

World Trade Center Health Program (WTCHP) at Mount Sinai

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Introduction

- Aftermath of the September 11 World Trade Center (WTC) attack, a large number of people sustained potential exposures to:
 - Smoke, dust, particulate matter, and a variety of toxins, including asbestos, pulverized concrete, glass fibers, polycyclic aromatic hydrocarbons(PAHs), and polychlorinated furans and dioxins
- Most common effects seen to date are respiratory and mental health consequences
- Long-term consequences of exposures are not yet known, and there remains concern about the potential for late-emerging diseases



WTCHP Responder Population



“Traditional responders”:

- Firefighters
- Paramedics
- Law enforcement officers



“Nontraditional” responders :

- Construction workers
- Laborers and clean-up workers
- Telecommunications workers
- Gas and electric workers
- Transit workers
- Public sector workers (DOT, Parks, etc)
- Volunteers



Program Description

- Clinical Centers of Excellence (CCE) and Data Center *
- Provide comprehensive clinical periodic monitoring examinations for eligible WTC responders and treatment for WTC related conditions
- Disseminate information about WTC health effects and programs available to responders, the public, and health care providers
- Collect standardized clinical information to identify and track WTC physical and mental health consequences
- Conduct disease surveillance

*Consortium included National Program thru June 30th 2008



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Description of Cohort

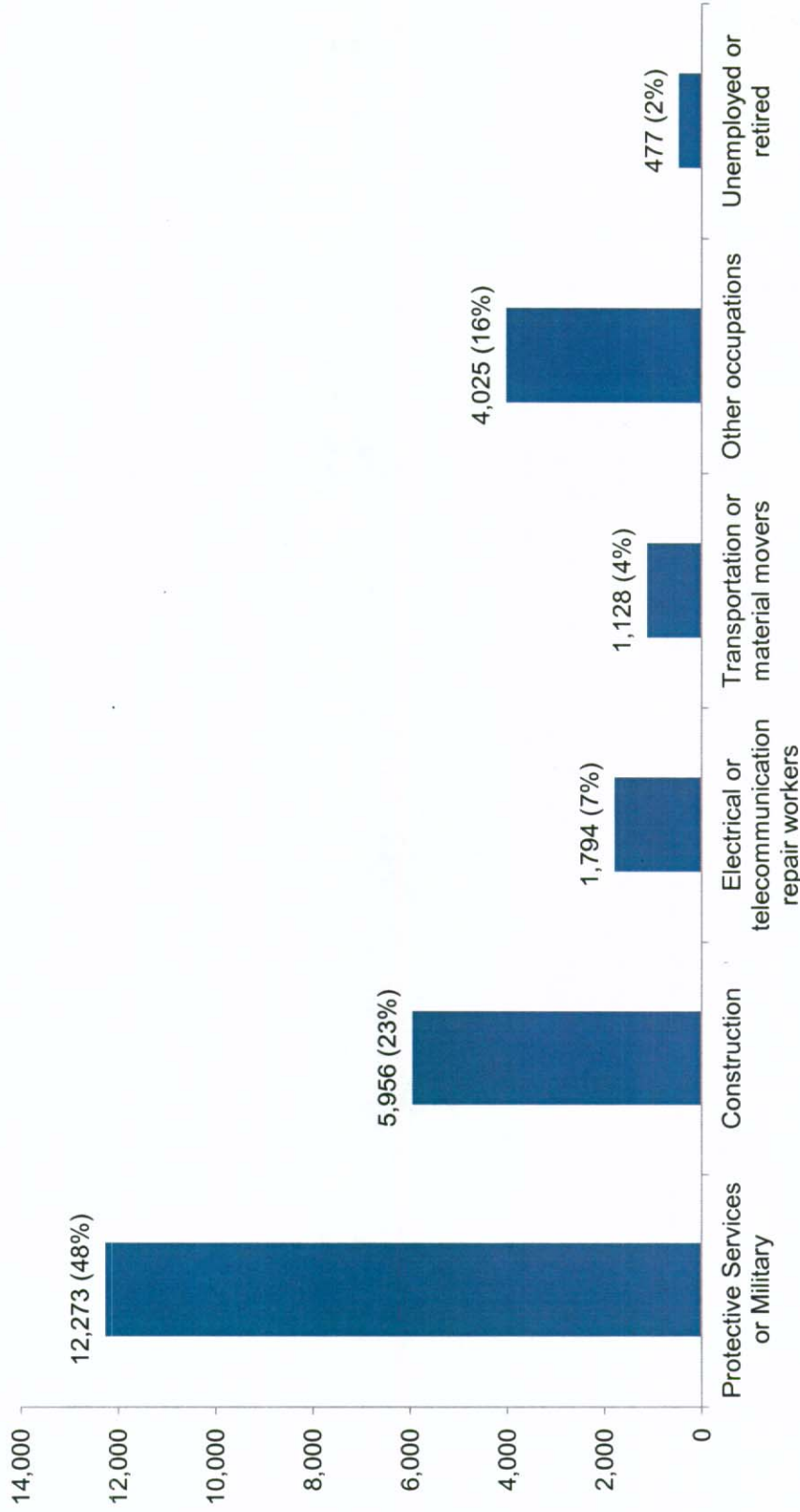
- N= 27,449*
- 86% Male
- Median Age= 38
- 57% Whites, 11% Black, 1% Asian, 3% Other, 28% Unknown, 31% Hispanic
- 83% Union Member
- Work Status: 81% Employee, 11% Volunteer, 8% Both

