disproportionately bear a greater burden of asthma. For example, in 2019, non-Hispanic Blacks were 30 percent more likely to have asthma than non-Hispanic Whites[6]. In 2020, non-Hispanic Blacks were almost three times more likely to die from asthma-related causes than the non-Hispanic White population, and non-Hispanic Black children had a death rate eight times that of non-Hispanic White children[6]. Furthermore, in 2019, non-Hispanic black children were 4.5 times more likely to be admitted to the hospital for asthma as compared to non-Hispanic white children[6]. The burden of asthma is also high among the Hispanic population. A study shows that 13.5% and 7.5% of non-Hispanic Black and Hispanic children, respectively, currently have asthma compared to 6.4% of non-Hispanic White children[7]

A gender disparity is well-established in asthma and changes throughout life[8]. Male children are more likely to have asthma than female children (11.9% vs. 7.5%, respectively)[9], and male children are also twice as likely as female children to be hospitalized for an asthma exacerbation [10]. This trend reverses in adulthood, where female adults are more likely to have asthma than male adults. By adulthood, women have increased asthma prevalence compared to men (9.6% versus 6.3%. respectively) [9, 11], and women are three times more likely than men to be hospitalized for an asthma-related event [12-14]. A study [15] suggests this shift in asthma prevalence based on gender is because of the effects of testosterone on lung cells. Testosterone, a male sex hormone, has been found change pathways associated with asthma pathogenesis, and to decrease the swelling of the airways in asthma [15].

Previous studies have shown an association between low-socioeconomic status (SES), which has traditionally been reported with education, income, and occupation [16], and higher prevalence of asthma [17-19]. In the U.S., the current rate of asthma among children living below the poverty threshold is estimated at 11% compared with 7.7% to 8.5% among those not living in poverty threshold [16]. Low socioeconomic status has been associated with the increased exposure to air pollution which in turn lead to a greater risk of asthma as well as asthma hospitalization in children [20].

In addition to SES disparities, there are also significant regional disparities in the prevalence of asthma in the United States. Overall, the prevalence of asthma was higher in the Northeast (8.9%) than in the South (7.6%) and the West (7.7%); among adults, the current asthma prevalence was higher in the Northeast (8.8%) than in the South (7.4%) [21]. While the exact causes of asthma are not fully understood, it is known that certain genetic and environmental factors can trigger asthma attacks. Common triggers of asthma include allergens such as dust mites, and pollen, as well as irritants such as tobacco smoke, air pollution on, chemical; overweight weight, and obesity can contribute to asthma [22].

With an increasing burden of asthma over the years, understanding the prevalence and distribution of asthma among different demographic groups is crucial for implementing effective prevention strategies. The objective of this study is to assess regional and socio-demographic disparities in the prevalence of asthma among adults in the United States and discuss implications for primary prevention efforts.

2. METHODS

2.1. Data source

The research utilized data from the 2021 Behavioral Risk Factor Surveillance System (BRFSS), focusing on asthma prevalence rates across different demographic groups and geographical regions. The BRFSS is the nation's leading system of health-related telephone surveys that collects state data from a random sample of noninstitutionalized adult population—aged 18 years or older regarding their health-related risk behaviors and events, chronic health conditions, and use of preventive services annually [23]. The states use a standardized core questionnaire-where some core questions are asked every year (fixed core) and others are asked every other year (rotating core)—optional modules—that states can choose to use according to need-and state-added questions[24]. Because the BRFSS data were both de-identified and publicly available and is used for health policy development and advocacy at both the national and state levels, data use agreements or ethical approval from an institutional review committee was not required for this study. More information about BRFSS can be found at the BRFSS Homepage (https://www.cdc.gov/brfss/)

2.2. Measures

All measures in this study were based on the self-reported data obtained from the 2021 BRFSS.

2.3. Dependent Variable

The prevalence of self-reported asthma was calculated as the proportion of respondents who said "yes" to the question: ""Has a doctor, nurse, or other professional ever told that you had asthma" and "Do you still have asthma?" Possible responses include "yes," "no," "don't know/not sure," or "refused." However, we included only records with "yes" or "no" responses for "ever been told you have had" in the analysis. Records with "don't know/not sure," or "refused." responses or missing data were excluded from the analysis to minimize underestimation.

2.4. Covariates

Control variables included were sociodemographic characteristics (gender, race or ethnicity, age, education, income, and region of residence).

2.5. Statistical Analysis

Initially, we performed a bivariate analysis to assess factors independently associated with selfreported asthma. We included all variables that had achieved $P \le .05$ in the bivariate analysis in our multivariable logistic regression model to estimate the adjusted odds ratios (AORs) and 95% confidence intervals (95% CIs). To account for the possibility of individual characteristics confounding any observed associations, the multivariable logistic regression model was adjusted for sex, race/ethnicity, age, level of education, level of income, and region of residence. A 2-sided P value of $\leq .05$ was considered statistically significant. All statistical analyses were conducted using SAS version 9.4 [25].

