Assessment of Woodsmoke Exposure in Wild-land Firefighters

Robert L. Reed, Gretchen D. Onstad, and Christopher D. Simpson, Environmental and Occupational Health Sciences, UW School of Public Health and Community Medicine

BACKGROUND

Woodsmoke is a complex mixture of particles and gaseous components. The fine particulate matter of less than 2.5 μm in diameter along with other chemicals like polycyclic aromatic hydrocarbons, nitrogen dioxide, volatile organic compounds, and carbon monoxide are of concern because of their contribution to adverse health such as asthma, COPD, impaired lung function, and lung cancer. 100,000 people annually are exposed to elevated levels of woodsmoke from wildfires, urban fires, agricultural field burning, and prescribed burns. An estimated 70,000-80,000 of these individuals are wildland firefighters. To better understand this occupational exposure, personal sampling of 12 United States Forest Service (USFS) firefighters working controlled burn activities at Savannah River Site, Georgia took place during Spring ’08. Their exposures to fine particle matter (PM$_{2.5}$), carbon monoxide (CO), and levoglucosan (LG) are characterized here.

METHODS AND DESIGN

Collection and Analysis of Particulate Matter

Personal levels of PM$_{2.5}$ (µg/m$^3$) were measured on firefighters on days they worked on a prescribed burn. They wore the PM$_{2.5}$ sampling equipment for the full work shift. Personal sampling was accomplished by an SKC Air Check Pump attached to a cyclone selective for fine particle matter by Tygon tubing. Attached to the cyclone was a cassette with a PTFE membrane filter inside where the particulate matter could be collected.

Measurement of CO

Carbon monoxide (CO) was measured using a Draeger Pac III CO chemical sensor with data logger. Measurements were taken and logged every 60 seconds. Equipment was hung at the beginning and removed at the end of each shift. Time weighted average concentrations of CO are reported here for each firefighter workshift.

RESULTS

Table 2: Workshift concentrations

<table>
<thead>
<tr>
<th>Analyte</th>
<th>$N$</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{2.5}$ (µg/m$^3$)</td>
<td>71</td>
<td>50</td>
<td>1466</td>
<td>553</td>
<td>306</td>
</tr>
<tr>
<td>LG (µg/m$^3$)</td>
<td>71</td>
<td>1.4</td>
<td>97</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>CO (ppm)</td>
<td>71</td>
<td>0.4</td>
<td>7.5</td>
<td>2.3</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Quality Control

Field blanks were analyzed for LG along with all other samples. The mean concentration of these filters is 0.16 ± 0.12 µg/mL. Five of the data points were excluded because of quality issues either with the collection of the sample or from poor recovery during extraction analysis. Instrument precision was ± 2% for duplicate injections. The recovery of d7-LG for all samples was 75% ± 10%.

DISCUSSION

In general there are good correlations between all three comparisons. Concentrations of LG and PM$_{2.5}$ show the strongest relationship. Outliers in scatter points could have been associated with different work activities among the firefighters on the day of the controlled burn. Future analysis could focus on dividing up data into different exposure groups.

Are these exposures levels safe? OSHA’s TWA for CO is 50 ppm and EPA’s annual average NAAQS for PM$_{2.5}$ should not exceed 35 µg/m$^3$.

CONCLUSIONS

1. Levoglucosan is a better surrogate than CO for woodsmoke exposure.
2. Exposure levels are not exceeding occupational limits, but far exceed EPA’s limits for personal exposure.

Acknowledgements

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References