Wildfire, Air Quality, and Viral Respiratory Infections (including COVID-19)

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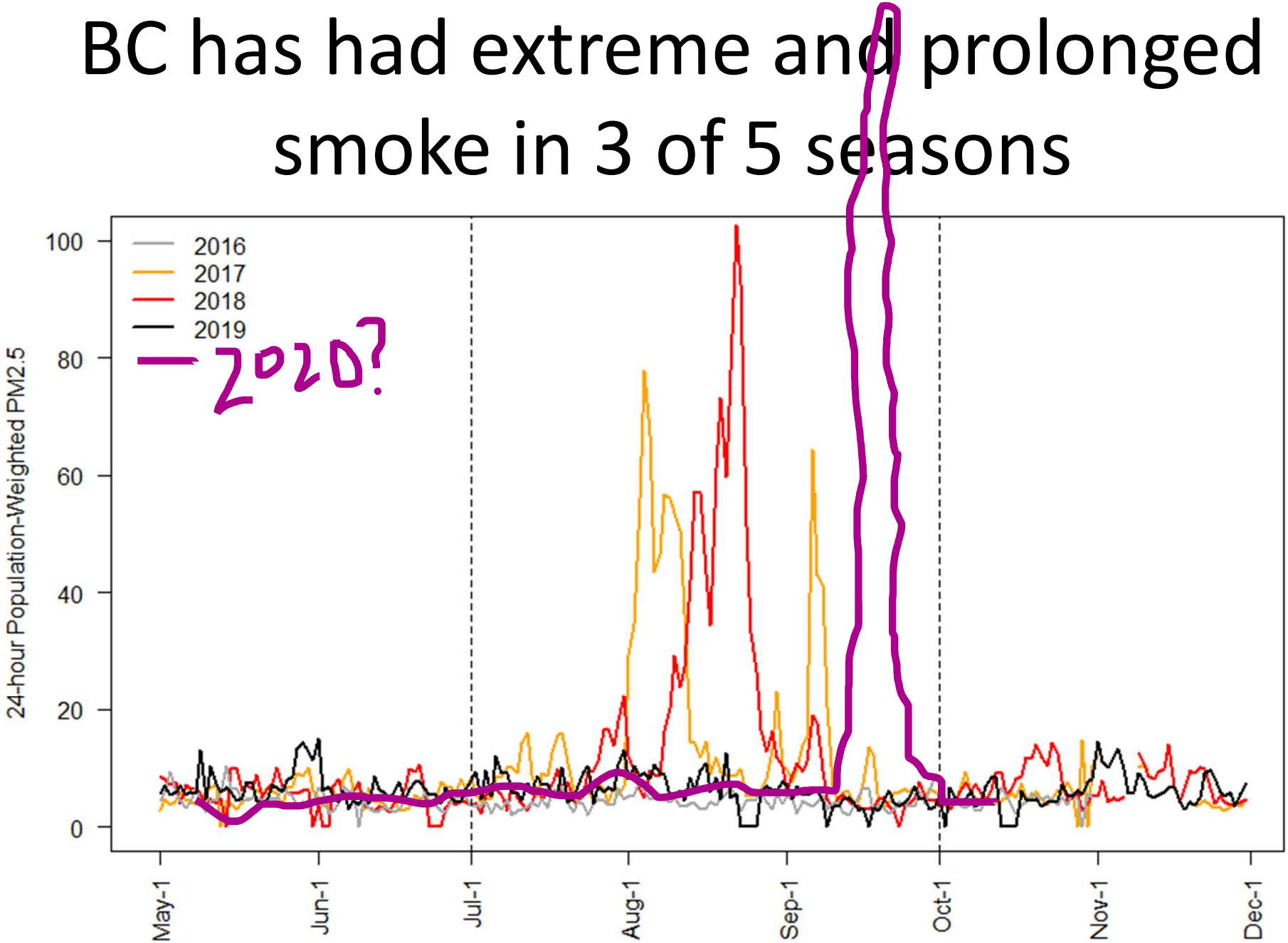
National Academies of Sciences, Engineering, and Medicine Workshop

