Health Effects of Wildfire Smoke

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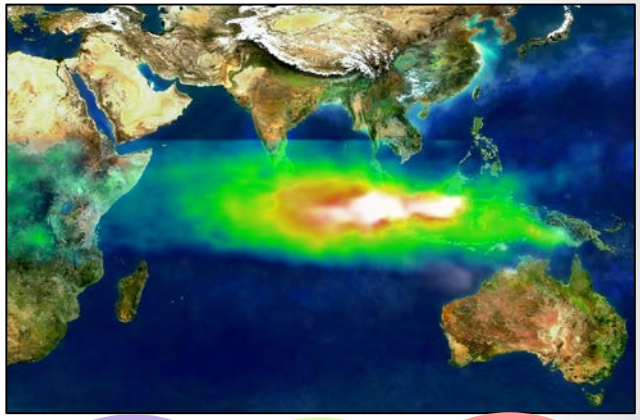
Wildland Fire Smoke & Populations

Regional Impacts on At-Risk Populations



Russia 2010

Victoria Australia 2009

Californ 2007

Canada 2003

Canada 2015

California 2015

Washingt on 2015

donesia 1997

Sydney ustralia 1994

How often do fires impact air quality?

The odds are -If there is an unhealthy air quality - there is a plume!

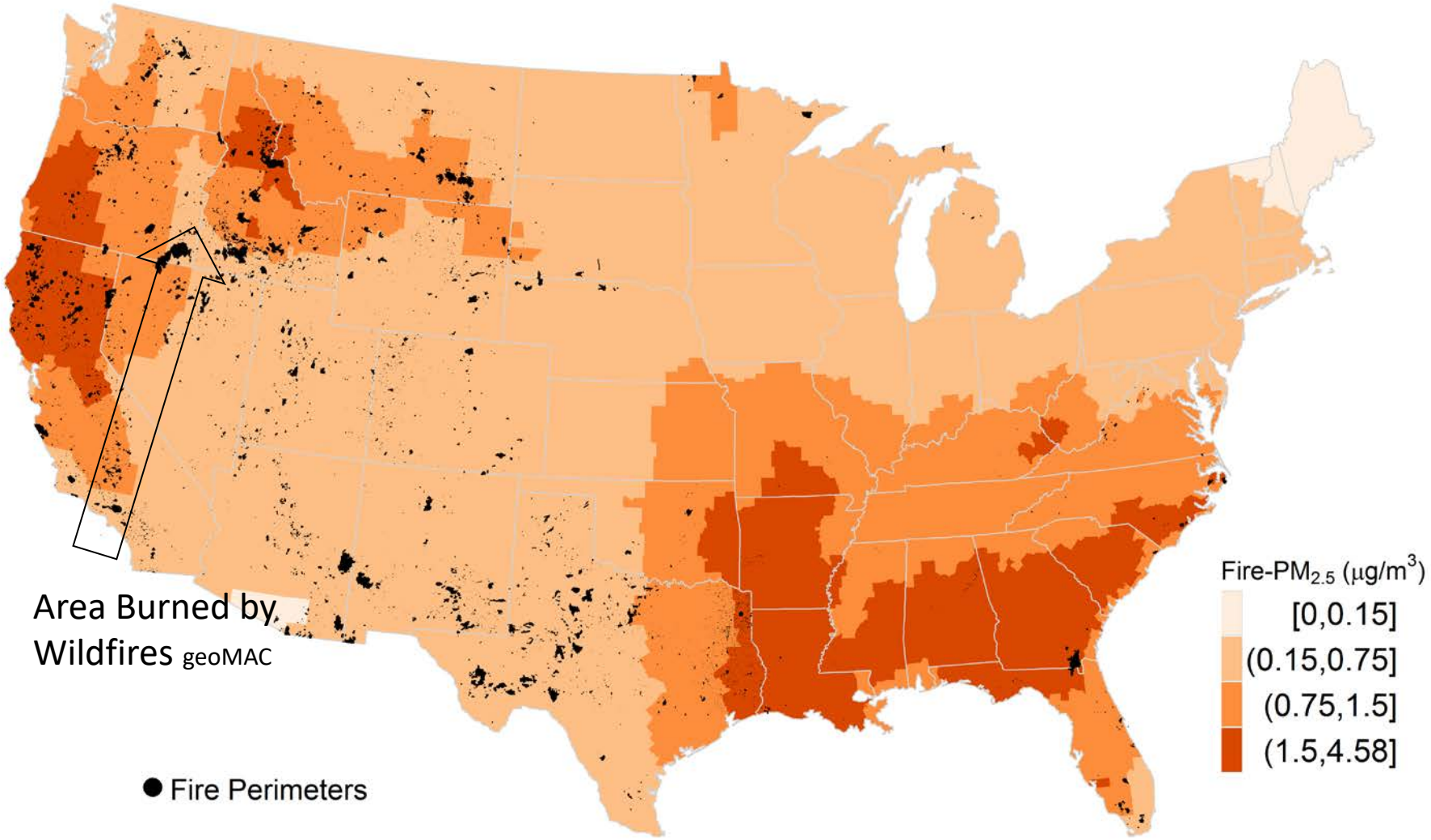
AIR QUALITY INDEX CHART

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Pollutant		AQI Color Code				
		Green	Yellow	Orange	Red	Purple
Ozone	% Plume Days for each AQI code	6.1%	18.0%	25.8%	30.1%	28.8%
	Odds Ratio	0.278	3.13	4.34	5.20	4.82
FRM $PM_{2.5}$	% Plume Days for each AQI code	4.2%	10.6%	15.8%	16.5%	50.0%
	Odds Ratio	0.360	2.65	2.88	3.02	15.0

- nationally 2006-2013 Adopted from "Impacts of fire smoke plumes on regional air quality", Alexandra Larsen, Reich BJ, Mark Ruminski and Rappold AG, in review

Geographic Footprint of Smoke-$PM_{2.5}$ (wild & rx)



Community Vulnerability to Health Impacts of Wildland Fire Smoke Exposure. Rappold et al. 2017 ES&T.

Health Effects of Wildland Fires

A Personal (Occupational) Issue

Constituents of wildfire smoke:

