

World Trade Center workers with asthma and post-traumatic stress disorder perceive airflow limitation more accurately



Juan P. Wisnivesky, MD, DrPH^{*,†}; Nikita Agrawal, MD[†]; Jyoti Ankam, MBBS, MPH^{*}; Adam Gonzalez, PhD[‡]; Paula Busse, MD[§]; Jenny Lin, MD, MPH^{*}; Alex Federman, MD, MPH^{*}; Jonathan Feldman, PhD^{||,¶,♯}; Jeffrey J. Weiss, PhD, MS^{*}; Steven B. Markowitz, MD, DrPH^{**}

^{*} Division of General Internal Medicine, Icahn School of Medicine at Mount Sinai, New York, New York

[†] Division of Pulmonary and Critical Care Medicine, Icahn School of Medicine at Mount Sinai, New York, New York

[‡] Department of Psychiatry and Behavioral Health, Stony Brook University, Stony Brook, New York

[§] Division of Allergy and Immunology, Icahn School of Medicine at Mount Sinai, New York, New York

^{||} Ferkauf Graduate School of Psychology, Albert Einstein College of Medicine, Bronx, New York

[¶] Division of Academic General Pediatrics, Department of Pediatrics, Albert Einstein College of Medicine, Children's Hospital at Montefiore, Bronx, New York

[♯] Division of Academic General Pediatrics, Department of Psychiatry and Behavioral Sciences, Albert Einstein College of Medicine, Children's Hospital at Montefiore, Bronx, New York

^{**} Barry Commoners Center for Health and Environment, Queens College, City University of New York, New York

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ABSTRACT

Background: Post-traumatic stress disorder (PTSD) is a major risk factor for increased asthma morbidity among World Trade Center (WTC) workers.

Objective: To investigate whether differences in perception of airflow limitation mediate the association of PTSD with worse asthma control in WTC workers.

Methods: We collected data from WTC workers on asthma control (Asthma Control Questionnaire and Asthma Quality of Life Questionnaire) and daily peak expiratory flow (PEF) measures over 6 weeks. Perception of airway limitation was assessed by comparing guessed vs actual PEF values. Post-traumatic stress disorder was diagnosed using the Structured Clinical Interview. We used unadjusted and adjusted models to compare PEF and perception measures in WTC workers with PTSD with those of workers without PTSD.

Results: Overall, 25% of 224 participants had PTSD. Post-traumatic stress disorder was associated with worse Asthma Control Questionnaire (2.2 ± 0.8 vs 1.1 ± 0.9 , $P < .001$) and Asthma Quality of Life Questionnaire (3.9 ± 1.1 vs 5.4 ± 1.1 , $P < .001$) scores. Adjusted analyses showed no significant differences in PEF between WTC workers with (351.9 ± 143.3 L/min) and those without PTSD (364.6 ± 131.6 L/min, $P = .55$). World Trade Center workers with PTSD vs those without PTSD had increased proportion of accurate perception ($67.0 \pm 37.2\%$ vs $53.5 \pm 38.1\%$, $P = .01$) and decreased underperception ($23.3 \pm 32.1\%$ vs $38.9 \pm 37.5\%$, $P = .004$) of airflow limitation during periods of limitation. Similar results were obtained in adjusted analyses.

Conclusion: This study indicates that differences in perception of airflow limitation may mediate the relationship of PTSD and increased asthma symptoms, given WTC workers with PTSD have worse self-reported asthma control, an increased proportion of accurate perception, and decreased underperception, despite no differences in daily PEF measures.

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Introduction

Asthma is a chronic inflammatory condition often reported among first responders to the World Trade Center (WTC), rescue and recovery personnel, and local residents and passersby.^{1,2} Moreover, many individuals exposed to WTC have uncontrolled disease, are at high risk of acute exacerbations leading to emergency department (ED) visits and hospitalizations, and have functional limitations due to

asthma.³ Thus, asthma is a major source of morbidity and impaired quality of life among individuals exposed to the WTC dust.

Post-traumatic stress disorder (PTSD) is also a highly prevalent condition among individuals exposed to WTC that frequently coexists with asthma, with previous studies revealing concurrent PTSD in one-third of individuals with asthma who were exposed to WTC.^{4,5} Moreover, PTSD is strongly associated with increased asthma symptoms, worse disease control, increased risk of ED visits and hospitalizations, and poorer quality of life.⁶ However, the mechanisms underlying the association between PTSD and increased asthma

Address correspondence to: Juan P. Wisnivesky, MD, DrPH, One Gustave L. Levy Place, Box 1087, New York, NY 10029; E-mail: juan.wisnivesky@mssm.edu.

