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## The relationship between asthma and depression in a community-based sample

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### ABSTRACT

**Objective:** Asthma is an increasingly prevalent disease that is associated with substantial physical and financial burdens. Additionally, asthma is linked to psychiatric disorders. This study examines the relationship between asthma diagnosis, current depressive symptoms, and lifetime psychiatric disorder history in a large, community-based sample. **Methods:** We analyzed data from 2168 participants in the Dallas Heart Study, a large, diverse, community-based sample of people designed to be representative of the Dallas County population. Logistic regressions analyzing the relationship between asthma diagnosis and history of a psychiatric disorder, as well as between asthma diagnosis and the Quick Inventory of Depressive Symptomatology (QIDS) scores were performed, controlling for demographic data. **Results:** 13.4% of the sample had an asthma diagnosis. Asthma diagnosis was significantly associated with a history of nervous, emotional, or mental health disorder diagnosis [OR 1.810 (95% CI 1.280–2.559)  $p = 0.001$ ], and with QIDS scores consistent with moderate or greater current depressive symptom severity [OR 1.586 (95% CI 1.106–2.274)  $p = 0.012$ ]. The relationships were not moderated by age, gender, race, smoking status, or Body Mass Index. **Conclusions:** A diagnosis of asthma may be associated with current clinically significant levels of depressive symptoms and a lifetime psychiatric disorder. The current report adds to the existing literature in this area by assessing both current and lifetime symptoms and by using a large and diverse population. The findings highlight the clinical importance of considering the possibility of psychiatric illness in asthma patients and suggest further research in this area is needed.

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## Introduction

Asthma is increasing in prevalence (1). Recent data suggest that approximately 25.7 million people (8%) in the United States have asthma. There are large racial disparities in asthma, with African Americans being more likely to be diagnosed with asthma. African Americans with asthma also have higher rates of emergency department visits and hospitalizations due to asthma, as well as a higher asthma mortality rate than white persons (2). In addition, asthma is associated with a large financial burden. The 2016 Drug Trend Report ranks asthma as the 10th most expensive traditional and specialty therapy class in the United States with a cost of about 56 billion dollars annually in the United States (3).

In addition to the financial and physical hardships related to the disease, asthma patients may also be at an increased risk for mental health disorders. Several reports suggest that those with asthma have higher rates of anxiety and depression (4,5), as well as other psychiatric disorders such as bipolar disorder (6) and schizophrenia (7). Furthermore, asthma has been associated with increased likelihood of suicidal ideation and suicide

attempts among adults (8). A limitation of the existing research is the generalizability of the findings since many of the reports did not include diverse samples. A 2005 literature review by Opolski and Wilson concluded there have been somewhat mixed and contradictory results regarding whether there is a relationship between asthma and depression (9).

A potential source of variability in prior studies is the use of different and, sometimes, highly specialized participant samples, such as male Israeli Army recruits (10) or people completing fee-for-service preventive medical examinations (11). The prevalence of depression and anxiety (12), as well as asthma (13), vary considerably by race and ethnicity. Loerbroks et al. used data from the 2002 World Health Survey to examine the relationship between asthma or wheezing and major depressive episodes in 245,727 people from 57 countries (14). In the overall sample, asthma was associated with a greater likelihood of depression (OR 2.37) with a somewhat stronger association in men (OR 3.18) than women (OR 1.97). The ORs varied widely by continent (ORs ranged from 1.66 in Australia to 2.86 in South America) and the sex

difference, while consistently present, varied greatly between regions. Scott et al. used data from a survey of 42,697 people in 17 countries to assess relationships between asthma and 12-month anxiety, depressive, and alcohol use disorders. The psychiatric disorders were more common in people with asthma in some, but not all, countries and the strength of the association was variable among countries (15). Strine et al. used data from the Behavioral Risk Factor Surveillance Survey, a random-digit-dialed telephone survey, that collected depression and anxiety data from 217,379 people in 38 states, plus the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. In this sample, current depressive symptoms (OR 2.4), lifetime diagnosis of depression (OR 2.3), and lifetime diagnosis of anxiety (OR 2.2) were all more common in asthma than in people without asthma (12). Goodwin et al. used data from the Canadian Community Health Survey to assess the relationship between asthma and mental disorders (16). Asthma was associated with a variety of mental disorders including depression (OR 1.66). The ethnic and racial composition of the participant sample was not discussed. Jiang et al. examined the relationship between mental health and asthma in 9280 people using data from the Guangzhou Biobank Cohort Study. Depressive symptoms and asthma demonstrated a significant association which was greater for severe, than moderate, depressive symptoms. In the current report we evaluate a large and diverse (including people of different races or cultures) community-based (involving a defined “general population,” as opposed to hospital-based or occupation-based population (17) adult cohort from Dallas County, Texas. Using data from this study, we report on the relationship between asthma and a history of a mental, emotional, or nervous disorder, as well as between asthma and current depressive symptom severity. The potential influence of sex and race/ethnicity on the findings is explored. Our hypothesis was that asthma would be associated with higher current depressive symptom severity and higher rates of positive response to the lifetime question about mental, emotional, or nervous disorders.

