Relationship between posttraumatic stress disorder and asthma among New York area residents exposed to the World Trade Center disaster

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A B S T R A C T

Objective: The heightened prevalence rates of respiratory problems and posttraumatic stress disorder (PTSD) among New York area residents following the World Trade Center disaster on September 11, 2001, have received national attention. Although there is some evidence suggesting that PTSD is associated with increased risk for asthma, this relationship has not been well documented in this population at high risk for both disorders. There is also a need to examine this relationship while controlling for notable confounds, including dust exposure and smoking.

Method: This study examined the association between symptoms indicative of probable PTSD and the diagnosis of asthma following 9/11 among the individuals who participated in the World Trade Center Health Registry (WTCHR) baseline study between September 2003 and November 2004. A total of 71,437 participants enrolled in this study and completed questionnaires pertaining to exposure, physical health symptoms before and after 9/11, and self-reported PTSD symptoms.

Results: Logistic regression revealed that, compared to participants without probable PTSD, individuals with probable PTSD were 1.65 times more likely to be diagnosed with asthma following 9/11, which was significant after controlling for the effects of gender, ethnicity, income, smoking status, dust exposure, and non-specific psychological distress (Wald $\chi^2(1) = 52.375, P < .001$).

Conclusion: These results suggest that PTSD symptoms are associated with the development of asthma following 9/11 and that this relationship is not explained by sociodemographic, environmental, and lifestyle factors.

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Introduction

Concerned about the effects of environmental toxins that were released due to the collapse of the World Trade Center (WTC) on September 11, 2001, as well as the mental health needs of the affected residents and first responders, the Agency for Toxic Substances and Disease Registry and the New York City Department of Health and Mental Hygiene collaborated to create the World Trade Center Health Registry (WTCHR) in July 2002. Several studies have shown increased prevalence of posttraumatic stress disorder (PTSD) [1,2] in this population. In addition, in part due to the dust and smoke exposure from the disaster, first responders and residents have experienced new or worsening respiratory problems, including asthma [1,3].

The relationship between PTSD and asthma has been documented in studies of primary care patients [4], community patients [5], veterans [6–9], firefighters [10], and general adult [11–13] and adolescent [14,15] samples. A biopsychosocial model of asthma posits that biological, psychological, and social pathways are involved in the development of asthma. Biological abnormalities associated with both PTSD and asthma include changes to the hypothalamic–pituitary–adrenal (HPA) axis and sympathetic–adrenal–medullary (SAM) system [16–18], which may lead to disinhibition of inflammatory processes [19]. In addition, stress has been shown to reduce an individual’s resistance to respiratory infection agents [20]. Finally, psychological mechanisms (e.g., poor coping) and behavioral mechanisms (e.g., engaging in health risk factors such as smoking) that are related to PTSD may influence the development of asthma.

The body of literature examining the relationship between PTSD and asthma has produced some inconsistent findings. However, in a meta-analysis by Weiser [21], the prevalence rate of PTSD among adults with asthma was not significantly different from the lifetime prevalence rate of PTSD in the general population. Inconsistencies in findings may be attributable to multiple confounds that have been noted as potentially explaining a relationship between PTSD and asthma, including age, gender, ethnicity, health status, smoking status, obesity, exercise status, and socioeconomic status [12,22,23]. Other symptoms of psychological distress, such as symptoms of anxiety and depression, are also common among asthma patients [20,24] and patients with PTSD [25] and could also represent a potential confound.
Examining the link between asthma and PTSD among individuals exposed to 9/11 is an important endeavor, given the high risk for these disorders in this population. Two studies found the diagnosis of PTSD to increase the risk of having asthma in this population [26,27]. However, these researchers did not control for potential environmental confounds (e.g., dust exposure) or health habits (e.g., smoking) that are related to both asthma and PTSD in this population [28]. Thus, it is possible that any relationship between asthma and PTSD could be accounted for by dust exposure and smoking. In the present study, we hypothesized a relationship between PTSD and asthma controlling for dust exposure, smoking, nonspecific psychological distress, and other background variables.

