Epidemiological Evidence of Wildfire Smoke Health Impacts

BC Lung Association 2019 Air Quality and Health Workshop

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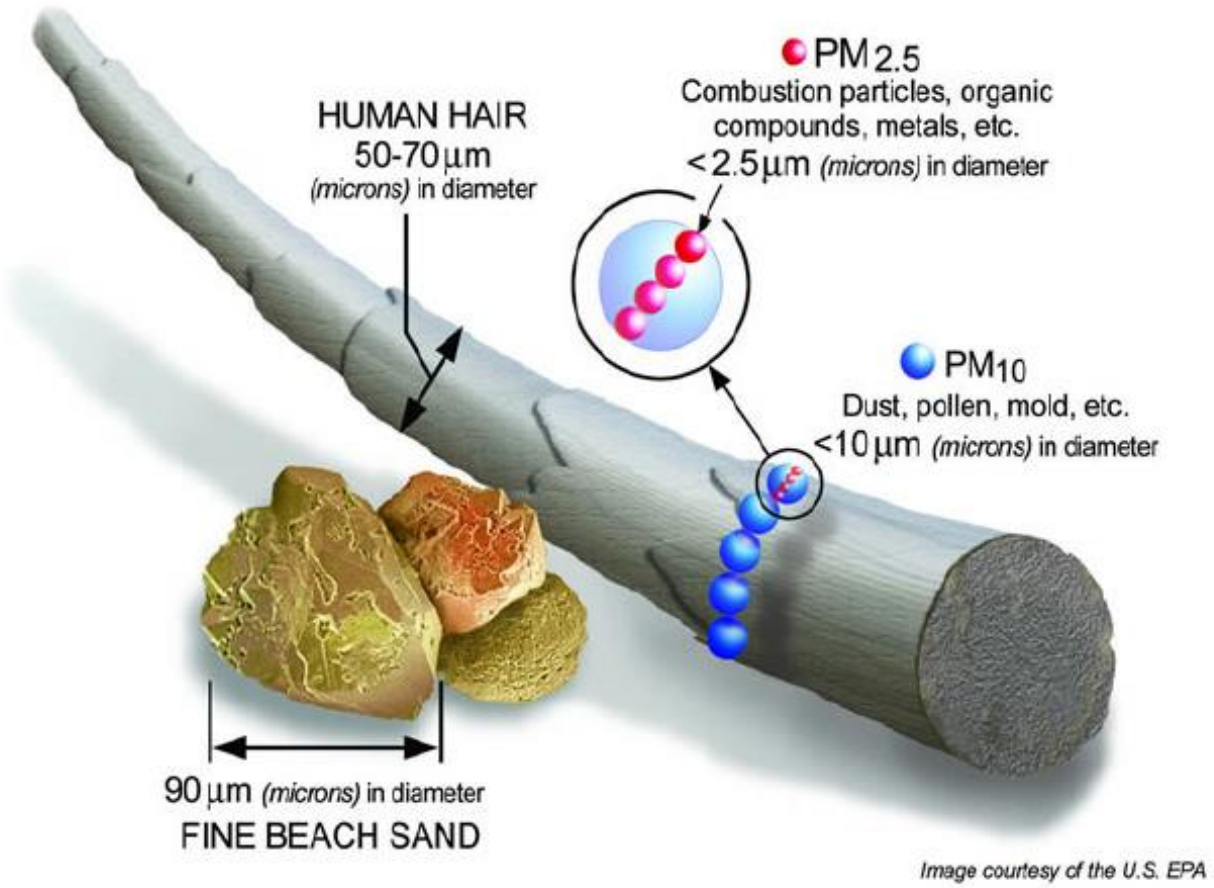
Emissions from Wildfires with Health Concerns

<u>Primary air pollutants</u>

- CO
- NO_2
- PAHs – polycyclic aromatic hydrocarbons
- VOCs – volatile organic compounds
- Particulate Matter (PM)

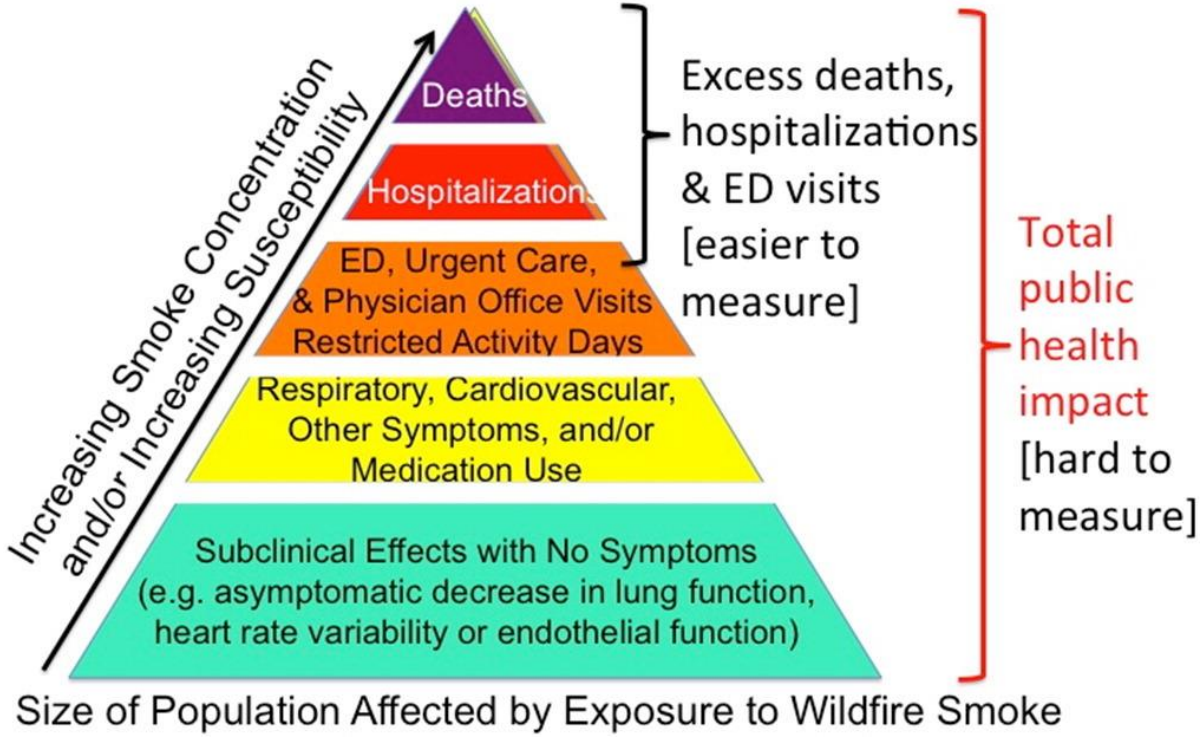
<u>Secondary air pollutants</u>

- Particulate Matter (PM)
- Ozone



Epidemiological Difficulties in Studying Wildfires

- Studies are retrospective
  - → must use administrative health data
- Some fires tend to be
  - Short in duration
  - In rural areas
  - → small populations
- This leads to low power to observe a health effect if there is one