3. RESULTS

Table 1 summarizes the demographic and socioeconomic characteristics of the participants by number and percentages about their gender, race or ethnicity, age group, level of education, level of income, and region of residence. Of the 418,105 participants who responded to the question: "Ever told by a doctor, nurse, or other health professional that you had asthma?", 42 660 (10.2%) reported they had asthma, and 375 445 (89.80%) did not report they had asthma. Most of the respondents who had asthma were females (13%), Non-Hispanic Black (34.2%), between the ages of 45 to 64 (22%), had Grades 9 through 11 (Some high school) education (15%), had annual household incomes less than \$25 000 (15.7%), and resided on the North region of the U.S. (Table 1).

Table 1. Number and percentage for self-reported asthma status among adults by select characteristics: 2021Behavioral Risk Factor Surveillance System, United States

Select characteristics	Self-reported	asthma status	Total	P-Value
	Current n (%)	Never n (%)	n (%)	
Overall	42660 (10.2)	375445 (89.8)	418105 (100)	
Gender				<.0001
Female	28877 (13.0)	195824 (87.0)	224701 (100)	
Male	13783 (7.0)	179621 (93.0)	193404 (100)	
Race/Ethnicity				<.0001
White, non-Hispanic	31650 (10.0)	285511 (90.0)	317161 (100)	
Black, non-Hispanic	3812 (12.0)	27720 (88.0)	31532 (100)	
Hispanic	3668 (10.0)	33049 (90.0)	36717 (100)	
Asian, non-Hispanic	646 (6.0)	10405 (94.0)	11051 (100)	
American Indian or Alaska Native, non-Hispanic	938 (13.4)	6063 (86.6)	7001 (100)	
Other	1946 (13.3)	12697 (86.7)	14643 (100)	
Age Group				<.0001
18-24	2828 (12.0)	20935 (88.0)	23763 (100)	
25-34	4731 (10.7)	39319 (89.3	44050 (100)	
35-44	5820 (10.5)	49721 (89.5)	55541 (100)	
45-54	7207 (11.0)	57879 (89.0)	65086 (100)	
55-64	8842 (11.0)	71012 (89.0)	79854 (100)	
≥65	13232 (9.0)	136579 (91.0)	149811 (100)	
Level of Education <.00				
Never attended school or only kindergarten	41 (7.0)	543 (93.0)	584 (100)	
Grades 1 through 8 (Elementary)	825 (10.4)	7099 (89.6)	7924 (100)	
Grades 9 through 11 (Some high school)	2393 (15.0)	13851 (85.0)	16244 (100)	
Grade 12 or GED (High school graduate)	10581 (10.0)	95997 (90.0)	106578 (100)	
College 1 year to 3 years (Some college or technical school)	12953 (11.3)	101250 (88.7)	114203 (100)	
College 4 years or more (College graduate)	15695 (9.2)	154631 (90.8)	170326 (100)	
level of Income	• • • •	• • • •	•	<.0001
Less than \$24,999	8709 (15.7)	4684 (84.3)	55549 (100)	
\$25,000 to \$49,99	9406 (10.7)	78502 (89.3)	87908 (100)	
\$50,000 to \$74,99	5202 (9.2)	51588 (90.8)	56790 (100)	

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\$75,000 to \$99,99	3967 (8.7)	41726 (91.3)	45693 (100)	
\$100,000 to \$149,99	3851 (8.5)	41651 (91.5)	45502 (100)	
\$150,000 or more	2884 (7.8)	34092 (92.2)	36976 (100)	
Region of Residence				<.0001
Midwest	11539 (9.5)	109752 (90.5)	121291 (100)	
Northeast	10733 (11.3)	84537 (88.7)	95270 (100)	
South	6166 (9.5)	58643 (90.5)	64809 (100)	
West	9416 (10.2)	82513 (89.7)	91929 (100)	

After adjusting for socio-demographic and region of residence variables, factors associated with higher odds of reporting current asthma include being male (AOR=1.90; 95% CI=1.85, 1.95), being non-Hispanic Black (AOR=1.05; 95% CI=1.01, 1.10), American Indian or Alaska Native Non-Hispanic (AOR=1.10; 95% CI=1.01, 1.19), having grades 9 through 11 (some high school) level of education (AOR=1.24; 95%

CI=1.17, 1.32), having college 1 year to 3 years (Some college or technical school) level of education (AOR=1.07; 95% CI=1.04, 1.10), and having low annual household income. Furthermore, as compared with respondents from the Midwest region of the U.S., those from the North (AOR=1.23; 95% CI=1.19, 1.27) and West (AOR=1.11; 95% CI=1.07, 1.15) had higher odds of reporting asthma.