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morbidity are not well understood. Previous studies have shown that behavioral factors, such as lower adherence to asthma controller medications, do not mediate this relationship.⁷ Interestingly, PTSD is more strongly associated with subjective markers of asthma morbidity, such as asthma symptoms and self-reported level of control, than with objective measures like lung function or peak expiratory flow (PEF), suggesting that PTSD may influence perception of airway limitation in individuals exposed to WTC.⁸

In this study, we used prospectively collected data on perception of airway limitation alongside PEF measurements from a cohort of rescue and recovery workers with asthma who were at WTC to test whether perception of airway limitation is a potential mechanism underlying the association between PTSD and worse asthma control.

Methods

Study Population

We recruited a prospective cohort of workers at the WTC enrolled in the Mount Sinai Hospital and Northwell Health System sites of the WTC Health Programs (WTCHP) Clinical Centers of Excellence. As previously reported, individuals eligible for the WTCHP worked or volunteered at the WTC site for at least 4 hours from September 11 to September 14, 2001, for at least 24 hours during September 2001, or for at least 80 hours from September to December 2001.⁹ Personnel of the Office of the Chief Medical Examiner and workers of the Port Authority Trans Hudson Corporation who participated in recovery activities were also eligible. Study participants were at least 18 years old, had a physician diagnosis of asthma, and spoke English or Spanish. We excluded individuals with history of chronic obstructive lung disease (COPD), other chronic lung diseases, or history of at least 15 pack-years of tobacco smoking, to avoid recruiting individuals with potentially undiagnosed COPD.

Potentially eligible WTC workers were sent a recruitment letter and then called by a research assistant to offer participation in the study and to perform an eligibility assessment. Study participants underwent a standardized in-person interview administered in English or Spanish by trained research staff. All participants signed an informed consent, and the study was approved by the institutional review board (IRB) of the Icahn School of Medicine at Mount Sinai (IRB# 16-01055) and Queens College, City University of New York (IRB# DOE000652).

Study Measures

We collected basic sociodemographic information (eg, age, sex, race, ethnicity, education, and income) using validated items from the National Health Interview Survey.¹⁰ History of asthma included self-reported age of onset, diagnosis in relation to WTC exposure (pre- vs post- September 11, 2001), history of allergies and other asthma-related comorbidities (eg, chronic sinusitis, nasal polyps, gastroesophageal reflux, obstructive sleep apnea, seasonal and food allergies), controller medication regimen, and history of acute resource utilization (including ED visits and hospitalizations) in the previous year.

Asthma control was assessed with the Asthma Control Questionnaire (ACQ), a validated tool available in English and Spanish, which is recommended by national and international guidelines and is usually used to assess asthma symptoms in routine care.⁹ The ACQ is a 6-item questionnaire with individual items ranging from 0 (totally controlled) to 6 (severely uncontrolled), with a mean score of at least 1.5 indicating poorly controlled asthma.¹¹ We used the Mini Asthma Quality of Life Questionnaire (AQLQ), a validated 15-item tool, to assess the impact of asthma on quality of life.¹² The AQLQ (English and Spanish versions) evaluates the impact of asthma along 4 subdomains (symptoms, activity limitations, emotional function, and

environmental stimuli), with higher scores indicating better quality of life.^{13,14} A difference of 0.5 units is considered clinically meaningful for both scales.¹⁵

We collected data on other comorbidities such as hypertension, diabetes, and coronary artery disease. Level of exposure to the WTC site was categorized using a previously published classification based on the total amount of time spent at the WTC site, the extent of exposure to the WTC dust cloud, and work on the pile at the WTC site.¹

Participants underwent a Structured Clinical Interview for Diagnostic and Statistical Manual for Mental Disorders Clinician Version Five (SCID-5) to identify workers with PTSD.^{16,17} The SCID-5 is recognized as the reference standard for the psychiatric diagnosis of PTSD conducted as part of clinical research, is well validated and reliable, and is available in English and Spanish. The interviews were conducted by research staff with a background in psychology who, before conducting the interviews, underwent standardized training in the administration procedures and were supervised by an experienced clinical psychologist. The severity of PTSD symptoms was assessed using the PTSD Checklist 5 (PCL-5).¹⁸ The PCL-5 is a 20-item self-report measure that assesses the 20 *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition) symptoms of PTSD and has high internal consistency, test-retest reliability, and convergent and discriminant validity.¹⁹

