Determinants of Asthma Morbidity in World Trade Center Rescue and Recovery Workers

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Asthma is one the most common chronic conditions affecting World Trade Center (WTC) rescue and recovery workers in the aftermath of the terrorist attacks on September 11, 2001. While exposure-response gradients between asthma risk and duration of work at the WTC...
site, exposure to the dust cloud, and work in the Ground Zero pit, compounded by inadequate protection have been described, there is limited knowledge about how exposure and other factors affect long-term asthma outcomes among WTC rescue and recovery workers. In this study, we used data from a cohort of WTC workers with a physician diagnosis of asthma to study factors associated with worse asthma control, acute asthma-related outpatient and inpatient resource utilization, and poor quality of life.

We collected data on asthma history, levels of WTC exposures (categorized based on established criteria), and comorbidities from a prospective cohort of 218 WTC workers with physician-diagnosed asthma who were enrolled in the WTC Health Program (WTCHP). Structured clinical interviews assessed for post-traumatic stress disorder (PTSD) and major depression. A validated questionnaire was used to measure gastroesophageal reflux disease (GERD) symptoms. Outcomes included asthma control, self-report resource utilization, and quality of life. We performed multiple regression analyses to identify factors associated with increased morbidity.

Asthma was well controlled in 63 (29%) WTC workers, not well controlled in 60 (28%) and very poorly controlled in 95 (44%). More than one-third had an unscheduled asthma-related physician visit (67%), while 37 participants (17%) had inpatient asthma-related visits in the twelve months prior to study enrollment. More than half of patients (53%) had poor asthma-related quality of life.

Table 1 shows that after adjustment for socio-demographic and health status variables, very poor asthma control was associated with increased age (odds ratio [OR]: 1.89 per 10 years, 95% confidence interval [CI]: 1.05–3.41), lower income (OR: 7.52, 95% CI: 2.56–22.08), high WTC exposure levels (OR: 5.19, 95% CI: 1.14–23.73), higher GERD scores (OR: 1.13, 95% CI: 1.06–1.20), and PTSD (OR: 3.44, 95% CI: 1.08–10.95).

Outpatient resource utilization was associated with intermediate WTC exposures (OR: 0.23, 95% CI: 0.08–0.71) and major depression (OR: 2.70, 95% CI: 1.01–7.21), while inpatient resource utilization was associated with higher GERD scores (OR: 1.06, 95% CI: 1.01–1.10) and PTSD (OR: 3.52, 95% CI: 1.30–9.48). Poor asthma quality of life was associated with lower income (OR: 3.58, 95% CI: 1.68–7.60), post 9/11 asthma (OR: 2.73, 95% CI: 1.09–6.86), and higher GERD scores (OR: 1.05, 95% CI: 1.01–1.09).

Our study revealed that WTC-related asthma is frequently poorly controlled and results in substantial impairment in quality of life. Furthermore, we found that lower income and physical and mental health comorbidities were independently associated with increased asthma morbidity in the WTC rescue and recovery worker populations. Our results highlight the medical needs of WTC workers with asthma and suggest potential targets for future interventions.

Our findings are consistent with a study conducted among members of the WTC Health Registry, encompassing both local residents and rescue and recovery workers, which found participants to have low levels of asthma control. A potential reason for the high levels of asthma morbidity in WTC rescue and recovery workers is the high prevalence of comorbid GERD, estimated to affect almost 40% of WTC workers and identified as an important
exacerbating factor in patients with poorly controlled asthma. In addition, our finding of a strong association between PTSD and worse asthma morbidity in adjusted analysis is consistent with some community-based studies that reported associations between mental health comorbidities and poor asthma control.

Post 9/11 asthma onset was associated with worse morbidity suggesting more severe disease. While it is possible that workers with pre 9/11 asthma were more likely to utilize respiratory protection and avoid high exposure areas, our findings are consistent with research reporting that late-onset asthma is associated with a poorer response to standard asthma treatments and increased morbidity. There is evidence of a distinct pathophysiological signature associated with irritant-induced WTC-related asthma that is marked by increased sputum eosinophils and neutrophils, elevated blood eosinophils and persistent lower respiratory tract symptoms of cough, wheeze, dyspnea on exertion, and chest tightness.