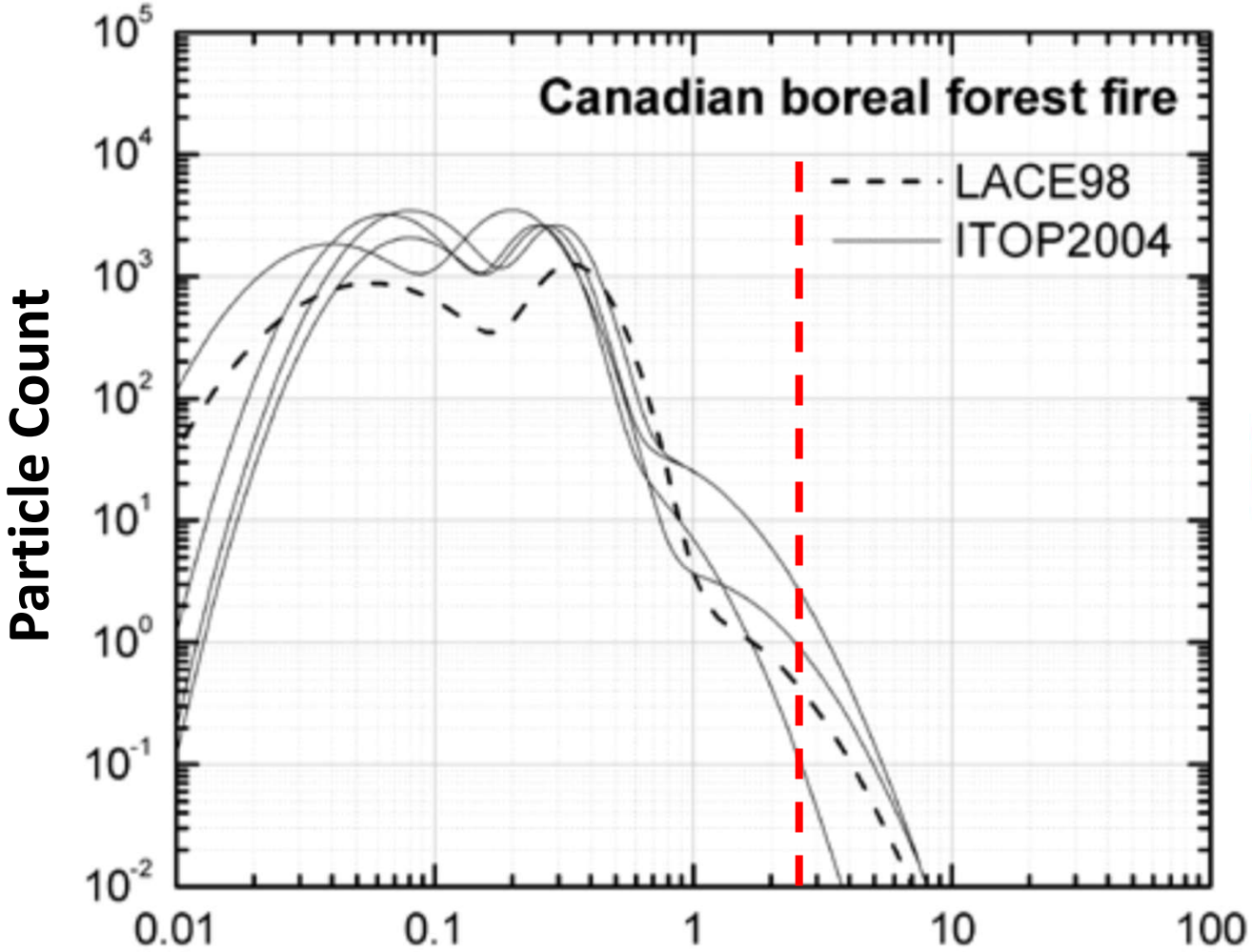
Key messages

- Wildfire smoke is different from other types of ambient pollution
- Smoke exposure can affect susceptibility to respiratory viruses via different mechanisms
  1) Disrupted immune and cilial function
  2) Interactions between acute health effects
  3) Longer-term immunosuppression
- We must learn from the 2020 experience
- We must plan for smoke with ongoing COVID-19, influenza, and future pandemics

BC has had extreme and prolonged smoke in 3 of 5 seasons

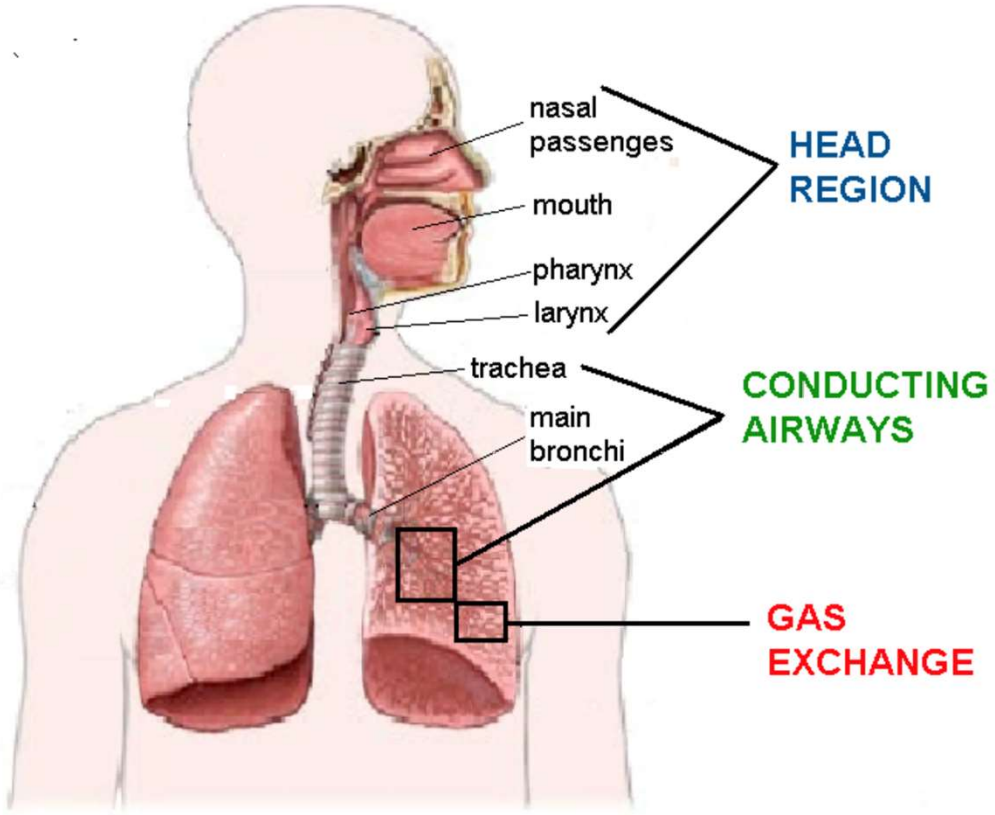


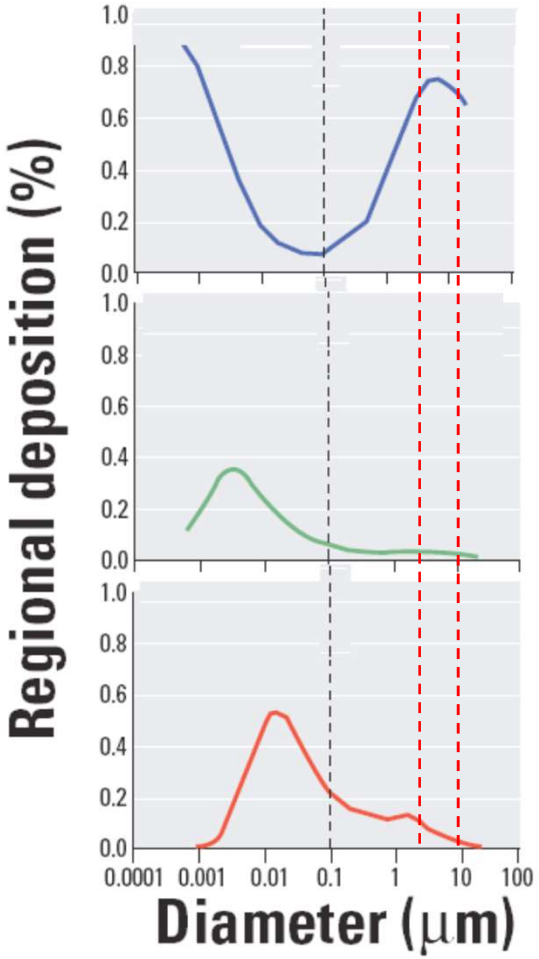
Most Smoke $PM_{2.5}$ <<< 2.5 μm



Atmos. Chem. Phys., 13, 2487–2505, 2013
www.atmos-chem-phys.net/13/2487/2013/
doi:10.5194/acp-13-2487-2013

