

Future of World Trade Center Health Program Research

FDNY WTCHP

Survivor WTCHP

Responder WTCHP

Presented by Laura Crowley, MD



**Mount
Sinai**

Description of WTCHP Cohorts

☐ **FDNY program:**

- All active and retired FDNY members who responded to the 9/11 attack

☐ **Responder program:**

- Include Workers and Volunteers who responded to the 9/11 attacks

☐ **Survivor program:**

- People who worked, lived or attended school, child care or adult/senior care and who were involved in debris removal and clean up in the NYC disaster area.



Characteristics of WTCHP

- provides medical monitoring and surveillance
- provides specialized WTC treatment services for exposure related diseases (upper airway, lower airway, gastroesophageal reflux, mental health, specific --- musculoskeletal diseases and cancers)
- unique and well characterized population with high retention rates
- unprecedented exposure without control for comparison

James Zadroga 9/11 Health and Compensation Act of 2010: Research into Conditions

(a) IN GENERAL— With respect to individuals, including enrolled WTC responders and certified-eligible WTC survivors, receiving monitoring or treatment under subtitle B, the WTC Program Administrator shall conduct or support—

- (1) **research on physical and mental health conditions** that may be related to the September 11, 2001, terrorist attacks;
- (2) **research on diagnosing WTC-related health conditions** of such individuals, in the case of conditions for which there has been **diagnostic uncertainty**
- (3) **research on treating WTC-related health conditions** of such individuals, in the case of conditions for which there has been **treatment uncertainty**.

(b) TYPES OF RESEARCH— The research under subsection (a)(1) shall include **epidemiologic** and other research studies on WTC related health conditions or **emerging conditions**—



Research

- Mechanism

“concept that particular scientific areas of interest may be explained in terms of structure, interaction of their component parts”

- Outcomes

“clinical and population based research that seeks to study and optimize the end results of healthcare in patients, development of strategies and interventions to improve care”

- Progression of Disease

evaluation of disease states and objective markers that may place patients at risk for disease advancement. Allows for early treatment interventions that may promote regression of disease

Mechanism



Inflammatory Biomarkers Predict Airflow Obstruction After Exposure to World Trade Center Dust

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Background: The World Trade Center (WTC) collapse on September 11, 2001, produced airflow obstruction in a majority of firefighters receiving subspecialty pulmonary evaluation (SPE) within 6.5 years post-September 11, 2001.

Methods: In a cohort of 801 never smokers with normal pre-September 11, 2001, FEV₁, we correlated inflammatory biomarkers and CBC counts at monitoring entry within 6 months of September 11, 2001, with a median FEV₁ at SPE (34 months; interquartile range, 25-57). Cases of airflow obstruction had FEV₁ less than the lower limit of normal (LLN) (100 of 801; 70 of 100 had serum), whereas control subjects had FEV₁ greater than or equal to LLN (153 of 801; 124 of 153 had serum).

Results: From monitoring entry to SPE years later, FEV₁ declined 12% in cases and increased 3% in control subjects. Case subjects had elevated serum macrophage derived chemokine (MDC), granulocyte-macrophage colony-stimulating factor (GM-CSF), granulocyte colony-stimulating factor, and interferon inducible protein-10 levels. Elevated GM-CSF and MDC increased the risk for subsequent FEV₁ less than LLN by 2.5-fold (95% CI, 1.2-5.3) and 3.0-fold (95% CI, 1.4-6.1) in a logistic model adjusted for exposure, BMI, age on September 11, 2001, and polymorphonuclear neutrophils. The model had sensitivity of 38% (95% CI, 27-51) and specificity of 88% (95% CI, 80-93).

Conclusions: Inflammatory biomarkers can be risk factors for airflow obstruction following dust and smoke exposure. Elevated serum GM-CSF and MDC levels soon after WTC exposure were associated with increased risk of airflow obstruction in subsequent years. Biomarkers of inflammation may help identify pathways producing obstruction after irritant exposure.