Cascio. (2017). Wildland fire smoke and human health. Science of the Total Environment.

Review

A Section 508–conformant HTML version of this article
is available at http://dx.doi.org/10.1289/ehp.1409277.

Critical Review of Health Impacts of Wildfire Smoke Exposure

Colleen E. Reid,[1,2] Michael Brauer,[3] Fay H. Johnston,[4,5] Michael Jerrett,[1,6] John R. Balmes,[1,7] and Catherine T. Elliott[3,8]

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CURRENT OPINION

Wildfire smoke exposure under climate change: impact on respiratory health of affected communities

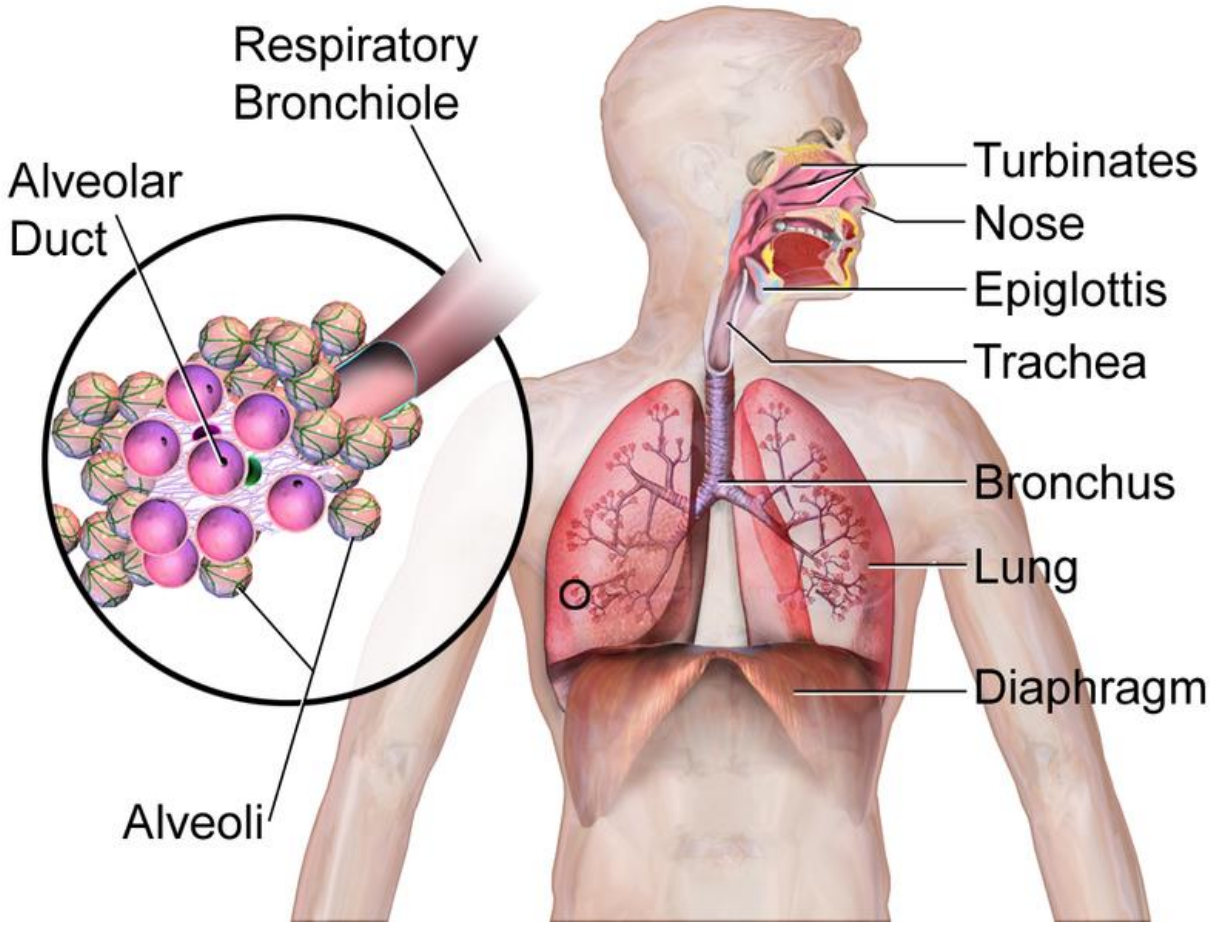
Curr Opin Pulm Med 2018, 24:000–000
DOI:10.1097/MCP.0000000000000552

Colleen E. Reid[a] and Melissa May Maestas[b]