We used the AM2 programmable peak flow monitor (ERT Corporation, Philadelphia, Pennsylvania) to assess perception of airway limitation by comparing actual with perceived (ie, guessed) PEF values measured daily in the morning and evening for 6 weeks after enrollment. Following a validated protocol,²⁰ research staff trained participants to enter their guessed PEF into the AM2 device and then to perform 3 PEF measurements (to avoid a learning effect, participants were blinded to the PEF results). To help participants guess their PEF, we placed a colored sticker on the electronic device showing how their predicted PEF values (based on age, sex, and height) corresponded to the green, yellow, and red zones of asthma control as specified in the national asthma guidelines.²¹ PEF results were included if participants had performed at least 20 valid measurements. Each PEF guess was characterized as being in the accurate (guessed PEF $\leq 10\%$ lower or higher than the measured PEF), underperception (guessed PEF $> 10\%$ higher than measured), or overperception (guessed PEF $< 10\%$ lower than measured) of airway limitation zone using a validated asthma risk grid.²² The percentage of time a participant spent in each zone was calculated and treated as a continuous variable. The validity for this method to assess perception of airway limitation has been confirmed in several studies.^{23–25} It is unlikely that participants would report underperception of asthma symptoms during periods without airway limitation (because participants would have to guess a supranormal PEF to be classified as experiencing underperception). Thus, we also calculated the percentage of the time each participant spent in the under-, over-, and accurate perception zones while they had airway limitation (ie, the PEF was $< 80\%$ predicted).

Statistical Analysis

We used a *t* test, Wilcoxon test, or χ^2 test to compare the baseline characteristics of WTC workers with PTSD with those of workers without PTSD. Similar analyses were used to assess the relationship between PTSD and ACQ and AQLQ scores. Unadjusted actual and predicted PEF values were compared among WTC workers with and without PTSD using a linear mixed model with a participant random intercept to incorporate clustering due to repeated measures within individuals. Airway limitation perception scores in WTC workers with and those without PTSD were compared using a *t* test. We used the Pearson correlation coefficient to assess the unadjusted relationship between PCL-5 scores and perception of airway limitation.

The adjusted associations of PTSD with ACQ, AQLQ, and PEF measures were evaluated using linear regression or mixed linear models (random participant intercept), respectively, controlling for sociodemographic characteristics, asthma history, comorbidities, and level of exposure while working at the WTC site. Similar models were used to assess the association of PTSD with under-, accurate, or overperception of airway limitation after adjusting for age and sex but not for other markers of asthma control (given symptom perception was conceptualized as being in the pathway between PTSD and asthma outcomes). We repeated the analyses, limiting to data points obtained during periods of airway limitation. We also fit a generalized linear mixed model (random patient intercept), using each individual PEF measure (categorized as under-, accurate, or overperception) as the outcome and including PTSD status and other confounders as predictors.

Sample size calculation showed that with approximately 200 participants, the study will have greater than 80% power to show a difference of more than 25 units in PEF or more than 5% of the time spent in the under-, accurate or overperception zones in WTC workers with than in those without PTSD. Analyses were conducted with SAS software version 9.4 (SAS, Cary, North Carolina) using 2-sided *P* values at a .05 significant level.

Results

Between February 2017 and January 2020, we contacted WTC workers with a history of asthma enrolled in the WTCHP program; of these, 177 were found ineligible during screening (23% reported no history of asthma; 23% had COPD; 14% were not English or Spanish speakers, and 40% owing to other reasons). Of the 360 WTC workers who consented to the study, 3 were found to be ineligible after enrollment; 13 withdrew after consent, and 16 did not complete the SCID-5. Of the 328 eligible patients, 245 had PEF data collected; however, 21 did not have sufficient data points to reliably estimate perception of airway limitation and were thus excluded. Our final cohort included 224 WTC workers with asthma and valid PEF measures.

Overall, 57 participants (25%) had PTSD based on SCID-5 results. World Trade Center workers with PTSD were younger ($P = .01$), and more likely to be Hispanic ($P = .03$) and to have a lower income ($P = .002$) (Table 1). There were no significant differences in other sociodemographic characteristics, smoking history, asthma history or management, and comorbidities between WTC workers with and those without PTSD ($P > .05$ for all comparisons). World Trade Center workers with PTSD had worse asthma control (ACQ scores: 2.2 ± 0.8 vs 1.1 ± 0.9 , $P < .001$), higher rates of ED visits (31% vs 8%, $P < .001$) or hospitalizations (9% vs 1%, $P = .01$), and poorer quality of life (AQLQ scores: 3.9 ± 1.1 vs 5.4 ± 1.1 , $P < .001$) than did those without PTSD.