*Through 9/11/2010



Description of Cohort

Occupation Totals in WTCHP responders (n=27,449)*



*Through 9/11/2010

Note: Data missing for 1,796 rescue and recovery workers



Total Visit 1 Year to Date

- A total of 32,108 Visit 1 examinations have been completed with in the NY/NJ consortium (including the National Program) as of August 31, 2011

WTC WAMSP* (7/2002 - 6/2004)		WTC MEDICAL MONITORING PROGRAM (7/2004 - PRESENT)																	
		Visit 1*		Visit 2		Visit 3		Visit 4		Visit 5		Visit 6							
Clinic	Total	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)	YEAR 1 - YEAR 7	YEAR 8 (7/11 - present)		
Mount Sinai	8,824	11,107	126	12,595	355	7,883	354	4,245	290	2,023	193	448	253						
Queens	525	1,850	20	1,595	26	932	49	506	35	195	15	28	18						
LI - Port Jeff/ Islandia	1,250	3,783	64	3,749	68	2,816	77	1,744	84	713	78	183	30						
LI - Nassau																			
Bellerue/NTU	163	1,468	13	866	25	468	29	227	27	83	20	17	9						
UMDNJ	363	1,227	8	1,081	19	721	16	430	33	143	31	26	19						
NY/NJ Consortium Total	11,125	19,435	231	19,886	493	12,820	525	7,152	469	3,157	337	702	329						
National Program**	658	659		382		96													
TOTAL	11,783	20,094	231	20,268	493	12,916	525	7,152	469	3,157	337	702	329						

Clinic	Total Monitoring Program Exams (V1 - V6)	Total Screening and Monitoring Program Exams (V1 - V6)
Mount Sinai	39,872	48,696
Queens	5,269	5,794
LI - Port Jeff/ Islandia	13,289	14,639
LI - Nassau		
Bellerue/NTU	3,252	3,415
UMDNJ	3,754	4,117
NY/NJ Consortium Total	65,536	76,661
National Program**	1,137	1,795
TOTAL	66,673	78,456

*The total numbers of MAMP Visit 1, 2, 3, 4, 5 and 6 exams were self-reported by each CC. Long Island Year 2 totals (for V1 and V2) were estimated by subtracting Year 1 exams from the total number of exams performed through June 2006

**The total number of MAMP Visit 2 exams performed in Year 1 were taken from FFT transmissions from each CC to the DCC

***National Program numbers were coordinated through the DCC as of June 30, 2008. Effective July 1, 2008, Logistics Health Incorporated (LHI) is the NP clinical center with coordination provided by NIOSH

****WTC WAMSP - World Trade Center Worker and Volunteer Medical Screening Program





Publications



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Health Effects of World Trade Center Site Workers

Stephen Levin, MD,* Robin Herbert, MD, Gwen Skloot, MD, Jaime Szeinuk, MD,
Alvin Teirstein, MD, David Fischler, MD, Debra Milek, MD, George Piligian, MD,
Elizabeth Wilk-Rivard, MD, and Jacqueline Moline, MD

LESSONS LEARNED

While, a thorough analysis of the clinical, preventive, and other public health issues that emerged in the aftermath of the WTC disaster remains to be carried out, some questions/policies already suggest themselves as warranting attention.

