Health Effects of Wildfire Smoke

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Outline

- Wildfire smoke / woodsmoke
- Evidence from
  - Ambient air pollution
  - Wildfire smoke
- Conclusions

How can woodsmoke hurt you?

- Sources:
  - Residential cookstoves
  - Residential heating
  - Agricultural burning
  - Wildfires
  - Prescribed burning
- Burning wood (and other biomass) produces CO_2 and H_2O if efficient
- The problem: most burning is not efficient

Woodsmoke

- Hundreds of compounds
- Particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO_2)
- Hydrocarbons, e.g.:
  - 1,3 butadiene, benzene, benzo(a)pyrene, 100's of others…
- Oxygenated organics, e.g.:
  - Formaldehyde, methanol, hydroquinone, many more…
- Chlorinated organics (e.g., dioxin)

Naeher et al. 2007

Particulate Matter (PM)

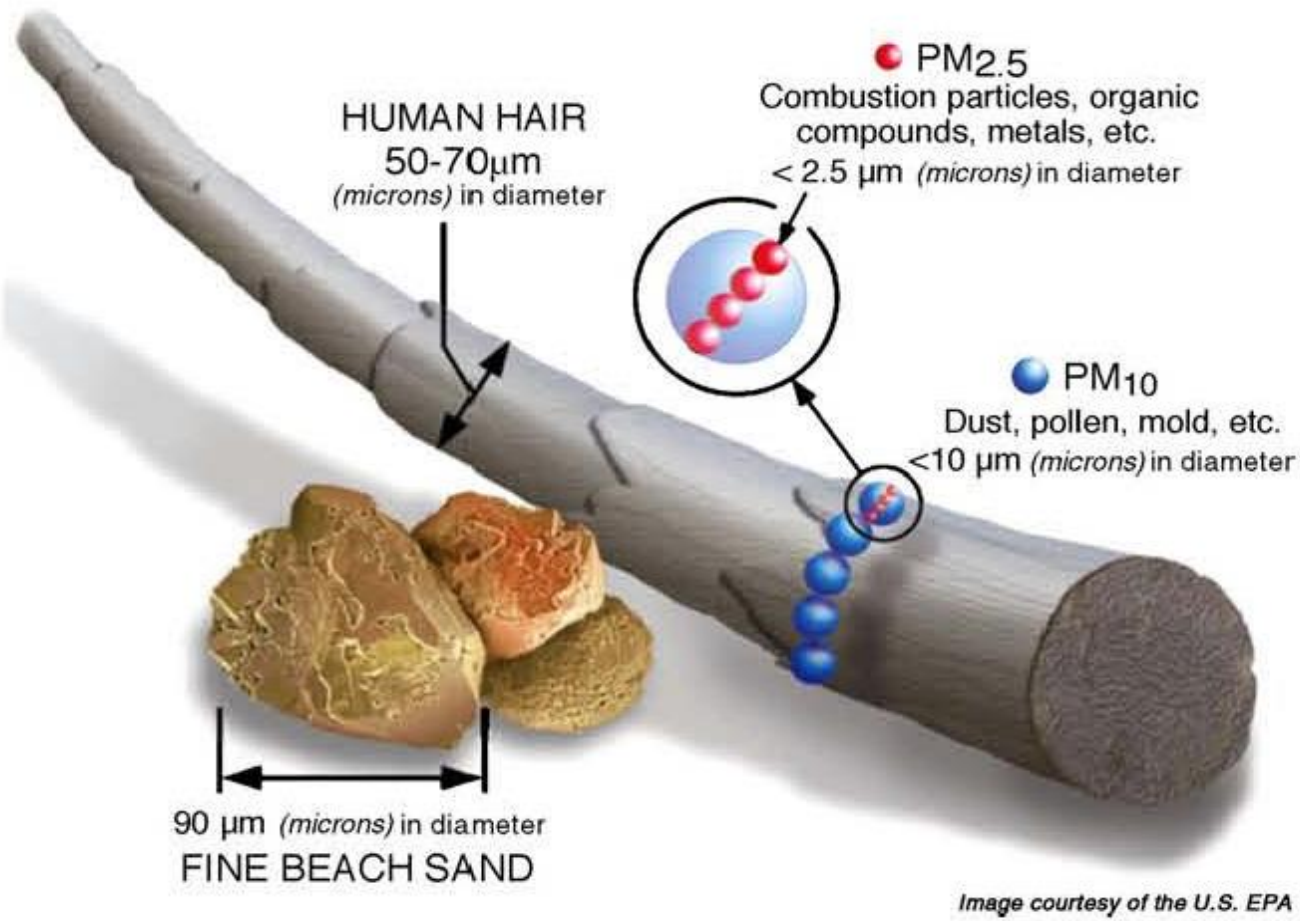
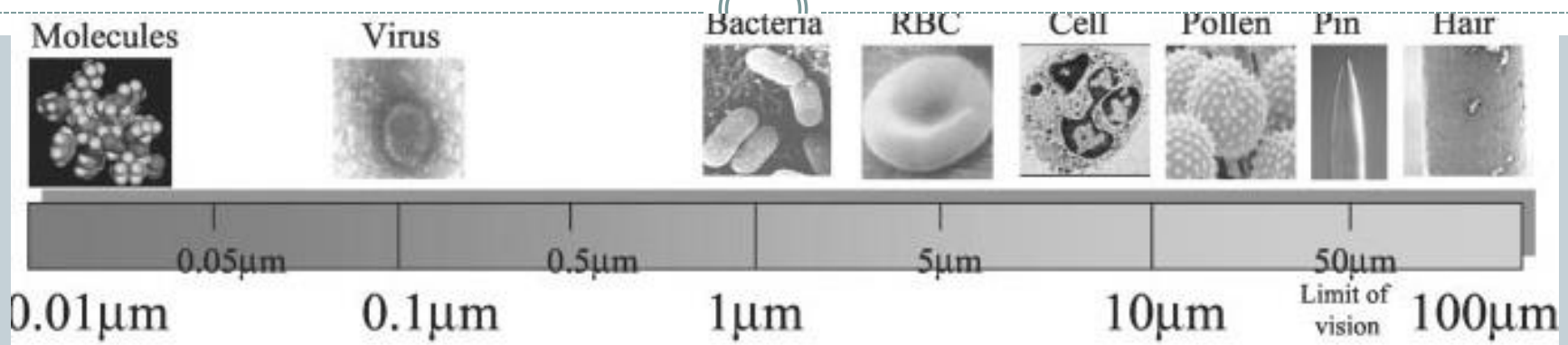
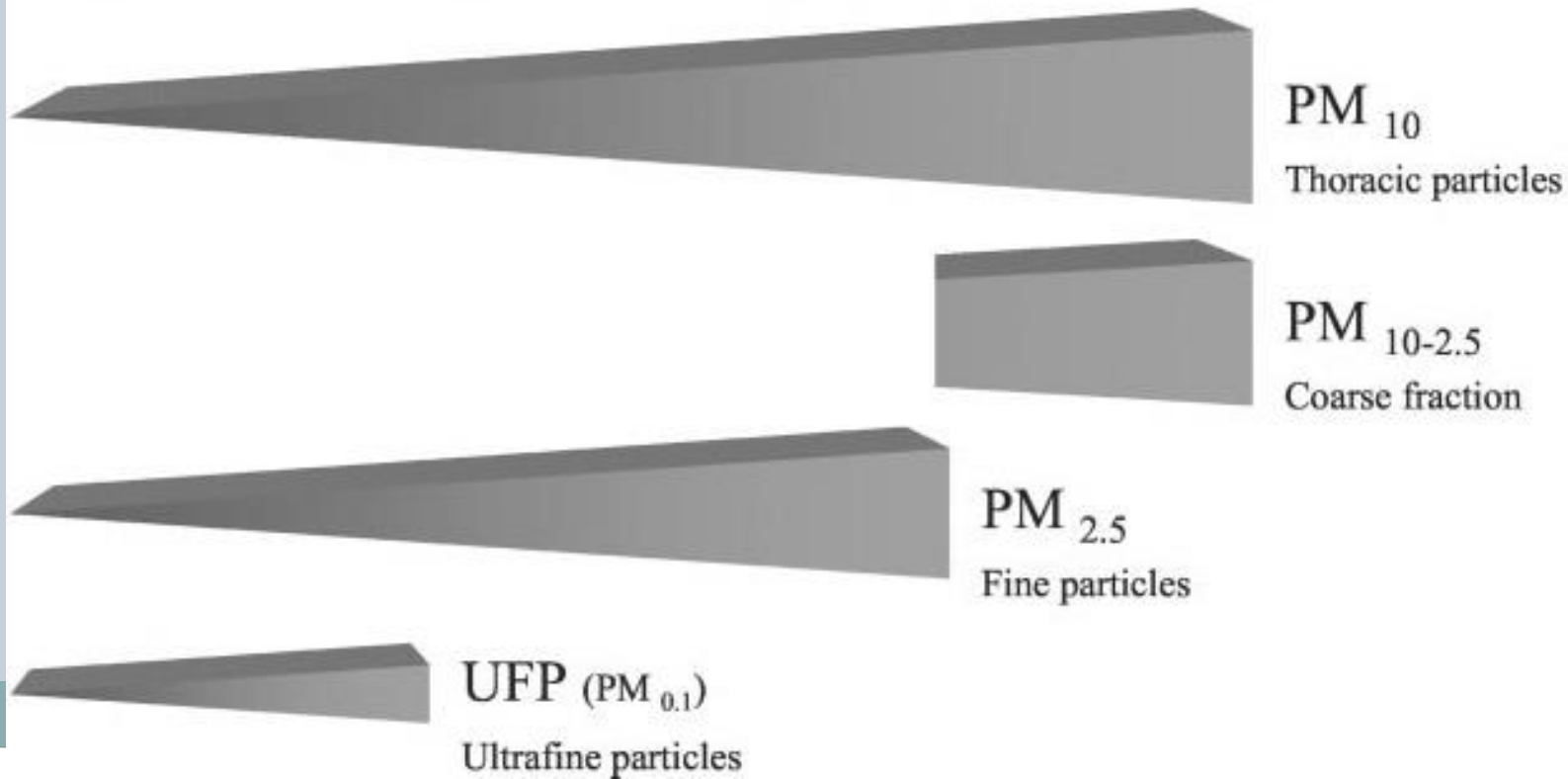