Method

The publicly accessible WTCHR data set was used for this study, with permission from the New York City Department of Health and Mental Hygiene. Data collection for the WTCHR is described in detail elsewhere [1]. A total of 71,437 first responders, residents, and students near the WTC were enrolled between September 2003 and November 2004. Interviews were conducted by phone (n = 67,525) or in person (n = 3,910). Sixty-three percent of participants identified as Caucasian, 11.9% as African American, 13.4% as Hispanic, 7.5% as Asian, and 4.3% as Other. Sixty percent of the participants were male and 40% were female. 4.6% reported that they were younger than 18 at the time of the WTC attack, 6.2% were between 18 and 24, 52.1% were between 25 and 44, 33.5% were between 45 and 64, and 3.7% were 65 and older.

Participants were asked about 9/11-related injuries, new or worsening respiratory symptoms after 9/11, new or worsening nonrespiratory symptoms, and specific conditions diagnosed by health professionals after 9/11. The presence of newly diagnosed asthma was established by the participants' self-reports of a physician's diagnosis of asthma after 9/11: "Did the enrollee report new onset of asthma diagnosed by a doctor or a health care professional since 9/11/01?" Exposure to dust and debris cloud that resulted from the collapse of the buildings was captured by one question: "Did the enrollee indicate that he/she was outdoors on 9/11/01 within the dust or debris cloud resulting from the collapse of the WTC?" Participants were asked about their smoking status at the time of interview and were classified into three categories: never smoked, former smoker, and current smoker. In the present study, participants were categorized into those who have no history of smoking (never-smokers) and former or current smokers (ever-smokers). This change was made because the participants' smoking status at the time of 9/11 or the weeks following is unclear in the original classification and could complicate interpretations of differences between "former smokers" and "current smokers" in particular.

The Kessler 6 scale [29] measured symptoms of nonspecific psychological distress at the time of interview. It is a widely used instrument for the screening of mental disorders in the general population that has demonstrated excellent internal consistency and reliability [29]. A standard cutoff score of 13 or above is considered indicative of severe psychological distress, which is highly associated with anxiety and depressive disorders but does not identify a specific mental illness diagnosis. Among the 66,856 individuals who responded to this item, 8.4% scored at least 13 on the scale.

PTSD symptoms were assessed using the PTSD-checklist, civilian version (PCL-C) [30], a 17-item, self-report rating scale with excellent psychometric properties, including internal consistency, test–retest reliability, convergent validity, and discriminant validity [31]. In the publicly accessible data set, individuals who scored 44 and above were classified as having probable current PTSD. This cutoff score of 44 has been shown to have good specificity, sensitivity, and diagnostic efficiency [32]. Among the 66,038 participants who responded to this item, 16.3% met the criterion for probable PTSD.

Results

The overall prevalence of new diagnosis of asthma following 9/11 in this sample was 3%. Chi-square tests of association examined the bivariate relationships between asthma and sociodemographic variables, smoking status, dust exposure, nonspecific psychological distress, and probable PTSD. Due to missing data, the number of participants included in each analysis varies. The results revealed that asthma was associated with gender [n = 70,930; χ²(2) = 55.971, P < .001], ethnicity [n = 70,931; χ²(4) = 49.286, P < .001] income [n = 67,285; χ²(3) = 47.785, P < .001], dust exposure [n = 70,972; χ²(1) = 52.683, P < .001], nonspecific psychological distress [n = 66,684; χ²(1) = 71.392, P < .001], and probable PTSD [n = 65,884; χ²(1) = 146.912, P < .001]. Smoking status and asthma were not associated [n = 67,680; χ²(1) = 2.095; P = .148]. Logistic regression was applied to examine the overall fit of the model as well as the association between probable PTSD and asthma, over and above the potentially confounding variables (see Table 1). Listwise deletion was used to handle missing data. Predictors were entered into the equation in separate blocks in the following order: gender, ethnicity, income, smoking status, dust exposure, nonspecific psychological distress, and probable PTSD. This set of predictors improved prediction of asthma over the null model [model χ²(12) = 219.125, P < .001]. The full model was shown to have a good fit (Hoemser and Lemeshow χ²(8) = 5.105, P = .746) and the overall prediction success rate was 67.7%. As indicated by McFadden’s R², 1.46% of the variance on asthma diagnosis after 9/11 was explained by the variables in this study. Probable PTSD was the strongest predictor of asthma diagnosis after 9/11 and incrementally contributed to prediction of asthma, other above variables. Individuals with symptoms indicative of probable PTSD were 1.65 times more likely than 95% CI = 1.44, 1.89 to have a diagnosis of asthma following 9/11 than individuals without these symptoms.