## Methods

### Study sample

This study analyzed data from the Dallas Heart Study (DHS), a large, socially and ethnically diverse community-based study that included adults living in Dallas County, Texas. The first installation of the DHS (DHS-1) was conducted from 2000 to 2002 and the second installation (DHS-2) from 2007 to 2009. DHS-1 consisted of an epidemiologic sample of Dallas County adult residents except that African Americans

were intentionally overrepresented (approximately 50% of the sample) to explore heart disease risk factors in this subpopulation. DHS-2 included participants from DHS-1 plus additional participants (e.g., family members of DHS-1 participants) to replace participants lost to attrition. While DHS was designed to study risk factors associated with heart disease, participants were selected to represent an epidemiologic sample of Dallas County, not based on the presence of or increased risk for heart disease. DHS included a wealth of information, such as demographic and health data (e.g., asthma diagnosis), nervous, emotional, or mental disorder diagnosis, and Quick Inventory of Depressive Symptomatology (QIDS) scores, which were all used in this study. Extensive information about the design and recruitment methods of the DHS can be found in Victor et al. (18).

All participants provided written informed consent as approved by the University of Texas Southwestern Medical Center Institutional Review Board (IRB). We studied participants who participated in both DHS-1 and DHS-2 because QIDS data were obtained during DHS-2, while asthma data were obtained during DHS-1.

A questionnaire administered to all participants in DHS-1 asked “Has a doctor or other health professional ever told you that you have any of the following health conditions or health problems?” with “asthma” and “nervous, emotional, or mental disorder” being listed as possible answer options. Participants answered “yes,” “no,” “don’t know,” or “refuse to answer.” The content of the questions were developed by staff at UT Southwestern for DHS-1. RTI survey methodologists then reviewed the draft instrument based on RTI’s cognitive assessment tool, and suggested revisions. The initial extracted dataset only included those who provided a “yes” or “no” answer to both the asthma diagnosis question and the nervous, emotional, or mental disorder diagnosis question (2485 participants). The self-report version of the QIDS that was used in the DHS is a 16-item self-rated scale assessing depressive symptom severity. It has high internal consistency (Cronbach’s  $\alpha = 0.86$ ) and total scores correlate highly with the clinician-rated Hamilton Rating Scale for Depression (HRSD) (19). Additional information about the scale is available at [www.ids-qids.org](http://www.ids-qids.org). Those who had missing values for number of years of completed education, missing values for QIDS, or missing values for smoking and asthma history, were excluded from the analysis (Figure 1). This resulted in a final sample size of 2168.

### Demographic and clinical assessment

Demographic data, including gender, race, age, and years of completed education were collected. Due to the

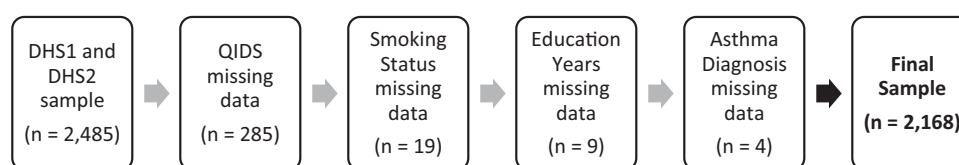


**Figure 1.** Final sample determination for logistic regression flow diagram.

overrepresentation of African Americans, we dichotomized the race variable into African Americans and “other” races. Questions about asthma and nervous, emotional, or mental health diagnosis were dichotomized to “yes” or “no.” The QIDS is a validated 16-item self-report survey used to determine depressive symptom severity (20,21). QIDS scores were dichotomized into  $\leq 10$  ( $n = 1925$  (88.8%)) and  $> 10$  ( $n = 243$  (11.2%)) because scores greater than 10 are associated with moderate to severe depressive symptom severity (19).