- Particulate matter
- Trace gases
- VOCs
- Ozone
- CO
- Air toxics
- Hg

Whitewater-Baldy Complex, Gila National Forest, New Mexico, May, 2012

Health Effects of Wildland Fires

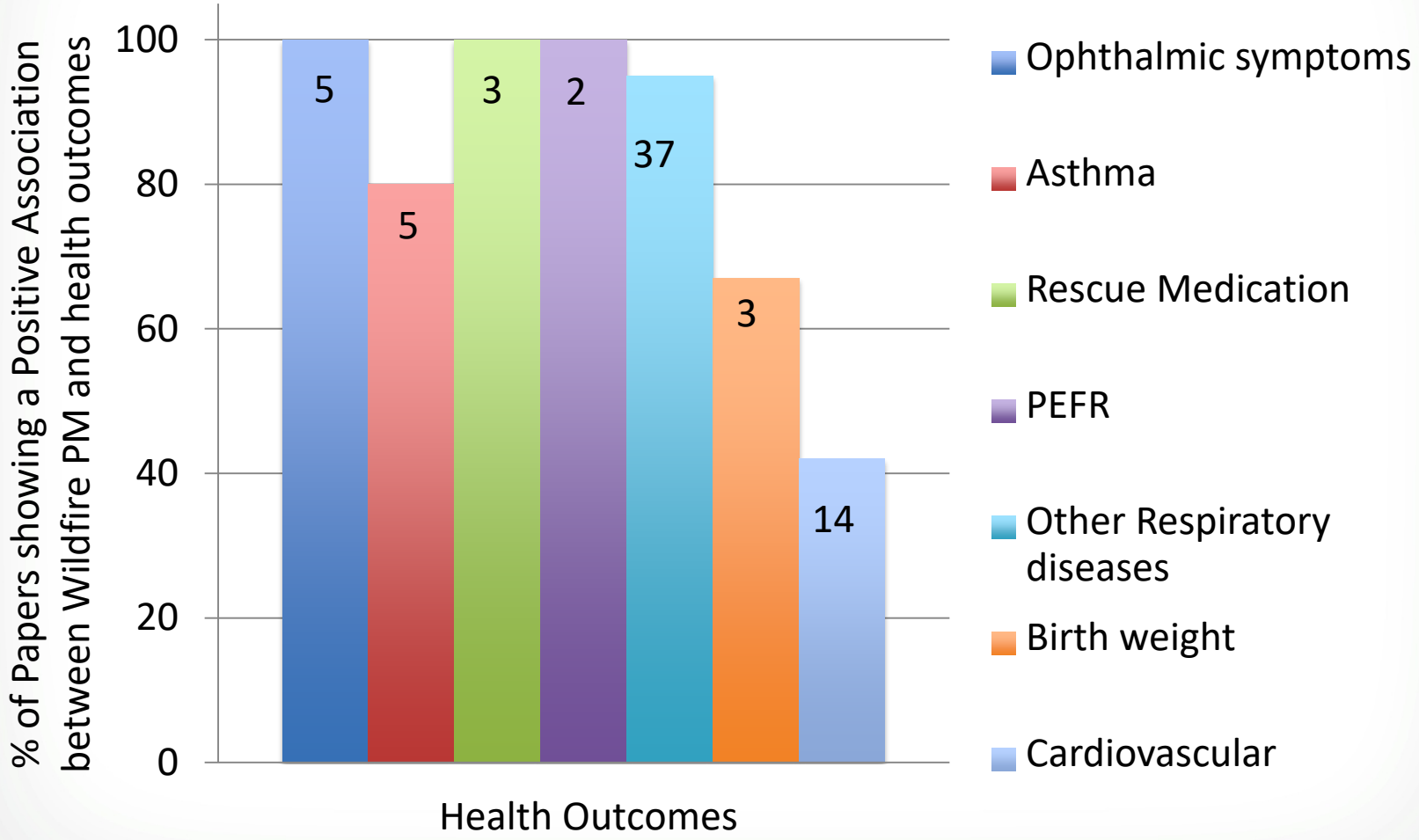
Health effects known or suspected to be caused by wildfire smoke:

- All-cause mortality
- Asthma & COPD exacerbations
- Bronchitis & pneumonia
- Childhood respiratory disease
- Cardiovascular outcomes
- Adverse birth outcomes
- Anxiety
- Symptoms such as: eye irritation, sore throat, wheeze and cough

Elliott CT. Guidance for BC Public Health Decision Makers During Wildfire Smoke Events 2014

Epi Studies & Health Outcomes

Studies with Positive Associations (in %)



Liu et al. A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. *Environmental Research 2015*

At-Risk Populations

Susceptible populations include –

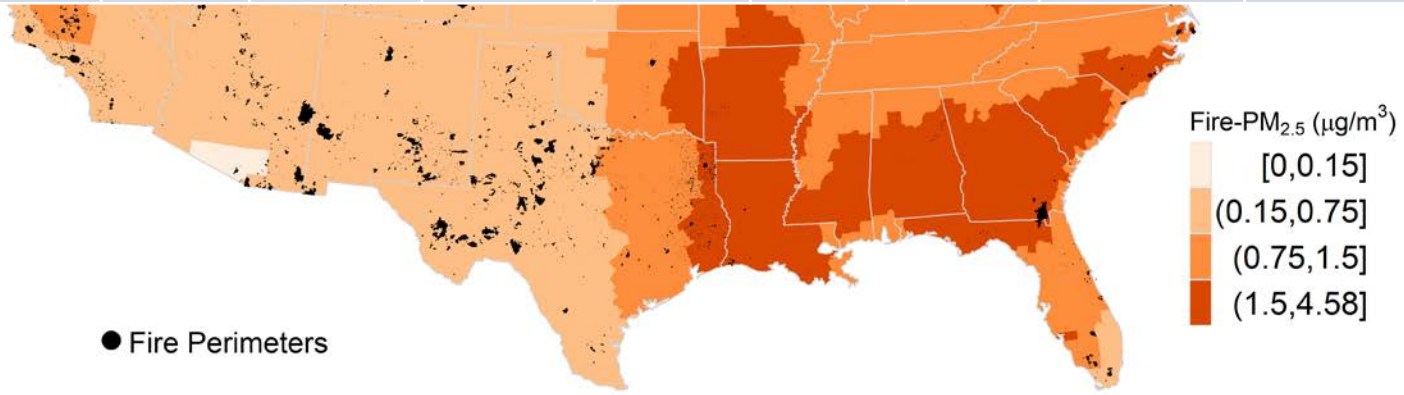
- Populations with pre-existing cardiovascular and respiratory disease
- Older adults
- Children
- Populations with lower socio-economic status

Populations suspected to be at greater risk –

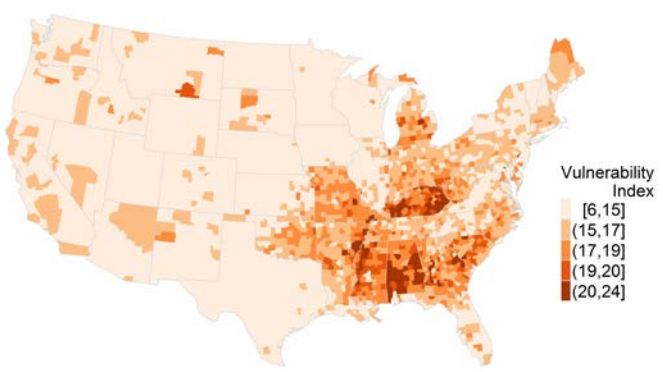
- Pregnant women and their fetuses
- Populations with chronic inflammatory diseases (e.g., diabetes, obesity)
- Populations with specific genetic polymorphisms (e.g. GSTM1) that mediate physiologic response to air pollution