Examining the covariates entered in this model, all except smoking status and nonspecific psychological distress were found to uniquely contribute to prediction of asthma diagnosis following 9/11. Females were 1.39 times more likely than males to report a new diagnosis of asthma diagnosis following 9/11. Females were 1.39 times more likely than males to report a new diagnosis of asthma. Individuals who were exposed to dust and debris were 1.30 times more likely those who were not exposed to report a new diagnosis of asthma. When the minority ethnic groups were contrasted with the Caucasian group, only the contrast between African Americans and Caucasians was significant; being African American reduced the odds of being diagnosed with asthma by approximately 26%. Significant differences were found between the highest income group and each of the other groups; higher income was associated with lower risk of asthma diagnosis.

In this sample, gender was also associated with probable PTSD χ²(1) = 528.86, P < .001, with females being 1.62 times more likely than males to have probable PTSD (95% CI = 1.56, 1.65). Stratifying the sample by gender, probable PTSD remained a significant predictor of asthma for both males (OR = 1.73, P < .001, 95% CI = 1.43, 2.09) and females (OR = 1.49, 95% CI = 1.44, 1.55).

Table 1

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</table>

SE = standard error; OR = odds ratio; CI = confidence interval.

⁎ P < .05.
⁎⁎ P < .01.
⁎⁎⁎ P < .001.
Discussion

While the underlying mechanism of the co-occurrence of PTSD and asthma is unclear, one possible explanation is that the relationship between PTSD and asthma is better explained by sociodemographic factors, environmental factors, health risk behaviors, and other psychological factors associated with both disorders. Our study adds to the body of literature linking PTSD and asthma [4–8,10–15] and extends this literature by documenting this relationship in a large sample of individuals exposed to the WTC disaster while controlling for potential confounds including gender, ethnicity, socioeconomic status, dust exposure, non-specific psychological distress, and smoking. Covarying for those variables, probable PTSD following 9/11 increased the odds of developing asthma following 9/11 by 65%. Considering asthma as a biopsychosocial illness, these results suggest that in individuals exposed to the WTC disaster, the relationship between PTSD and asthma is not explained by increased engagement in health risk factors such as smoking. The relationship between PTSD and asthma may partly be explained by biological mechanisms, including alterations to the HPA-axis and SAM system evident in both PTSD and asthma [15–17], leading to disinhibition of inflammatory processes [18], or through PTSD reducing resistance to respiratory infection agents [19].

Smoking status was not associated with asthma in this sample, a finding that although consistent with some other studies [33–35] seems counterintuitive and contradicts a larger body of literature associating active and former smoking with increased risk of asthma [37–43]. One possible explanation for this finding is that individuals newly diagnosed with asthma are less likely to smoke because it exacerbates their symptoms [36]. The relationship between asthma and smoking remains open to debate and replication, and the inconsistencies of findings may speak to the complexity and heterogeneity of adult asthma.

Some limitations of this study should be noted. First, neither the causal pathways between PTSD and asthma nor its directionality can be ascertained in this study’s correlative design. Second, this study relied solely on self-reports, which may have resulted in misclassification of participants. Clinical guidelines for the diagnosis of asthma by the U.S. Department of Health and Human Services [44] recommend the use of medical history, physical examination, and pulmonary function tests, such as spirometry, which are not feasible in large epidemiological surveys. Patients’ self-reports of most chronic illnesses, including asthma, however, are found to be generally accurate [11,45,46].

Third, there are many potentially important factors that were not included in this study, such as prior trauma exposure, childhood adversities, family history of asthma, medical problems, exposure to environmental allergens besides cigarette smoke and dust, and medications. Similarly, severity of asthma and severity of PTSD may be important factors. Finally, while anxiety and depression symptoms were taken into account in this study in its measure of general psychological distress, specific mental health diagnostic categories were not used in the analysis as covariates. Asthma is shown to be associated with a wide range of psychiatric conditions besides PTSD, such as depressive disorders [11,12,47–49], generalized anxiety disorder [11,12,21,50], and panic disorder [22].

Notwithstanding the limitations, this study sheds some light on the public health impact of 9/11 as well as the connection between PTSD and somatic illness. Future studies should continue to consider mediating factors that might further explain the relationship between asthma and PTSD, including psychological factors (e.g., coping, hostility) or behavioral factors (e.g., decreased medical service utilization, poorer functional status). The longitudinal nature of the WTC CHR surveys also allows for the investigation of long-term effects of trauma exposure on PTSD and asthma.

Conflict of interest statement

The Authors declare that there is no conflict of interests.

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