Feature

World Trade Center dust-inhalation: assessing the fallout

Nearly 14 years after Al-Qaeda’s Sept 11, 2001, terrorist attacks on the World Trade Center (WTC) in New York City, USA, residents and others exposed to dust from the collapsed buildings continue to suffer and die from respiratory diseases—while efforts to study the epidemiology of these cases have been hampered by gaps in environmental sampling data, experts tell The Lancet Respiratory Medicine.

The WTC Health Registry is “the largest post-disaster public health registry in US history, tracking the long-term physical and mental health of more than 71 000 people, both responders and survivors, directly exposed to the WTC disaster”, notes Alice Welch (New York City Department of Health & Mental Hygiene, New York, NY, USA). US Government-funded studies have used WTC registry data. But information about WTC exposures remains surprisingly “obscure”, notes Raja Flores, professor of thoracic surgery at Icahn School of Medicine, Mount Sinai, New York, NY, USA. “There are conflicting reports about exposure levels of carcinogenic substances such as asbestos. Also, differing techniques were used to obtain these measurements, which can lead to conflicting reports.”

“Essentially, all useful opportunities for monitoring were lost”, says Morton Lippmann (Nelson Institute of Environmental Medicine, New York University, New York, NY, USA). “Government agencies came in and did a lot of monitoring but they made a fundamental early mistake: they looked only ‘under the lamp-post’. Their monitors were off-the-shelf equipment for fine-particle monitoring; they became clogged and screened out larger toxic particles.”

“A major challenge in studying short- and long-term health effects of WTC dust is that no systematic environmental exposure data were collected, in particular in the acute phase”, agrees Paolo Boffetta (Icahn School of Medicine). “Available measurements are likely to be non-representative, and therefore only partially useful for retrospective exposure assessment.”

Researchers Paul Lioy and Michael Gochfeld visited Ground Zero 4 days after the Sept 11 attacks to collect dust samples, reports Gochfeld (Environmental and Occupational Health Sciences Institute, Rutgers University, New Brunswick, NJ, USA). Lioy died on July 8, 2015.

“We were concerned with the sluggishness of the sampling, and the prevailing sense that ‘dust is dust’, Gochfeld recalls. “In reality, WTC dust proved to be extremely complex. We felt that the EPA (US Environmental Protection Agency) did not take the dust seriously enough, soon enough. It was an embarrassment that all the electricity had been knocked out in the blocks around Ground Zero and EPA did not have a backup, contingency sampling procedure or equipment, and relied on a sluggish contracting process to bring in outside industrial hygiene and safety people. That was true for all domains—not just dust sampling.” “It would be a reasonable question to ask whether we are prepared for another attack”, Gochfeld adds.

WTC-associated respiratory disorders are “heterogeneous clinically, physiologically, and likely etiologically”, says Albert Miller (Mount Sinai Beth Israel, New York, NY, USA). They are “best characterised in first responder rescue and recovery workers in whom likelihood and severity of disease is related to intensity and timing of exposure—presence at Ground Zero within hours [of the buildings’ collapse] and entrapment in the dust plume”. Nor do these cases always fit easily into existing clinical-diagnostic categories of asthma, chronic bronchitis, reactive airways syndrome, or bronchiolitis, Miller notes. “They may not respond well to medications used for these diagnoses”, he adds.

Thousands of school children in Lower Manhattan were exposed to the collapsed buildings’ dust plumes, and subsequent environmental dust exposures. “Asthma prevalence after Sept 11 among children younger than 5 years of age enrolled in the WTC Health Registry was higher than national estimates, and was associated with dust exposure in all age groups of children”, notes WTC Health Registry medical director James Cone (New York, NY, USA). “Adult residents and office workers in Lower Manhattan also experienced an increased prevalence of new-onset asthma following Sept 11, 2001, associated with exposure to the dust cloud, residential dust and damage, and not having evacuated from homes.”

Children’s exposures to WTC dust “occurred during a very vulnerable developmental window, when lung development could have been affected to predispose these children to COPD as adults”, notes pediatrician Leonardo Trasande (New York University School of Medicine, New York, NY, USA). Children’s respiratory symptoms are comparable to those of adults, he notes. Possibly because of ingestion of dusts, gastro-oesophageal reflux disease (GERD) is also common among exposed children, his team found.

Cardiometabolic disruption in exposed children could be due to dioxins in the dust—and might leave these children prone to cardiovascular disease later in life, Trasande worries. While the precise biological mechanisms underlying WTC-associated respiratory disorders remain unclear, airway restriction with air trapping and bronchial-wall thickening on CT has been noted by researchers—as has increased residual volume, airway hyperreactivity, and improvement with bronchodilators “suggesting obstructive lung disease along with interstitial processes”, Cone notes. “Distal airway involvement is also suggested as a further mechanism since increased airway resistance has been measured in a group of WTC-exposed residents and area workers with lower respiratory symptoms and normal spirometry.”
Efforts are underway to develop and validate biomarkers that can shed light on disease pathways and help to predict who will develop respiratory disease after such exposures, notes Anna Nolan (Division of Pulmonary, Critical Care and Sleep, New York University School of Medicine, New York, NY, USA).