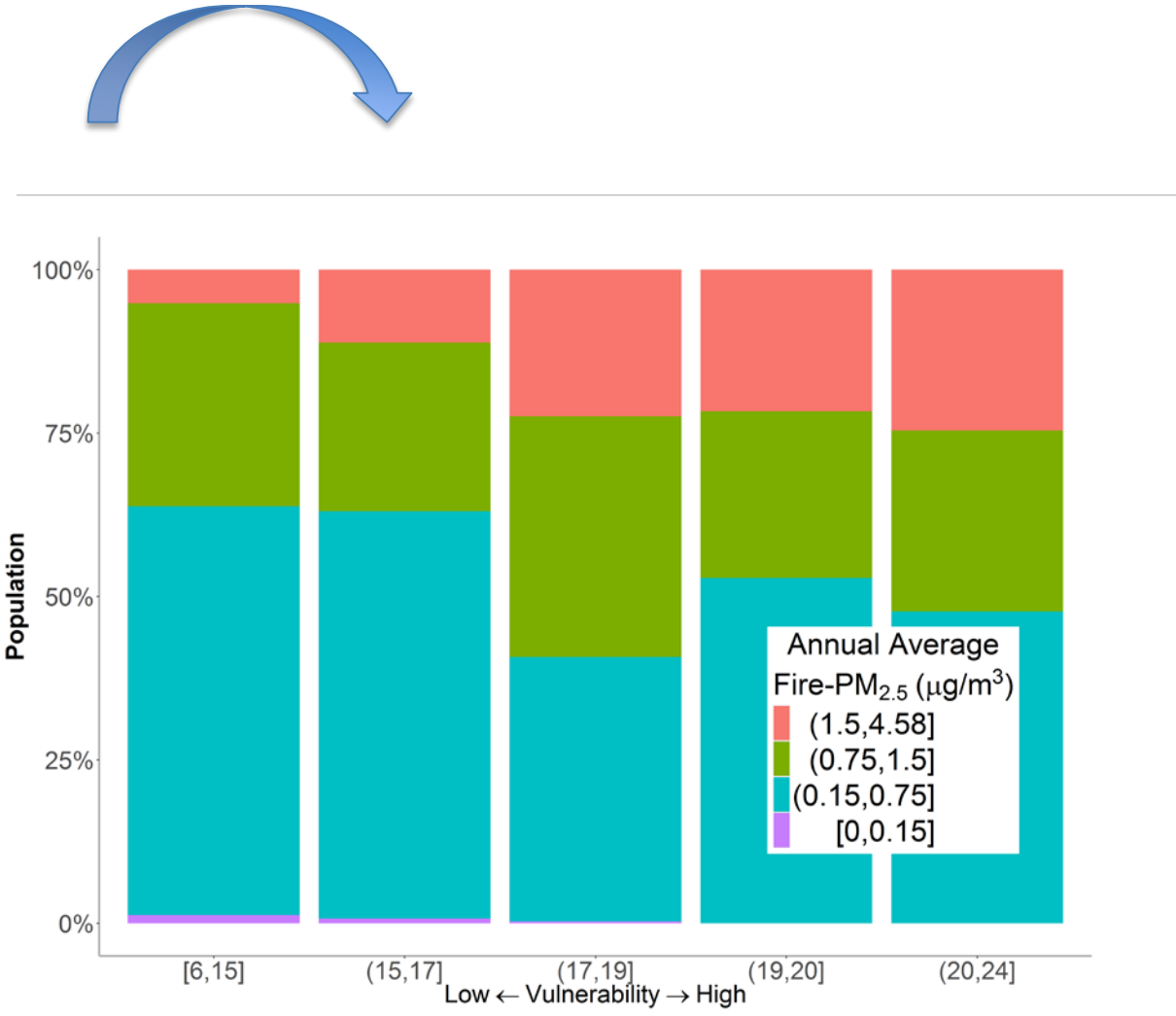
Population Size at Risk
(in millions)

$PM_{2.5}$ (µg/m3)	Adult Asthma	Pediatric Asthma	COPD	Hyper-tensive	Diabetes	Obesity	Poverty	Under 18	65 and Over	Total Population
	20.8	6.4	11.8	68.8	20.3	60.9	42.5	73.7	40.0	306.7
(0,0.15]	0.2	0.1	0.1	0.6	0.2	0.5	0.4	0.6	0.4	2.8
(0.15,0.75]	12.7	3.8	6.6	40.0	11.3	34.4	23.6	43.5	23.7	182.2
(0.75,1.5]	5.9	1.9	3.8	20.8	6.4	19.0	13.2	22.2	11.9	91.1
(1.5,4.58]	2.0	0.7	1.3	7.4	2.4	7.0	5.3	7.4	4.0	30.5



Community Health Vulnerability





Factors of Vulnerability

- Peds & Adult Asthma
- COPD
- Obesity
- Diabetes
- Hypertension
- % population age 65+
- Income, education, poverty, unemployment

Community Vulnerability to Health Impacts of Wildland Fire Smoke Exposure. Rappold et al. 2017 ES&T.

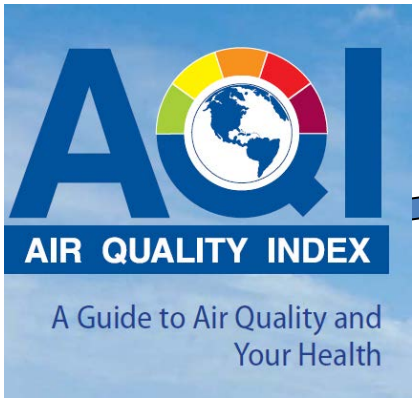
Premature deaths and illnesses attributable to wildfire-related $PM_{2.5}$ concentrations; 2008-2012

Endpoint	2008	2009	2010	2011	2012
Respiratory Hospital Admissions					
Delfino et al. (2009)	8,500 (4,400—12,000)	5,200 (2,700—7,700)	6,200 (3,200—9,100)	6,300 (3,300—9,300)	6,400 (3,300—9,400)
Zanobetti et al. (2009)	6,300 (3,600—9,000)	3,900 (2,300—5,500)	4,600 (2,600—6,500)	4,700 (2,700—6,700)	4,800 (2,800—6,800)
Cardiovascular Hospital Admissions					
Delfino et al. (2009)	2,800 (-500--6,000)	1,700 (-320--3,700)	2,100 (-380--4,400)	2,100 (-380--4,500)	2,100 (-390--4,600)
Premature deaths from short-term exposure to $PM_{2.5}$					
Zanobetti & Schwartz (2009)	2,500 (1,900—3,000)	1,500 (1,100—1,800)	1,700 (1,300—2,100)	1,900 (1,400—2,200)	1,800 (1,400—2,200)

[A]Values rounded to two significant figures; all functions estimated for populations ages 0-99

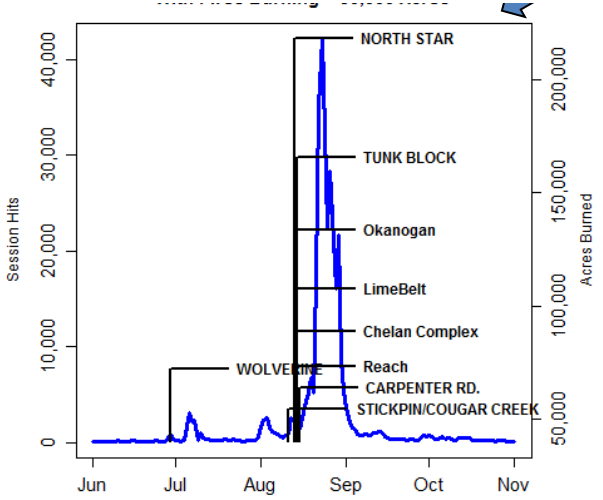
Fann et al. 2017 The health impacts and economic value of wildland fire episodes in the U.S.: 2008-2012