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Abbreviations: FDNY = Fire Department City of New York; G-CSF = granulocyte colony-stimulating factor; GM-CSF = granulocyte-macrophage colony-stimulating factor; IP-10 = interferon inducible protein-10; LLN = lower limit of normal; MDC = macrophage-derived chemokine; MME = medical monitoring entry; NHANES = National Health and Nutrition Examination Survey; PFT = pulmonary function test; PM = particulate matter; PMN = polymorphonuclear neutrophil; SPE = subspecialty pulmonary evaluation; WTC = World Trade Center

Mechanism

BIOMARKERS

Elevated Peripheral Eosinophils Are Associated with New-Onset and Persistent Wheeze and Airflow Obstruction in World Trade Center-Exposed Individuals

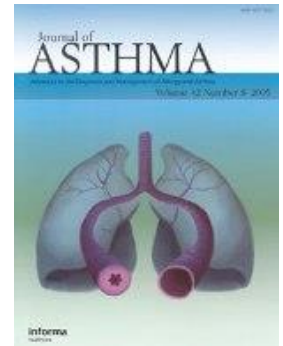
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Background. Exposure to World Trade Center (WTC) dust and fumes is associated with the onset of asthma-like respiratory symptoms in rescue and recovery workers and exposed community members. Eosinophilic inflammation with increased lung and peripheral eosinophils has been described in subpopulations with asthma. We hypothesized that persistent asthma-like symptoms in WTC-exposed individuals would be associated with systemic inflammation characterized by peripheral eosinophils. **Methods.** The WTC Environmental Health Center (WTC EHC) is a treatment program for local residents, local workers, and cleanup workers with presumed WTC-related symptoms. Patients undergo a standardized evaluation including questionnaires and complete blood count. Between September 2005 and March 2009, 2462 individuals enrolled in the program and were available for analysis. Individuals with preexisting respiratory symptoms or lung disease diagnoses prior to September 2001 and current or significant tobacco use were excluded. **Results.** One thousand five hundred and seventeen individuals met the inclusion criteria. Patients had a mean age of 47 years, were mostly female (51%), and had a diverse race/ethnicity. Respiratory symptoms that developed after WTC dust/fume exposure and remained persistent included dyspnea on exertion (68%), cough (57%), chest tightness (47%), and wheeze (33%). A larger percentage of patients with wheeze had elevated peripheral eosinophils compared with those without wheeze (21% vs. 13%, $p < .0001$). Individuals with elevated peripheral eosinophils were more likely to have airflow obstruction on spirometry (16% vs. 7%, $p = .0003$). **Conclusion.** Peripheral eosinophils were associated with wheeze and airflow obstruction in a diverse WTC-exposed population. These data suggest that eosinophils may participate in lung inflammation in this population with symptoms consistent with WTC-related asthma.