Another potential explanation for the relatively higher morbidity rates observed in our study is low adherence to asthma self-management behaviors. It is possible that some WTC workers with asthma are not adhering to inhaled corticosteroids or to other self-management behaviors such as allergen avoidance, use of peak flow meters, and action plans, which are important for adequate asthma control. Future studies are needed to examine whether these factors are important, and potentially modifiable, contributors to asthma morbidity in this population.

Our study was limited by reliance on self-report measures of several risk factors and; however, we used validated scales to measure all study variables. In addition, while our three-level measure of WTC exposure was based on established criteria based on self-report data, no objective assessments have been developed to date. Moreover, our sample was limited to WTC rescue and recovery workers enrolled in the WTCHP. Thus, our results may not be generalizable to other WTC workers or other populations affected by the WTC disaster. Nonetheless, this study has a number of strengths including its use of clinically-validated mental health measures.

In summary, we found high levels of asthma morbidity among WTC rescue and recovery workers over 15 years after exposure. Our finding that GERD symptom and PTSD are associated with worse asthma outcomes can help identify high-risk WTC workers and guide development of highly needed interventions.

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Abbreviations

ACQ          Asthma Control
AQLQ         Asthma Quality of Life
CI            Confidence Interval
COPD         Chronic Obstructive Pulmonary Disease
DSM          Diagnostic and Statistical Manual
GERD         Gastro-Esophageal Reflux Disease
OR           Odds Ratio
PTSD         Post-Traumatic Stress Disorder
SCID         Structured Clinical Interview for DSM Disorders
WTC          World Trade Center
WTCHP        Health Program

References


Table 1
Adjusted Analysis – Asthma Control, Outpatient / Inpatient Resource Utilization, and Quality of Life