Fig. 1. Various sizes of particulate matter in comparison with a strand of human hair and grains of fine beach sand.

Particulate Matter (PM)





Evidence from ambient air pollution: Premature Mortality

- US EPA Integrated Science Assessments

	$PM_{2.5}$ 2009 ISA	$PM_{10-2.5}$ 2009 ISA	$PM_{0.1}$ 2009 ISA	NO_2 2008 ISA	CO 2010 ISA
Short Term					
Mortality	Causal	Suggestive	Inadequate	Suggestive	Suggestive
Long Term					
Mortality	Causal	Inadequate	Inadequate	Suggestive	Not likely causal

Evidence from ambient air pollution: Respiratory Disease Morbidity

- US EPA Integrated Science Assessments

	$PM_{2.5}$ 2009 ISA	$PM_{10-2.5}$ 2009 ISA	$PM_{0.1}$ 2009 ISA	NO_2 2008 ISA	CO 2010 ISA
Short Term					
Respiratory Morbidity	Likely causal	Suggestive	Suggestive	Causal	Suggestive
Long Term					
Respiratory Morbidity	Likely causal	Inadequate	Inadequate	Suggestive	Inadequate

Evidence from ambient air pollution: Cardiovascular Disease (CVD) Morbidity

- US EPA Integrated Science Assessments

	$PM_{2.5}$ 2009 ISA	$PM_{10-2.5}$ 2009 ISA	$PM_{0.1}$ 2009 ISA	NO_2 2008 ISA	CO 2010 ISA
Short Term					
CVD Morbidity	Causal	Suggestive	Suggestive	Inadequate	Likely
Long Term					
CVD Morbidity	Causal	Inadequate	Inadequate	Inadequate	Inadequate

Evidence from ambient air pollution: Adverse Birth Outcomes and Developmental Effects

- US EPA Integrated Science Assessments

	$PM_{2.5}$ 2009 ISA	$PM_{10-2.5}$ 2009 ISA	$PM_{0.1}$ 2009 ISA	NO_2 2008 ISA	CO 2010 ISA
Adverse birth outcomes and developmental effects	Suggestive	Inadequate	Inadequate	Inadequate	Suggestive

Biologic Mechanisms

- Irritation of the respiratory tract
- Reduced defense against infection
- Inflammation
  - Local
  - Systematic
- Translocation of particles

Evidence from wildfire smoke: premature mortality

- Few studies specifically examining smoke (PM) from wildfires
- Studies from Australia, Malaysia, United States, Finland
- Evidence was mixed; some evidence for all-cause mortality, respiratory mortality, less so for cardiovascular mortality
- Vedal and Dutton 2006
  - Two days in 2002, Denver metro area impacted by fires
  - "No perceptible increases in daily mortality"
  - Limited by power, PM 40-50ug/m^3
- Few studies, generally limited by power
- Johnston et al. 2012 estimated 339,000 deaths annually worldwide due to landscape fires (wildfires, prescribed burns, peat fires, agriculture burning, etc.)

Evidence from wildfire smoke: respiratory disease morbidity

- Multiple studies from Asia, Australia, United States, Europe, Canada
- Hospital admissions, emergency department visits, respiratory medication usage, lung function, respiratory symptoms (cough, wheeze, throat and eye irritation)
- Various age groups examined
- Exposure assessment varied
  - Measured PM
  - Modeled PM (e.g., satellite)
  - Fire vs. non-fire periods
- Length of time impacted from days to months

Evidence from wildfire smoke: respiratory disease morbidity

- Generally consistent evidence across studies
- Asthma the most commonly examined and consistent endpoint
- No consistent pattern when examining age groups
- Some suggestion of stronger associations among lower socioeconomic populations

Evidence from wildfire smoke: cardiovascular disease morbidity

- Fewer studies than for respiratory disease
- Australia, Asia, United States, Canada
- Primarily hospital admissions, emergency department visits
- Evidence is mixed, generally no associations but a few studies did observe positive associations

Evidence from intervention studies

- Allen et al. 2011, air filtration intervention study
  - Portable air cleaner in households
  - Healthy adults in a wood smoke-impacted community
  - Air filtration associated with improved endothelial function and decreased systemic inflammation, no association with oxidative stress
- Johnston et al. 2013 (Tasmania, Australia)
  - Community education campaigns, enforcement of regulations, wood heater replacement programs
  - Suggestion of reduced all-cause, respiratory, and cardiovascular mortality in winter

Evidence from intervention studies

- Noonan et al. 2012
  - Wood stove exchange program in Libby, Montana
  - Decrease in childhood wheeze, itchy eyes, sore throat, cold, bronchitis, influenza, throat infections

Conclusions

- Evidence for with respect to fine particulate matter strong (+)
  - Premature mortality, respiratory disease, cardiovascular disease
  - Also evidence for CO, NO_2 for various health outcomes

Conclusions

- Community wildfire exposure (+ / -)
  - Fairly strong evidence for respiratory disease
    - Some evidence of increased susceptibility among asthmatics, lower socioeconomic status
  - Limited evidence for premature mortality
  - Mixed evidence for cardiovascular disease
  - Limited studies evaluating birth outcomes (Holstuis et al. 2012; reduced birth weight during 2003 California fires), other health outcomes (e.g., stress, mental health)
  - Studies limited by exposure assessment, power

Questions?

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