Acute health impacts of short-term wildfire smoke exposures

Clear evidence of an association between wildfire smoke and respiratory health

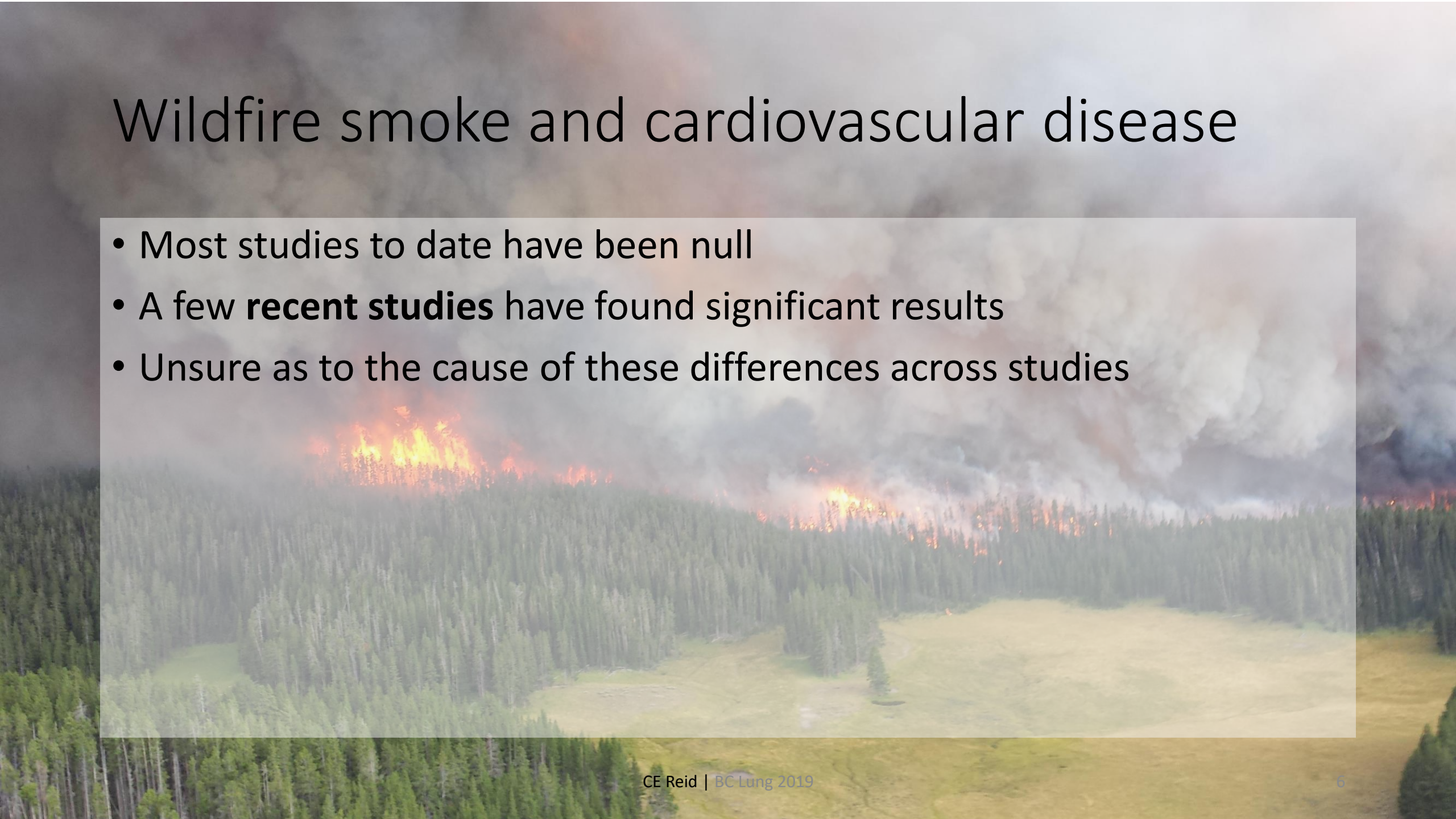
- Asthma exacerbations significantly associated with higher wildfire smoke ***in nearly every study***
- Exacerbations of chronic obstructive pulmonary disease (COPD) significantly associated with higher wildfire smoke in most studies
- Growing evidence of a link between wildfire smoke and respiratory infections (pneumonia, bronchitis)