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Participants N = 218</th>
<th>Very Poor vs. Good Asthma Control OR (95% CI)</th>
<th>Poor vs. Good Asthma Control OR (95% CI)</th>
<th>Outpatient Resource Utilization OR (95% CI)</th>
<th>Inpatient Resource Utilization OR (95% CI)</th>
<th>Poor vs. Good Asthma Quality of Life OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, Years (SD) 1</td>
<td>52.9 (8.0)</td>
<td>1.89 (1.05–3.41)</td>
<td>1.10 (0.62–1.92)</td>
<td>1.04 (0.67–1.62)</td>
<td>0.77 (0.43–1.38)</td>
<td>1.23 (0.79–1.93)</td>
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<tr>
<td>Female Sex, N (%)</td>
<td>62 (28.4)</td>
<td>0.88 (0.33–2.38)</td>
<td>0.93 (0.35–2.48)</td>
<td>1.45 (0.67–3.17)</td>
<td>1.44 (0.56–3.68)</td>
<td>1.09 (0.50–2.36)</td>
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<tr>
<td>Race, N (%)</td>
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<tr>
<td>Non-Hispanic White</td>
<td>29 (13.4)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
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<td>Reference</td>
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<tr>
<td>Non-Hispanic Black</td>
<td>77 (35.7)</td>
<td>1.64 (0.43–6.24)</td>
<td>0.75 (0.20–2.85)</td>
<td>0.81 (0.28–3.22)</td>
<td>1.87 (0.50–6.98)</td>
<td>1.71 (0.99–4.97)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>95 (44.0)</td>
<td>0.99 (0.35–2.77)</td>
<td>0.90 (0.34–2.40)</td>
<td>0.44 (0.19–1.02)</td>
<td>1.03 (0.34–3.10)</td>
<td>1.16 (0.52–2.59)</td>
</tr>
<tr>
<td>Other</td>
<td>15 (6.9)</td>
<td>1.61 (0.33–7.94)</td>
<td>0.84 (0.17–4.14)</td>
<td>0.52 (0.13–2.20)</td>
<td>0.69 (0.09–5.33)</td>
<td>1.49 (0.40–5.48)</td>
</tr>
<tr>
<td>Monthly Income, N (%)</td>
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<tr>
<td>Over $3,000</td>
<td>117 (53.4)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Under &gt;$3,000</td>
<td>81 (37.0)</td>
<td>7.52 (2.56–22.08)</td>
<td>3.69 (1.28–10.60)</td>
<td>0.68 (0.30–1.52)</td>
<td>1.46 (0.54–3.93)</td>
<td>3.58 (1.68–7.60)</td>
</tr>
<tr>
<td>Unknown</td>
<td>21 (9.6)</td>
<td>1.64 (0.24–11.28)</td>
<td>1.77 (0.24–13.10)</td>
<td>0.98 (0.20–4.74)</td>
<td>0.95 (0.18–5.04)</td>
<td>1.97 (0.49–7.94)</td>
</tr>
<tr>
<td>Post 9/11 Asthma, N (%)</td>
<td>169 (81.6)</td>
<td>1.72 (0.55–5.39)</td>
<td>1.01 (0.36–2.84)</td>
<td>0.58 (0.23–1.41)</td>
<td>0.43 (0.14–1.35)</td>
<td>2.73 (1.09–6.86)</td>
</tr>
<tr>
<td>Atopy 2, N (%)</td>
<td>119 (54.3)</td>
<td>0.87 (0.36–2.13)</td>
<td>0.57 (0.24–1.36)</td>
<td>1.25 (0.61–2.55)</td>
<td>0.33 (0.13–0.84)</td>
<td>0.81 (0.41–1.60)</td>
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<tr>
<td>WTC Exposure, N (%)</td>
<td></td>
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<tr>
<td>Low</td>
<td>27 (12.4)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
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<tr>
<td>Intermediate</td>
<td>98 (45.0)</td>
<td>4.04 (0.91–17.91)</td>
<td>3.62 (0.84–15.62)</td>
<td>0.23 (0.08–0.71)</td>
<td>0.38 (0.09–1.59)</td>
<td>2.26 (0.71–7.22)</td>
</tr>
<tr>
<td>High</td>
<td>93 (42.7)</td>
<td>5.19 (1.14–23.73)</td>
<td>2.42 (0.54–10.87)</td>
<td>1.05 (0.36–3.09)</td>
<td>1.31 (0.33–5.22)</td>
<td>2.09 (0.64–6.82)</td>
</tr>
<tr>
<td>Comorbidities, N (%)</td>
<td></td>
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<tr>
<td>GERD Score 3</td>
<td>9.4 (10.5)</td>
<td>1.13 (1.06–1.20)</td>
<td>1.07 (1.01–1.14)</td>
<td>1.04 (1.00–1.08)</td>
<td>1.06 (1.01–1.10)</td>
<td>1.05 (1.01–1.09)</td>
</tr>
<tr>
<td>Sinusitis 4</td>
<td>135 (64.0)</td>
<td>0.81 (0.31–2.13)</td>
<td>0.65 (0.26–1.62)</td>
<td>1.06 (0.48–2.32)</td>
<td>1.19 (0.43–3.29)</td>
<td>0.70 (0.33–1.50)</td>
</tr>
<tr>
<td>Major Depression 5</td>
<td>35 (16.0)</td>
<td>1.33 (0.34–5.20)</td>
<td>0.60 (0.13–2.66)</td>
<td>2.70 (1.01–7.21)</td>
<td>0.82 (0.25–2.73)</td>
<td>2.05 (0.71–5.95)</td>
</tr>
<tr>
<td>PTSD 6</td>
<td>61 (27.9)</td>
<td>3.44 (1.08–10.95)</td>
<td>1.86 (0.56–6.19)</td>
<td>1.50 (0.65–3.43)</td>
<td>3.52 (1.30–9.48)</td>
<td>1.99 (0.85–4.67)</td>
</tr>
</tbody>
</table>

GERD: Gastro-esophageal reflux disease; PTSD: Post-traumatic stress disorder;

1 = Per 10 years in adjusted analysis.
2 = IgE-validated Indoor Allergies,  
3 = Validated GERD Score,  
4 = Self-reported,  
5 = SCID-diagnosed major depression,  
6 = SCID-diagnosed PTSD