Unadjusted analyses showed no significant differences in mean PEF measures (351.92 ± 143.25 L/min vs 364.62 ± 131.62 L/min, $P = .55$) or predicted PEF ($73 \pm 30\%$ vs $76 \pm 27\%$, $P = .78$) between WTC workers with and those without PTSD (Table 2). In terms of perception of airway limitation, WTC workers with PTSD had decreased rates of underperception ($16.0 \pm 24.7\%$ vs $22.4 \pm 25.2\%$, $P = .02$) compared with those without PTSD. Moreover, during periods of airway limitation, WTC workers with PTSD were more likely to have accurate perception ($67.0 \pm 37.2\%$ vs $53.5 \pm 38.1\%$, $P = .01$) and less likely to have underperception ($23.3 \pm 32.1\%$ vs $38.9 \pm 37.5\%$, $P = .004$) than were workers without PTSD. Post-traumatic stress disorder was not associated with overperception overall ($22.4 \pm 32.2\%$ vs $15.6 \pm 23.8\%$, $P = .3$) or during periods of airway limitation ($4.5 \pm 18.2\%$ vs $3.2 \pm 14.6\%$, $P = .4$). Similarly, higher PCL-5 scores were significantly positively correlated with accurate perception ($r = 0.2$, $P = .004$) and negatively correlated with underperception ($r = -0.2$, $P = .005$) during periods of airway limitation. Post-Traumatic Stress Disorder Checklist 5 scores were not significantly correlated with overperception ($r = 0.1$, $P = .13$) during periods of airway limitation (Figs 1-3).

Table 1

Characteristics of World Trade Center Workers With Asthma With and Without Post-Traumatic Stress Disorder

| Characteristic | PTSD N = 57 | No PTSD N = 167 | <i>P</i> value |
|---|----------------|--------------------|----------------|
| Age, y, mean (SD) | 53.4 (9) | 56.0 (8) | .01 |
| Female, n (%) | 19 (33) | 41 (25) | .1 |
| Race/ethnicity, n (%) | | | |
| White | 19 (33) | 67 (40) | .03 |
| Black | 7 (12) | 42 (25) | |
| Hispanic | 19 (33) | 41 (25) | |
| Other | 12 (21.1) | 17 (10.2) | |
| Married, n (%) | 29 (51) | 106 (65) | .06 |
| Education, n (%) | | | |
| High school or less | 12 (21) | 38 (24) | .7 |
| Some college or college graduate | 45 (79) | 124 (76) | |
| Income, n (%) | | | |
| ≤\$3000 per mo | 24 (46) | 38 (24) | .002 |
| >\$3000 per mo | 28 (54) | 118 (76) | |
| World Trade Center exposure, n (%) | | | |
| Low | 5 (11) | 14 (11) | .4 |
| Intermediate | 26 (59) | 83 (67) | |
| High | 5 (12) | 42 (38.2) | |
| Very high | 8 (18) | 11 (9) | |
| Never smoker, n (%) | 41 (75) | 117 (74.5) | .9 |
| Post-9/11 asthma, n (%) | 43 (83) | 127 (83.5) | .8 |
| Sensitized to aeroallergens, n (%) | 13 (34) | 42 (38.2) | .6 |
| On asthma controller medication, n (%) | 34 (60) | 105 (62.9) | .6 |
| Asthma Control Questionnaire, mean (SD) | 2.2 (0.8) | 1.1 (0.9) | <.001 |
| Asthma Quality of Life Questionnaire, mean (SD) | 3.9 (1.1) | 5.4 (1.1) | <.001 |
| Resource utilization, n (%) | | | |
| Oral steroid use in the past y | 22 (39) | 43 (26) | .06 |
| Emergency department visit for asthma in the past y | 17 (31) | 13 (8) | <.001 |
| Hospitalized for asthma in the past y | 5 (9) | 2 (1) | .01 |
| Body mass index, mean (SD) | 31.4 (5.5) | 31.7 (5.7) | .85 |
| Comorbidities, n (%) | | | |
| Gastric esophageal reflux disorder | 40 (70.2) | 112 (67.1) | .6 |
| Chronic sinusitis | 38 (66.7) | 97 (58.1) | .2 |
| Diabetes mellitus | 11 (19.3) | 32 (19.2) | .9 |
| Hypertension | 21 (36.8) | 82 (49.1) | .1 |

