IMPACTS OF A WILDFIRE EVENT –
HEALTH EFFECTS OF SMOKE EXPOSURE

PNWER Summit
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July 22, 2019
WILDFIRES INCREASING

- Increasing in numbers of fires\(^1\)
  - \(~140/yr\) in the 1980’s
  - \(~160/yr\) in the 1990’s
  - \(~250/yr\) in the 2000’s

- Increasing in duration – avg of 5 months (1970’s) to 7+ months (2000’s)\(^1\)

- Increase in average temperatures:
  - Melts snowpack earlier (up to 4 weeks)
  - Drier forests

- Montana is perennial top 10 state for wildfire exposures

- Summer of 2017:
  - Rice Ridge fire >150,000 acres
  - Lolo Peak fire ~54,000 acres

[https://www.carbonbrief.org/factcheck-how-global-warming-has-increased-us-wildfires](https://www.carbonbrief.org/factcheck-how-global-warming-has-increased-us-wildfires)
POTENTIAL FOR HEALTH EFFECTS

- Air pollution
  - PM$_{2.5}$
  - Not all PM$_{2.5}$ is created equal

- At risk populations (respiratory, cardiovascular, elderly, pediatrics)

- Previous studies focus on historical data
  - ED visits
  - Hospital admissions
  - ICD-10 codes
Sizing up particulate matter

Pollution particles of soot and other specks called PM-10 and PM-2.5 are microscopic, yet they are thousands of times larger than ultrafine particles. Ultrafines are measured in nanometers, and can be 100 nanometers and smaller. A typical germ measures about 1,000 nanometers.

PM-10
About six would fit across the width of a human hair.

PM-2.5
About 30 would fit across the width of a human hair.

Ultrafine particles
About 1,000 would fit across the width of a human hair.
A majority of studies have found that wildfires are linked to health outcomes (Liu 2015)

- Hospital admission rates
- Increase contact with hospitals or clinics

Hospital/clinic/provider visits (Wettstein 2018, Alman 2012)

- Respiratory (asthma, wheeze, COPD)
- Cardiovascular, cerebrovascular

Increase asthma visits in the ED during wildfire event (Haikerwal 2016)

While some studies suggest increased mortality, difficult to correlate
HEALTH COSTS

- Hospitalizations
- Medications
- Lost wages

- Study: Health Costs of Wildfires (Richardson 2011)
  - $84.42 = amount for reduction of symptoms for 1 day
  - California Station Fire of 2009
  - Defensive behavior not historically in the calculations
    - Averting actions
    - Mitigating actions
COST-BENEFIT STUDY

- Fisk and Chan 2017
- Reduction of household PM$_{2.5}$
  - HVAC – continuously vs on demand
  - HVAC filter upgrade
  - Portable continuous filters
- Potential health benefits
  - 11-63% of hospital admissions
  - 7-39% of deaths attributable to wildfire particles
- Added interventions cost/benefit
  - all potential households: cost > benefit
  - Target ≥65 year olds: decreases costs by 80%, while benefits are same magnitude
THE SEELEY LAKE STUDY

- Opportunity to assess in real time
- Unprecedented exposure
- Relatively local
- History of wildfires and smoke
Rice Ridge Fire - >150,000 acres

July 31st-September 18th

24-hr average: 220.9 μg/m³

35/50 days “very unhealthy” or “hazardous”
Last 5 yrs - PM$_{2.5}$ Daily Averages

- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- EPA standard

Days in 2017

PM$_{2.5}$ (µg/m$^3$)

NAAQS 24-hr Std
# Spirometry — Lung Function

<table>
<thead>
<tr>
<th>Tests/Units</th>
<th>Definition</th>
<th>Measurement Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FVC</strong></td>
<td>Forced Vital Capacity (L)</td>
<td>Decreased in restrictive disorders and severe obstruction</td>
</tr>
<tr>
<td></td>
<td>The Maximum volume of air exhaled</td>
<td></td>
</tr>
<tr>
<td><strong>FEV1</strong></td>
<td>Forced Expiratory Volume in 1 second (L)</td>
<td>Decreased in obstruction of large to mid sized airways</td>
</tr>
<tr>
<td></td>
<td>Volume of air exhaled over one second</td>
<td></td>
</tr>
<tr>
<td><strong>FEV1/FVC</strong></td>
<td>Forced Expiratory Volume Ratio %</td>
<td>Decreased in small airway obstruction. Also used to grade severity of obstruction. Increased with restrictive disorders</td>
</tr>
<tr>
<td></td>
<td>A ratio of FEV1 to the Forced Vital Capacity expressed as a percentage</td>
<td></td>
</tr>
</tbody>
</table>
SPIROMETRY RESULTS:

FEV1/FVC Ratio

- **All**: 78.00 (2017), 76.00 (2018)
- **Females**: 76.00 (2017), 74.00 (2018)
- **Males**: 82.00 (2017), 80.00 (2018)

Significance:
- **All**: **P < 0.01**
- **Males**: ***P < 0.001**
Percent change of individuals

<table>
<thead>
<tr>
<th>Gender</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>-6.30%</td>
</tr>
<tr>
<td>Females</td>
<td>-3.86%</td>
</tr>
<tr>
<td>Males</td>
<td>-8.91%</td>
</tr>
</tbody>
</table>
2019 UPDATE: RESPIRATORY EFFECTS

![Graph showing FEV1/FVC levels for 2017, 2018, and 2019 with a decrease from 2017 to 2019.]
### WHAT IS NORMAL?

#### Normal FEV1/FVC Ranges

<table>
<thead>
<tr>
<th>Age</th>
<th>FEV1/FVC</th>
</tr>
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<tbody>
<tr>
<td>8-19</td>
<td>85%</td>
</tr>
<tr>
<td>20-38</td>
<td>80%</td>
</tr>
<tr>
<td>40-59</td>
<td>75%</td>
</tr>
<tr>
<td>60-80</td>
<td>70%</td>
</tr>
</tbody>
</table>

*EPR-3 Guidelines

#### Decreased lung function (FEV₁/FVC)

<table>
<thead>
<tr>
<th>Year</th>
<th>Below age-range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>6</td>
</tr>
<tr>
<td>2018</td>
<td>15</td>
</tr>
<tr>
<td>2019</td>
<td>14</td>
</tr>
</tbody>
</table>
**FUTURE**

- Fires will continue
- Need to understand other long- and short-term health effects
  - Cardiovascular
  - Behavioral
  - Community
- Mitigation and defensive strategies
  - What should be done
  - What can be done
- Continue to expand and follow our cohort
- Additional cohorts in western Montana
ACKNOWLEDGEMENTS

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  - Pharmacy, nursing, social work

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QUESTIONS?
REFERENCES

- Fisk WJ, Chan WR. 2017a. Health benefits and costs of filtration interventions that reduce indoor exposure to pm2.5 during wildfires. Indoor air 27:191-204.
RESULTS: PUBLIC HEALTH

- 54% used a plug-in HEPA unit
- 34% “evacuated”
  - Avg of 59.3 miles
  - Range of 1-59 days
  - 17% >100 miles
  - 62% ≤32 miles
# Demographics

<table>
<thead>
<tr>
<th>Year</th>
<th>Participants</th>
<th>Age (yrs)</th>
<th>#Females</th>
<th>#Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>95</td>
<td>63</td>
<td>51</td>
<td>44</td>
</tr>
<tr>
<td>2018</td>
<td>42</td>
<td>64</td>
<td>25</td>
<td>17</td>
</tr>
<tr>
<td>2019</td>
<td>60</td>
<td>64</td>
<td>34</td>
<td>26</td>
</tr>
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