Keywords asthma, eosinophil, spirometry, World Trade Center



Mechanism



Health and Environmental Consequences of the World Trade Center Disaster

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The attack on the World Trade Center (WTC) created an acute environmental disaster of enormous magnitude. This study characterizes the environmental exposures resulting from destruction of the WTC and assesses their effects on health. Methods include ambient air sampling; analyses of outdoor and indoor settled dust; high-altitude imaging and modeling of the atmospheric plume; inhalation studies of WTC dust in mice; and clinical examinations, community surveys, and prospective epidemiologic studies of exposed populations. WTC dust was found to consist predominantly (95%) of coarse particles and contained pulverized cement, glass fibers, asbestos, lead, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated furans and dioxins. Airborne particulate levels were highest immediately after the attack and declined thereafter. Particulate levels decreased sharply with distance from the WTC. Dust pH was highly alkaline (pH 9.0–11.0). Mice exposed to WTC dust showed only moderate pulmonary inflammation but marked bronchial hyperreactivity. Evaluation of 10,116 firefighters showed exposure-related increases in cough and bronchial hyperreactivity. Evaluation of 183 cleanup workers showed new-onset cough (33%), wheeze (18%), and phlegm production (24%). Increased frequency of new-onset cough, wheeze, and shortness of breath were also observed in community residents. Follow-up of 182 pregnant women who were either inside or near the WTC on 11 September showed a 2-fold increase in small-for-gestational-age (SGA) infants. In summary, environmental exposures after the WTC disaster were associated with significant adverse effects on health. The high alkalinity of WTC dust produced bronchial hyperreactivity, persistent cough, and increased risk of asthma. Plausible causes of the observed increase in SGA infants include maternal exposures to PAH and particulates. Future risk of mesothelioma may be increased, particularly among workers and volunteers exposed occupationally to asbestos. Continuing follow-up of all exposed populations is required to document the long-term consequences of the disaster. *Key words:* air pollution, airway hyperresponsiveness, asbestos, occupational lung disease, PM_{2.5}, PM₁₀, small for gestational age (SGA). *Environ Health Perspect* 112:731–739 (2004). doi:10.1289/ehp.6702 available via <http://dx.doi.org/> [Online 18 February 2004]



Mechanism

Dimensional structure and course of post-traumatic stress symptomatology in World Trade Center responders

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Background. Post-traumatic stress disorder (PTSD) in response to the World Trade Center (WTC) disaster of 11 September 2001 (9/11) is one of the most prevalent and persistent health conditions among both professional (e.g. police) and non-traditional (e.g. construction worker) WTC responders, even several years after 9/11. However, little is known about the dimensionality and natural course of WTC-related PTSD symptomatology in these populations.

Method. Data were analysed from 10835 WTC responders, including 4035 police and 6800 non-traditional responders who were evaluated as part of the WTC Health Program, a clinic network in the New York area established by the National Institute for Occupational Safety and Health. Confirmatory factor analyses (CFAs) were used to evaluate structural models of PTSD symptom dimensionality; and autoregressive cross-lagged (ARCL) panel regressions were used to examine the prospective interrelationships among PTSD symptom clusters at 3, 6 and 8 years after 9/11.

Results. CFAs suggested that five stable symptom clusters best represent PTSD symptom dimensionality in both police and non-traditional WTC responders. This five-factor model was also invariant over time with respect to factor loadings and structural parameters, thereby demonstrating its longitudinal stability. ARCL panel regression analyses revealed that hyperarousal symptoms had a prominent role in predicting other symptom clusters of PTSD, with anxious arousal symptoms primarily driving re-experiencing symptoms, and dysphoric arousal symptoms primarily driving emotional numbing symptoms over time.

Conclusions. Results of this study suggest that disaster-related PTSD symptomatology in WTC responders is best represented by five symptom dimensions. Anxious arousal symptoms, which are characterized by hypervigilance and exaggerated startle, may primarily drive re-experiencing symptoms, while dysphoric arousal symptoms, which are characterized by sleep disturbance, irritability/anger and concentration difficulties, may primarily drive emotional numbing symptoms over time. These results underscore the importance of assessment, monitoring and early intervention of hyperarousal symptoms in WTC and other disaster responders.



Outcomes

Outcomes

The Respiratory Pyramid: From Symptoms to Disease in World Trade Center Exposed Firefighters



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Anna Nolan, MD, MS,^{1,4} Lara Glass, MPH,¹ Kerry J. Kelly, MD,¹ and David J. Prezant, MD^{1,2,3}

Background This study utilizes a four-level pyramid framework to understand the relationship between symptom reports and/or abnormal pulmonary function and diagnoses of airway diseases (AD), including asthma, recurrent bronchitis and COPD/emphysema in WTC-exposed firefighters. We compare the distribution of pyramid levels at two time-points: by 9/11/2005 and by 9/11/2010.

Methods We studied 6,931 WTC-exposed FDNY firefighters who completed a monitoring exam during the early period and at least two additional follow-up exams 9/11/2005–9/11/2010.