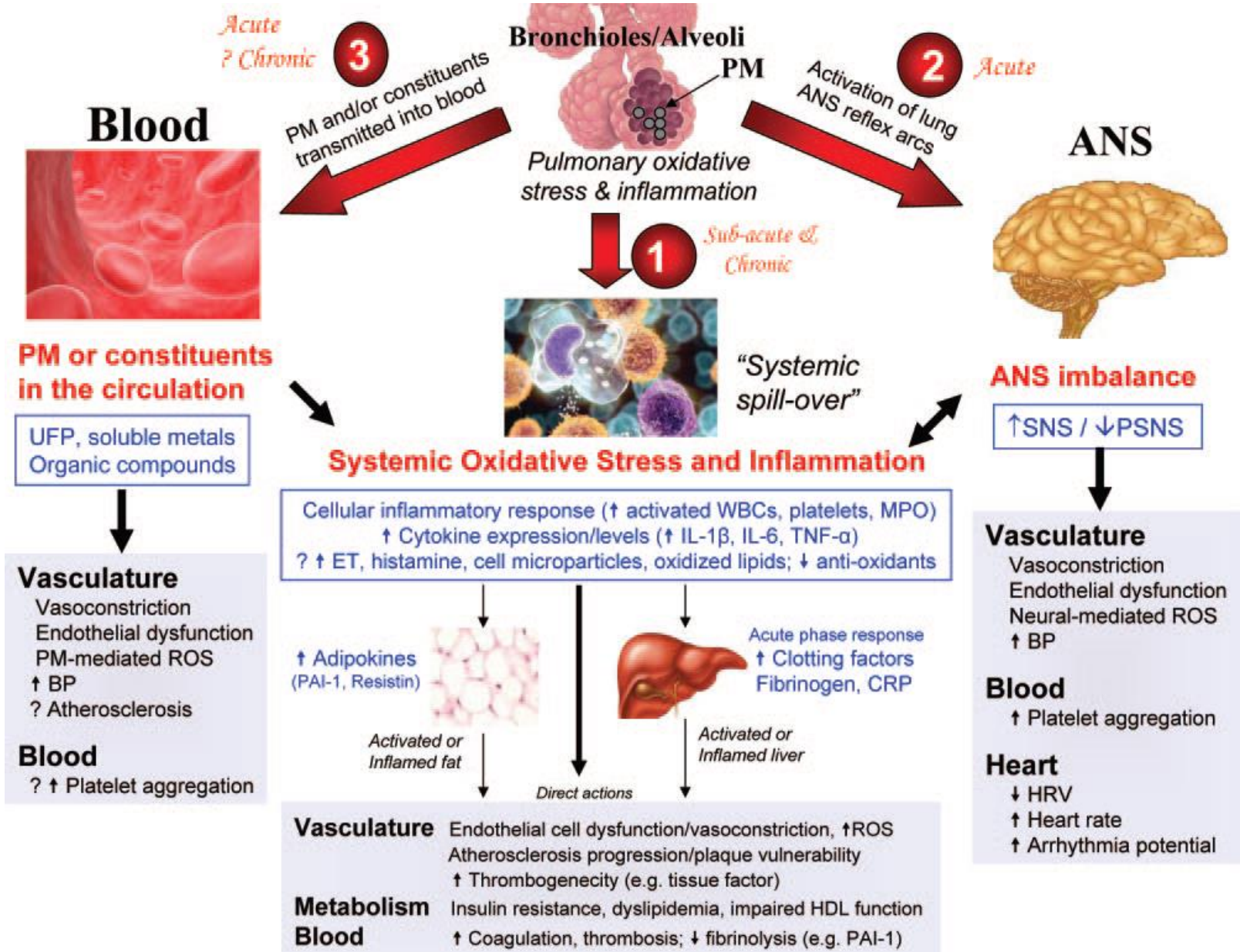


https://commons.wikimedia.org/wiki/File:Respiratory_System_(Illustration).png

Wildfire smoke and cardiovascular disease

- Most studies to date have been null
- A few **recent studies** have found significant results
- Unsure as to the cause of these differences across studies





Brook, R. D. et al. Circulation 2010;121:2331-2378

Out-of-hospital cardiac arrests

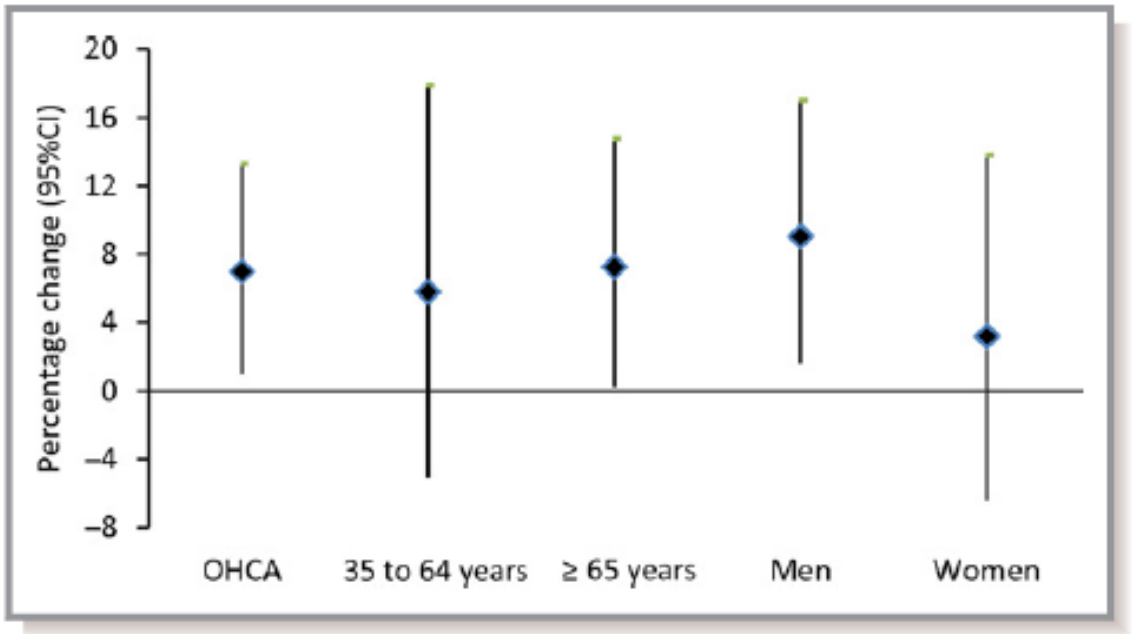


Figure 1. Percentage increase in risk (and 95% CI) of out-of-hospital cardiac arrests by age and by sex for interquartile range increase in $PM_{2.5}$ by 9 $\mu g/m^3$ after adjusting for temperature and relative humidity for lag 0 to 1 (lag 0 to 1: averages of exposure concentrations on the day of the event and exposure concentrations 1 day before the event). OHCA indicates out-of-hospital cardiac arrests; $PM_{2.5}$, fine particulate matter.

