Air pollution and health

• Ambient air pollution (individual) risk is small...but large exposed population = large population risk
  – Drug abuse: Larger risk, smaller exposed population
• Major impacts are on chronic disease progression
• Diseases impacted by air pollution are multifactorial...
• ...Air pollution as a contributing risk factor
Air pollution and health

- On **days** with worse air quality, more people die*
- In **more polluted cities**, people die earlier than in less polluted cities...
- ...and, in the **most polluted areas** of cities, there is an increased risk of dying


*out-of-hospital, >65 yrs
300,000 Adult Canadians (CCHS)
8 – 11 year follow-up

No evidence of threshold above 1 µg/m³ minimum level

Particulate Matter

- **PM$_{2.5}$**: Combustion particles, organic compounds, metals, etc. (less than 2.5 microns in diameter)
- **PM$_{10}$**: Dust, pollen, mold, etc. (less than 10 microns in diameter)

**Human Hair**: 50-70 microns in diameter

**Fine Beach Sand**: 90 microns in diameter

*Image courtesy of the U.S. EPA*
87% global population in areas exceeding WHO Air Quality Guideline (10 μg/m³ PM$_{2.5}$ annual average)

Brauer et al., 2015
Environment Canada

BC State of the Air Report
2014 PM$_{2.5}$ Levels in B.C.

Annual average PM$_{2.5}$ (μg/m³)
8,800 deaths/yr PM$_{2.5}$  680 deaths/yr ozone

Among top risk factors (#10 deaths, #11 DALYs)

BC Crude Estimate (population proportion):
1147 PM$_{2.5}$ + 87 Ozone

Canada: Household heating ~8.3 %, ~750 deaths/yr

IHD, Stroke, Lung Cancer, COPD, Lower Respiratory Infections
Woodsmoke health effects

“....based on the current, limited experimental findings, we cannot conclude that exposure to residential biomass emissions in developed countries is less harmful than exposure to combustion particles from fossil fuel combustion.”
PM composition

Wood smoke soot

Wood smoke organic particles (low-temp combustion)

from Kocbach et al, Science of the Total Environment, 2005

“Good” wood pellet combustion PM (alkali salt particles)


“conventional”

“advanced”
Combustion conditions, composition & toxicity

More Toxic

Less Toxic

M. F. Heringa; P. F. DeCarlo; R. Chirico; A. Lauber; A. Doberer; J. Good; T. Nussbaumer; A. Keller; H. Burtscher; A. Richard; B. Miljevic; A. S. H. Prevot; U. Baltensperger; Environ. Sci. Technol. 2012, 46, 11418-11425. DOI: 10.1021/es301654w Copyright © 2012 American Chemical Society
<table>
<thead>
<tr>
<th>Combustion source</th>
<th>Emissions (mg/MJ)</th>
<th>Composition</th>
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<tbody>
<tr>
<td>Open fireplace</td>
<td>160 – 910</td>
<td>□ □ □</td>
</tr>
<tr>
<td>Conventional woodstove</td>
<td>50 – 2100</td>
<td>□ □ □</td>
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<tr>
<td>Conventional log boilers</td>
<td>50 – 2000</td>
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<td>(50 – 250)</td>
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<td>‘Modern” woodstoves</td>
<td>34 – 330</td>
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<td>log/chip boilers</td>
<td>5 – 450</td>
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adapted from: Kocbach Bølling et al. 2009
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adapted from: Kocbach Bølling et al. 2009
Controlled human exposure studies

• Subjects exposed to realistic (high) concentrations (~250 μg/m^3) of woodsmoke for 4 hrs
  – Increases in measures of inflammation, oxidative stress post-exposure compared to clean air

• Pellet stove incomplete combustion
  - No inflammation
  - Early adaptive protective response


• ~30% reduction in winter PM$_{2.5}$
• ↓ in childhood wheeze, itchy eyes, sore throat, cold, bronchitis, influenza, throat infections
• School absence associations inconsistent

Tasmania woodstove → electricity

- ~39% reduction in winter PM$_{10}$
- ↓ winter cardiovascular (-19.6%) and respiratory (-27.9%) mortality
- Similar decreases not observed in control community

Particle infiltration

Mean infiltration: 27% no filter, 10% with filter

Stove exchange and indoor levels

Epidemiology

• “...emissions from current biomass combustion products negatively affect respiratory and, possibly, cardiovascular health...”

• “Epidemiological studies strongly suggest that there are adverse health effects related to short-term as well as long-term exposure to biomass smoke in the developed world. Intervention studies performed, to date, suggest beneficial health effects of reducing exposure to biomass smoke.”

• We recommend that emissions from biomass combustion should be kept to a minimum to protect public health.”
New regulations

- 2016-17: Only wood and pellet stoves, boilers, furnaces certified to meet new US EPA or CSA emission standards legal to sell in B.C.
- 30 m setback for new Outdoor Wood Boilers (OWBs); Phase-out of older OWBs
- Prohibit burning of undesirable fuels, such as garbage, plastics and treated wood
Thank you!

Questions?

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