AirNow.gov

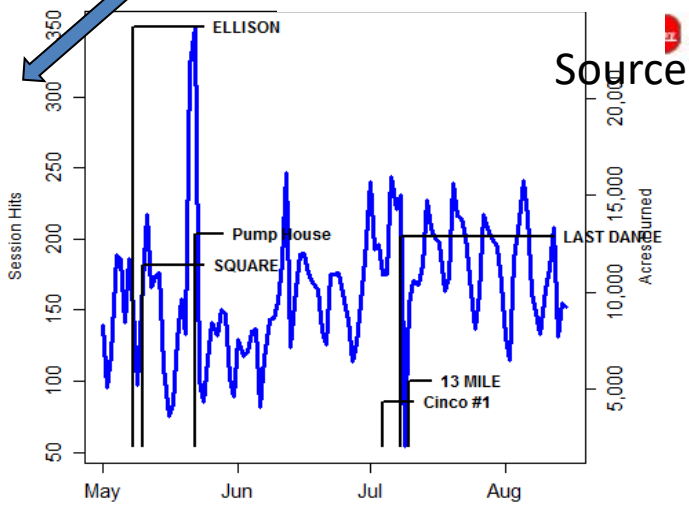


Source: AirNow

Daily Sessions, WA



Daily Sessions, FL



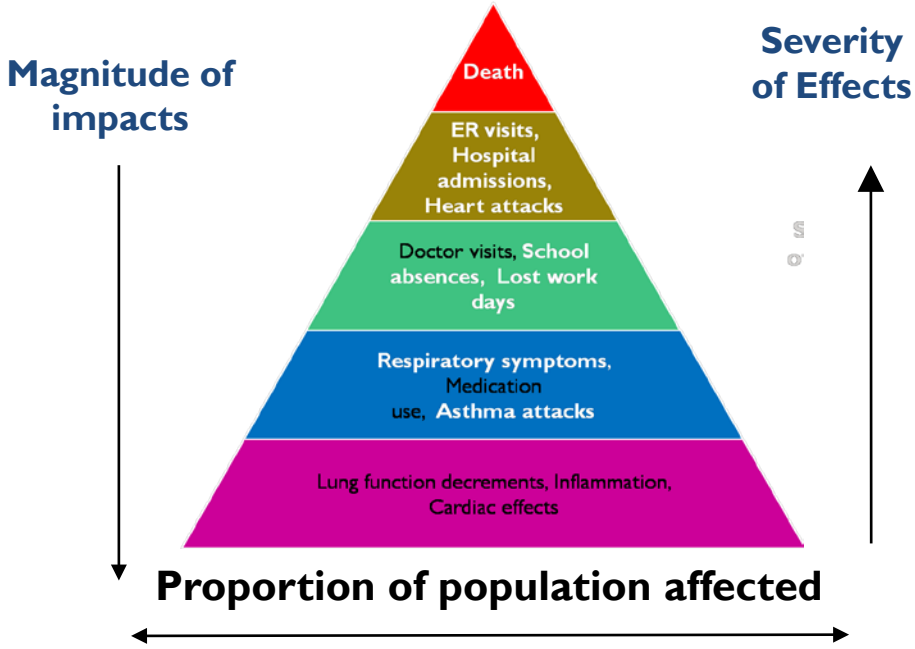
But it doesn't tell us about the likelihood of the impact, how long it will last, and how will it impact me!

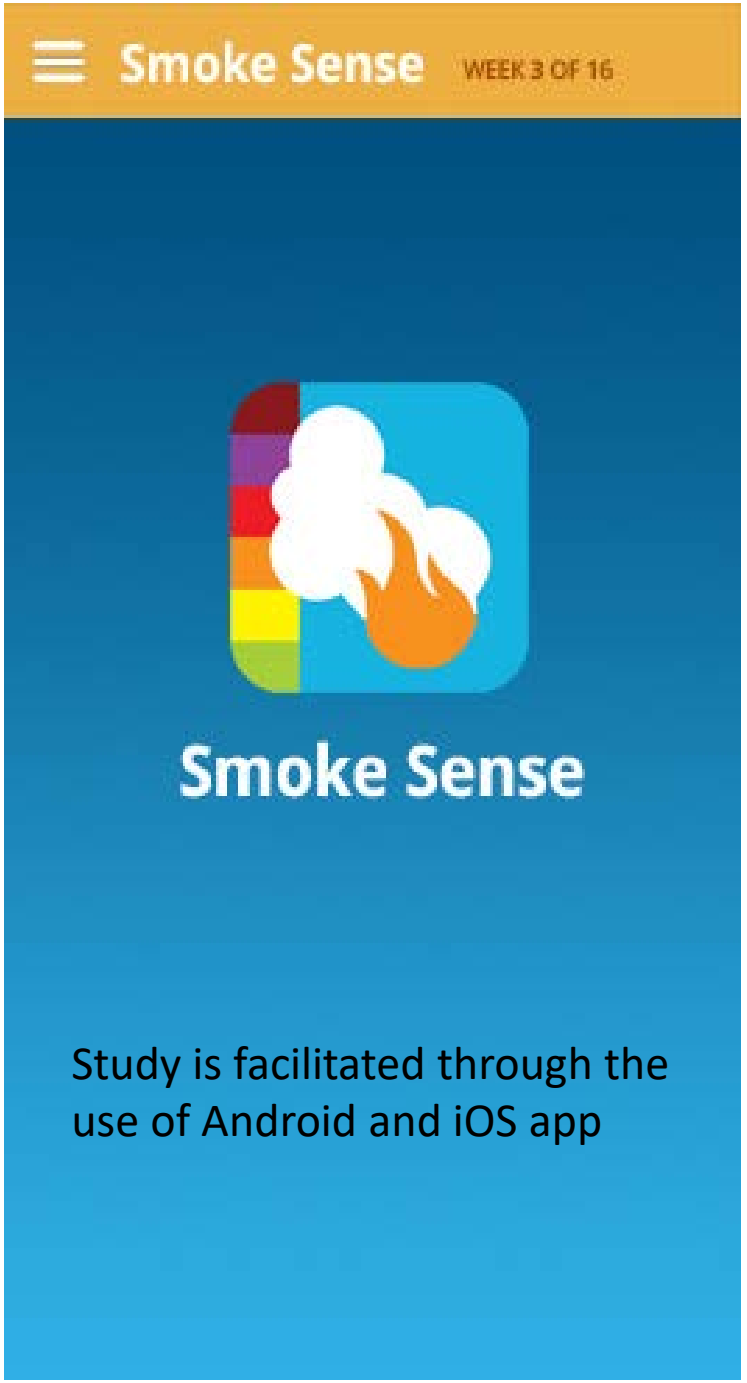
Smoke Sense

A citizen science study with goals to:

1) determine the extent to which exposure to wildland fire smoke affects health and productivity
2) develop health risk communication strategies that protect public health during smoke days