Hospital admissions for IHD

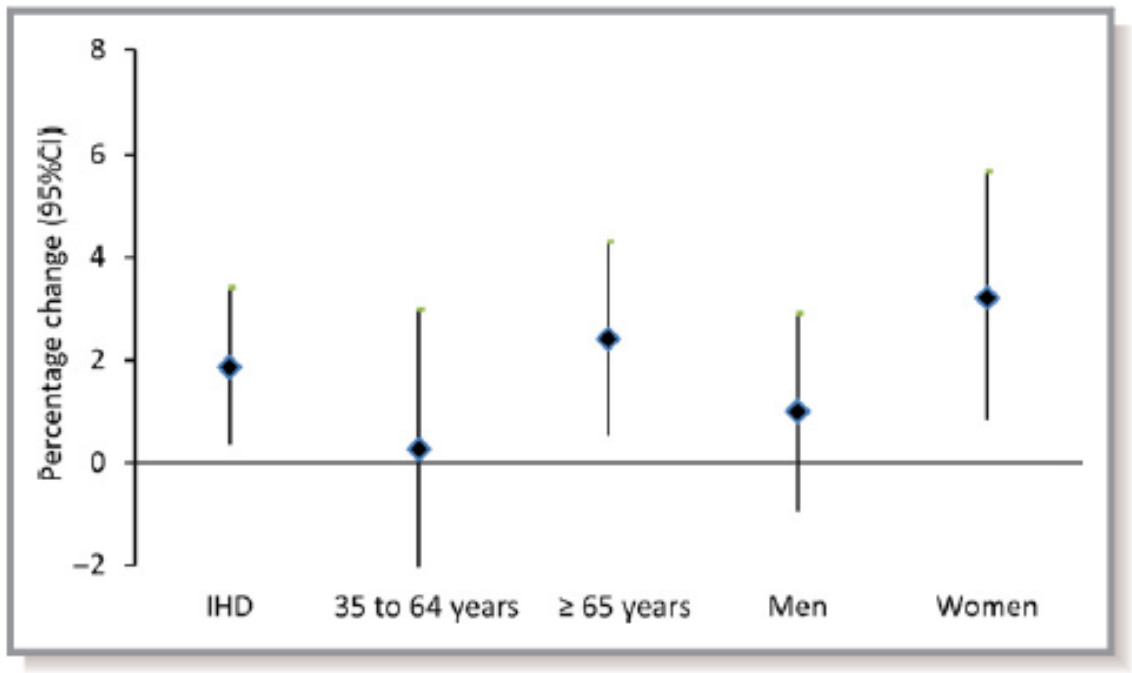
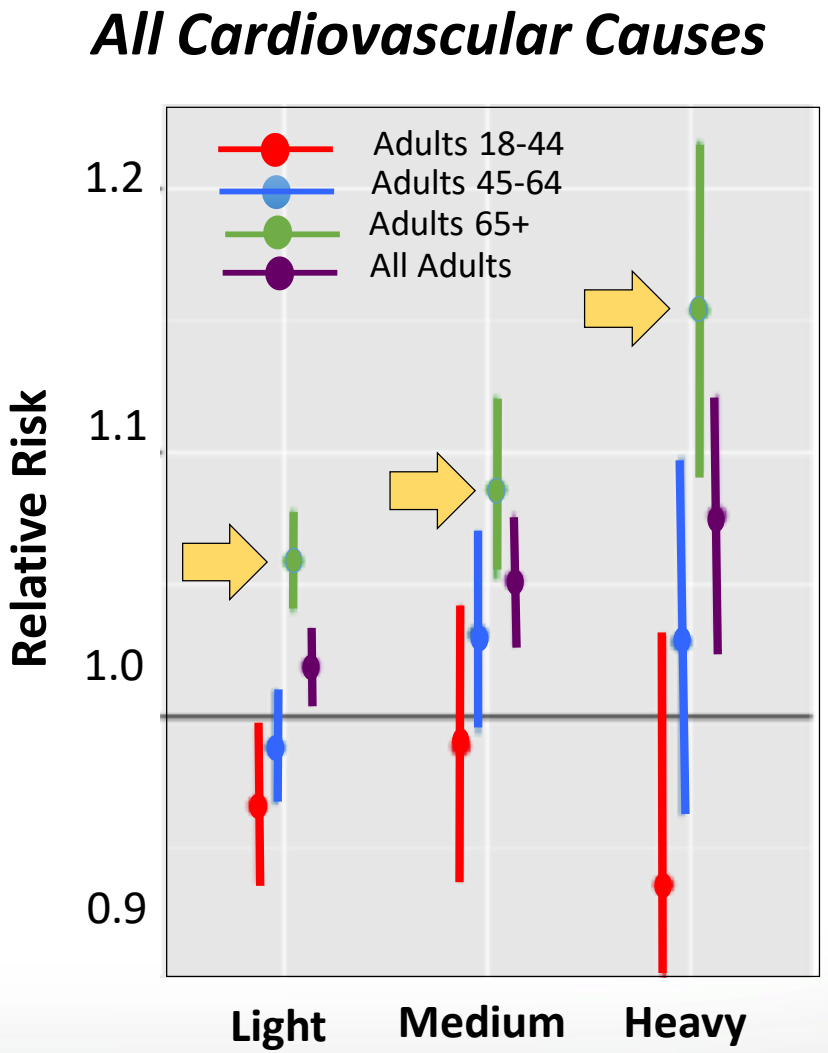


Figure 2. Percentage increase in risk (and 95% CI) of hospital admission for IHD (by age and by sex) for an interquartile range increase in $PM_{2.5}$ by 9 $\mu g/m^3$ after adjusting for temperature and relative humidity at lag 2 (exposure concentrations 2 days before the event). IHD indicates ischemic heart disease; $PM_{2.5}$, fine particulate matter.

Haikerwal et al. (*J Am Heart Assoc*. 2015;4:e001653 doi: 10.1161/JAHA.114.001653)

Wildfire-$PM_{2.5}$ Increases Heart Attack & Stroke

- ***Wildfire-$PM_{2.5}$ associated with heart attacks and strokes for all adults, particularly for those over 65 years old***
- ***Increase in risk the day after exposure:***
  - All cardiovascular, 12%
  - Heart attack, 42%
  - Heart failure, 16%
  - Stroke, 22%
  - All respiratory causes, 18%
  - Abnormal heart rhythm, 24%
    (on the same day as exposure)



Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al. JAHA April 11, 2018

Slide credit: Wayne Cascio

Magnitude of respiratory risks versus cardiovascular risks?