- The importance of an advisory to health care providers ASAP to assist with their evaluation and clinical management of the physical and psychological problems WTC-related patients experienced.
- Immediate capture of registry (contact) information for volunteers and workers.
- Rapid distribution of appropriate respiratory protection and a peer-based structure for encouraging consistent use.
- Rapid mobilization of resources for pro-active medical evaluation/treatment—respiratory, musculoskeletal, and psychological—during the weeks following exposure at the disaster site.
- Testing of indoor settings, including analysis of settled dust and aggressive air monitoring, to establish a gradient of exposure with distance from Ground Zero to guide recommendations regarding clean-up and reoccupancy.
- Communication by public health agencies regarding exposure hazards in lay language, with focus not only on long-term cancer risks, but on short-term health consequences as well.





MMWRTM

Morbidity and Mortality Weekly Report

Weekly

September 10, 2004 / Vol. 53 / No. 35

Physical Health Status of World Trade Center Rescue and Recovery Workers and Volunteers — New York City, July 2002–August 2004

This report underscores the need for comprehensive occupational health assessment and treatment for rescue workers and volunteers as part of all emergency preparedness programs. Guidelines for professional emergency response workers have been developed (1). The results described in this report suggest that disaster preparedness also should include 1) planning for rapid provision of suitable respiratory and other protective gear and 2) provision of medical care for first responders and nontraditional responders (e.g., persons from construction trades, utility workers, and other occupational groups).



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Health and Environmental Consequences of the World Trade Center Disaster

Philip J. Landrigan,¹ Paul J. Liroy,² George Thurston,³ Gertrud Berkowitz,¹ L.C. Chen,³ Steven N. Chillrud,⁴ Stephen H. Gavett,⁵ Panos G. Georgopoulos,² Alison S. Geyh,⁶ Stephen Levin,¹ Frederica Perera,⁷ Stephen M. Rappaport,⁸ Christopher Small,⁴ and the NIEHS World Trade Center Working Group*

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]

The World Trade Center Disaster and the Health of Workers: Five-Year Assessment of a Unique Medical Screening Program

Robin Herbert,¹ Jacqueline Moline,¹ Gwen Skloot,² Kristina Metzger,¹ Sherry Baron,³ Benjamin Luft,⁴ Steven Markowitz,⁵ Iris Udasin,⁶ Denise Harrison,⁷ Diane Stein,¹ Andrew Todd,¹ Paul Enright,⁸ Jeanne Mager Stellman,^{1,9} Philip J. Landrigan,¹ and Stephen M. Levin¹

BACKGROUND: Approximately 40,000 rescue and recovery workers were exposed to caustic dust and toxic pollutants following the 11 September 2001 attacks on the World Trade Center (WTC). These workers included traditional first responders, such as firefighters and police, and a diverse population of construction, utility, and public sector workers.

METHODS: To characterize WTC-related health effects, the WTC Worker and Volunteer Medical Screening Program was established. This multicenter clinical program provides free standardized examinations to responders. Examinations include medical, mental health, and exposure assessment questionnaires; physical examinations; spirometry; and chest X rays.

RESULTS: Of 9,442 responders examined between July 2002 and April 2004, 69% reported new or worsened respiratory symptoms while performing WTC work. Symptoms persisted to the time of examination in 59% of these workers. Among those who had been asymptomatic before September 11, 61% developed respiratory symptoms while performing WTC work. Twenty-eight percent had abnormal spirometry; forced vital capacity (FVC) was low in 21%; and obstruction was present in 5%. Among nonsmokers, 27% had abnormal spirometry compared with 13% in the general U.S. population. Prevalence of low FVC among nonsmokers was 5-fold greater than in the U.S. population (20% vs. 4%). Respiratory symptoms and spirometry abnormalities were significantly associated with early arrival at the site.

CONCLUSION: WTC responders had exposure-related increases in respiratory symptoms and pulmonary function test abnormalities that persisted up to 2.5 years after the attacks. Long-term medical monitoring is required to track persistence of these abnormalities and identify late effects, including possible malignancies. Lessons learned should guide future responses to civil disasters.