Results By 9/11/2005 the pyramid structure was as follows: 4,039 (58.3%) in Level 1, no respiratory evaluation or treatment; 1,608 (23.2%) in Level 2, evaluation or treatment without AD diagnosis; 1,005 (14.5%) in Level 3, a single AD diagnosis (asthma, emphysema/COPD, or recurrent bronchitis); 279 (4.0%) in Level 4, asthma and another AD. By 9/11/2010, the pyramid distribution changed considerably, with Level 1 decreasing to 2,612 (37.7% of the cohort), and Levels 3 ($N = 1,530$) and 4 ($N = 796$) increasing to 22.1% and 11.5% of the cohort, respectively. Symptoms, spirometry measurements and healthcare utilization were associated with higher pyramid levels.

Conclusions Respiratory diagnoses, even four years after a major inhalation event, are not the only drivers of future healthcare utilization. Symptoms and abnormal FEV-1 values must also be considered if clinicians and healthcare administrators are to accurately anticipate future treatment needs, years after initial exposure. *Am. J. Ind. Med.* 56:870–880, 2013. © 2013 Wiley Periodicals, Inc.

Outcomes



Persistence of multiple illnesses in World Trade Center rescue and recovery workers: a cohort study

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Summary

Background More than 50 000 people participated in the rescue and recovery work that followed the Sept 11, 2001 (9/11) attacks on the World Trade Center (WTC). Multiple health problems in these workers were reported in the early years after the disaster. We report incidence and prevalence rates of physical and mental health disorders during the 9 years since the attacks, examine their associations with occupational exposures, and quantify physical and mental health comorbidities.

Methods In this longitudinal study of a large cohort of WTC rescue and recovery workers, we gathered data from 27 449 participants in the WTC Screening, Monitoring, and Treatment Program. The study population included police officers, firefighters, construction workers, and municipal workers. We used the Kaplan-Meier procedure to estimate cumulative and annual incidence of physical disorders (asthma, sinusitis, and gastro-oesophageal reflux disease), mental health disorders (depression, post-traumatic stress disorder [PTSD], and panic disorder), and spirometric abnormalities. Incidence rates were assessed also by level of exposure (days worked at the WTC site and exposure to the dust cloud).

Findings 9-year cumulative incidence of asthma was 27·6% (number at risk: 7027), sinusitis 42·3% (5870), and gastro-oesophageal reflux disease 39·3% (5650). In police officers, cumulative incidence of depression was 7·0% (number at risk: 3648), PTSD 9·3% (3761), and panic disorder 8·4% (3780). In other rescue and recovery workers, cumulative incidence of depression was 27·5% (number at risk: 4200), PTSD 31·9% (4342), and panic disorder 21·2% (4953). 9-year cumulative incidence for spirometric abnormalities was 41·8% (number at risk: 5769); three-quarters of these abnormalities were low forced vital capacity. Incidence of most disorders was highest in workers with greatest WTC exposure. Extensive comorbidity was reported within and between physical and mental health disorders.

Interpretation 9 years after the 9/11 WTC attacks, rescue and recovery workers continue to have a substantial burden of physical and mental health problems. These findings emphasise the need for continued monitoring and treatment of the WTC rescue and recovery population.



Outcomes

Characteristics of a Residential and Working Community With Diverse Exposure to World Trade Center Dust, Gas, and Fumes

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From the Department of Medicine (Dr Reibman, Dr Rogers, Dr Lau, Dr Berger, Dr Goldring, Dr Fernandez-Beros, Dr Tonorezos, Dr Caplan-Shaw, Dr Gonzalez, Dr Filner, Mr Walter, Mr Kyng, Dr Rom); Department of Environmental Medicine (Dr Liu, Dr Cheng, Dr Marmor), New York University School of Medicine, New York, NY; and Department of Medicine (Dr Liautaud), Tufts University School of Medicine, Baystate Medical Center, Springfield, Mass.