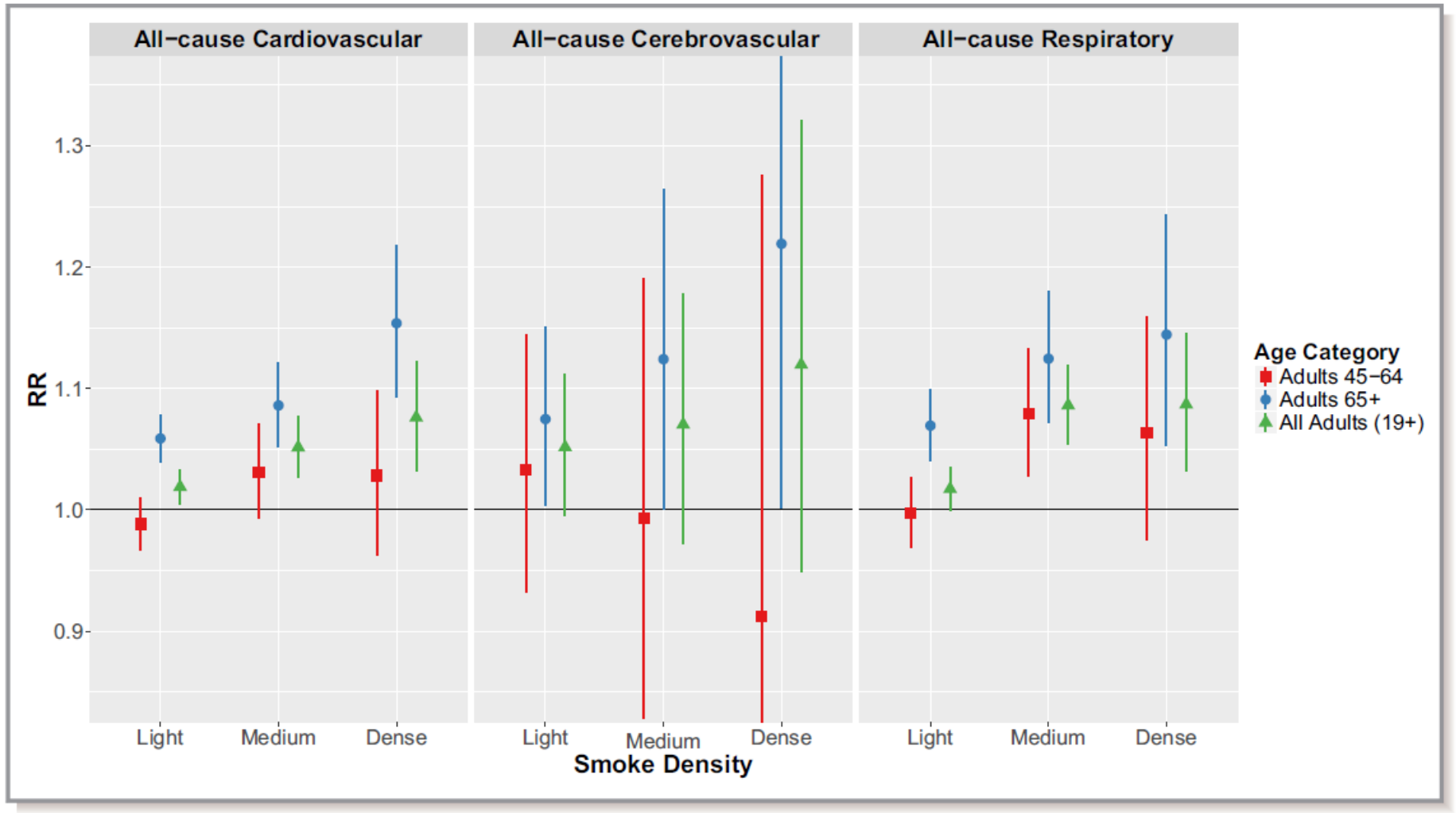
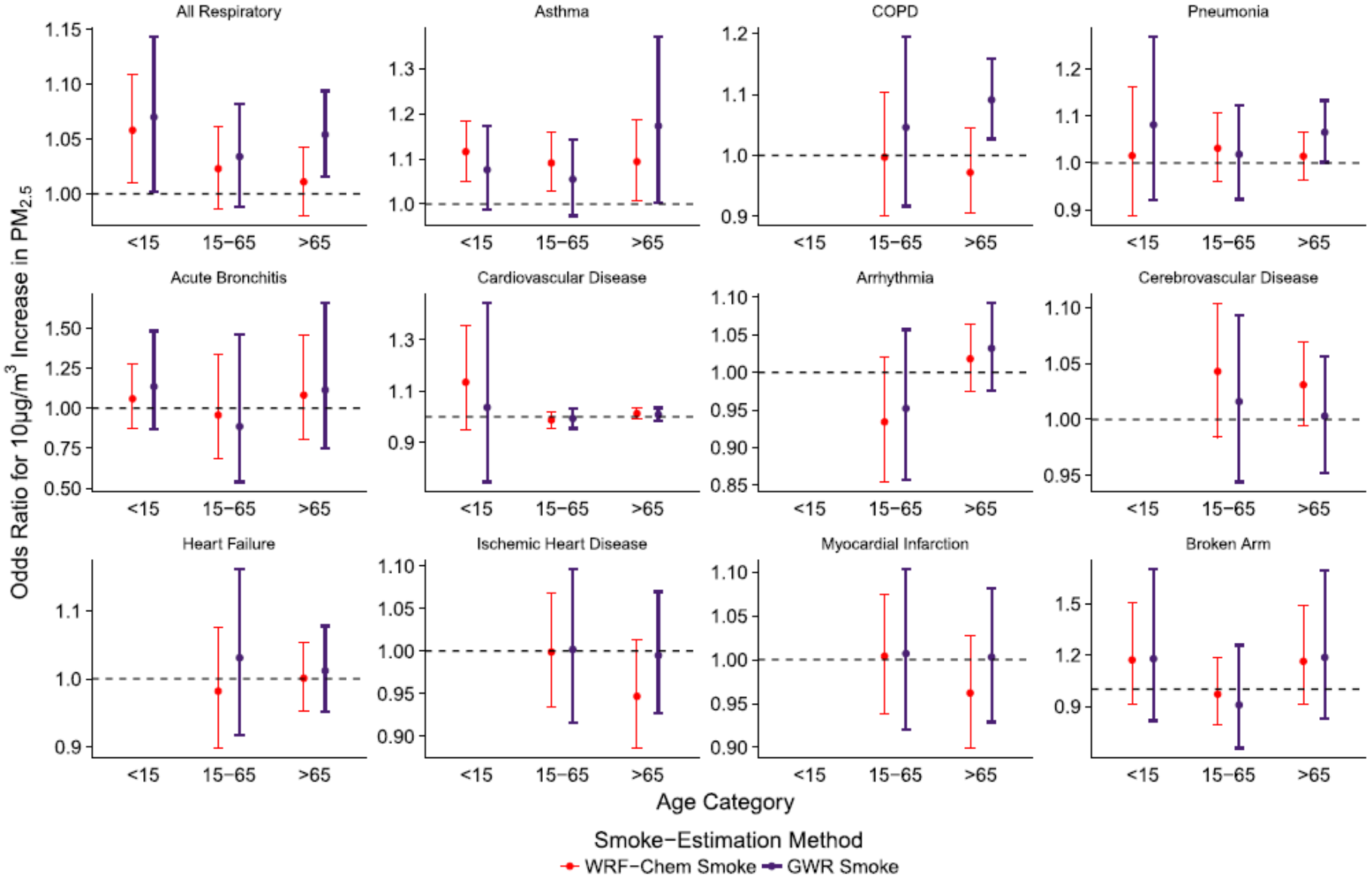


Figure 2. Relative risk and 95% confidence intervals for select cardiovascular, cerebrovascular, and respiratory outcomes relative to smoke-free days, at lag 0 days, stratified by age; 8 California air basins (May 1–September 30, 2015). Models adjusted for heat index, day of week, time trend, and log-population offset. RR indicates relative risk.

Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al. JAHA April 11, 2018



Gan RW, Ford B, Lassman W, et al. Comparison of wildfire smoke estimation methods and associations with cardiopulmonary-related hospital admissions. GeoHealth 2017; 1:122–136.

Chronic health impacts of extreme short-term smoke exposures or repeated seasonal exposures?

Long-term health effects of high air pollution exposures

Table 1
Lung capacity regression results – full-sample analysis (OLS estimation).
Dependent variable: lung capacity (as measured in 2007).

Explanatory variables	Coefficient	Robust standard error
Pollution	−5.370***	1.052
Age	−4.646***	0.234
Age squared	0.0215***	0.00238
Education	1.904***	0.183
Log PCE	3.098***	1.075
Having outside kitchen	1.424	1.389
Having outside water	−3.029*	1.640
Lung capacity 97	0.577***	0.0075
Const.	245.1***	14.26

Table A2
Lung capacity regression results – sub-sample analysis (OLS estimation). Dependent variable: lung capacity (as measured in 2007).

Explanatory variables	Full sample	0–21 yrs. old	21–41 yrs. old	>41 yrs. old
MEN				
Pollution	−8.156***	−3.913	−11.14***	−13.27***
	(1.654)	(2.760)	(2.589)	(3.051)

Kim Y, Knowles S, Manley J, Radoias V. Long-run health consequences of air pollution: evidence from Indonesia's forest fires of 1997. Econ Hum Biol 2017; 26:186–198.

Health impacts of wildfire smoke on the very young

Fires effect on birth weight

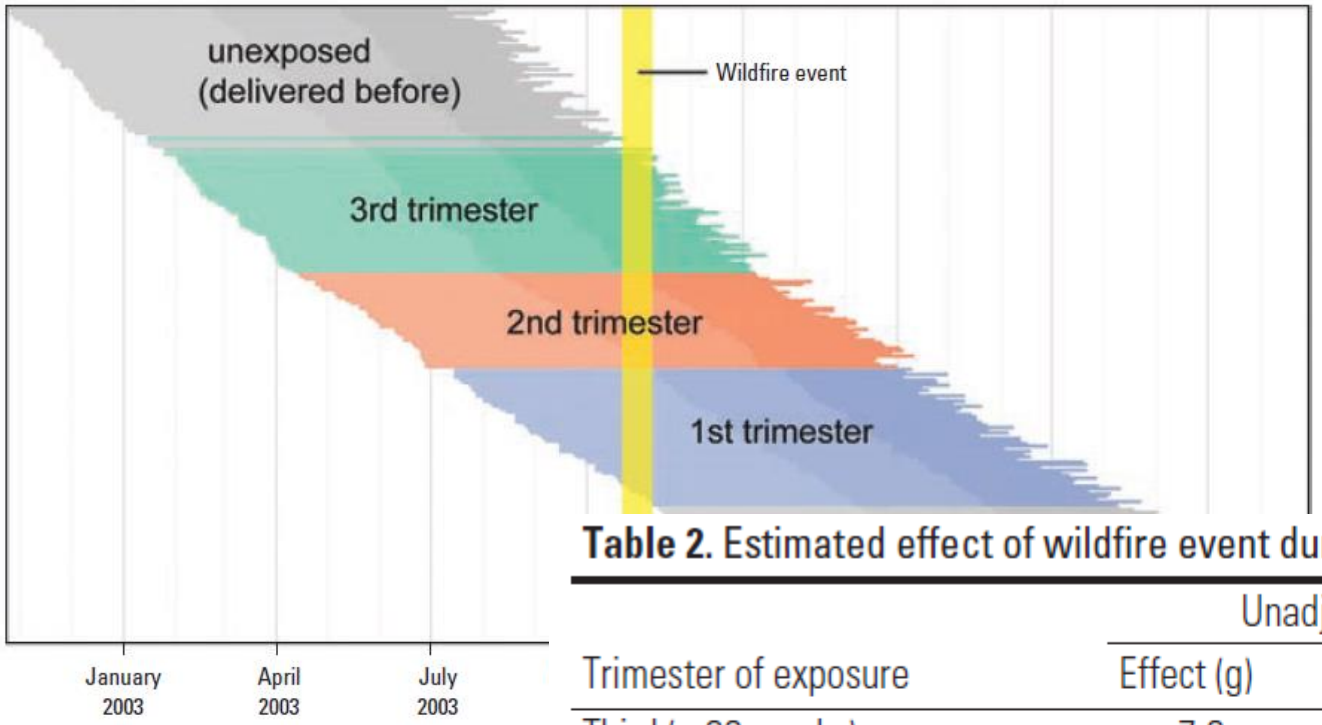


Figure 2. Schematic illustrating exposure as
lap between the wildfire event (yellow) an
clarity, gestational intervals are shown orde
from 2002–2004 is shown. Dates on the *x*-ax
seasonality.

Table 2. Estimated effect of wildfire event during gestation on birth weight (g), by trimester.

	Unadjusted model		Adjusted model	
Trimester of exposure	Effect (g)	95% CI	Effect (g)	95% CI
Third (≥ 29 weeks)	–7.9	(–12.8, –3.1)	–7.0	(–11.8, –2.2)
Second (17–28 weeks)	–17.1	(–21.9, –12.3)	–9.7	(–14.5, –4.8)
First (1–16 weeks)	–3.9	(–7.8, 0.0)	–3.3	(–7.2, 0.6)
Any trimester	–8.8	(–11.5, –6.1)	–6.1	(–8.7, –3.5)

Adjusted model includes terms for fetal sex, gestational age, parity, maternal age, maternal education, maternal race/ethnicity, secular trend, and season.