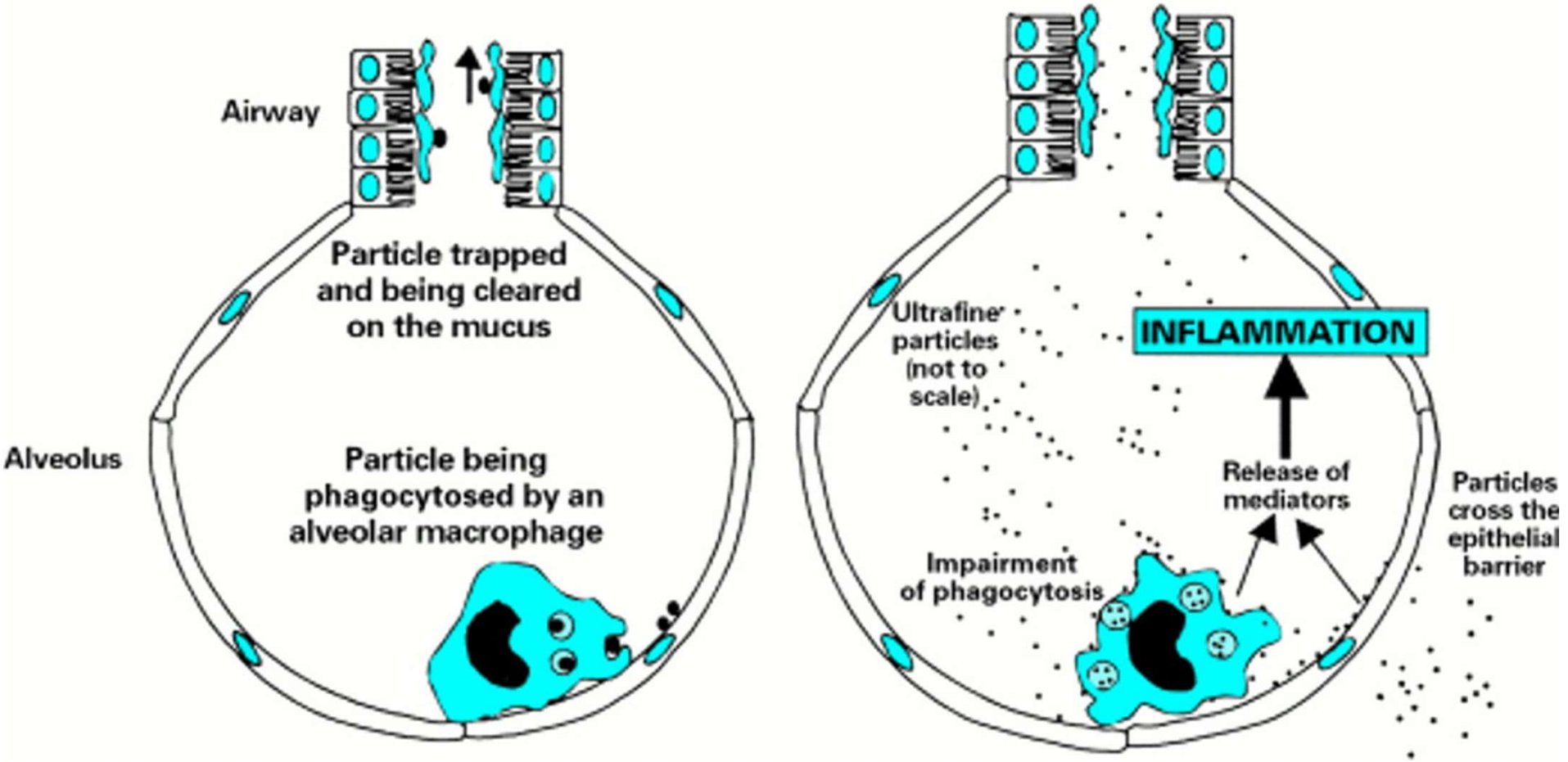
The smaller the particles, the deeper they go into your lungs





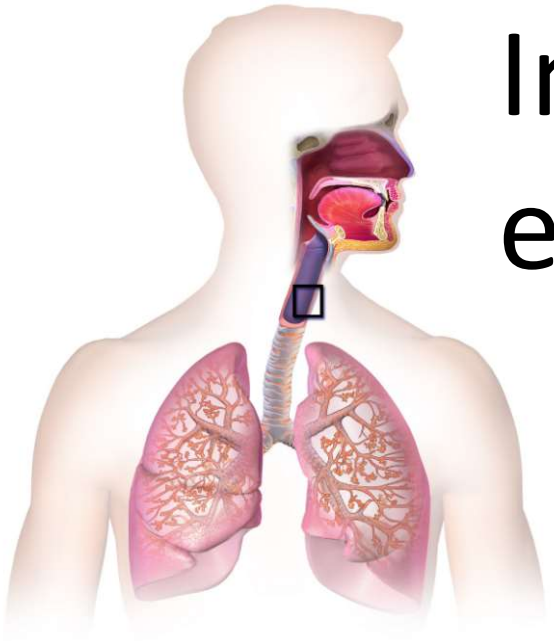
Particle deposition and clearance from the respiratory tract: https://tinyurl.com/y7uzpk8k

