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Respiratory effects of inhalation exposure among workers during the clean-up effort at the World Trade Center disaster site ☆

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Abstract

During December 2001 we conducted a field study of 183 clean-up and recovery workers at the World Trade Center (WTC) disaster site to assess respiratory health effects potentially resulting from their work at the site. On site, we administered a respiratory health questionnaire designed to assess upper respiratory symptoms and lower respiratory symptoms, including cough, phlegm, and wheeze, as well as indices of exposure, including number of days worked at the site and job category. Spirometry was conducted for 175 workers. Sixty-five percent of the workers surveyed arrived at the site without lower respiratory symptoms. Of this group, 34% developed cough, 24% developed phlegm, and 19% developed wheeze. Prevalence rates of these symptoms were related to the number of days spent working at the WTC, but not job category. The mean percentage predicted FEV_1 and FVC were 6% and 5% lower, respectively, for workers who developed new lower respiratory symptoms compared to those who remained symptom free. While the development of new wheeze suggested the presence of airway obstruction, the near-normal distribution of age-adjusted FEV_1/FVC ratios suggested that the degree of obstruction was mild. The prevalence rates of upper airway symptoms (nasal congestion, sore throat, hoarse throat) exceeded those of lower respiratory symptoms, however, it was not determined whether symptoms pre-dated arrival at the WTC site.
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1. Introduction

On September 11, 2001, two hijacked commercial airliners were crashed into the north and south towers of the World Trade Center (WTC) in New York City (NY, USA). Both towers and a number of surrounding skyscrapers collapsed or sustained significant structural damage, leaving behind an area of destruction that covered 16 acres and debris estimated to exceed 1.2 million tons (Elisburg and Moral, 2001). The debris pile was unstable, underground fires burned, and the rubble smoldered well into December, when the fires were finally extinguished.

The clean-up and recovery effort formally began approximately 3 weeks after the attacks. This effort involved an enormous number of workers representing a wide range of occupations. In addition to firefighters and police officers, several other occupational groups, including iron workers, heavy equipment operators, truck drivers, laborers, sanitation workers, carpenters,

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mechanics, and others, played a critical role in the overall disaster response. During the first months after the attacks, working conditions were especially hazardous. In addition to the potential for physical injury resulting directly from the removal of debris, workers were exposed to a variable and complex mixture of mechanically generated dust, combustion particles, gases, and fumes (Claudio, 2001; Environmental Protection Agency, 2002). The consequences of exposure to these airborne contaminants were considered potentially severe (Stephenson, 2002).

While we were on site in October 2001 conducting a study to assess the acute exposure of WTC workers to these contaminants, a number of the workers expressed concern about problems that they were having with breathing. To examine this concern, we conducted a study of WTC workers who were actively involved in the removal of debris to assess the prevalence of respiratory symptoms and ventilatory function.

The focus of this limited study was to assess the extent of respiratory problems of clean-up and recovery workers during the middle of December 2001 when they were actively exposed to WTC airborne containments. This paper describes the respiratory health status of 183 workers who were on site 1–3 months after the day of the attack.

2. Materials and methods

2.1. Recruitment

The study population consisted of union workers involved in the clean-up and recovery effort at the WTC site. Workers were recruited through direct invitation on site by study personnel. The inclusion criteria required that participants be at least 18 years old, employed in clean-up and recovery activities at the WTC site, and willing to answer questions about their health. Informed consent was obtained from all participants.

We worked directly with union representatives of the truck drivers and carpenters to recruit all on-site workers from those organizations. We also recruited workers who were represented by other trade unions without working through their union representation. To maximize participation, we recruited and evaluated workers at different locations around the area of destruction where we had authorized access: on the south side of the site in a tent, erected at the corner of Albany and West Streets; on the north side of the site roadside, north of the intersection of West and Vesey Streets, at Pier 25 and at Pier 6.

Work activity was continuous throughout the week, with debris removal conducted 24 h/day, 7 days/week. The day was divided into two 12-h work shifts, which began at either 6:00 AM or 6:00 PM. Recruitment and evaluations were conducted across both shifts and took place at most hours of the day and night. All assessments were conducted at the convenience of the workers, for whom participation required taking time off from the job. All procedures were carried out on site during work shifts from December 11 to17, 2001.

2.2. Questionnaire

The Respiratory Health Questionnaire was adapted, in part, from standardized questions developed by the American Thoracic Society (ATS) for use in epidemiological research (Ferris, 1978). In addition, several new questions were developed to quantify respiratory symptoms that were experienced while working at the WTC site. The questionnaire was designed to be interviewer-administered and, based on recommendations by union colleagues, to take approximately 10 min. Therefore, the scope and length of the questionnaire were limited to the minimum number of questions necessary to obtain useful indices of symptoms and exposure while allowing time for spirometry.

The questionnaire was designed to assess the presence of upper respiratory symptoms experienced at the WTC, lower respiratory symptoms experienced before and after starting work at the WTC, surrogates for cumulative WTC exposure, and potential confounding factors such as smoking history and respirator use. To estimate the duration of exposure, workers were asked to identify their first day on site and the number of days they had off since their first day on site. The questionnaire was administered to participants by trained staff.

2.3. Spirometry

Two pulmonary function technicians, with US National Institute of Occupational Health and Safety-certified training, conducted the spirometry using Puritan Bennet Flow spirometers (Renaissance Spirometry System Model No. BP100, Wilmington, MA, USA), following ATS guidelines (American Thoracic Society, 1995). Approximately 1 h before the beginning of the daily 6:00 AM shift, the instruments were calibrated using a certified 3-L syringe. Predicted values were calculated using the equations developed by Knudsen et al. (1983). All spirometric measurements were adjusted for race (Coultas et al., 1994). The FEV_1/FVC ratios were adjusted for age (Glindmeyer et al., 1995).

The study was approved by the Institutional Review Board of the Johns Hopkins Bloomberg School of Public Health.

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