Holstius et al. 2012 *EHP*

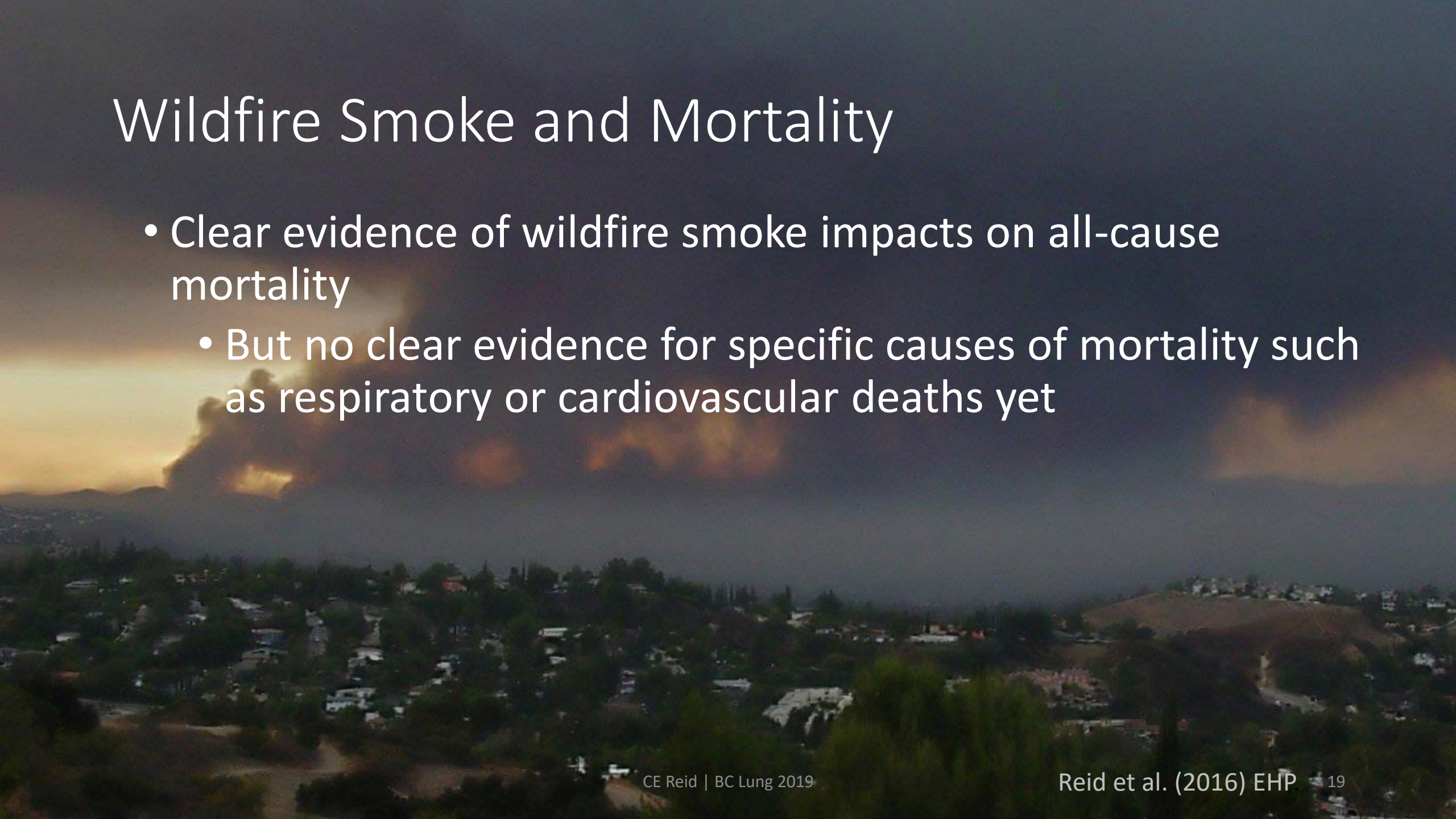
Other health impacts relevant to children

- Over 15,000 “Missing children” in Indonesian census in cohorts affected by the 1997 Indonesian wildfires
  - Jayachandran (2009). Journal of Human Resources 44: 916–954.
- Physician visits for otitis media
  - Yao et a. (2014) JESEE
- Papers that examine differential effects by age group find differing results

Other health impacts of wildfire smoke

Wildfire Smoke and Mortality

- Clear evidence of wildfire smoke impacts on all-cause mortality
  - But no clear evidence for specific causes of mortality such as respiratory or cardiovascular deaths yet



Reid et al. (2016) EHP

Mental Health

- Most studies of mental health with wildfires find evidence of various mental health impacts of wildfire smoke exposure including PTSD, depression
  - Many of these studies are of populations that were not just exposed to smoke but also were evacuated or lost property or loved ones
  - Concerns about self-report of both exposure and health endpoints in many of these studies

Photo credit: https://www.flickr.com/photos/kylewith/14435190829

Lived experience of a record wildfire season in the Northwest Territories, Canada

Warren Dodd[1] · Patrick Scott[2] · Courtney Howard[3,4,5] · Craig Scott[6] · Caren Rose[7,8,9] · Ashlee Cunsolo[10] · James Orbinski[11,12,13]

"You know, I think that people were more isolated because people weren't out working in their gardens. They weren't out walking around…they weren't out participating in things the way they normally are. So that really impacts community, sense of comm cohesion, all of those things."

"It was like we didn't have a summer, for me, because, usually we get outside, we do things on the water…we enjoy being in the North. We enjoy being outside. We enjoy the environment. We enjoy cooking. Everything that's outside, we enjoy, and, I feel like I lost that…that impacts you emotionally and mentally."

Most pressing gaps in the epidemiological evidence

What do we still not know?

- The long-term health impacts of repeated exposures to wildfires
- There are likely other health endpoints related to wildfire smoke that have not been studied
  - Metabolic disorders, cognitive decline, child development, maternal health
- Why are findings different across studies – particularly for CVD
  - Is it because of different underlying health burdens, fire characteristics (duration, fuels, meteorology, chemistry), statistical methodology, exposure assessment method
- Health impacts of other air pollutants from wildfires not just PM
- Need more research into vulnerable populations
- Need more research into the effectiveness of public health interventions

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