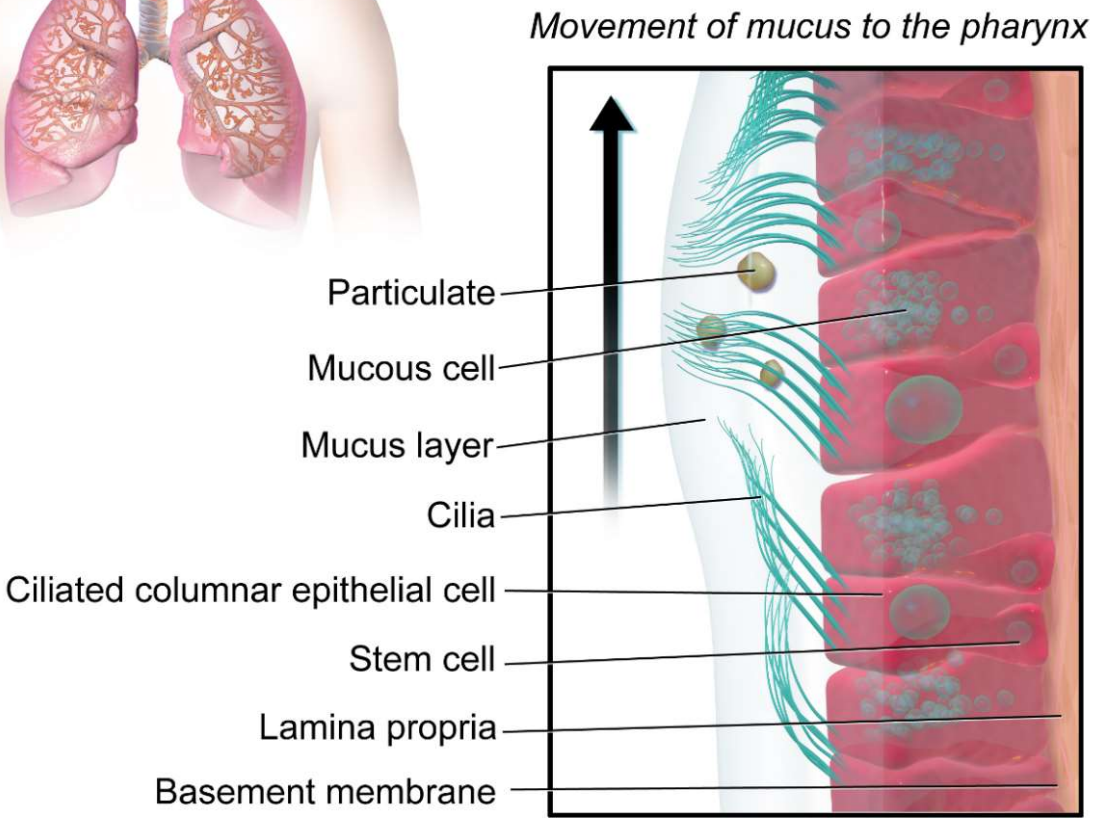
Impairment of immune function



Donaldson K, Stone V, Clouter A*, et al* Ultrafine particles. *Occupational and Environmental Medicine* 2001;**58:**211-216.

Impairment of epithelial cilia





Epithelial cilia: sweep mucus and dirt out of the respiratory tract

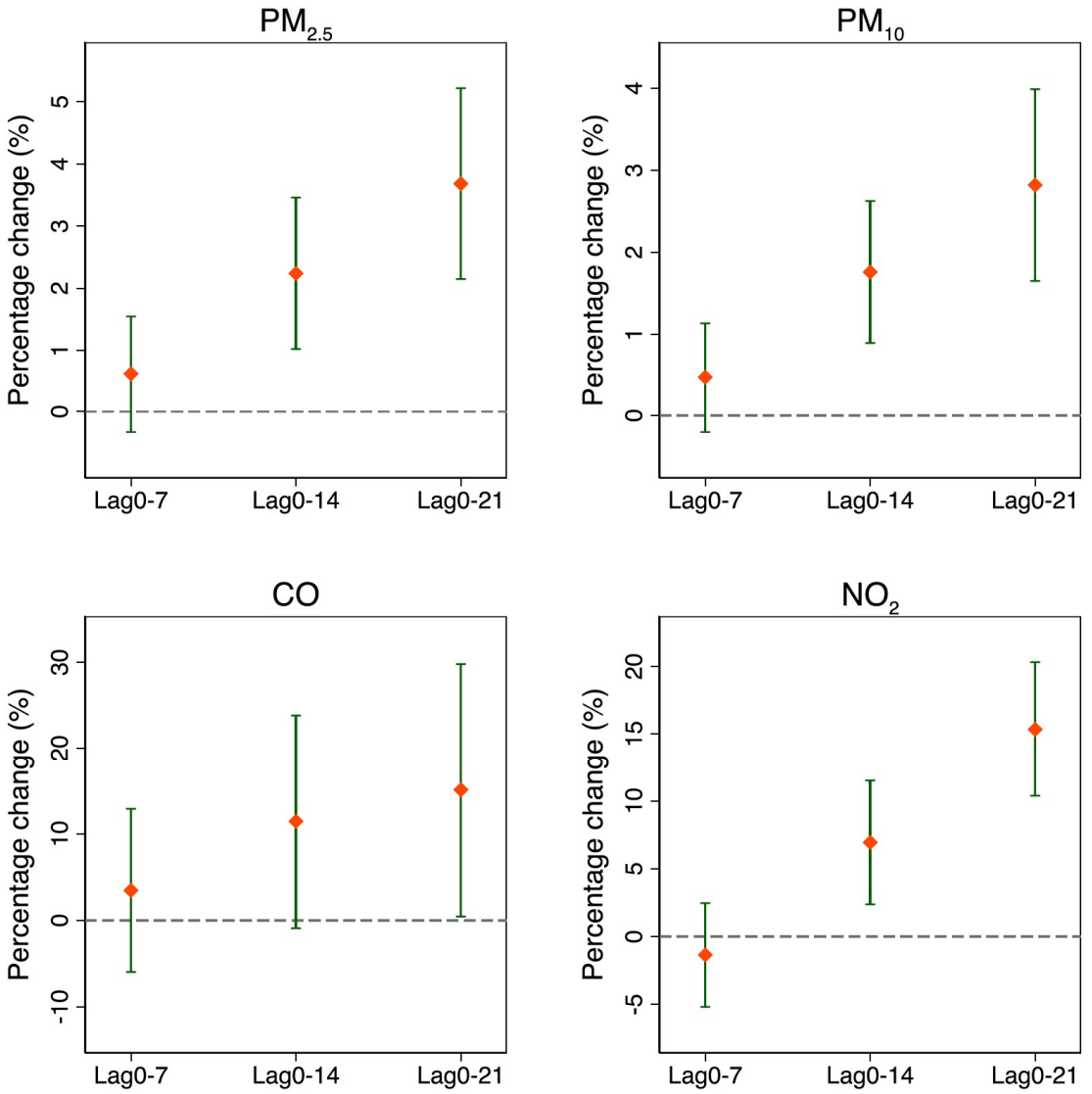
Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010