Abstract

Objective—To describe physical symptoms in those local residents, local workers, and cleanup workers who were enrolled in a treatment program and had reported symptoms and exposure to the dust, gas, and fumes released with the destruction of the World Trade Center (WTC) on September 11, 2001.

Methods—Symptomatic individuals underwent standardized evaluation and subsequent treatment.

Results—One thousand eight hundred ninety-eight individuals participated in the WTC Environmental Health Center between September 2005 and May 2008. Upper and lower respiratory symptoms that began after September 11, 2001 and persisted at the time of examination were common in each exposure population. Many (31%) had spirometry measurements below the lower limit of normal.

Conclusions—Residents and local workers as well as those with work-associated exposure to WTC dust have new and persistent respiratory symptoms with lung function abnormalities 5 or more years after the WTC destruction.



Outcomes

Exposure, probable PTSD and lower respiratory illness among World Trade Center rescue, recovery and clean-up workers

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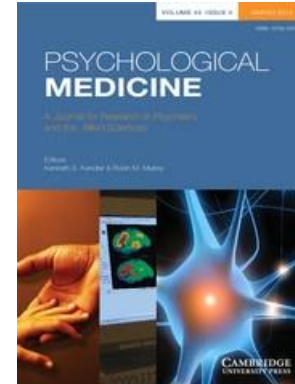
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Background. Thousands of rescue and recovery workers descended on the World Trade Center (WTC) in the wake of the terrorist attack of September 11, 2001 (9/11). Recent studies show that respiratory illness and post-traumatic stress disorder (PTSD) are the hallmark health problems, but relationships between them are poorly understood. The current study examined this link and evaluated contributions of WTC exposures.

Method. Participants were 8508 police and 12333 non-traditional responders examined at the WTC Medical Monitoring and Treatment Program (WTC-MMTP), a clinic network in the New York area established by the National Institute for Occupational Safety and Health (NIOSH). We used structural equation modeling (SEM) to explore patterns of association among exposures, other risk factors, probable WTC-related PTSD [based on the PTSD Checklist (PCL)], physician-assessed respiratory symptoms arising after 9/11 and present at examination, and abnormal pulmonary functioning defined by low forced vital capacity (FVC).

Results. Fewer police than non-traditional responders had probable PTSD (5.9% *v.* 23.0%) and respiratory symptoms (22.5% *v.* 28.4%), whereas pulmonary function was similar. PTSD and respiratory symptoms were moderately correlated ($r=0.28$ for police and 0.27 for non-traditional responders). Exposure was more strongly associated with respiratory symptoms than with PTSD or lung function. The SEM model that best fit the data in both groups suggested that PTSD statistically mediated the association of exposure with respiratory symptoms.

Conclusions. Although longitudinal data are needed to confirm the mediation hypothesis, the link between PTSD and respiratory symptoms is noteworthy and calls for further investigation. The findings also support the value of integrated medical and psychiatric treatment for disaster responders.



Outcomes



Enduring Mental Health Morbidity and Social Function Impairment in World Trade Center Rescue, Recovery, and Cleanup Workers: The Psychological Dimension of an Environmental Health Disaster

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BACKGROUND: The World Trade Center (WTC) attacks exposed thousands of workers to hazardous environmental conditions and psychological trauma. In 2002, to assess the health of these workers, Congress directed the National Institute for Occupational Safety and Health to establish the WTC Medical Monitoring and Treatment Program. This program has established a large cohort of WTC rescue, recovery, and cleanup workers. We previously documented extensive pulmonary dysfunction in this cohort related to toxic environmental exposures.

OBJECTIVES: Our objective in this study was to describe mental health outcomes, social function impairment, and psychiatric comorbidity in the WTC worker cohort, as well as perceived symptomatology in workers' children.

METHODS: Ten to 61 months after the WTC attack, 10,132 WTC workers completed a self-administered mental health questionnaire.