Table 2. Adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) for factors associated with self-reported current asthma by select characteristics: 2021 Behavioral Risk Factor Surveillance System, United States

Select characteristics	Self-report (Current a	P-Value						
	AOR	95%CI						
Gender								
Male		Ref						
Female	1.90	1.85-1.95	<.0001					
Race/Ethnicity								
White, non-Hispanic		Ref						
Black, non-Hispanic	1.05	1.01-1.10	0.0441					
Hispanic	0.78	0.75-0.82	<.0001					
Asian, non-Hispanic	0.56	0.51-0.62	<.0001					
American Indian or Alaska Native, non-Hispanic	1.10	1.01-1.19	0.0331					
Age Group								
18-24		Ref						
25-34	0.96	0.90-1.02	0.1764					
35-44	0.93	0.87-0.97	0.0158					
45-54	1.00	0.94-1.06	0.9231					
55-64	0.91	0.86-0.97	0.0022					
≥65	0.68	0.65-0.72	<.0001					
Level of Educat	ion							
Never attended school or only kindergarten	0.69	0.44-1.02	0.0785					
Grades 1 through 8 (Elementary)	0.87	0.78-0.96	0.0055					
Grades 9 through 11 (Some high school)	1.24	1.17-1.32	<.0001					
Grade 12 or GED (High school graduate)	0.89	0.86-0.92	<.0001					
College 1 year to 3 years (Some college or technical school)	1.07	1.04-1.10	<.0001					
College 4 years or more (College graduate)		Ref						
Level of Incom	ie							
Less than \$24,999	2.17	2.06-2.29	<.0001					
\$25,000 to \$49,99	1.45	1.38-1.52	<.0001					
\$50,000 to \$74,99	1.19	1.13-1.26	<.0001					
\$75,000 to \$99,99	1.11	1.06-1.18	<.0001					
\$100,000 to \$149,99	1.06	1.01-1.12	0.0262					
\$150,000 or more		Ref						
Region of Residence								
Midwest		Ref						
North	1.23	1.19-1.27	<.0001					
South	0.96	0.92-0.99	0.0245					
West	1.11	1.07-1.15	<.0001					

4. **DISCUSSION**

Asthma is a multifaceted condition with varying prevalence across different ages and genders. Our findings indicate that females are 90% more likely to report asthma than males. During childhood, asthma prevalence is higher in boys compared to girls; however, in adulthood, women exhibit both increased prevalence and severity of asthma [10, 26-28]. The higher prevalence of asthma in females compared to males in the US can be attributed to a combination of hormonal influences, immune responses, airway development, and socioeconomic and environmental factors [29-31].

For instance, females generally have a more robust immune system, which may contribute to greater susceptibility to allergic a and autoimmune conditions, including asthma [32, 33]. Anatomical and physiological differences also play a role; females often have smaller airways than males, leading to increased airway resistance and decreased airflow, making them more susceptible to asthma triggers such as and irritants[34]. allergens Hormonal fluctuations during the menstrual cycle and pregnancy can also impact asthma symptoms. Some females may experience worsening symptoms during certain phases of their menstrual cycle or during pregnancy[35-37], although the mechanisms by which estrogen signaling regulates airway inflammation, mucus production, and airway hyperreactivity are not fully understood[35]. Further research is needed to elucidate the mechanisms by which sex hormones contribute to the gender disparity in asthma prevalence. Another potential explanation involves gender differences in exposure to indoor allergens and healthcareseeking behaviors. Females may spend more time indoors than males, where pollutant concentrations can be two to five times higher outdoor levels, potentially affecting than health[36]. Additionally, differences in healthcare-seeking behaviors between males and females may influence asthma diagnosis and management, with females more likely to seek medical attention for respiratory symptoms [37].

Our study found that non-Hispanic Black individuals and non-Hispanic American Indian or Alaska Native (AI/AN) individuals had significantly higher odds of reporting current asthma compared to other racial and ethnic groups. These findings are consistent with previously reported disparities and likely result

a combination of environmental. from socioeconomic, structural, and healthcare-related factors. One major contributor is environmental exposure. Minority communities are more likely to reside in areas with higher levels of pollutants, such as traffic-related air pollution, industrial emissions, and indoor allergens like mold, cockroaches, and dust mites. For instance, Krieger et al. (2002) found that African American children living in urban areas had greater exposure to indoor allergens, increasing their risk of developing asthma [38]. Socioeconomic disadvantages are another key factor. Both Black and AI/AN populations experience higher rates of poverty, inadequate housing, and limited access to preventive healthcare services, all of which contribute to asthma prevalence and severity [39]. Additionally, these populations often face barriers to asthma management, including limited access to culturally competent care [40], and a historical mistrust of the healthcare system [41].