Association between short-term exposure to air pollution and COVID-19 infection: Evidence from China

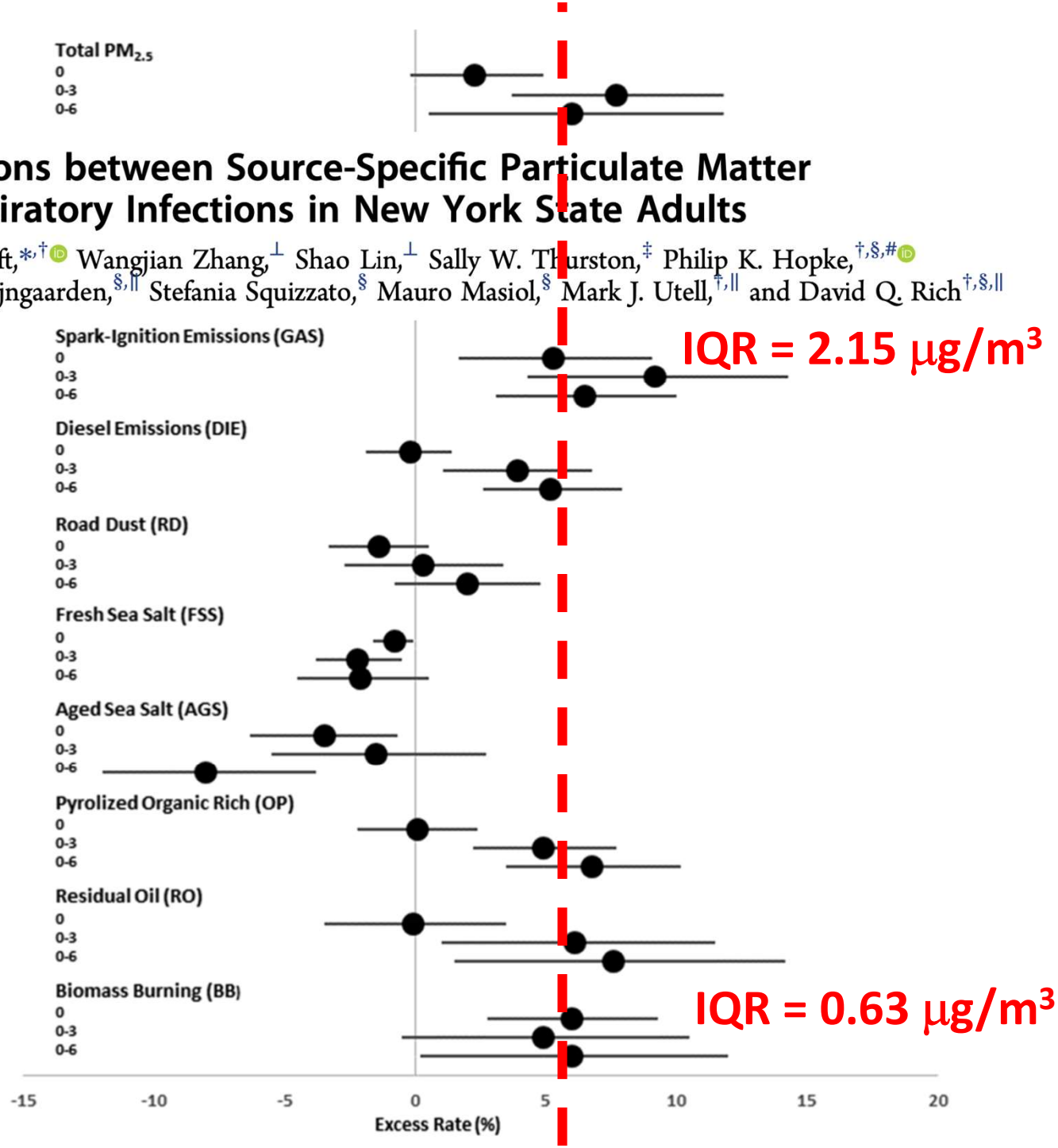
Positive associations of $PM_{2.5}$, PM_{10}, CO, NO_2 and O_3 with newly diagnosed COVID-19

Controlled for meteorology, city size and density, and lockdown start, but not otherwise

Possible artefact of there likely being more testing in symptomatic



Y. Zhu et al. / Science of the Total Environment 727 (2020) 138704



Associations between Source-Specific Particulate Matter and Respiratory Infections in New York State Adults

Daniel P. Croft,[*,†] Wangjian Zhang,[⊥] Shao Lin,[⊥] Sally W. Thurston,[‡] Philip K. Hopke,[†,§,#] Edwin van Wijngaarden,[§,∥] Stefania Squizzato,[§] Mauro Masiol,[§] Mark J. Utell,[†,∥] and David Q. Rich[†,§,∥]

IQR = 2.15 μg/m³

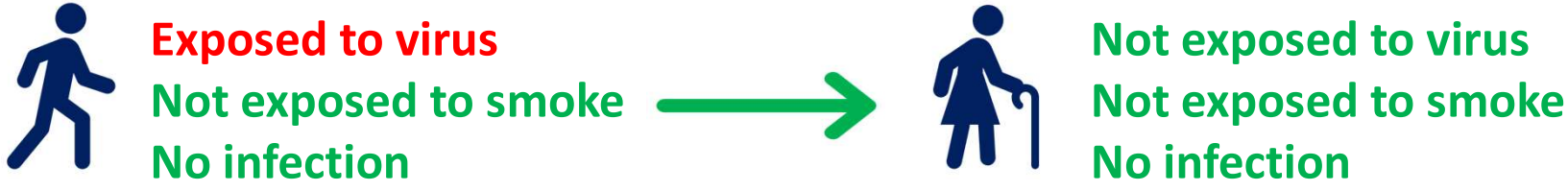
IQR = 0.63 μg/m³

Co-exposure to wildfire smoke and respiratory viruses may lead to:

1. More cases of COVID-19 disease

Scenario #1

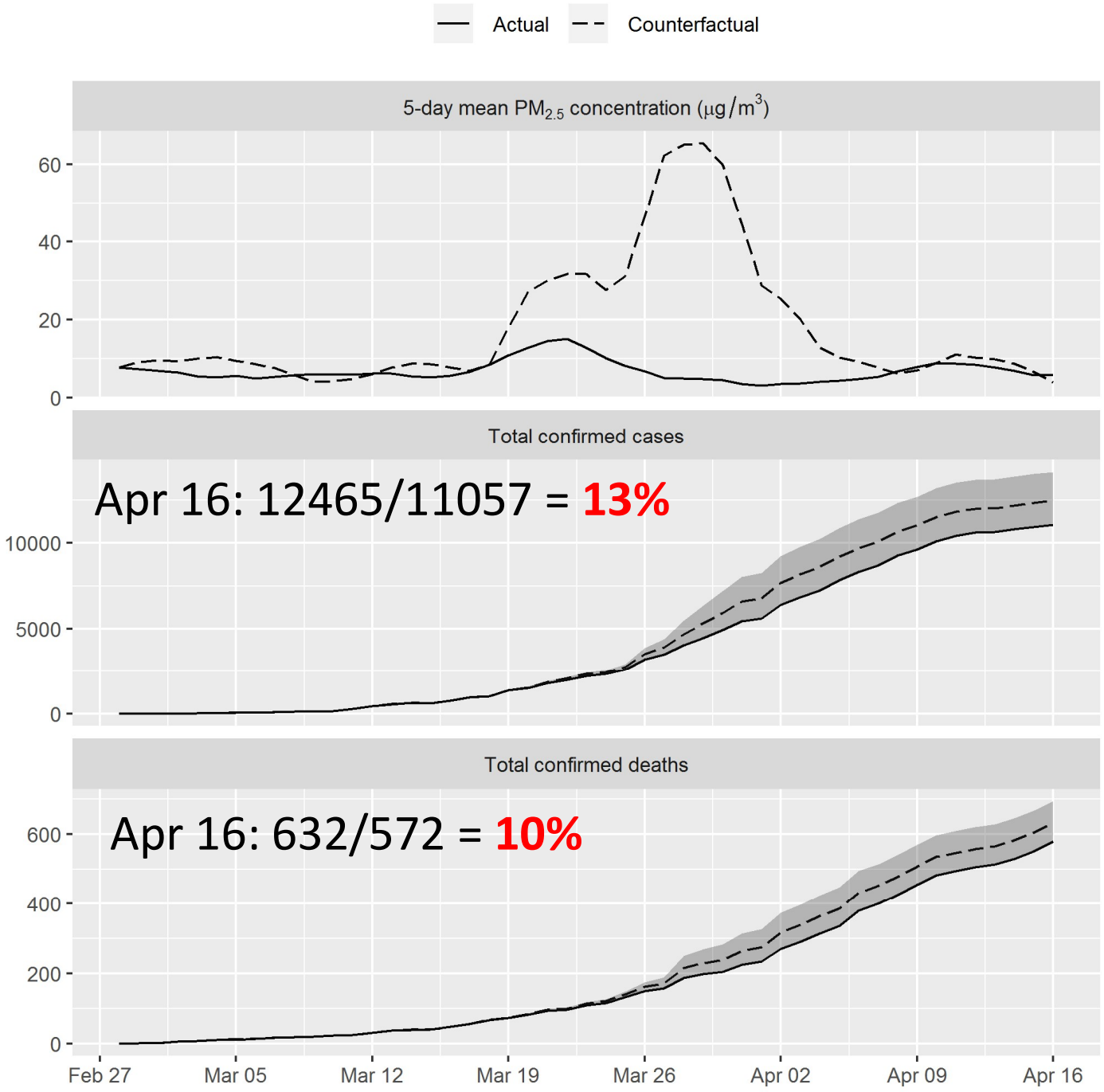
Scenario #2



2. More severe infections

AJPH Editorial

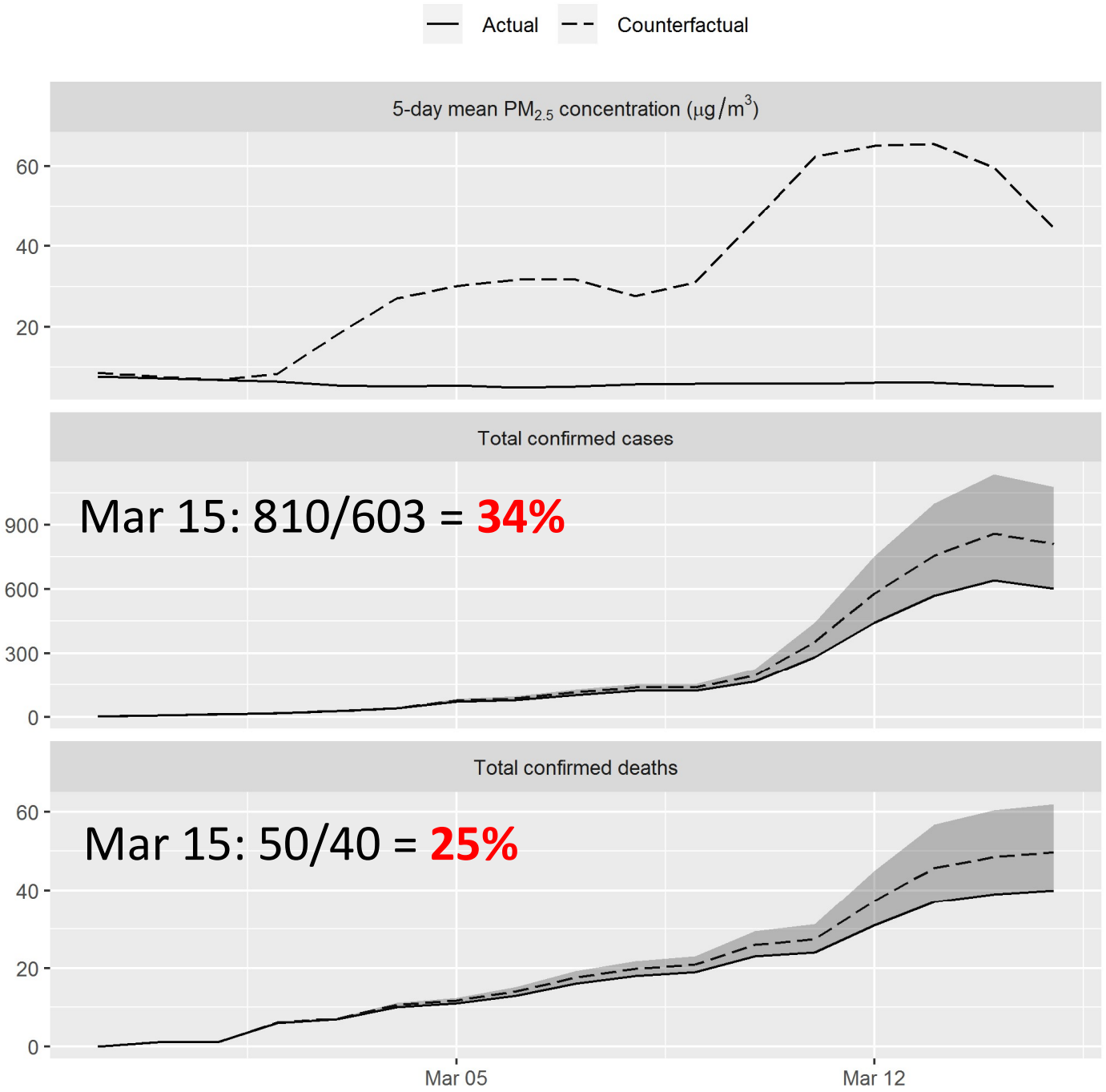
Summer 2018 air quality in WA applied to spring 2020 COVID-19 cases

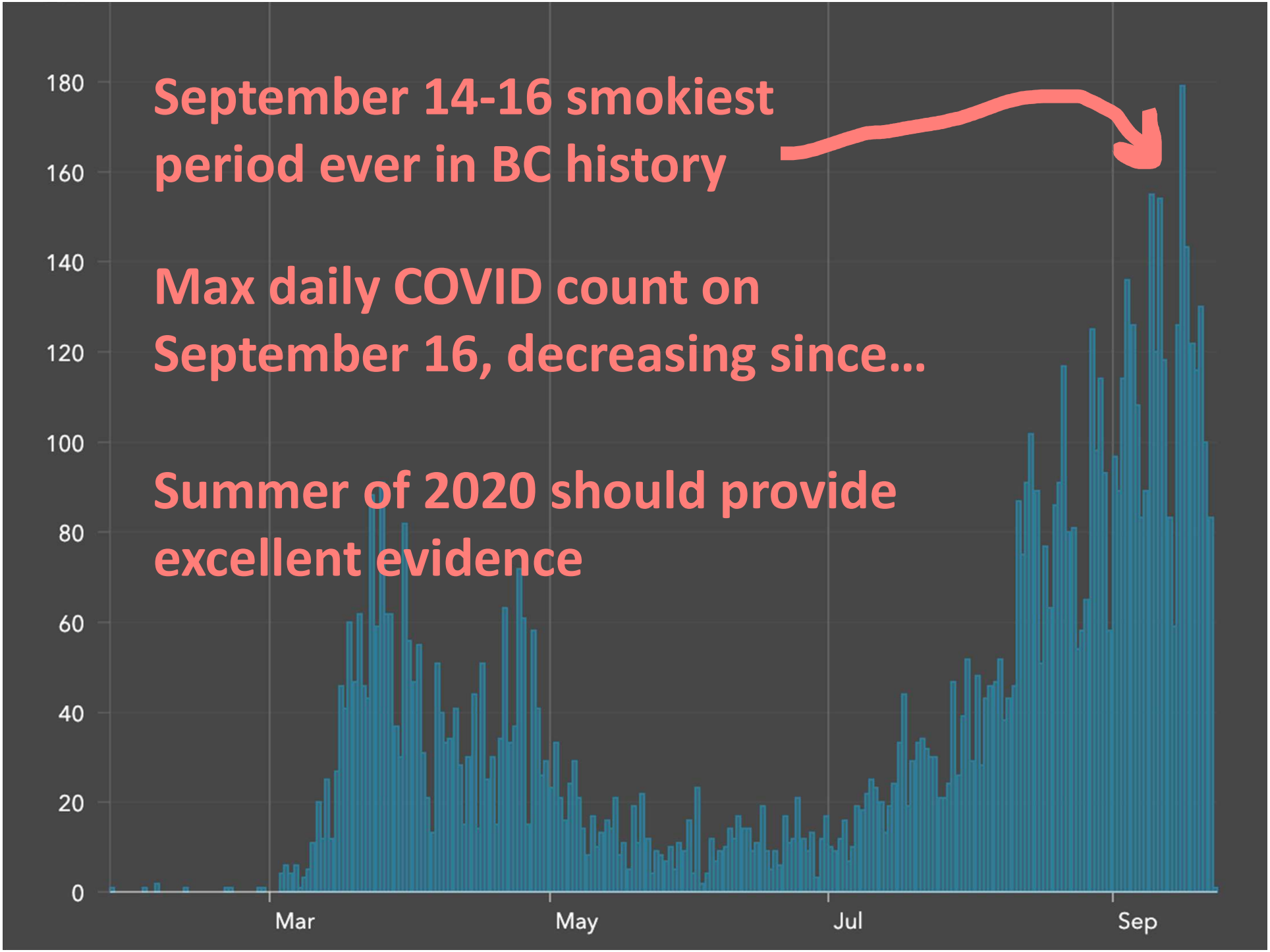


https://ajph.aphapublications.org/doi/10.2105/AJPH.2020.305744

Depends on timing along the curve

Implications for potential subsequent waves in summer and fall




September 14-16 smokiest period ever in BC history
Max daily COVID count on September 16, decreasing since…
Summer of 2020 should provide excellent evidence
180
160
140
120
100
80
60
40
20
0
Mar
May
Jul
Sep

Interaction between the acute health effects

The health effects of wildfire smoke and COVID-19, colour-coded by strength of the evidence (darker = stronger).