Adjusted analyses showed that PTSD was significantly associated with worse asthma control (mean difference in ACQ scores, 0.9; 95% confidence interval [CI], 0.5-1.3) and poorer quality of life (mean difference in ACQ scores, -1.4; 95% CI, -1.9 to -1.0) after controlling for potential confounders (Table 3). However, there was no significant association between PTSD and PEF (mean difference, -10.5; 95% CI, -47.3 to 26.4 L/min) or predicted PEF (mean difference, -3; 95% CI, -10 to 5). Although there were no significant differences in symptom perception among groups overall, PTSD was significantly associated with accurate perception (mean difference, 13.5; 95% CI, 0.8%-26.3%) and less likely associated with underperception (mean difference, -14.8; 95% CI, -27.0 to -2.7%) during periods of airway limitation. Similarly, PCL-5 scores were significantly associated with increased accurate perception (mean difference, 5.90; 95% CI, 1.91-9.90)/10 U difference in PCL-5) and lower rates of underperception (mean difference, -5.63; 95% CI, -9.44 to -1.81)/10 U difference in PCL-5) but not with overperception (mean difference, -0.14; 95% CI, -1.82 to 1.54)/10 U difference in PCL-5) during periods of limitation after controlling for confounders. Adjusted analyses using perception assessments based on individual PEF measures as the outcome also showed that PTSD was associated with increased odds of accurate perception overall (odds ratio, 2.01; 95% CI, 1.12-3.63) and during periods of airway limitation (odds ratio, 2.23; 95% CI, 1.02-4.87).

Discussion

PTSD has been consistently associated with increased asthma morbidity in studies in individuals exposed to WTC and in other

Table 2
Unadjusted Associations of Post-Traumatic Stress Disorder With Measures of Asthma Control, Airway Limitation, and Symptom Perception

| Outcome | PTSD | No PTSD | P value |
|---|-----------------|-----------------|---------|
| PEF, L/min, mean (SD) | 351.92 (143.25) | 364.62 (131.61) | .55 |
| Predicted PEF, mean % (SD) | 73 (30) | 76 (27) | .78 |
| PEF perception, mean percentage of time (SD) | | | |
| Overperception (guessed PEF <10% lower than measured) | 22.4 (32.2) | 15.6 (23.8) | .3 |
| Accurate perception (guessed PEF ≤10% lower or higher than measured) | 61.6 (31.7) | 62.0 (25.6) | .6 |
| Underperception (guessed PEF >10% higher than measured) | 16.0 (24.7) | 22.4 (25.2) | .02 |
| PEF perception when obstructed, mean percentage of time (SD) | | | |
| Overperception (guessed PEF <10% lower than measured) | 4.5 (18.2) | 3.2 (14.6) | .4 |
| Accurate perception (guessed PEF ≤10% lower or higher than measured) | 67.0 (37.2) | 53.5 (38.1) | .01 |
| Underperception (guessed PEF >10% higher than measured) | 23.3 (32.1) | 38.9 (37.5) | .004 |

Abbreviations: PEF, peak expiratory flow; PTSD, post-traumatic stress disorder.

populations.^{6,26} However, PTSD has been more strongly associated with subjective than with objective asthma morbidity markers, suggesting potential differences in symptom perception.⁸ In this study, we found that WTC workers with and without PTSD had similar degrees of airflow limitation as evidenced by PEF values, thus suggesting equal asthma control. However, despite similar objective measures of asthma control, those with PTSD had worse ACQ and AQLQ scores. Our study highlights that symptom perception may partially explain the difference in subjective asthma morbidity markers, given WTC workers with PTSD were more likely to accurately perceive and less likely to underperceive airway limitation.

Multiple studies have described the substantial burden of asthma morbidity in first responders to WTC, WTC recovery workers, and exposed community members, with reports of poorly controlled disease in 34% and very poorly controlled symptoms in 35% of individuals

exposed.⁵ Increased risk of ED visits and hospitalizations in addition to poorer quality of life in WTC workers with asthma have also been reported, showing a substantial impact on well-being and functional status.³ Post-traumatic stress disorder is 1 of the most common comorbidities among individuals with asthma who were exposed to WTC.²⁷ Mental health conditions in general, and PTSD in particular, have been associated with increased asthma morbidity.²⁸ A study of participants in the WTCHP showed that WTC workers with PTSD had worse asthma control, increased healthcare use, and poorer quality of life.⁴ Similarly, a prospective study in workers exposed to WTC indicated that severity of PTSD symptoms predicted new onset and worsening of asthma.²⁹ Data from studies in the general population have also shown a significant association between PTSD and increased asthma morbidity.^{30,31} Thus, PTSD has been recognized as a major contributor to poor asthma outcomes in first responders to and rescue workers at WTC.