RESULTS: Of the workers who completed the questionnaire, 11.1% met criteria for probable post-traumatic stress disorder (PTSD), 8.8% met criteria for probable depression, 5.0% met criteria for probable panic disorder, and 62% met criteria for substantial stress reaction. PTSD prevalence was comparable to that seen in returning Afghanistan war veterans and was much higher than in the U.S. general population. Point prevalence declined from 13.5% to 9.7% over the 5 years of observation. Comorbidity was extensive and included extremely high risks for impairment of social function. PTSD was significantly associated with loss of family members and friends, disruption of family, work, and social life, and higher rates of behavioral symptoms in children of workers.

CONCLUSIONS: Working in 9/11 recovery operations is associated with chronic impairment of mental health and social functioning. Psychological distress and psychopathology in WTC workers greatly exceed population norms. Surveillance and treatment programs continue to be needed.

KEY WORDS: depression, disaster workers, functional impairment, occupational health, post-traumatic stress disorder, stress, World Trade Center. *Environ Health Perspect* 116:1248–1253 (2008). doi:10.1289/ehp.11164 available via <http://dx.doi.org/> [Online 13 May 2008]



Progression of Disease

Progression of disease



CHEST

Original Research

OCCUPATIONAL AND ENVIRONMENTAL LUNG DISEASES

Pulmonary Function Predicting Confirmed Recovery From Lower-Respiratory Symptoms in World Trade Center-Exposed Firefighters, 2001 to 2010

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Background: We examined the relationship between pulmonary function (FEV₁) and confirmed recovery from three lower-respiratory symptoms (LRSs) (cough, dyspnea, and wheeze) up to 9 years after symptom onset.

Methods: The study included white and black male World Trade Center (WTC)-exposed firefighters who reported at least one LRS on a medical monitoring examination during the first year after September 11, 2001. Confirmed recovery was defined as reporting no LRSs on two consecutive and all subsequent examinations. FEV₁ was assessed at the first post-September 11, 2001, examination and at each examination where symptom information was ascertained. We used stratified Cox regression models to analyze FEV₁, WTC exposure, and other variables in relation to confirmed symptom recovery.

Results: A total of 4,368 firefighters met inclusion criteria and were symptomatic at year 1, of whom 1,592 (36.4%) experienced confirmed recovery. In univariable models, first post-September 11, 2001, concurrent, and difference between first post-September 11, 2001, and concurrent FEV₁ values were all significantly associated with confirmed recovery. In adjusted analyses, both first post-September 11, 2001, FEV₁ (hazard ratio [HR], 1.07 per 355-mL difference; 95% CI, 1.04-1.10) and FEV₁ % predicted (HR, 1.08 per 10% predicted difference; 95% CI, 1.04-1.12) predicted confirmed recovery. WTC exposure had an inverse association with confirmed recovery in the model with FEV₁, with the earliest arrival group less likely to recover than the latest arrival group (HR, 0.73; 95% CI, 0.58-0.92).

Conclusions: Higher FEV₁ and improvement in FEV₁ after September 11, 2001, predicted confirmed LRS recovery, supporting a physiologic basis for recovery and highlighting consideration of spirometry as part of any postexposure respiratory health assessment.

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Abbreviations: FDNY = Fire Department City of New York; FDNY-WTC-MMP = Fire Department City of New York World Trade Center Medical Monitoring Program; HR = hazard ratio; LRS = lower-respiratory symptom; WTC = World Trade Center



Progression of disease



Longitudinal spirometry among patients in a treatment program for community members with World Trade Center (WTC)-related illness

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Abstract

Objective—The course of lung function in community members exposed to World Trade Center (WTC) dust and fumes remains undefined. We studied longitudinal spirometry among patients in the WTC Environmental Health Center (WTCEHC) treatment program.

Methods—Observational study of 946 WTCEHC patients with repeated spirometry measures analyzed on the population as a whole and stratified by smoking status, initial spirometry pattern and WTC-related exposure category.