A "Pyramid of Effects" from Air Pollution





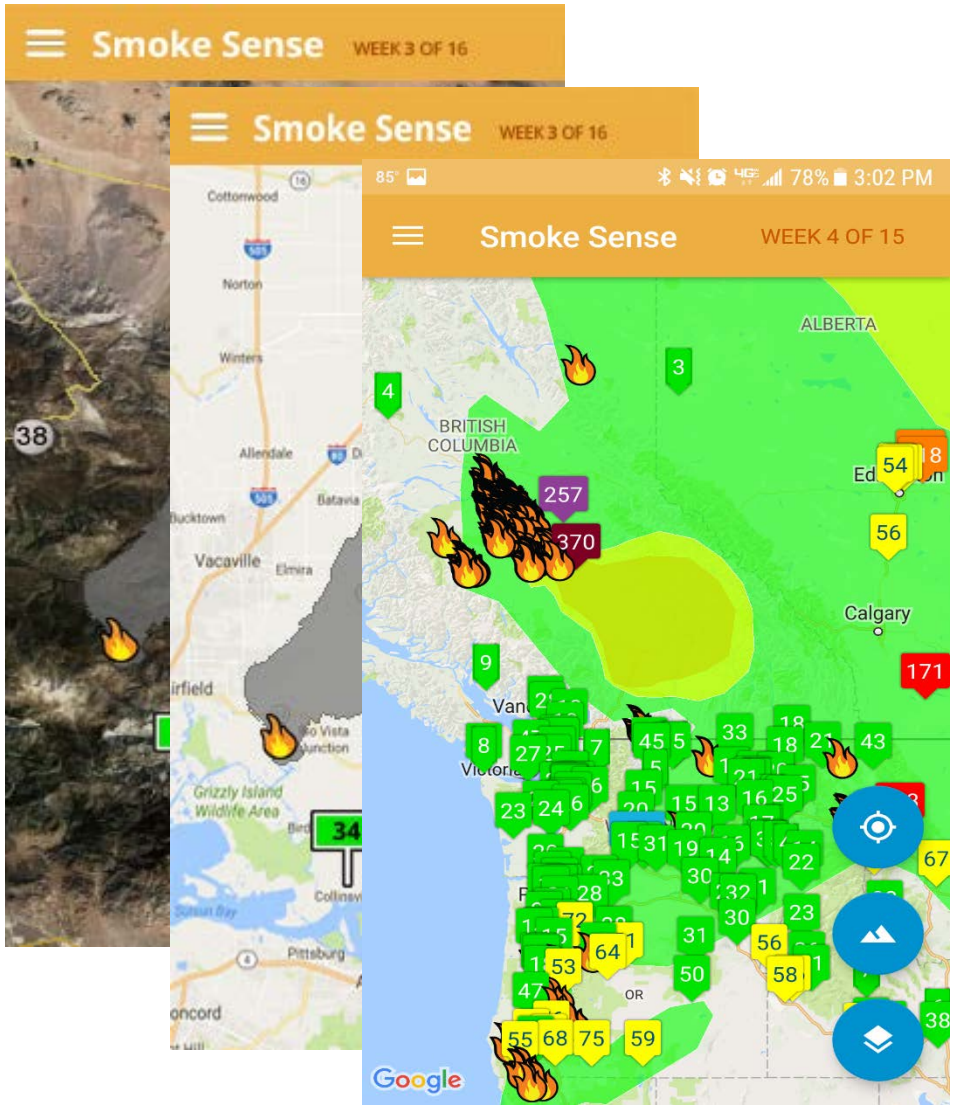
For participants:

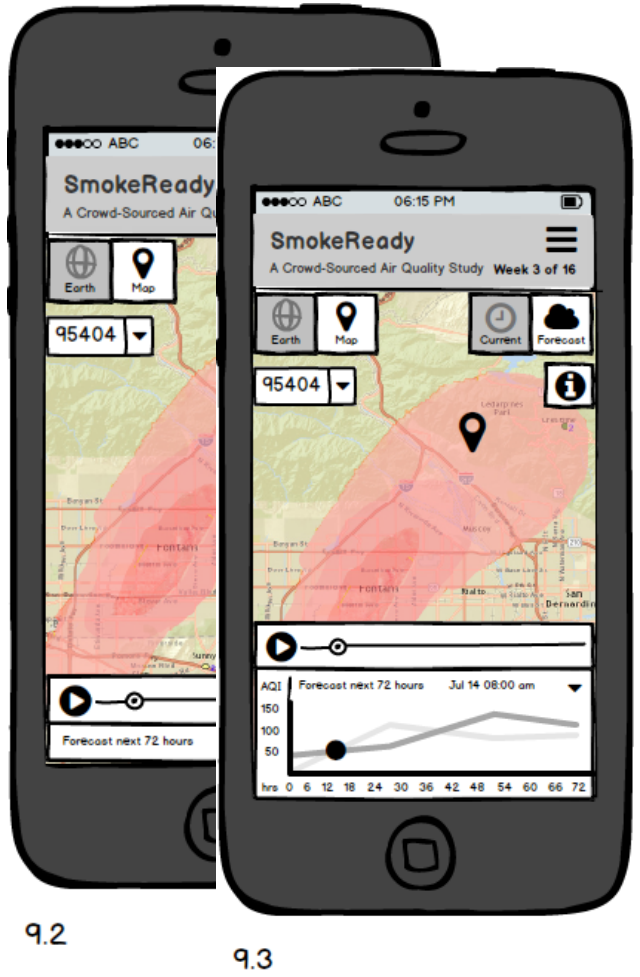
- Current and forecast air quality.
- Satellite imagery of smoke.
- Public health risk messaging.
- Air Quality 101 module.
- Gamification to promote desired behaviors.

For investigators:

- Demographic profile of users.
- Symptom and medication usage survey.
- Behavioral survey.
- App usage statistics.
- Score card on Gamification compliance behavior.

Satellite images of smoke plumes hourly smoke forecasts,



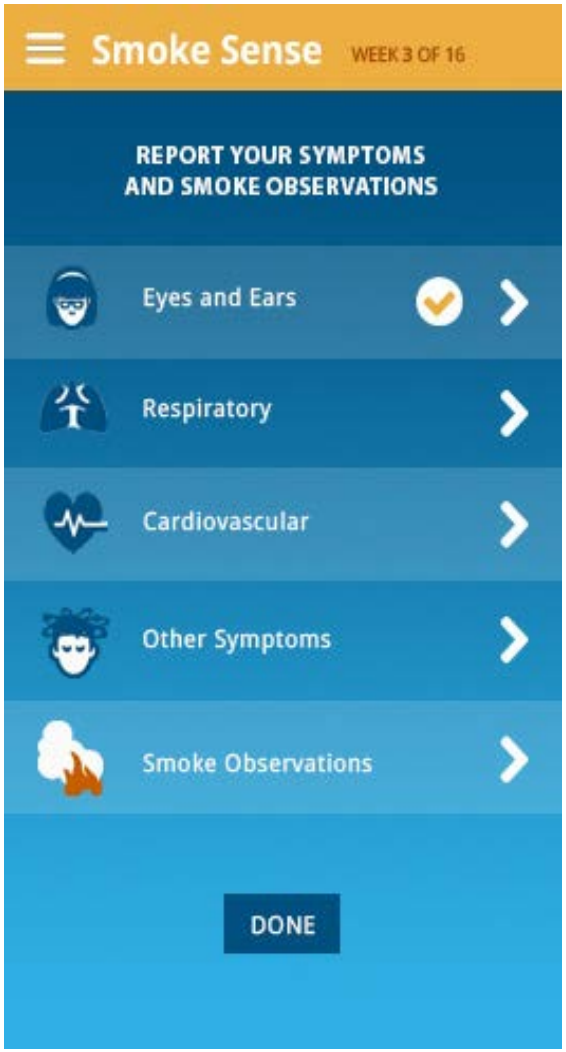


Surveys

Profile Survey - demographic information and baseline levels of health symptoms, baseline activity level and perceptions about health risks of air pollution.

Symptoms Survey –on Monday mornings participants will receive a notification on their device inviting them to complete the weekly survey on health symptoms (Yes/No).

Smoke Observation Surveys –questions about smoke exposure during the previous week including their actions (did you miss days from work) and perceived or actual exposures (did you smell smoke inside your home) during the past week.



Gamification - Participation Component

Badge Reward System **facilitates and measures** engagement.

Air Quality Badge - for participating and launching the app at least once per week.

Science Science/ Reporter Badge - for reporting symptoms and smoke observations once per week.