KEY WORDS: air pollution, disaster response, occupational lung disease, pulmonary function, September 11, spirometry, World Trade Center. *Environ Health Perspect* 114:1853–1858 (2006). doi:10.1289/ehp.9592 available via <http://dx.doi.org/> [Online 6 September 2006]

Air Trapping Detected on End-Expiratory High-Resolution Computed Tomography in Symptomatic World Trade Center Rescue and Recovery Workers

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Robin Herbert, MD
Rafael E. de la Hoz, MD, MPH, MSc

Objectives: We utilized end-expiratory chest computed tomography (CT) to investigate air trapping (AT) in symptomatic former World Trade Center (WTC) workers, and correlated the findings with clinical, physiological, and exposure-related characteristics. **Methods:** Twenty-nine WTC workers with lower respiratory symptoms were evaluated. Clinical data included symptom inventories, quantitative respiratory symptom scores, WTC dust exposure duration, pulmonary function tests, and inspiratory and end-expiratory high-resolution chest CT scans. The latter were scored quantitatively for AT (by two methods) and interstitial changes, and those scores were correlated with the clinical data. **Results:** The two AT scoring methods yielded highly correlated results. AT was demonstrated in 25 of 29 patients, with scores ranging from 0 to 24 (mean, 10.6). There was a statistically significant correlation between AT and the duration of dust exposure. AT scores were significantly higher in patients with restrictive lung function data, and in lifetime nonsmokers. **Conclusions:** Our data suggest that AT from small airways disease may account for some of the reported clinical and pulmonary functional abnormalities in WTC dust-exposed workers, and support the use of high-resolution CT scans in the investigation and characterization of the pulmonary ailments of selected workers. (J Occup Environ Med. 2007;49:840-845)



Vocal Cord Dysfunction in Former World Trade Center (WTC) Rescue and Recovery Workers and Volunteers



Rafael E. de la Hoz, MD, MPH,^{1*} Michael R. Shohet, MD,^{2†} Laura A. Bienenfeld, MD,^{1†}
Aboaba A. Aflaka, MD,^{3†} Stephen M. Levin, MD,^{3†} and Robin Herbert, MD^{3‡}

Background Vocal cord dysfunction (VCD) is a condition characterized by paradoxical partial adduction of the vocal cords on inspiration. It has been associated with exposures to irritants, as well as with psychological illnesses and conditions. Workers who participated in the recovery of the WTC disaster site were exposed to a large amount of irritants as well as considerable psychological stressors. We describe the clinical characteristics of 10 symptomatic former WTC workers diagnosed with this condition, as well as the frequency of spirometric findings suggestive of variable extrathoracic obstruction.

Methods Workers who became symptomatic after their WTC work experience have been evaluated clinically by a multidisciplinary team at an academic medical center. The evaluation included history, physical examination, chest radiograph, blood tests, and pre- and post-bronchodilator spirometry in all patients. Additional evaluations and diagnostic tests included otolaryngological evaluation with flexible rhinolaryngoscopy and stroboscopy, gastroenterological and psychiatric evaluations. A randomly selected sample of 172 spirometry results were reviewed for evidence of inspiratory flow limitation.

Results Variable extrathoracic obstruction was found in 18.6% of the spirometries. Ten patients were diagnosed with VCD. In addition to symptoms suggestive of co-morbid conditions (particularly rhinitis and acid reflux disease), most of the 10 patients had (1) hoarseness, (2) dyspnea that was not associated with bronchial hyperreactivity, or (3) dyspnea associated with asthma, with either mild bronchial hyperreactivity and/or poor response to asthma treatment.

Conclusions VCD appears to be part of the spectrum of airway disorders caused by occupational exposures at the WTC disaster site. Further study of this association is warranted. Am. J. Ind. Med. 51:161–165, 2008. © 2008 Wiley-Liss, Inc.

KEY WORDS: occupational medicine; inhalation injury; vocal cord dysfunction; asthma; respiratory diseases; irritant exposures



WTC Medical Monitoring and Treatment Program: Comprehensive Health Care Response in Aftermath of Disaster

Jacqueline M. Moline, MD, MSc,¹ Robin Herbert, MD,¹ Stephen Levin, MD,¹
Diane Stein, BS,¹ Benjamin J. Luft, MD,² Iris G. Udasin, MD,³ and Philip
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ABSTRACT

The attack on the World Trade Center (WTC) on September 11th, 2001 exposed thousands of individuals to an unprecedented mix of chemicals, combustion products and micronized building materials.