Results—Improvement in forced expiratory volume (FVC; 54.4 ml/year; 95% CI: 45.0-63.8) and forced expiratory volume in one second (FEV₁; 36.8 ml/year; 95% CI: 29.3-44.3) was noted for the population as a whole. Heavy smokers did not improve. Spirometry changes differed depending on initial spirometry pattern and exposure category.

Conclusions—These data demonstrate spirometry improvement in select populations suggesting reversibility in airway injury and reinforcing the importance of continued treatment.



Progression of disease



CHEST

Original Research

WORLD TRADE CENTER DISASTER

Longitudinal Assessment of Spirometry in the World Trade Center Medical Monitoring Program*

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Background: Multiple studies have demonstrated an initial high prevalence of spirometric abnormalities following World Trade Center (WTC) disaster exposure. We assessed prevalence of spirometric abnormalities and changes in spirometry between baseline and first follow-up evaluation in participants in the WTC Worker and Volunteer Medical Monitoring Program. We also determined the predictors of spirometric change between the two examinations.

Methods: Prebronchodilator and postbronchodilator spirometry, demographics, occupational history, smoking status, and respiratory symptoms and exposure onset were obtained at both examinations (about 3 years apart).

Results: At the second examination, 24.1% of individuals had abnormal spirometry findings. The predominant defect was a low FVC without obstruction (16.1%). Between examinations, the majority of individuals did not have a greater-than-expected decline in lung function. The mean declines in prebronchodilator FEV₁ and FVC were 13 mL/yr and 2 mL/yr, respectively (postbronchodilator results were similar and not reported). Significant predictors of greater average decline between examinations were bronchodilator responsiveness at examination 1 and weight gain.

Conclusions: Elevated rates of spirometric abnormalities were present at both examinations, with reduced FVC most common. Although the majority had a normal decline in lung function, initial bronchodilator response and weight gain were significantly associated with greater-than-normal lung function declines. Due to the presence of spirometric abnormalities > 5 years after the disaster in many exposed individuals, longer-term monitoring of WTC responders is essential. (CHEST 2009; 135:492–498)

Key words: bronchodilator response; occupational lung disease; spirometry; weight gain; World Trade Center

Abbreviations: BMI = body mass index; LLN = lower limit of normal; RADS = reactive airway dysfunction syndrome; WTC = World Trade Center



Progression of disease

ORIGINAL RESEARCH

Trends in Probable PTSD in Firefighters Exposed to the World Trade Center Disaster, 2001–2010



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ABSTRACT

Objective: We present the longest follow-up, to date, of probable posttraumatic stress disorder (PTSD) after the 2001 terrorist attacks on the World Trade Center (WTC) in New York City firefighters who participated in the rescue/recovery effort.

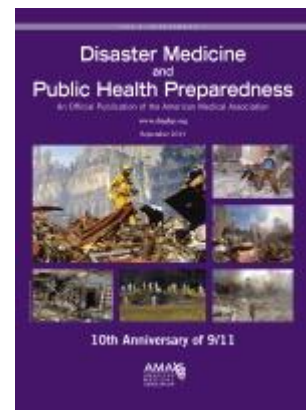
Methods: We examined data from 11 006 WTC-exposed firefighters who completed 40 672 questionnaires and reported estimates of probable PTSD by year from serial cross-sectional analyses. In longitudinal analyses, we used separate Cox models with data beginning from October 2, 2001, to identify variables associated with recovery from or delayed onset of probable PTSD.

Results: The prevalence of probable PTSD was 7.4% by September 11, 2010, and continued to be associated with early arrival at the WTC towers during every year of analysis. An increasing number of aerodigestive symptoms (hazard ratio [HR] 0.89 per symptom, 95% confidence interval [CI] 0.86-.93) and reporting a decrease in exercise, whether the result of health (HR 0.56 vs no change in exercise, 95% CI 0.41-.78) or other reasons (HR 0.76 vs no change in exercise, 95% CI 0.63-.92), were associated with a lower likelihood of recovery from probable PTSD. Arriving early at the WTC (HR 1.38 vs later WTC arrival, 95% CI 1.12-1.70), an increasing number of aerodigestive symptoms (HR 1.45 per symptom, 95% CI 1.40-1.51), and reporting an increase in alcohol intake since September 11, 2001 (HR 3.43 vs no increase in alcohol intake, 95% CI 2.67-4.43) were associated with delayed onset of probable PTSD.