### Statistical analysis

All statistical analyses were conducted using SPSS version 24 (IBM, Armonk, NY). Comparison of demographic characteristics of participants included and excluded from the analysis as well as among those without an asthma diagnosis was performed using independent sample *t*-tests for continuous data and Pearson Chi-Square for dichotomous data. Logistic regression was used to determine the relationship between asthma diagnosis (independent variable) and nervous, mental, or emotional disorder diagnosis, and between asthma diagnosis and dichotomized QIDS scores (dependent variables). Age, gender, ethnicity, years of completed education, body mass index (BMI), and smoking status (1-current smoker; 0-not a smoker) were all controlled for in the analysis. Statistical significance was determined by a *p* value less than 0.05.

### Results

The demographics of the study group and the excluded group were similar (Table 1) except that participants excluded due to missing data ( $n = 317$ ) had, on average, 0.65 fewer years of education ( $p < 0.001$ ) and were 1.36 years older ( $p = 0.029$ ). A diagnosis of asthma was reported in 290 of 2168 subjects (13.4%). A “yes” response to the diagnosis of nervous, emotional, or mental disorder was reported in 11.0% of subjects ( $n = 238$ ), while QIDS score of 11 or above (moderate depressive symptom severity) was noted in 11.2% of participants ( $n = 243$ ). Participants diagnosed with asthma were demographically similar to those without asthma except for having a greater proportion of women (64.5% vs. 56.5%), and a 1.79 higher average BMI ( $p < 0.001$ ).

A logistic regression, controlling for age, gender, ethnicity, years of education completed, BMI, and smoking status, was used to examine the relationship between diagnosis of asthma and diagnosis of nervous, emotional, or mental disorder. After controlling for these covariates, asthma diagnosis was highly significantly associated with a “yes” response to this question (OR 1.810, CI 1.280, 2.559,  $p = .001$ ) (Table 2). The odds ratio indicates that an asthma diagnosis was associated with approximately an 81% increase in frequency of a positive response to this question.

A logistic regression, controlling for age, gender, ethnicity, years of education completed, BMI, and smoking status, was also used to study the association between the asthma diagnosis and the QIDS scores greater than or less than or equal to 10 Table 3. After controlling for these covariates, asthma was significantly associated with a QIDS score of 11 or above (OR 1.586, CI 1.106, 2.274,  $p = 0.012$ ). The odds ratio indicates that an asthma diagnosis was associated with approximately a 59% increase in frequency QIDS scores consistent with at least moderate depressive symptom severity.

To explore the influence of demographic characteristics on the results, age by asthma, gender by asthma, and race/ethnicity by asthma interaction terms were created and added to the regression models. In the psychiatric disorder regression, age by asthma ( $p = 0.848$ ), gender by asthma ( $p = 0.789$ ), ethnicity by asthma ( $p = 0.730$ ), BMI by asthma ( $p = 0.507$ ), and smoking status by asthma ( $p = 0.576$ ) were not significant. In the QIDS  $> 10$  regression, age by asthma ( $p = 0.076$ ), gender by asthma ( $p = 0.929$ ), ethnicity by asthma ( $p = 0.145$ ), BMI by asthma ( $p = 0.281$ ), and smoking status by asthma ( $p = 0.215$ ) were also not significant. Since, none of the interaction terms were significant (all  $p > 0.05$ ), subgroups analyses were not conducted (22). Medication history information was very limited.

### Discussion

Among participants in a large, diverse, community-based sample of adults in Dallas County, asthma diagnosis was associated with a 64% increased likelihood of depressive symptoms of at least moderate severity and a 90% increased likelihood of lifetime diagnosis of a nervous, emotional, or mental disorder. These findings are