Clinicians at the Mount Sinai Irving Selikoff Center for Occupational and Environmental Medicine, in partnership with affected stakeholder organizations, developed a medical screening program to evaluate the health status of workers and volunteers who spent time at the WTC site and thus sustained exposure in the aftermath of September 11th. Standardized questionnaires were adapted for use in this unique population and all clinicians underwent training to ensure comparability.

The WTC Worker and Volunteer Medical Screening Program (MSP) received federal funding in April 2002 and examinations began in July 2002. The MSP and the follow up medical monitoring program has successfully recruited nearly 22,000 responders, and serves as a model for the rapid development of a medical screening program to assess the health of populations exposed to environmental hazards as a result of natural and man-made disasters.

The MSP constitutes a successful screening program for WTC responders. We discuss the challenges that confronted the program; the absence of a prior model for the rapid development of a program to evaluate results from mixed chemical exposures; little documentation of the size of the exposed population or of who might have been exposed; and uncertainty about both the nature and potential severity of immediate and long-term health effects. *Mt Sinai J Med* 75:67-75, 2008. © 2008

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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]

Reflux Symptoms and Disorders and Pulmonary Disease in Former World Trade Center Rescue and Recovery Workers and Volunteers

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Background: Gastroesophageal reflux disease is one of the most prevalent conditions among former World Trade Center (WTC) rescue and recovery workers. The reason for this proposed association with an inhalation injury is unclear. In this study, we clinically characterized the reflux disorders in former WTC workers, and we investigated their association with pulmonary function abnormalities and with clinical diagnoses of other WTC-related diseases. **Methods:** Forty-two former WTC workers underwent the following testing: symptom inventories, physical examination, spirometry, esophago-gastro-duodenoscopy, and 24-hour pH monitoring studies for the evaluation of chronic reflux-like symptoms. Patients were classified into two groups based on clinical evaluation: group 1 (reflux patients) including definitive reflux disorders (gastroesophageal reflux, nonerosive reflux, nonacid reflux, and laryngopharyngeal reflux diseases) and group 2 (no-reflux patients) patients without clinically significant reflux disease, including functional heartburn, and hypersensitive esophagus disorder. **Results:** The reflux and no-reflux patients had significantly different Johnson-DeMeester scores and esophageal acid exposure times. Patients with reflux disorders were more likely to have reduced forced vital capacity ($\chi^2 = 5.49, P = 0.031$) and also more likely to have been diagnosed with a lower airway disease ($\chi^2 = 7.14, P = 0.008$). We found no significant association between reflux and psychiatric disorders ($\chi^2 = 0.02, P = 0.89$), levels of exposure at the WTC site, or incidence of dry cough, or other upper airway disorders. **Conclusions:** A spectrum of reflux symptoms and disorders are present in WTC responders. Our data suggest that the presence of reflux disease is related to that of pulmonary function abnormality suggestive of air trapping and a diagnosis of a lower respiratory disease. (J Occup Environ Med. 2008;50:1351-1354)



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

Gaven S. Skloot, MD; Clyde B. Schechter, MD; Robin Herbert, MD; Jacqueline M. Moline, MD; Stephen M. Lectin, MD; Laura E. Crowley, MD; Benjamin J. Luft, MD; Iris G. Ulasin; and Paul L. Enright, MD, FCCP

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

The Psychiatrist

FORMERLY THE PSYCHIATRIC BULLETIN

Psychiatric symptoms in Ground Zero ironworkers in the aftermath of 9/11: prevalence and predictors

CRAIG L. KATZ, STEPHEN LEVIN, ROBIN HERBERT, SIMON MUNRO, ANAND PANDYA AND REBECCA SMITH

AIMS AND METHOD

To establish the prevalence of, and risk factors for, psychiatric symptoms in Ground Zero ironworkers.

Questionnaires commonly used to screen for psychiatric symptoms were completed by 124 workers.

RESULTS

We have established the prevalence of screening positive for symptoms of post-traumatic stress disorder, panic attacks, generalised anxiety, depression and alcohol misuse. Among the risk factors were alcohol misuse, injury to or death of a family member, friend or co-worker at Ground Zero and one or more adverse life events since 9/11.

CLINICAL IMPLICATIONS

Ironworkers at Ground Zero tend to have significant psychiatric symptoms likely to be associated with the traumatic experience of working there during the clean-up operation. Risk factors for psychiatric symptoms were established.