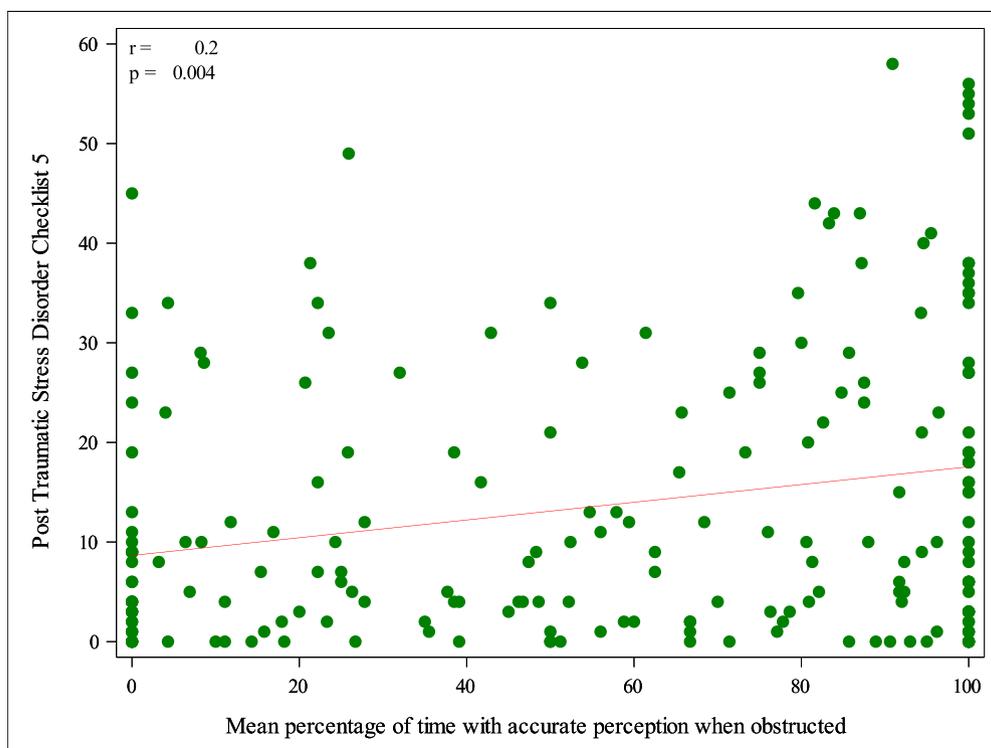


Figure 1. Correlation of severity of post-traumatic stress disorder with mean percentage of time with accurate perception when obstructed (guessed peak expiratory flow ≤10% lower or higher than measured) as measured with peak expiratory flow.