**Table 1.** Demographics of study participants (asthma and non-asthma groups) and excluded participants.

| Variables                           | Study participants<br>( <i>n</i> = 2168) | Asthma<br>( <i>n</i> = 290) | No asthma<br>( <i>n</i> = 1878) | Asthma vs.<br>non-asthma<br><i>p</i> -value | Excluded ( <i>n</i> = 317) | Study vs.<br>excluded.<br><i>p</i> -value |
|-------------------------------------|------------------------------------------|-----------------------------|---------------------------------|---------------------------------------------|----------------------------|-------------------------------------------|
| Sex [ <i>n</i> (%)]                 |                                          |                             |                                 | 0.010                                       |                            | 0.789                                     |
| Male                                | 920 (42.4)                               | 103 (35.5)                  | 817 (43.5)                      |                                             | 132 (41.6)                 |                                           |
| Female                              | 1248 (57.6)                              | 187 (64.5)                  | 1061 (56.5)                     |                                             | 185 (58.4)                 |                                           |
| Race/ethnicity<br>[ <i>n</i> (%)]   |                                          |                             |                                 | 0.277                                       |                            | 0.225                                     |
| Non-Hispanic African American       | 1111 (51.2)                              | 140 (48.3)                  | 971 (51.7)                      |                                             | 174 (54.9)                 |                                           |
| Non-Hispanic White                  | 721 (33.3)                               | 114 (39.3)                  | 607 (32.3)                      |                                             | 84 (26.59)                 |                                           |
| Hispanic                            | 291 (13.4)                               | 28 (9.7)                    | 263 (14.0)                      |                                             | 56 (17.7)                  |                                           |
| Other                               | 45 (2.1)                                 | 8 (2.8)                     | 37 (2.0)                        |                                             | 3 (0.9)                    |                                           |
| Smoking Status<br>[ <i>n</i> (%)]   |                                          |                             |                                 | 0.320                                       |                            | 0.532                                     |
| Current smoker                      | 489 (22.6)                               | 72 (24.8)                   | 417 (22.2)                      |                                             | 57 (24.4)                  |                                           |
| Not a smoker                        | 1679 (77.4)                              | 218 (75.2)                  | 1461 (77.8)                     |                                             | 177 (75.6)                 |                                           |
| Age in years<br>[M(SD)]             | 50.42 (10.3)                             | 50.23 (10.4)                | 50.45 (10.3)                    | 0.736                                       | 51.78 (10.2)               | 0.029                                     |
| Education in<br>years [M(SD)]       | 12.69 (2.2)                              | 12.74 (2.0)                 | 12.68 (2.2)                     | 0.676                                       | 12.04 (2.5)                | <0.001                                    |
| Body Mass<br>Index (BMI)<br>[M(SD)] | 31.28 (7.5)                              | 32.83 (8.7)                 | 31.04 (7.2)                     | <0.001                                      | 30.87 (7.5)                | 0.377                                     |

**Table 2.** Logistic regression analysis of the relationship between asthma and nervous, emotional, or mental disorder diagnosis.

| Variable                                                 | All Participants<br>OR(95%CI) | <i>P</i> Value |
|----------------------------------------------------------|-------------------------------|----------------|
| Asthma (yes vs. no)                                      | 1.810 (1.280–2.559)           | 0.001          |
| Gender (female = 0, male = 1)                            | 0.501 (0.371–0.677)           | <0.001         |
| Age                                                      | 1.017 (1.003–1.031)           | 0.015          |
| Ethnicity (African American vs. other)                   | 0.699 (0.527–0.928)           | 0.013          |
| Education                                                | 0.944 (0.892–0.999)           | 0.045          |
| Body Mass Index (BMI)                                    | 1.006 (0.987–1.025)           | 0.545          |
| Smoking Status (not a smoker = 0,<br>current smoker = 1) | 2.147 (1.583–2.912)           | <0.001         |

consistent with previous studies demonstrating a link between asthma and depressive symptoms, as well as between asthma and other mental health disorders. For example, Trojan et al. found that asthma diagnosis was associated with a 41% increased likelihood of current depressive symptoms and a 64% increased likelihood of lifetime depression in a sample of mostly (>94%) white

**Table 3.** Logistic regression analysis of the relationship between asthma and QIDS scores >10 and ≤10.

| Variable                                                 | All Participants<br>OR (95%CI) | <i>P</i> Value |
|----------------------------------------------------------|--------------------------------|----------------|
| Asthma (yes vs. no)                                      | 1.586 (1.106–2.274)            | 0.012          |
| Gender (female = 0, male = 1)                            | 0.458 (0.335–0.626)            | <0.001         |
| Age                                                      | 0.985 (0.972–0.999)            | 0.030          |
| Ethnicity (African American vs. other)                   | 1.408 (1.051–1.885)            | 0.022          |
| Education                                                | 0.830 (0.787–0.875)            | <0.001         |
| Body Mass Index (BMI)                                    | 1.018 (1.000–1.036)            | 0.05           |
| Smoking Status (not a smoker = 0,<br>current smoker = 1) | 1.951 (1.439–2.644)            | <0.001         |

patients undergoing fee-for-service preventive medical examinations (11). Lev-Tzion et al. found a 20% increased likelihood of mental health disorder among Israeli male army recruits who had asthma (10).