Tobacco smoking by traumatised survivors and residents might well compound their disease risks. Welch and her colleagues examined smoking behaviour among people in the WTC registry. “We found that those with post-traumatic stress disorder were more likely to be smokers and were 25-40% less likely to quit smoking during the [9-year] study period”, she says.

“Concrete, slag wool, gypsum, and window glass—which were the main constituents in all of the dust samples”, notes Geoffrey Plumlee (US Geological Survey, Denver, CO, USA). “When we zoomed in to microscopic scales, we started seeing many other less-abundant materials, such as asbestos fibres and particles of lead. At all scales, the dust was a complex mixture of particle types and sizes. But chemically and mineralogically, we didn’t see any consistent geographical variations.

Overall, the concentrations of dust to which people were exposed seems to be the best predictor of respiratory symptoms. “Respiratory effects have been reported in first responders, late responders, and residents, in a dose-dependent manner”, notes Boffetta.

But there were differences between indoor and outdoor dusts. “We noted in our initial reports to emergency managers on Sept 27, 2001, and to the public on Nov 27, 2001, that most of the outdoor dust samples were not nearly as alkaline as the indoor dusts—because rainfall on Sept 14 had neutralised caustic alkali particles in the dust”, Plumlee notes. “The rain also dissolved away the gypsum and may have concentrated less-soluble things like lead.”

In June, 2015, a federal judge in Manhattan approved a nearly US$54 million settlement for 83 indoor cleanup workers who developed respiratory symptoms and cancers. Some were hazardous substance workers, while others were “hired off the street” or were janitors without experience in hazardous-substance work, according to their attorney, Gregory Cannata (Gregory J Cannata & Associates Law Firm, New York, NY, USA). “They had irritant-induced asthma, exacerbations of COPD, interstitial lung disease, and cancers”, Cannata says. Acute symptoms like cough and sinusitis emerged soon after exposure but asthma diagnoses were made 1–3 years later, he says. There were also some patients with cancers, including lung cancers, but these cannot be attributed to WTC dust exposure, and cases would not yet be expected based on typical latency periods, Lippmann and Miller note. Lippmann testified as an expert witness in Cannata’s case.

The cleanup workers’ half-face respirators quickly became clogged with dust, and workers were told to shake them out and reuse the filters. Workers did not have enough filters and frequently ate in contaminated areas, possibly contributing to a high prevalence of GERD, Cannata says. Their employers “didn’t appreciate the volume of the dust or the fact that it was very light and easily suspended and resuspended in the air”, Cannata says.

Lack of interagency coordination was a key problem with the early response effort, Lippmann says. He Advocates the rapid establishment of expert committees for such disasters, like the EPA’s scientific advisory board or the US National Academy of Sciences work groups—“broad groups of experts from different disciplines”.

However, the EPA abruptly disbanded one of its scientific panels before members could report their recommendation that dust alkalinity be used to identify residual residential WTC dust after cleanup efforts, according to Lippmann, who served on the panel.

Additional “development work and interlaboratory testing that would have been necessary required significant additional time”, explains Cathy Milbourn (EPA, Washington, DC, USA). “The agency decided instead to implement the Lower Manhattan Test and Clean Program, a voluntary programme, offered to residents and building owners concerned about potential residual contamination in buildings impacted by the collapse of the WTC towers. [...] EPA concluded that in the absence of a unique marker for WTC dust, the agency would be unable to detect a remaining pattern of contamination due to the collapse of the WTC.” The Test and Clean Program allowed residents and building owners to have the air and dust in their units tested for four contaminants associated with WTC dust, “thus addressing concerns about the possibility of residual contamination in sampled areas”, Milbourn says.

Former EPA chief Christine Todd Whitman’s now-notorious early reassurances about WTC dusts’ safety were based largely on the relatively low concentrations of asbestos. But according to the 2002 US Geological Survey report, an initial analysis on WTC dust—requested by the EPA and US Public Health Service, and reported just over 2 weeks after the 9/11 attacks—noted caustic alkalinity in indoor dusts.

There are institutional lessons from the 9/11 attacks, others are quick to note. “You have to adequately test the substances to know what you’re dealing with and to consider the possible health effects”, Cannata says. “That was not done in this case. The authorities focused on asbestos.”

A precautionary approach was eschewed in favour of assuring the public that the dust was not a major hazard, Cannata says. “They should really have mandated a higher level of protection if they were uncertain what they were dealing with”, he says. “Then they could’ve eased down requirements if they determined the dust wasn’t dangerous. They did the opposite—and then it was too late, because the workers were already exposed.”

Bryant Furlow