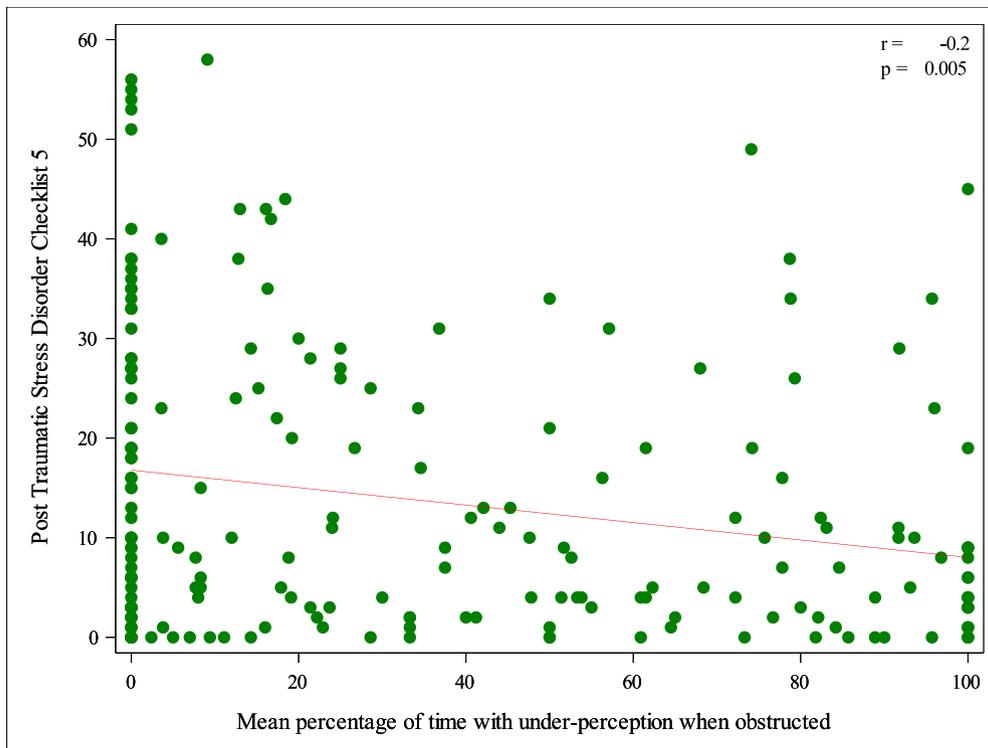


Figure 2. Correlation of severity of post-traumatic stress disorder with mean percentage of time with underperception when obstructed (guessed peak expiratory flow >10% higher than measured) as measured with peak expiratory flow.

Although PTSD is associated with increased objective and subjective asthma morbidity markers, previous studies have reported stronger associations with subjective measures.^{32,33} Similarly to previous research, our study indicated WTC workers with PTSD reported worse

asthma control and poorer quality of life.³ However, we found no significant differences in daily PEF values collected over 6 weeks between WTC workers with and those without PTSD, suggesting similar levels of airflow limitation. Moreover, we found that PTSD was associated

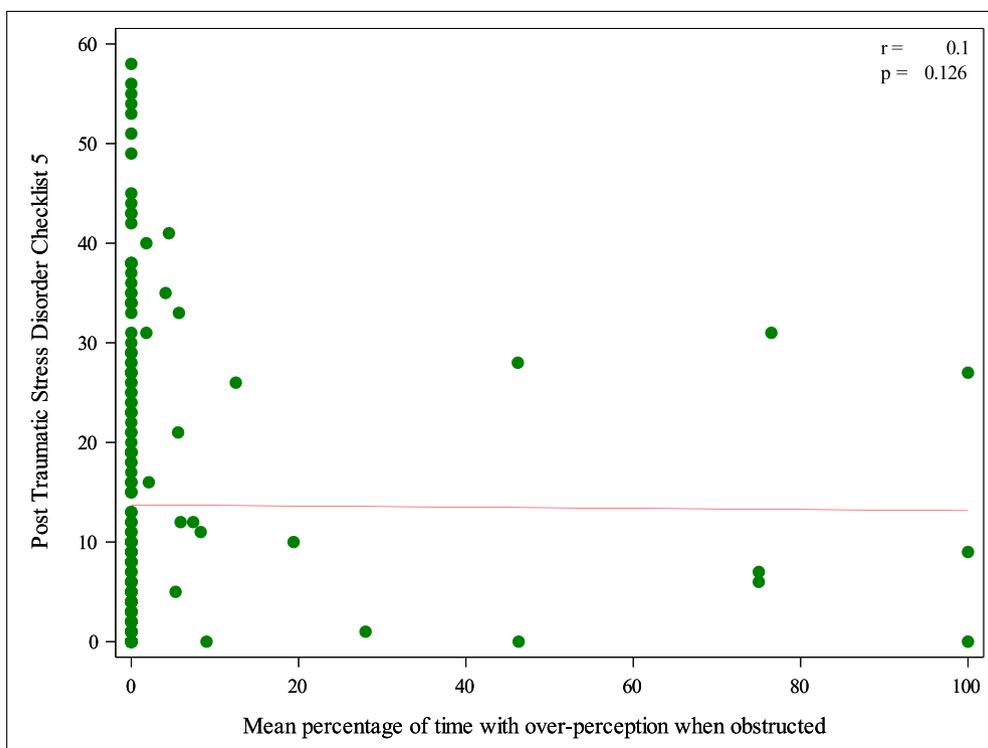


Figure 3. Correlation of severity of post-traumatic stress disorder with mean percentage of time with overperception when obstructed (guessed peak expiratory flow <10% lower than measured) as measured with peak expiratory flow.