Multiple Myeloma in World Trade Center Responders: A Case Series

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Objectives: We report on cases of multiple myeloma (MM) observed in World Trade Center (WTC) responders registered in the WTC Medical Program. *Methods:* Possible cases of MM diagnosed between September 11, 2001, and September 10, 2007, in responders were confirmed if they met the World Health Organization and Mayo Clinic diagnostic criteria. *Results:* Among 28,252 responders of known sex and age, eight cases of MM were observed (6.8 expected). Four of these cases were observed in responders younger than 45 years at the time of diagnosis (1.2 expected). A slight deficit of MM cases was observed in responders older than 45 years (4 observed, 5.6 expected). *Conclusion:* In this case series, we observe an unusual number of MM cases in WTC responders under 45 years. This finding underscores the importance of maintaining surveillance for cancer and other emerging diseases in this highly exposed population. (J Occup Environ Med. 2009;51:896–902)



Stories Behind the Symptoms: A Qualitative Analysis of the Narratives of 9/11 Rescue and Recovery Workers

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Vansh Sharma · Robin Herbert · Jacqueline M. Moline ·
Craig L. Katz

Abstract A qualitative study of the experiences of rescue and recovery workers/volunteers at Ground Zero following the terrorist attacks of 9/11/01 is reported. Information was extracted from a semi-structured clinical evaluation of 416 responders who were the initial participants in a large scale medical and mental health screening and treatment program for 9/11 responders. Qualitative analysis revealed themes that spanned four categories—occupational roles, exposures, attitudes/experiences, and outcomes related to the experience of Ground Zero. Themes included details regarding Ground Zero roles, grotesque experiences such as smells, the sense of the surreal nature of responding, and a turning to rituals to cope after leaving Ground Zero. **These findings personalize the symptom reports and diagnoses that have resulted from the 9/11 responders' exposure to Ground Zero, yielding richer information than would otherwise be available for addressing the psychological dimensions of disasters.** This work shows that large scale qualitative surveillance of trauma-exposed populations is both relevant and feasible.



Journal of Occupational and Environmental Medicine

Snoring and Obstructive Sleep Apnea Among Former World Trade Center Rescue Workers and Volunteers

Rafael E. de la Hoz, MD, MPH, Rashmi N. Aurora, MD, Paul Landsbergis, PhD, Laura A. Bienenfeld, MD, MPH, Abootba A. Afilaka, MD, MPH, and Robin Herbert, MD

Background: Snoring is a common symptom among workers with adverse health effects from their World Trade Center (WTC) occupational exposures. Rhinitis and upper airway disease are highly prevalent among these workers. Rhinitis has been associated with snoring and, in some studies, with obstructive sleep apnea (OSA). We examined the association of WTC exposure and findings on nocturnal polysomnogram, as well as known predictors of OSA in this patient population. **Methods:** One hundred participants with snoring underwent a polysomnogram to exclude OSA. Comorbidities had been previously evaluated and treated. The apnea-hypopnea index (AHI) defined and categorized the severity of OSA. Age, sex, body mass index (BMI), and WTC exposure variables were examined in bivariate and multiple regression analyses. **Results:** Our study sample had a similar prevalence of five major disease categories, as we previously reported. OSA was diagnosed in 62% of the patients and was not associated with any of those disease categories. A trend toward increasing AHI with increasing WTC exposure duration failed to reach the statistical significance ($P = 0.14$) in multiple regression analysis. An elevated AHI was associated with BMI ($P = 0.003$) and male sex ($P < 0.001$). **Conclusions:** OSA was associated with BMI and male sex but not with occupational WTC exposure indicators in this patient population.



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Case Report: Lung Disease in World Trade Center Responders Exposed to Dust and Smoke: Carbon Nanotubes Found in the Lungs of World Trade Center Patients and Dust Samples

Maoxin Wu,¹ Ronald E. Gordon,¹ Robin Herbert,² Maria Padilla,³ Jacqueline Moline,² David Mendelson,⁴ Virginia Little,⁵ William D. Travis,⁶ and Joan Gil¹

CONTEXT: After the collapse of the World Trade Center (WTC) on 11 September 2001, a dense cloud of dust containing high levels of airborne pollutants covered Manhattan and parts of Brooklyn, New York. Between 60,000 and 70,000 responders were exposed. Many reported adverse health effects.