However, a study in 54 countries by the World Health Organization found highly variable relationships between asthma and depression by country (ORs ranged from 0.5 in Senegal to 13.0 in Burkina Faso) (23). These findings suggest that factors such as environment, culture, and demographics may influence the relationship between asthma and depression. The current report adds to the existing literature by finding a relationship between current depression and lifetime psychiatric disorders, and asthma, in a large and diverse population. The lack of significant moderating effects of age, gender, race/ethnicity, BMI, and smoking status suggests that, at least in the current sample, the relationship between asthma and depression was not driven by these participant characteristics. Thus, the increased risk of depression or other psychiatric disorders may be generalizable, at least within residents of Dallas County.

The mechanisms linking depression and asthma are not clear. One possible explanation is the physical and financial burden of asthma. Possibly supporting illness burden as a potential mechanism are data suggesting greater frequency of clinically significant depression and anxiety in patients with severe, as compared to mild-moderate, asthma (24). Additionally, the inflammatory response associated with asthma may affect the brain. Research suggests that pro-inflammatory cytokine treatment is related to the development of depression (25,26). The use of systemic corticosteroids is also associated

with the development of psychiatric symptoms, including depression (27). Genetics could also be a factor. A Finnish study on identical and fraternal twins found that in 64% of cases, the link between depressive symptoms and atopic illness was related to family history and other genetic influences (28). Serotonergic symptoms may also play a role in the relationship between asthma and depression. A polymorphism in a serotonin transporter gene was associated with asthma and depression in one report (29). Additionally, platelet serotonin is implicated in allergic airway inflammation (30). Hippocampal volume reduction, a much replicated finding in depression, is also reported in people with asthma (31–33).

The findings have clinical implications. The data highlight the need for awareness of the elevated risk for psychiatric disorders by physicians treating asthma patients. Screening for depression using tools such as the QIDS might be considered. When diagnosed, the depression could be treated or referrals provided. This could be associated with improved clinical outcomes because some data suggest that improvement in depressive symptoms is associated with improvement in asthma control (34,35).

A limitation of this study is that asthma and psychiatric symptom data were obtained by self-report. However, self-reported asthma has relatively high sensitivity (0.86) and specificity (0.99) compared to a diagnosis based on primary care clinician records (36). The QIDS, while designed to assess depressive symptom severity, not to make a depression diagnosis, is a validated instrument that shows strong correlations with clinician rated depression scales (20,21). For example, as discussed in the methods section, the QIDS shows good internal consistency and sensitivity to change, and correlates highly with the widely used clinician-rated HRSD. Furthermore, the QIDS demonstrated good reliability and construct validity in a sample of depressed asthma patients (37). The question about lifetime psychiatric symptoms was developed for the DHS, and was not from a validated instrument. Another study limitation is the paucity of clinical data regarding asthma severity or medication use, and the specific types of nervous, emotional, and mental disorders reported. Thus, we were not able to control for clinical features of asthma. However, the analyses controlled for demographic characteristics. A possible limitation is that asthma was assessed at DHS-1 and depression several years later at DHS-2. This limitation is minimized by the fact that the screening questions ask if “a doctor or other health professional ever told you that you have” asthma. Because the question assesses lifetime, a yes answer would presumably always remain yes. Some people may have developed asthma between DHS-1 and DHS-2. However, the presence of these persons with asthma in the non-asthma group would presumably diminish, not

enhance, the strength of our positive findings, and lead to type II rather than type I error. It is possible that the generalizability of the study might have been reduced by oversampling for African American persons. However, the oversampling allowed for a more meaningful assessment of ethnic and racial differences. These differences, based on the non-significant interaction term, did not appear to influence the relationship between asthma and depression. Strengths of this study include its large sample size and diverse, community-based population. An additional strength was assessment of both current and lifetime psychiatric symptoms. Current symptoms (QIDS) only offer a snapshot of symptoms that may be transient or chronic. Lifetime symptom questions do not provide information about whether the symptoms are current. Thus, inclusion of both types of data provides a more complete picture of symptomatology. A limitation is that, due to the information available in the DHS dataset, the two assessments are different in scope.

In summary, this report from a large, community-based sample observed elevated rates of both current depressive symptoms and lifetime psychiatric disorders in patients with a lifetime diagnosis of asthma. The findings provide additional evidence supporting a relationship between asthma and psychiatric illnesses.

## Declaration of interest

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