Table 3
Adjusted Associations Between Post-Traumatic Stress Disorder, Peak Expiratory Flow, Symptom Perception in World Trade Center Workers With Asthma

| Outcome | Mean difference PTSD vs no PTSD | 95% confidence interval |
|---|------------------------------------|----------------------------|
| Asthma Control Questionnaire, mean (SD) | 0.9 | 0.5–1.3 |
| Asthma Quality of Life Questionnaire, mean (SD) | –1.4 | –1.9 to –1.0 |
| Peak expiratory flow, L/min | –10.5 | –47.3 to 26.4 |
| Predicted peak expiratory flow (%) | –3 | –10 to 5 |
| Symptom perception (%) ^a | | |
| Over | 6.2 | –2.1 to 14.5 |
| Accurate | 0.1 | –8.6 to 8.9 |
| Under | –6.5 | –14.5 to 1.6 |
| Symptom perception when obstructed (%) | | |
| Over | 1.4 | –3.8 to 6.6 |
| Accurate | 13.5 | 0.8–26.3 |
| Under | –14.8 | –27.0 to –2.7 |

Abbreviation: PTSD, post-traumatic stress disorder.

NOTE. Adjusted for age, sex, race/ethnicity, smoking status, income, post-September 11 asthma, use of controller medications, and comorbidities.

^aAdjusted for age, sex, and race/ethnicity.

with more accurate perception and lower underperception of airway limitation. Thus, our findings show that symptom perception may mediate the relationship of self-reported worse asthma control and quality of life in individuals with PTSD than in those without PTSD. Specifically, individuals with PTSD and asthma may report worse asthma control because these individuals are more likely to accurately perceive and less likely to underperceive airway limitation.

Effective asthma self-management behaviors require that patients recognize and respond to their symptoms (eg, use rescue medication, avoid triggers, seek medical care, etc). Self-monitoring of symptoms is also key for assessing response to treatment with controller medications and thus developing effective self-regulatory mechanisms.³⁴ Our findings that WTC workers with PTSD are more likely to accurately perceive episodes of airway limitation should alert healthcare providers to adequately address patients' persistent asthma symptoms because these are more likely to represent uncontrolled disease. Moreover, given that WTC workers with PTSD in our study had more accurate perception of airway limitation, these patients may increasingly benefit from single maintenance and reliever therapy that requires patients to use controller medications when experiencing worse asthma symptoms.

The differences in symptom perception between WTC workers with and those without PTSD may be due to an associative learning mechanism. Because worsening asthma symptoms can trigger negative affective states, an association between such a state and asthma symptoms can develop in WTC workers with PTSD. Therefore, subsequent negative emotional states due to PTSD may cause greater focus on respiratory symptoms and more accurate perceptions of airway limitation. Furthermore, a common cognitive process in PTSD and asthma is anxiety sensitivity, the tendency to focus on bodily sensations associated with anxious arousal (eg, shortness of breath). Anxiety sensitivity is significantly associated with PTSD³⁵ and predicts PTSD symptoms over time.³⁶ In addition, anxiety sensitivity is significantly associated with poor asthma-related quality of life and worse asthma control, greater asthma symptoms, and lower levels of lung function.³⁷ As such, anxiety sensitivity may influence asthma perception in WTC workers with coexisting PTSD. Specifically, individuals with elevated anxiety sensitivity and PTSD may be more attuned to and hyperfocused on their asthma symptoms, which, over time, may lead to more accurate perception of airway limitation. Moreover, PTSD is linked to cognitive representation of asthma as an acute, difficult-to-control illness.³⁸ A higher perceived threat of asthma may lead to increased attention to episodes of airway limitation and greater perception accuracy.

Our study has strengths and weaknesses that are worth discussing. We analyzed data from a well-characterized cohort of WTC

workers with asthma; however, we did not assess response to bronchodilators as part of the study. All participants underwent SCID-5 testing to assess for the presence of PTSD, which should minimize misclassification. In addition, we evaluated perception of airway limitation in naturalistic settings (rather than under artificial laboratory procedures) using a validated method. Similarly, we used well-validated instruments to assess asthma symptoms and quality of life, 2 well-established self-reported measures of asthma control broadly used in clinical practice. Our study focused on WTC workers participating in the WTCHP. Thus, our results may not be generalizable to other groups of individuals exposed to the WTC site, including downtown residents and passersby. Accurate PEF measurements are effort dependent, which may be differentially affected by PTSD. However, all participants underwent extensive in-person training and demonstrated their PEF maneuver to research staff. Furthermore, we did not find significant differences in PEF across WTC workers with and those without PTSD. Although our study showed independent associations among PTSD, perception of airway limitation, and asthma control, our observational design does not allow us to make causal inferences about these relationships.

In summary, our study showed that WTC workers with PTSD were more likely to accurately perceive episodes of airway limitation and less likely to report underperception. In addition, PTSD was associated with self-reported measures of asthma control but not with PEF measures. These findings suggest that perception of airway limitation may partially explain the increased level of asthma morbidity reported by WTC workers with asthma.

Disclosures

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