CASE PRESENTATION: In this report we describe clinical, pathologic, and mineralogic findings in seven previously healthy responders who were exposed to WTC dust on either 11 September or 12 September 2001, who developed severe respiratory impairment or unexplained radiologic findings and underwent video-assisted thoracoscopic surgical lung biopsy procedures at Mount Sinai Medical Center. WTC dust samples were also examined. We found that three of the seven responders had severe or moderate restrictive disease clinically. Histopathology showed interstitial lung disease consistent with small airways disease, bronchiolocentric parenchymal disease, and nonnecrotizing granulomatous condition. Tissue mineralogic analyses showed variable amounts of sheets of aluminum and magnesium silicates, chrysotile asbestos, calcium phosphate, and calcium sulfate. Small shards of glass containing mostly silica and magnesium were also found. Carbon nanotubes (CNT) of various sizes and lengths were noted. CNT were also identified in four of seven WTC dust samples.

DISCUSSION: These findings confirm the previously reported association between WTC dust exposure and bronchiolar and interstitial lung disease. Long-term monitoring of responders will be needed to elucidate the full extent of this problem. The finding of CNT in both WTC dust and lung tissues is unexpected and requires further study.

KEY WORDS: bronchiolitis, carbon nanotubes, interstitial lung disease, small airway disease, WTC. *Environ Health Perspect* 118:499–504 (2010). doi:10.1289/ehp.0901159 [Online 4 December 2009]

Chemosensory Loss: Functional Consequences of the World Trade Center Disaster

Pamela H. Dalton,¹ Richard E. Opiokun,² Michele Gould,¹ Ryan McDermott,¹ Tamika Wilson,¹ Christopher Maute,¹ Mehmet H. Ozdener,¹ Kai Zhao,¹ Edward Emmett,³ Peter S.J. Lees,⁴ Robin Herbert,⁵ and Jacqueline Moline⁵

BACKGROUND: Individuals involved in rescue, recovery, demolition, and cleanup at the World Trade Center (WTC) site were exposed to a complex mixture of airborne smoke, dust, combustion gases, acid mists, and metal fumes. Such exposures have the potential to impair nasal chemosensory (olfactory and trigeminal) function.

OBJECTIVE: The goal of this study was to evaluate the prevalence of chemosensory dysfunction and nasal inflammation among these individuals.

METHODS: We studied 102 individuals who worked or volunteered at the WTC site in the days and weeks during and after 11 September 2001 (9/11) and a comparison group with no WTC exposure matched to each participant on age, sex, and job title. Participants were comprehensively evaluated for chemosensory function and nasal inflammation in a single session. Individual exposure history was obtained from self-reported questionnaires.

RESULTS: The prevalence of olfactory and trigeminal nerve sensitivity loss was significantly greater in the WTC-exposed group relative to the comparison group [prevalence ratios (95% confidence intervals) = 1.96 (1.2–3.3) and 3.28 (2.7–3.9) for odor and irritation thresholds, respectively]. Among the WTC responders, however, individuals caught in the dust cloud from the collapse on 9/11 exhibited the most profound trigeminal loss. Analysis of the nasal lavage samples supported the clinical findings of chronic nasal inflammation among the WTC-exposed cohort.

CONCLUSIONS: The prevalence of significant chemosensory impairment in the WTC-exposed group more than 2 years after their exposure raises concerns for these individuals when the ability to detect airborne odors or irritants is a critical safety factor.

RELEVANCE TO CLINICAL PRACTICE: This outcome highlights the need for chemosensory evaluations among individuals with exposure to acute high or chronic levels of airborne pollutants.

KEY WORDS: chemosensation, inflammation, irritation, occupational exposure, olfaction, World Trade Center. *Environ Health Perspect* 118:1251–1256 (2010). doi:10.1289/ehp.1001924 [Online 18 May 2010]

“Sarcoid Like” Granulomatous Pulmonary Disease in World Trade Center Disaster Responders

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Background More than 20,000 responders have been examined through the World Trade Center (WTC) Medical Monitoring and Treatment Program since September 11, 2001. Studies on WTC firefighters have shown elevated rates of sarcoidosis. The main objective of this study was to report the incidence of “sarcoid like” granulomatous pulmonary disease in other WTC responders.

Methods Cases of sarcoid like granulomatous pulmonary disease were identified by: patient self-report, physician report and ICD-9 codes. Each case was evaluated by three pulmonologists using the ACCESS criteria and only “definite” cases are reported.

