

Beth Israel Deaconess Medical Center

Harvard School of Public Health

Smoke Signals: Epidemiologic Evidence of Wildfire Toxicity

Webinar for the Inhalation and Respiratory Specialty Section, Society of Toxicology
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Disclosures

- No relevant financial relationships with a commercial interest
- Chair of the American Thoracic Society Environmental Health Policy Committee
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At the end of this talk, I hope you will be able to:

- Describe the reasons for recent increases in wildland fire activity in the U.S.
- Identify respiratory effects of wildfire exposure
- Recognize likely cardiovascular effects of wildfire exposure among elderly

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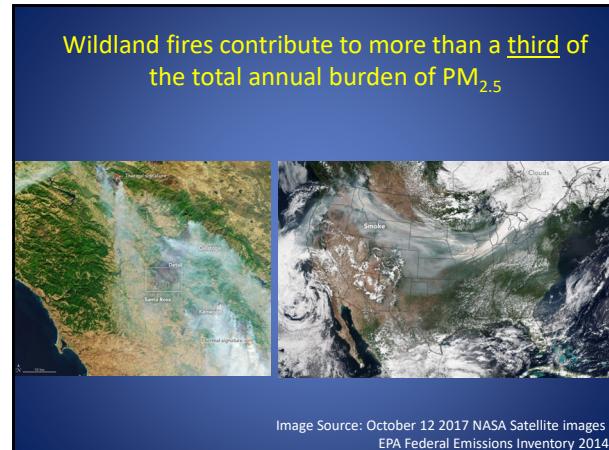
Increase in Acres Burned in U.S.

Total acres burned in wildfires in the United States, 1979 through 2018, with linear regression trend line (dashed). Source: National Interagency Fire Center.

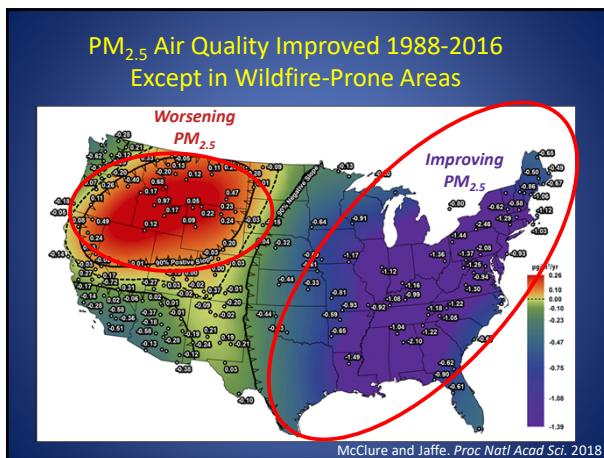
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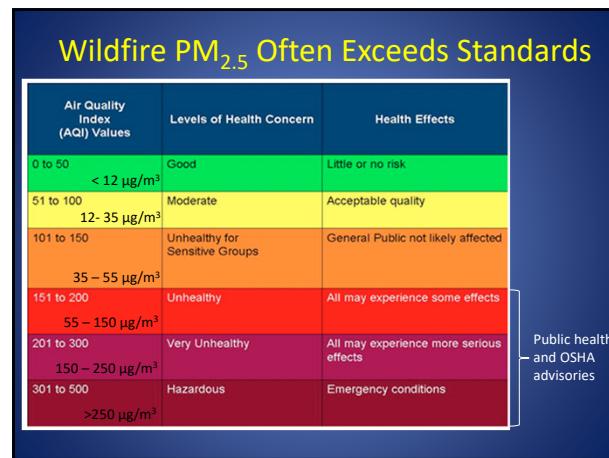
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Key Drivers of Wildland Fire Activity

<p><u>More Acres Burned</u></p> <ul style="list-style-type: none"> Drier conditions (climate change explains ~55% increase in aridity 1979-2015 in Western U.S.¹) Many more prescribed fires (300% ↑in acres/yr in past 10 years)² 	<p><u>More Loss of Life & Property</u></p> <ul style="list-style-type: none"> Years of fire suppression (biomass accumulation) Wildland-urban interface
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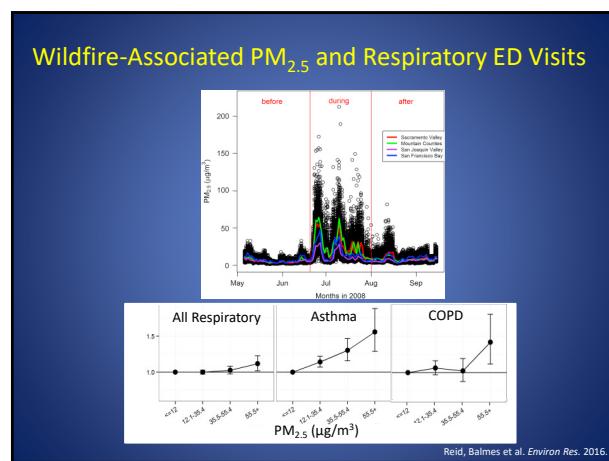
1. Abatzoglou and Williams. *Proc Natl Acad Sci USA*. 2016
2. Data from John Hall, Director, Joint Fire Science Program