Our findings indicate that individuals with lower levels of education (grades 9–11 and 1–3 years of college or technical school) had significantly higher odds of reporting asthma compared to those with higher education levels. Specifically, having grades 9–11 education was associated with an adjusted odds ratio (AOR) of 1.24 (95% CI: 1.17, 1.32), and 1–3 years of college or technical education with an AOR of 1.07 (95% CI: 1.04, 1.10). Additionally, lower household income was also associated with increased asthma prevalence.

The observed association between lower educational attainment, lower income, and increased asthma prevalence may be explained by several interrelated factors. Individuals with lower socioeconomic status (SES)-often proxied by limited education and income-are more likely to reside in substandard housing or densely populated urban areas with heightened exposure to asthma triggers such as mold, air pollution, and dust mites [42, 43]. Additionally, reduced access to healthcare services and preventive care among low-SES populations may lead to poor asthma control and higher rates of symptom reporting [44]. Limited health literacy, more common among individuals with lower educational attainment, may also contribute to suboptimal asthma management, reduced medication adherence, and delayed treatment [45]. Occupational exposures—such as dust, chemicals, and fumes-are another important factor, as individuals with lower education levels are more likely to work in high-risk environments for asthma [46]. These findings align with previous research demonstrating higher asthma prevalence among individuals below the poverty line and among racial/ethnic minorities [45] and further emphasize the role of social determinants in asthma disparities [47]. Bloomberg and Chen [48] similarly noted that lower SES is associated with increased asthma burden in children, likely reflecting comparable trends in adults. However, some studies suggest that the SES-asthma relationship may be moderated by environmental and psychosocial factors, indicating that SES may exert indirect rather than direct effects on asthma risk [49].

Our study found that respondents from the North and West regions of the U.S. had significantly higher odds of reporting asthma compared with those from the Midwest. This regional variation is consistent with prior studies and national surveillance data that have documented geographic disparities in asthma prevalence across the United States. The higher odds of reported asthma among respondents living in the North and West regions of the United States may be explained by a combination of environmental, climatic, and demographic factors. In particular, urban areas in the West are known for elevated levels of air pollution and ozone, both of which are associated with increased asthma risk. Additionally, the North experiences cold and damp winters, which can exacerbate respiratory conditions and promote exposure to indoor allergens such as mold and dust mites. In recent years, the Western U.S. has also faced increasing exposure to wildfire smoke-a growing concern linked to climate change-which has been associated with both asthma development and exacerbation [45].

Urbanization and higher population density in many parts of the North and West also contribute to greater exposure to traffic-related air pollution and other environmental irritants. Compared to the more rural Midwest, which generally has cleaner air and less densely populated urban centers, residents of these more urbanized regions may experience a higher burden of asthma triggers [45]. These environmental differences likely contribute to the geographic disparities in asthma prevalence across the United States.

Socioeconomic and healthcare access differences may further influence asthma reporting rates. Regions with better access to healthcare services and higher public health awareness—often found in urban centers—are more likely to have higher rates of diagnosed asthma. In contrast, asthma may be underdiagnosed in less resourced or rural areas, where healthcare access is limited, and individuals may be less likely to receive regular health screenings [45].

A study [45] has consistently reported higher asthma prevalence in the Northeast and Western U.S. compared to the Midwest and South [45]. Zahran et al. [50] similarly observed elevated asthma rates in these regions.

5. STUDY LIMITATIONS

This study has two limitations. First, the BRFSS is a telephone-based survey administered to civilian, non-institutionalized adults, excluding individuals without phone access, those residing in institutions, and military personnel on bases. As a result, the findings may not be fully generalizable to the entire U.S. population. Second, since the BRFSS relies on self-reported data collected via phone interviews, responses may be subject to recall and reporting biases.

6. CONCLUSION

These findings show notable sociodemographic and regional disparities in self-reported current asthma among U.S. adults. Higher odds were observed among males, certain racial/ethnic minorities, those with lower education and income levels, and residents of the Northeast and West. These disparities highlight the need for targeted public health efforts addressing social and geographic determinants of asthma.

7. CLINICAL IMPLICATIONS

Clinically, these findings underscore the importance of incorporating social and geographic risk factors into asthma screening, diagnosis, and management strategies. Healthcare providers should be especially vigilant in identifying and managing asthma among populations at higher risk—such as males, racial/ethnic minorities, and individuals with lower socioeconomic status-while also considering regional variations in asthma prevalence. Tailoring asthma care and education to these high-risk groups may help reduce disparities, improve disease control, and enhance health outcomes.

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