Results Thirty-eight patients were classified as “definite” cases. Six-year incidence was 192/100,000. The peak annual incidence of 54 per 100,000 person-years occurred between 9/11/2003 and 9/11/2004. Incidence in black responders was nearly double that of white responders. Low FVC was the most common spirometric abnormality.

Conclusions Sarcoid like granulomatous pulmonary disease is present among the WTC responders. While the incidence is lower than that reported among firefighters, it is higher than expected. Am. J. Ind. Med. 54:175–184, 2011. © 2010 Wiley-Liss, Inc.



Odor identification ability and self-reported upper respiratory symptoms in workers at the post-9/11 World Trade Center site

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Abstract Following the World Trade Center (WTC) collapse on September 11, 2001, more than 40,000 people were exposed to a complex mixture of inhalable nanoparticles and toxic chemicals. While many developed chronic respiratory symptoms, to what degree olfaction was compromised is unclear. A previous WTC Medical Monitoring and Treatment Program study found that olfactory and nasal trigeminal thresholds were altered by the toxic exposure, but not scores on a 20-odor smell identification test.

Objectives To employ a well-validated 40-item smell identification test to definitively establish whether the ability to identify odors is compromised in a cohort of WTC-exposed individuals and, if so, whether the degree of compromise is associated with self-reported severity of rhinitic symptoms.

Methods The University of Pennsylvania Smell Identification Test (UPSIT) was administered to 99 WTC-exposed persons and 99 matched normal controls. The Sino-Nasal Outcomes Test (SNOT-20) was administered to the 99 WTC-exposed persons and compared to the UPSIT scores. **Results** The mean (SD) UPSIT scores were lower in the WTC-exposed group than in age-, sex-, and smoking history-matched controls [respective scores: 30.05 (5.08) vs 35.94 (3.76); $p = 0.003$], an effect present in a subgroup of 19 subjects additionally matched on occupation ($p < 0.001$). Fifteen percent of the exposed subjects had severe microsmia, but only 3% anosmia. SNOT-20 scores were unrelated to UPSIT scores ($r = 0.20$; $p = 0.11$).

Conclusion Exposure to WTC air pollution was associated with a decrement in the ability to identify odors, implying that such exposure had a greater influence on smell function than previously realized.





THE LANCET

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.



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Future Scientific Projects



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Cancer among WTC Responders: Enhanced Surveillance, Exposure Assessment, and Cancer Specific Risks

- It is well established there is a latency between exposure and cancer development for most human carcinogens
- Prolonged follow-up is a necessity in this cohort
- Goals:
 - Identify and validate all cancer cases in WTC responders
 - Link exposure to cancer risk in WTC responders
- Identify risk of cancer among WTC responders



Pulmonary Function Abnormalities, Diastolic Dysfunction and WTC Exposure - Implications for Diagnosis and Treatment

- **Goal:** To determine the significance of the long-term effect of WTC particulate matter exposure on pulmonary function and cardiovascular health
- **Participants will undergo:**
 - questionnaires
 - pulmonary function testing
 - echocardiogram
 - sleep study
 - laboratory tests (CBC, metabolic panel, FBS, lipid panel, hormone profile, inflammatory markers)
- Study will provide critical information regarding exposure and risk factors for development of cardiopulmonary disease.
- Resulting in improvements in monitoring, diagnosis and treatment protocols



Trajectories of Psychological Risk and Resilience in WTC Responders

- Posttraumatic stress disorder (PTSD) and depression arising in response to this event are both highly prevalent (15%) and persistent, even several years after 9/11
- Goals:
 - Examine the extent of resilience, recovery, and chronicity over a span of eight years among participants in the WTCHP
 - Identify a set of modifiable risk factors that will inform personalized psychological intervention programs for this population
- Ultimately, our findings will help guide prevention efforts and preparedness planning for disaster responders



Goals

- Active screening and monitoring of all WTC responders
- Identify and treat diseases in their early stages
- Report on changing trends of certain diseases overtime
- Continue surveillance of diseases with long latency
- Educate responders to seek medical care if they have developed any illness following the WTC disaster on 9/11



Conclusion

- The WTC Health Program Clinical Centers of Excellence have medically screened over 30,000 WTC rescue and recovery workers and volunteers since it began in July 2002
- The Clinical Centers of Excellence have provided treatment for over 15,000 WTC responders
- Program has been successful in establishing a vibrant occupational medicine consortium



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