Wildfire smoke

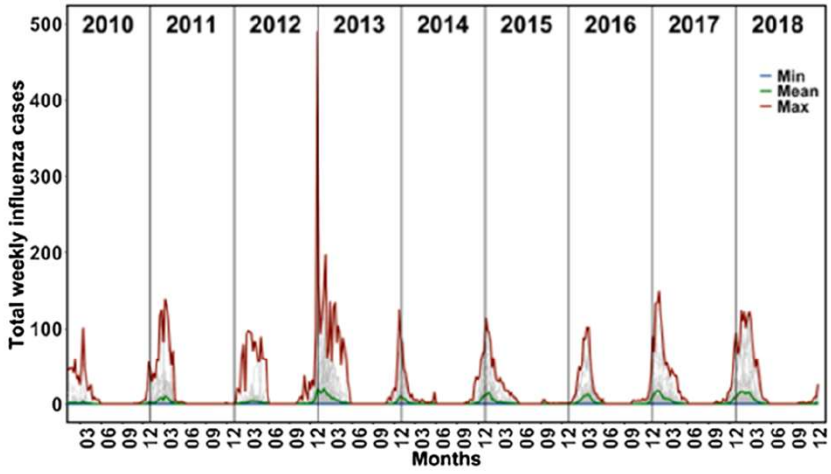
- Respiratory
- Cardiovascular
- Diabetes
- Pregnancy
- Cognitive
- Mental health

COVID-19 infection

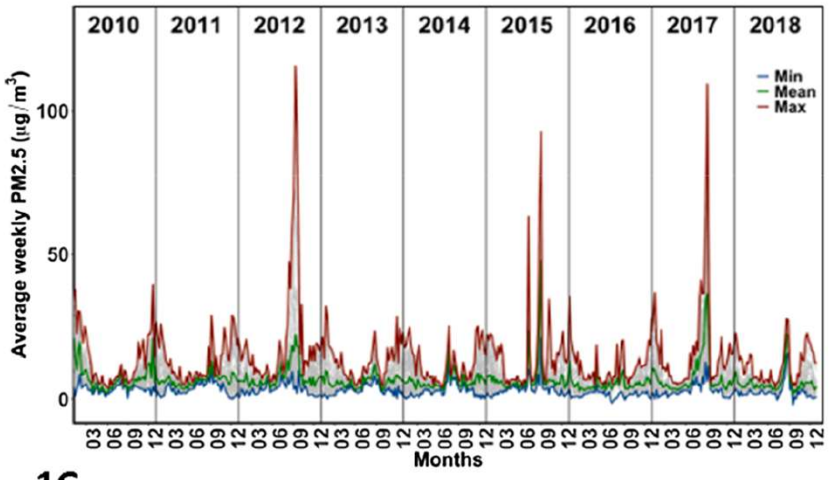
- Respiratory
- Cardiovascular
- Kidney
- Pregnancy
- Central nervous system
- Mental health

Smoke may increase susceptibility to future infections

"*Higher daily average $PM_{2.5}$ concentrations during the wildfire season was positively associated with increased influenza the following winter (**16% or 22% increase per 1 $\mu g/m^3$** based on two analyses, p = 0.04 or 0.008).*"



1A



1C

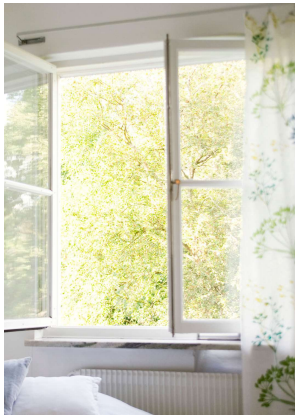
The delayed effect of wildfire season particulate matter on subsequent influenza season in a mountain west region of the USA

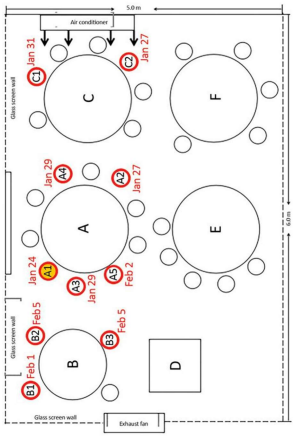
Erin L. Landguth[a,*], Zachary A. Holden[b], Jonathan Graham[a,c], Benjamin Stark[c], Elham Bayat Mokhtari[c], Emily Kaleczyc[d], Stacey Anderson[e], Shawn Urbanski[f], Matt Jolly[f], Erin O. Semmens[a], Dyer A. Warren[a], Alan Swanson[a], Emily Stone[c], Curtis Noonan[a]

Pandemic viruses complicate summer, which was already complicated

Virus	Smoke	Heat	Health protections required (prioritization is context-specific)
High	High	High	Virus measures, clean air, cooling
		Low	Virus measures, clean air
	Low	High	Virus measures, cooling
		Low	Virus measures
Low	High	High	Cooling, clean air
		Low	Clean air
	Low	High	Cooling
		Low	Phew! Enjoy!

Intersections and tensions





Natural ventilation reduces virus risk, and activities outdoors are recommended whenever possible. Both increase smoke exposure.	**Air conditioning and cleaning** are most effective with doors and windows closed, which may increase virus risk. Directed airflows may also contribute to virus transmission.	**Face masks** offer varying protection from wildfire smoke, and the supply of N95 respirators is precarious. Cleaner indoor air is the preferable protection, regardless.

Pre-season preparedness is the key to mid-season successes

http://www.bccdc.ca/health-info/prevention-public-health/wildfire-smoke
http://www.bccdc.ca/health-info/diseases-conditions/covid-19/prevention-risks/wildfires

1. Guidance for individuals sheltering in place
2. Guidance for long-term care facilities
3. Guidance for acute care facilities
4. Guidance for schools
5. Guidance for childcare
6. Guidance for…?

Thank you!

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