Wildfires are “Natural” Experiments

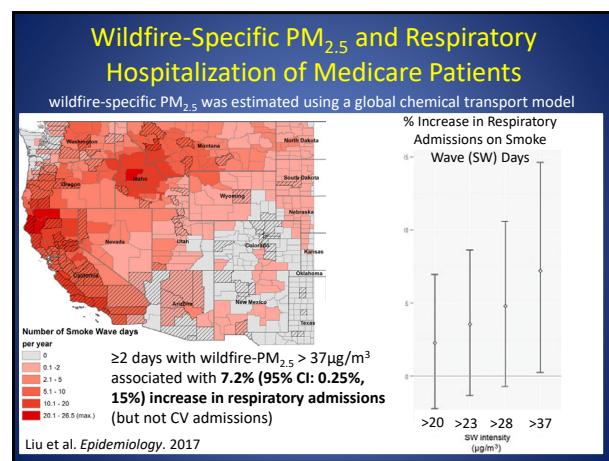
- Acute** respiratory health effects have been identified in many studies comparing rates of respiratory visits & admissions before, during and after smoke events
- Chronic** respiratory health effects of repeated exposure to regional wildfire smoke are not well-studied

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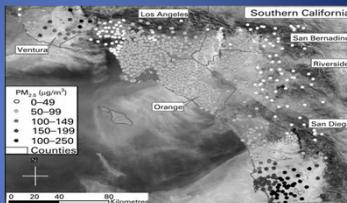
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Many Studies Find Increases in Asthma Admissions & Treatment During Wildfires

- More admissions for:
 - Asthma (34% increase during heavy smoke)
 - Acute bronchitis
 - Pneumonia
 - COPD
 - (not CV admissions)
- Wildfire PM may be **more toxic for asthmatics** than PM from other sources: 6.7% vs 1.3% increase in Medicare asthma hospitalization per 10 $\mu\text{g}/\text{m}^3$ of wildfire vs non-wildfire PM²



1. Delfino et al. *Occup Environ Med*. 2009.
2. DeFlorio-Barker et al. *EHP*. 2019.

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Respiratory Symptoms in Children

- Children's Health Study (ages 6-7 & 17-18)¹ found wildfire smoke associated with:
 - Upper respiratory symptoms (nose, eyes, throat irritation)
 - Lower respiratory symptoms (cough, bronchitis, wheeze)
 - Medication use for above symptoms
 - Greater symptom increases among asthmatics
 - 63% increase in asthma attacks
- Among **non-asthmatic** children, airway size (MMEF:FVC) associated with greater susceptibility to respiratory symptoms²



1. Kunzli et al. *AJRCCM*. 2006.
2. Mirabelli et al. *Epidemiology*. 2009.

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Wildland Firefighters

- Volunteer and professional (e.g. USFS firefighters)
- No approved respirator!
- Few studies of health effects due to research challenges
- Using exposures and PM dose-response functions,¹ firefighters with 5-25 yr career have:
 - 8-43% higher risk of lung cancer mortality
 - 16-30% higher risk of CV mortality



Photo by Kathleen Navarro.
1. Navarro et al. *Environ Res*. 2019.

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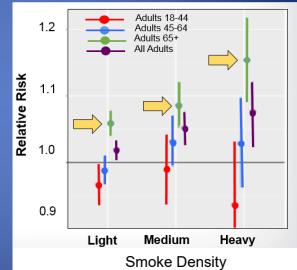
Elderly Likely at Risk for Acute Cardiovascular Effects of Wildfire Smoke

California 2015 Wildfire Study



- Wildfire-PM_{2.5} associated with hypertension, myocardial infarction, arrhythmia, and heart failure, particularly >65 years old

All Cardiovascular Admissions



Wettstein et al. *JAMA* 2018

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Conclusion

- Wildland fires are a major source of PM exposure, and air quality has worsened in wildfire-prone areas in US
- Wildfire smoke is associated with asthma attacks and respiratory admissions, and likely CV admissions among elderly
- Chronic health effects of repeated smoke exposure to communities and firefighters are not well-described