Forecast-based interventions can reduce the health and economic burden of wildfires

Supplemental Material

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Supplemental Material Figure 1.

a) 48 hour ahead forecast for June 12th and June 13th, 2008

b) 24 hour ahead forecasts for June 12th and June 13th, 2008

c) Re-analysis for June 12th and June 13th, 2008

An illustration of spatial prediction of PM_{2.5} (µg/m³) estimated by NOAA's Smoke Forecasting System and averaged over 24 hours. The columns of the panels represent a) 48hr ahead forecast; (b) 24hr ahead forecast; and (c) re-analysis, while rows illustrate two days of data (June 12th and June 13th, 2008).

Supplemental Material Figure 2.

(a)

(b)

Excess relative risk (%) for (a) asthma and (b) congestive heart failure related ED visits per 10 $\mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$ using re-analysis, the 48hr ahead forecasts, and simulated forecast-based interventions.

Supplemental Table 1: Ozone- and PM –related Health Endpoints and Studies Included

Endpoint	Study	Study Population	Risk Estimate (95 th Percentile Confidence Interval) ^a
Premature Mortality			
Premature mortality, time series, all-cause	Pooled estimate of Zanobetti et al. (2009)	All ages	<i>Charlotte</i> : $\beta = 0.000998$ (0.000482) <i>Durham</i> : $\beta = 0.001033$ (0.00519) <i>Raleigh</i> : $\beta = 0.001293$ (0.000499)
Chronic Illness			
Nonfatal heart attacks	Peters et al. (2001)	Adults (>18 years)	OR = 1.62 (1.13–2.34) per 20 $\mu\text{g}/\text{m}^3$
Hospital Admissions			
Respiratory	Zanobetti et al. (2009)—ICD 460-519 (All respiratory)	>64 years	$\beta=0.00207$ (0.00446)
	Kloog et al. (2012)—ICD 460-519 (All Respiratory)		$\beta=0.0007$ (0.000961)
	Moolgavkar (2000)—ICD 490–496 (Chronic lung disease)	18–64 years	1.02 (1.01–1.03) per 36 $\mu\text{g}/\text{m}^3$
	Babin et al. (2007)—ICD 493 (asthma)	<19	$\beta=0.002$ (0.004337)
	Sheppard (2003)—ICD 493 (asthma)	< 18	RR = 1.04 (1.01–1.06) per 11.8 $\mu\text{g}/\text{m}^3$

(continued)

Endpoint	Study	Study Population	Risk Estimate (95th Percentile Confidence Interval) ^a
Cardiovascular	<i>Pooled estimate:</i> Zanobetti et al. (2009)—ICD 390-459 (all cardiovascular)	>64 years	$\beta=0.00189$ (0.000283)
	Peng et al. (2009)—ICD 426-427; 428; 430-438; 410-414; 429; 440-449 (Cardio-, cerebro- and peripheral vascular disease)		$\beta=0.00068$ (0.000214)
	Peng et al. (2008)—ICD 426-427; 428; 430-438; 410-414; 429; 440-449 (Cardio-, cerebro- and peripheral vascular disease)		$\beta=0.00071$ (0.00013)
	Bell et al. (2008)—ICD 426-427; 428; 430-438; 410-414; 429; 440-449 (Cardio-, cerebro- and peripheral vascular disease)		$\beta=0.0008$ (0.000107)
	Moolgavkar (2000)—ICD 390-429 (all cardiovascular)	20-64 years	RR=1.04 (t statistic: 4.1) per 10 $\mu\text{g}/\text{m}^3$
Asthma-related ER visits	<i>Pooled estimate:</i> Mar et al. (2010)	All ages	RR = 1.04 (1.01-1.07) per 7 $\mu\text{g}/\text{m}^3$
	Slaughter et al. (2005)		RR = 1.03 (0.98-1.09) per 10 $\mu\text{g}/\text{m}^3$
	Glad et al. (2012)		$\beta=0.00392$ (0.002843)
Other Health Endpoints			
Acute bronchitis	Dockery et al. (1996)	8-12 years	OR = 1.50 (0.91-2.47) per 14.9 $\mu\text{g}/\text{m}^3$
Asthma exacerbations	<i>Pooled estimate:</i> Ostro et al. (2001) (cough, wheeze and shortness of breath) ^b	6-18 years	OR = 1.03 (0.98-1.07) OR = 1.06 (1.01-1.11) OR = 1.08 (1.00-1.17) per 30 $\mu\text{g}/\text{m}^3$
	Mar et al. (2004) (cough, shortness of breath)		RR = 1.21 (1-1.47) per RR = 1.13 (0.86-1.48) per 10 $\mu\text{g}/\text{m}^3$
Work loss days	Ostro (1987)	18-65 years	$\beta=0.0046$ (0.00036)
Acute respiratory symptoms	Ostro and Rothschild (1989) (Minor restricted activity days)	18-65 years	$\beta=0.00220$ (0.000658)
Upper respiratory symptoms	Pope et al. (1991)	Asthmatics, 9-11 years	1.003 (1-1.006) per 10 $\mu\text{g}/\text{m}^3$
Lower respiratory symptoms	Schwartz and Neas (2000)	7-14 years	OR = 1.11 (1.58-1.58) per 15 $\mu\text{g}/\text{m}^3$

Supplemental Table 2: Baseline and Prevalence Rates for Included Morbidity and Mortality Endpoints

Endpoint	Parameter	Rates	
		Value	Source ^a
Mortality	Daily or annual mortality rate	Age-, cause-, and county-specific rate	Centers for Disease Control (2008) (rates for 2004–2006)
Hospitalizations	Daily hospitalization rate	Age-, region-, and cause-specific rate	Agency for Healthcare Research and Quality (2007)
Asthma ER Visits	Daily asthma ER visit rate	Age- and region- specific visit rate	Agency for Healthcare Research and Quality (2007)
Nonfatal Myocardial Infarction (heart attacks)	Daily nonfatal myocardial infarction incidence rate per person, 18+	Age-, region-, state-, and county-specific rate	2007 AHRQ data files; adjusted by 0.93 for probability of surviving after 28 days [31]
Asthma Exacerbations	Incidence		
	• daily wheeze	0.076	Ostro et al. (2001)
	• daily cough	0.067	
	• daily dyspnea	0.037	
	Prevalence among asthmatic children	0.0780	American Lung Association [32]
Acute Bronchitis	Annual bronchitis incidence rate, children	0.043	American Lung Association (2002) Table 11
Lower Respiratory Symptoms	Daily lower respiratory symptom incidence among children ^d	0.0012	Schwartz (1994b, Table 2)
Upper Respiratory Symptoms	Daily upper respiratory symptom incidence among asthmatic children	0.3419	Pope et al. (1991, Table 2)
Work Loss Days	Daily WLD incidence rate per person (18–65)		
	• Aged 18–24	0.00540	US Bureau of the Census (2001)
	• Aged 25–44	0.00678	
	• Aged 45–64	0.00492	
Minor Restricted-Activity Days	Daily MRAD incidence rate per person	0.02137	Ostro and Rothschild (1989)

- ^a Healthcare Cost and Utilization Program (HCUP) database contains individual level, state and regional-level hospital and emergency department discharges for a variety of ICD codes.
- ^b See ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHDS/.
- ^c See ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHAMCS/.
- ^d Lower respiratory symptoms are defined as two or more of the following: cough, chest pain, phlegm, and wheeze.

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