Conclusions: Probable PTSD continues to be associated with early WTC arrival even 9 years after the terrorist attacks. Concurrent conditions and behaviors, such as respiratory symptoms, exercise, and alcohol use also play important roles in contributing to PTSD symptoms.

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Key Words: World Trade Center, mental health, posttraumatic stress disorder, psychological symptoms, firefighters



Progression of disease

Trajectories of PTSD risk and resilience in World Trade Center responders: an 8-year prospective cohort study

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Background. Longitudinal symptoms of post-traumatic stress disorder (PTSD) are often characterized by heterogeneous trajectories, which may have unique pre-, peri- and post-trauma risk and protective factors. To date, however, no study has evaluated the nature and determinants of predominant trajectories of PTSD symptoms in World Trade Center (WTC) responders.

Method. A total of 10835 WTC responders, including 4035 professional police responders and 6800 non-traditional responders (e.g. construction workers) who participated in the WTC Health Program (WTC-HP), were evaluated an average of 3, 6 and 8 years after the WTC attacks.

Results. Among police responders, longitudinal PTSD symptoms were best characterized by four classes, with the majority (77.8%) in a resistant/resilient trajectory and the remainder exhibiting chronic (5.3%), recovering (8.4%) or delayed-onset (8.5%) symptom trajectories. Among non-traditional responders, a six-class solution was optimal, with fewer responders in a resistant/resilient trajectory (58.0%) and the remainder exhibiting recovering (12.3%), severe chronic (9.5%), subsyndromal increasing (7.3%), delayed-onset (6.7%) and moderate chronic (6.2%) trajectories. Prior psychiatric history, Hispanic ethnicity, severity of WTC exposure and WTC-related medical conditions were most strongly associated with symptomatic trajectories of PTSD symptoms in both groups of responders, whereas greater education and family and work support while working at the WTC site were protective against several of these trajectories.

Conclusions. Trajectories of PTSD symptoms in WTC responders are heterogeneous and associated uniquely with pre-, peri- and post-trauma risk and protective factors. Police responders were more likely than non-traditional responders to exhibit a resistant/resilient trajectory. These results underscore the importance of prevention, screening and treatment efforts that target high-risk disaster responders, particularly those with prior psychiatric history, high levels of trauma exposure and work-related medical morbidities.



Research Considerations

- ▶ Time Frame:
 - 1 year
 - Future
- ▶ Vulnerable populations exposed to WTC disaster (Ex: children)

References

- ▶ FDNY WTC Health Program Clinical Center. Accessed at: <https://www.fdneywtcprogram.org/>
- ▶ World Trade Center Health Program. WTC Health Program: Eligible Groups. Accessed at: <http://www.cdc.gov/wtc/eligiblegroups.html#survivor>
- ▶ 9/11 Health. WTC Centers of Excellence. Accessed at: <http://www.nyc.gov/html/doh/wtc/html/treatment/centers.shtml>
- ▶ September 11th Victims Compensation Fund. Accessed at: <http://www.vcf.gov/faq.html#gen1>
- ▶ Workers Compensation Board. James Zadroga 9/11 Health and Compensation Act. Accessed at: <http://www.wcb.ny.gov/content/main/WTCVolunteerFund/HealthAndCompAct.jsp>
- ▶ Center of Disease Control and Prevention. NIOSH Docket. Implementation of James Zadroga 9/11 Health and Compensation Act 2010. Accessed at: <http://www.cdc.gov/niosh/docket/archive/docket226.html>