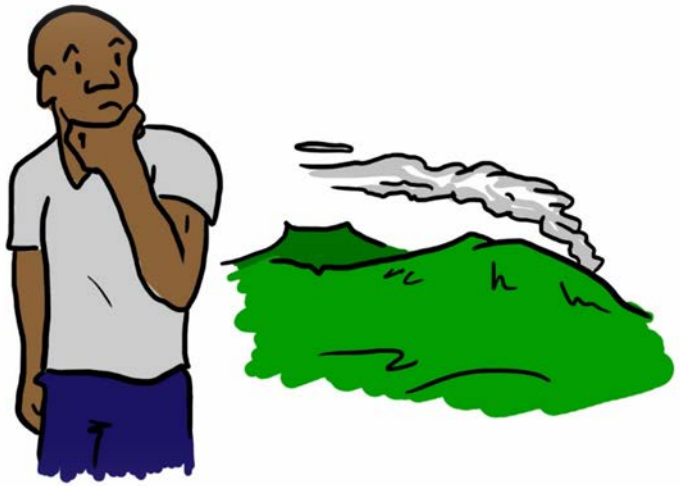
Knowledge Badge – for expanding air quality knowledge with a weekly air quality 101 lesson.

Smoke Explorer Badge – for exploring fire and smoke maps.

Gamification - Education component

Weekly Air Quality 101 module:

Week #8 Question:
"Kai is healthy and young.
Can he assume that the smoke from the wildfire won't affect him?"

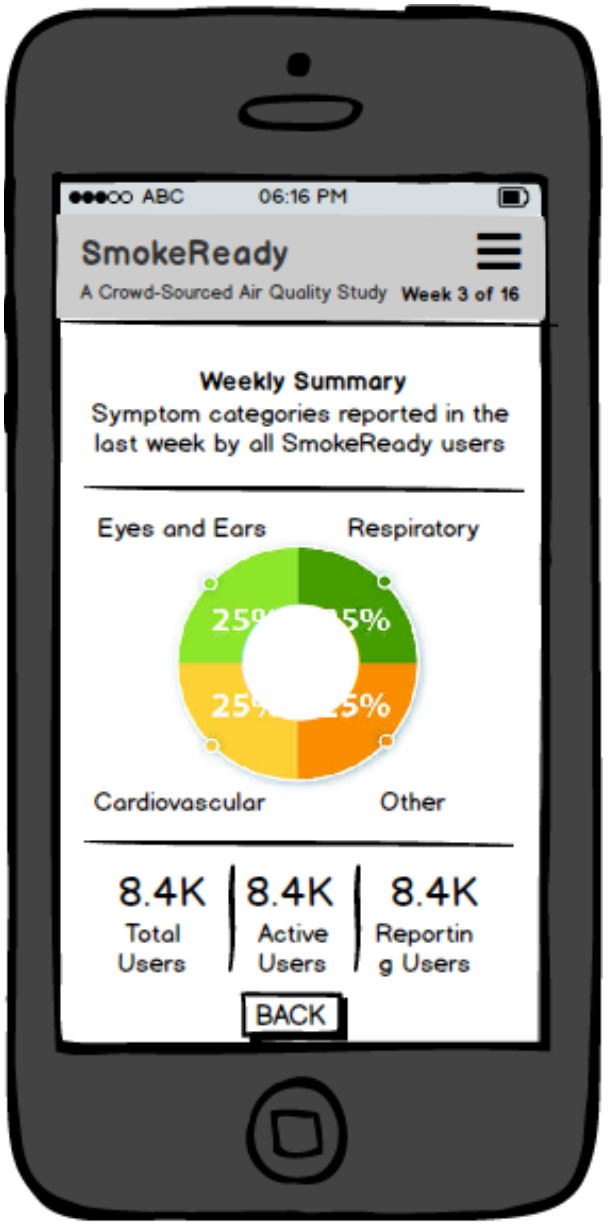


Answer:

NO. High concentrations of smoke can trigger a range of symptoms even in healthy individuals. Common symptoms include burning eyes, a runny nose, cough, phlegm, wheezing and difficulty breathing. Smoke may also reduce your lungs' ability to protect against inhaled substances such as pollen, bacteria or viruses. If you have heart or lung disease, smoke may make your symptoms worse. Learn about the health effects from smoke at https://go.usa.gov/xXa8c

Feedback to the Users

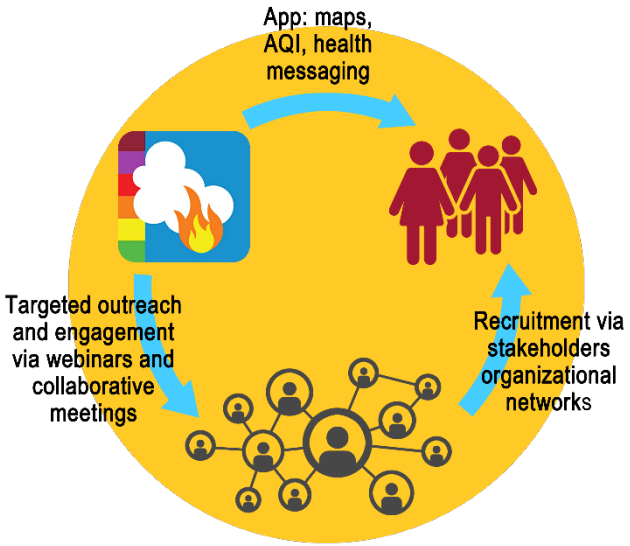
Individual weekly survey results will be aggregated and reported back to the app and available to the users.



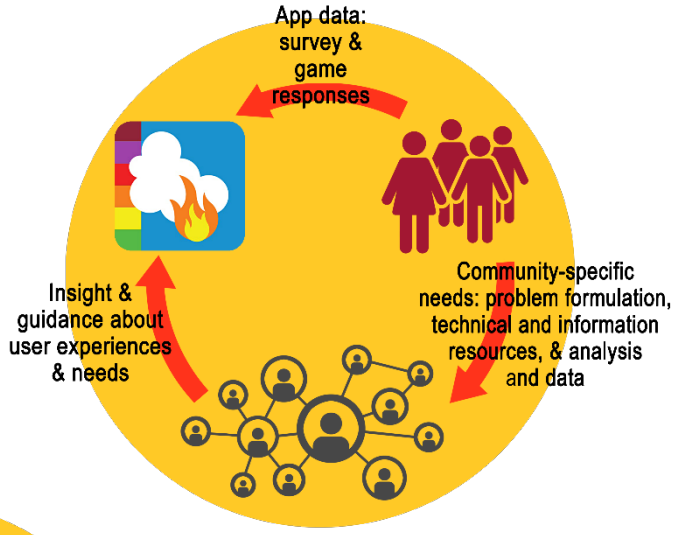
17.0

Smoke Sense is developing a two-way communication structures

…Phase I



… Phase II



Where we want to be…

First 3 weeks:

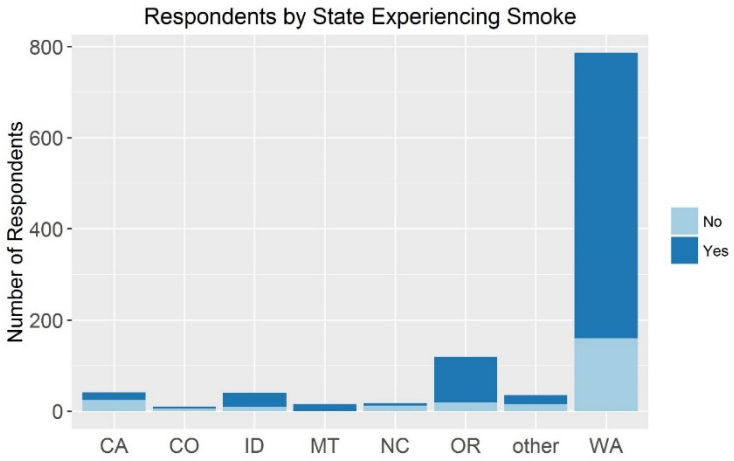
"Did you experience symptoms such as:

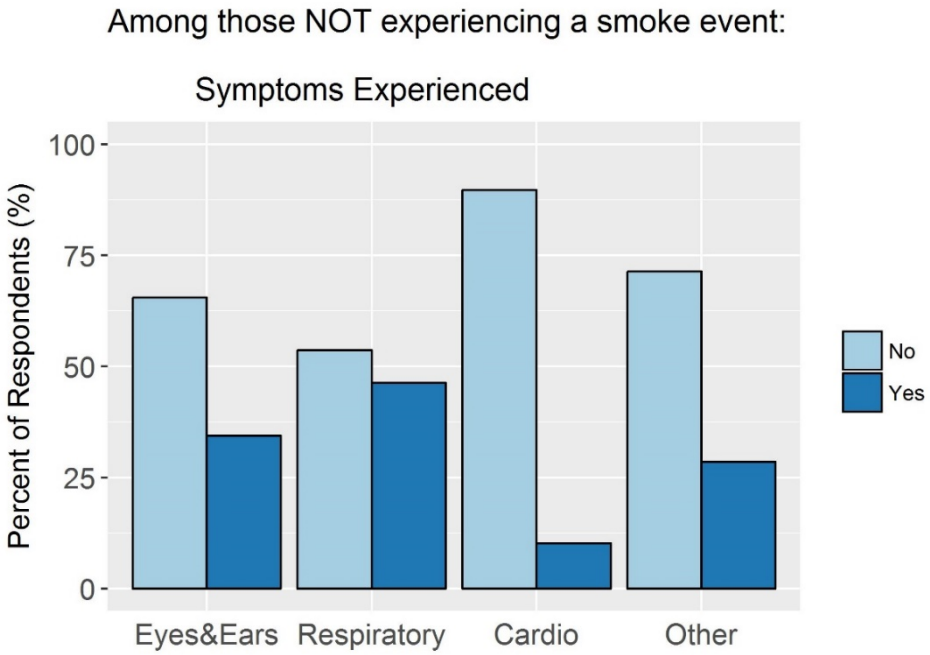
[Eyes&Ears] stinging, itchy, or watery eyes, ear infection, allergic symptoms, or similar?

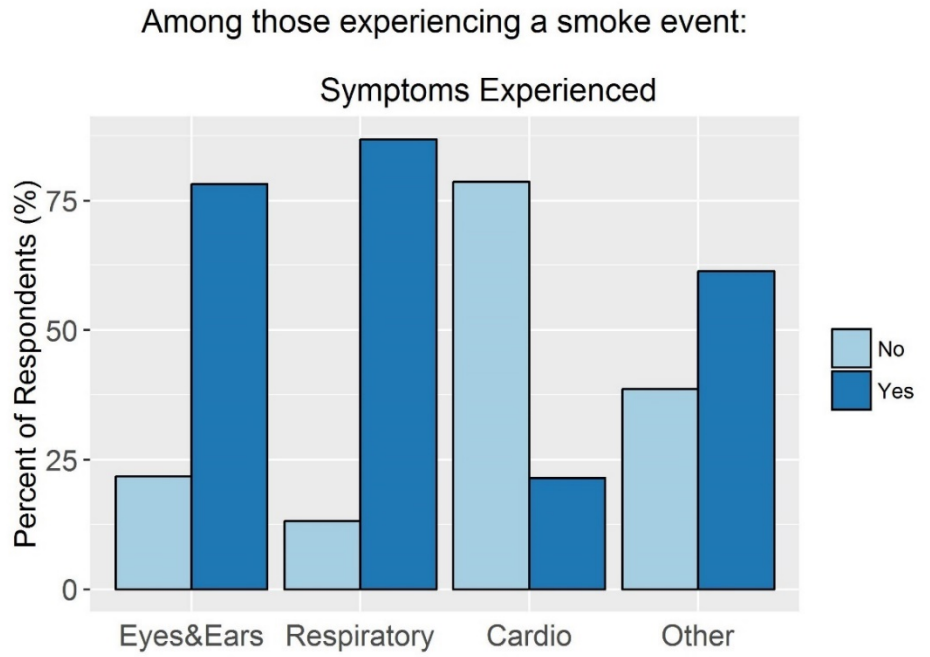
[Respiratory] runny or stuffy nose, scratchy thought, irritated sinuses, coughing, trouble breathing normally, shortness of breath, wheezing, asthma attack, allergic symptoms, or similar?

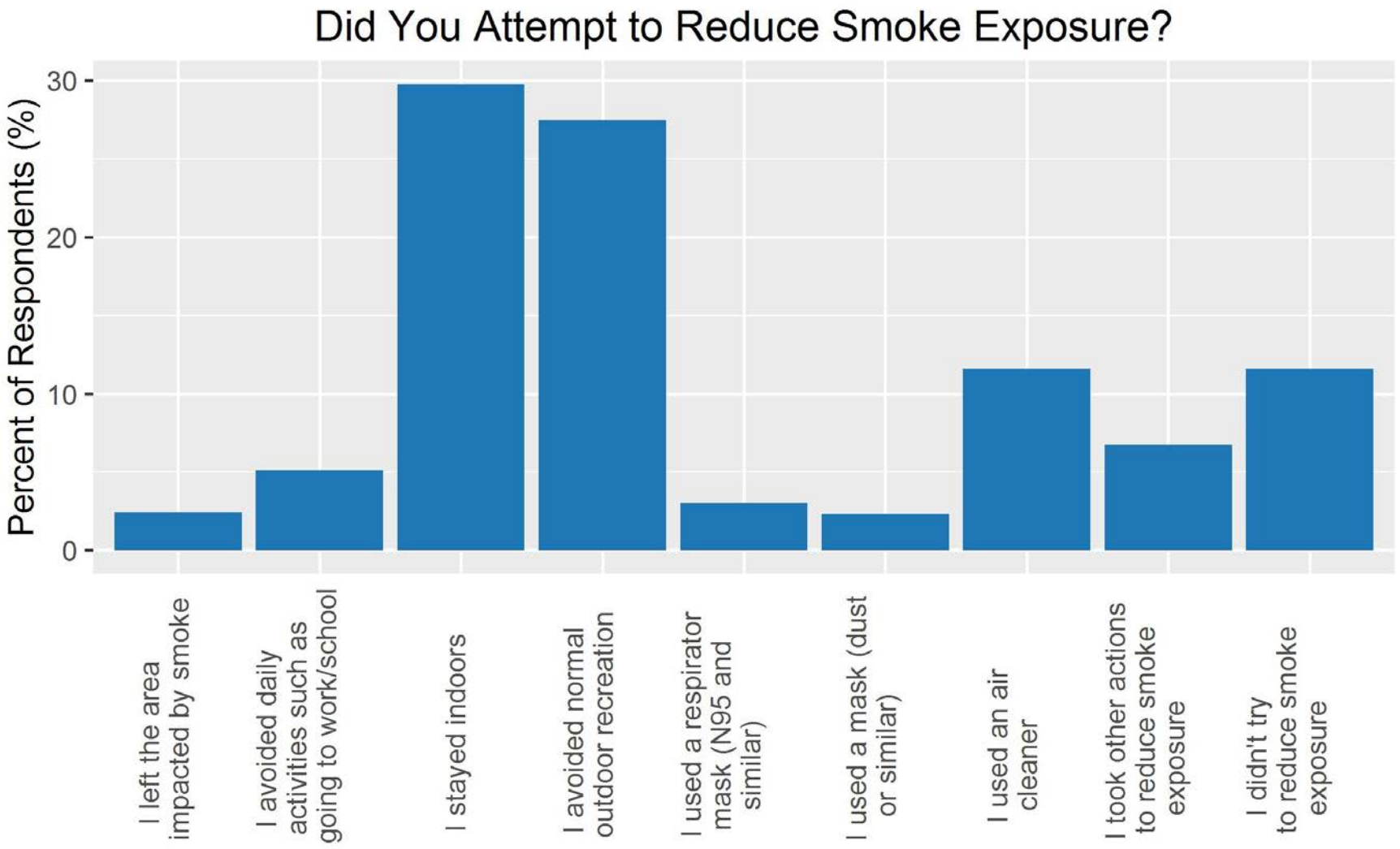
[Cardio] fast or irregular heart rate, pain or tightness in the chest, high blood pressure or similar?

[Other] tiredness, dizziness, viral infections, or other?"








Did You Attempt to Reduce Smoke Exposure?
Percent of Respondents (%)
30
20
10
0
I left the area impacted by smoke
I avoided daily activities such as going to work/school
I stayed indoors
I avoided normal outdoor recreation
I used a respirator mask (N95 and similar)
I used a mask (dust or similar)
I used an air cleaner
I took other actions to reduce smoke exposure
I didn't try to reduce smoke exposure

Summary

Wildland fires produce air pollution that adversely impacts people's health.

Incidence and severity of large fires are increasing. As emissions from other sources of PM decrease, relative contributions of fire-PM increase.

Need a public health strategy to address air quality during these periodic and transient exposures.

Smokes Sense was launched Aug 1st on Android and has received excellent feedback from the users.

We have established a valuable network of users and stakeholders and are committed to continue research that can lead to better public health outcomes and improving health risk communications.

Smoke Sense has also started new conversations that we didn't previously have.

We look forward to the full season in 2018.

We welcome your input and participation

Email: smokesense@epa.gov/ rappold.ana@epa.gov

Follow us on twitter #SmokeSense

Search “Smoke Sense at EPA”

https://www.epa.gov/air-research/smoke-sense-study-citizen-science-project-using-mobile-app

Thank you

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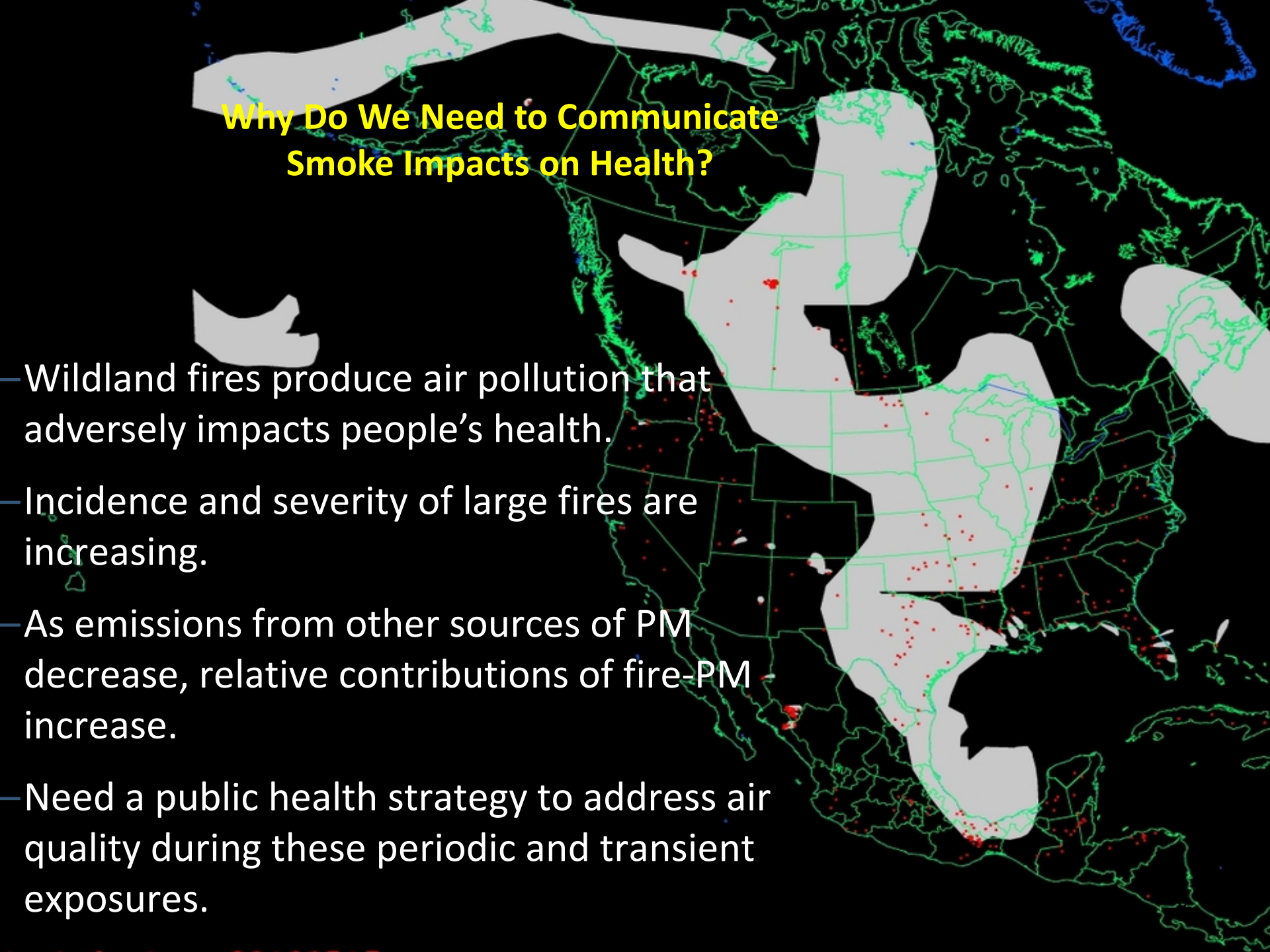

Why Do We Need to Communicate Smoke Impacts on Health?

- Wildland fires produce air pollution that adversely impacts people's health.
- Incidence and severity of large fires are increasing.
- As emissions from other sources of PM decrease, relative contributions of fire-PM increase.
- Need a public health strategy to address air quality during these periodic and transient exposures.

Health Effects of Wildfires

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]

[1]Environmental Health Sciences Division, School of Public Health, University of California, Berkeley, Berkeley, California, USA; [2]Harvard Center for Population and Development Studies, Harvard T.H. Chan School of Public Health, Cambridge, Massachusetts, USA; [3]School ...olumbia, Canada; [4]Menzies Institute of Medical ...lth Services, Department of Health and Human ...es, Fielding School of Public Health, University of ...versity of California, San Francisco, San Francisco, ...ial Services, Whitehorse, Yukon, Canada

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Review

A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke

Jia C. Liu [a,*], Gavin Pereira [b], Sarah A. Uhl [a], Mercedes A. Bravo [a], Michelle L. Bell [a]

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[b] Center for Perinatal Pediatric and Environmental Epidemiology, School of Medicine, Yale University, New Haven, CT 06511, USA

- Reviewed 61 peer reviewed journal articles on the topic of forest fire/wildfire smoke and health, published between 1 January 1986 and 30 May 2014.

- Since May 2014 several more studies have emerged including Tinling et al 2016, Haikerwal et al 2016, Haikerwal et al 2015; Resnick et al 2015; Johnston et al 2014; Reid et al 2016.