Health and Indoor Biomass Combustion

More Heat with Less Wood
Heather Adair-Rohani
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Overview of presentation

• Scale of the Problem: Global & Regional
• Health Impacts of Air Pollution
• Protecting Health: WHO air quality guidelines
• Healthy Interventions
Ambient Air Pollution from Residential Heating with Wood & Coal

**Exposure:**

- Globally, **less than 10%** of total ambient PM2.5 comes from residential heating stoves and boilers.

- However, **Central Europe accounts for 21%**, or the **highest fraction globally** of ambient PM2.5 attributed to residential heating.
Primary Solid Fuel Use for Residential Heating with Wood & Coal

- In a number of LMIC of EUR countries, more than half of households primarily rely on solid fuels for heating
- Rural areas show a larger primary reliance on solid fuels for heating

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Total</th>
<th>Urban</th>
<th>Rural</th>
<th>Urban</th>
<th>Rural</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosnia-Herzegovina</td>
<td>83%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Tajikistan (2009)</td>
<td>70%</td>
<td></td>
<td>40%</td>
<td></td>
<td></td>
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<tr>
<td>Armenia (2011)</td>
<td></td>
<td></td>
<td></td>
<td>31%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland (2011)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
<td>65%</td>
</tr>
<tr>
<td>Poland (2011)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
</tr>
</tbody>
</table>
### Health-damaging Pollutants from Residential Biomass & Coal Combustion

<table>
<thead>
<tr>
<th>Particles</th>
<th>Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fine particulate matter (PM$_{2.5}$)</td>
<td>• Carbon monoxide</td>
</tr>
<tr>
<td>• Black Carbon (BC)</td>
<td>• NO$_x$</td>
</tr>
<tr>
<td>• Organic Carbon (OC)</td>
<td>• PAHs</td>
</tr>
<tr>
<td></td>
<td>• SO$_2$</td>
</tr>
<tr>
<td></td>
<td>• VOCs</td>
</tr>
</tbody>
</table>
Health Impacts: Particulate Matter
Size makes a difference

PARTICLE SIZE AND DEPOSITION

PM$_{<10}$ – Coarse
PM$_{<2.5}$ – Fine
PM$_{<1}$ – Ultrafine

Medgadget.com
<table>
<thead>
<tr>
<th>Strong evidence</th>
<th>Tentative evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Child pneumonia</td>
<td>• Stillbirth</td>
</tr>
<tr>
<td>• Low birth weight</td>
<td>• Pre-term birth</td>
</tr>
<tr>
<td>• Chronic obstructive pulmonary disease (COPD)</td>
<td>• Stunting</td>
</tr>
<tr>
<td>• Lung cancer (coal)</td>
<td>• Cognitive development</td>
</tr>
<tr>
<td>• Lung cancer (biomass)</td>
<td>• Asthma</td>
</tr>
<tr>
<td>• Cataract</td>
<td>• Other cancers (naso-pharynx, uterine cervix)</td>
</tr>
<tr>
<td>• [Cardiovascular disease]</td>
<td>• Tuberculosis</td>
</tr>
</tbody>
</table>

Also: Additional health risks from unprocessed coal
IER function*: PM$_{2.5}$ and child ALRI risk

*Burnett et al (forthcoming)
IER function for $\text{PM}_{2.5}$ and child ALRI risk (linear scale)

WHO IT-1 (35 $\mu$g/m$^3$ $\text{PM}_{2.5}$)
Existing WHO Air Quality Guidelines (AQG)

- Global update (ambient) 2005:
  - PM$_{2.5}$, PM$_{10}$
  - Chapter on IAP
- Indoor AQG:
  - Dampness and Mould: 2009
  - Selected pollutants: 2010
  - Household fuel combustion: this project
HOUSEHOLD FUEL COMBUSTION
Executive Summary

World Health Organization
The primary audience for these guidelines is decision-makers developing, implementing, and evaluating policy to secure health benefits in the area of household energy, with a primary (but not exclusive) focus on LMICs.
# WHO Air Quality Guidelines: PM$_{2.5}$ and carbon monoxide (CO)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Guideline or target</th>
<th>Exposure period</th>
<th>Level (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM$_{2.5}$ (2005)</strong></td>
<td>Guideline</td>
<td>Annual average</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>IT-3</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>IT-2</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>IT-1</td>
<td></td>
<td>35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Guideline or target</th>
<th>Exposure period</th>
<th>Level (mg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon monoxide (2010)</strong></td>
<td>Guideline</td>
<td>8-hour</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Guideline</strong></td>
<td>24-hour</td>
<td>7</td>
</tr>
</tbody>
</table>
General considerations

• Household emissions enter ambient air, re-enter homes and lower IAQ: hence, total emissions should be minimised.

• Local ambient air quality (from homes and other sources) affect indoor air quality: this must be considered in order to achieve clean indoor air.

• Homes have multiple energy needs (cooking, heating, lighting, etc.) so use and emissions from all sources should be considered.

• Household energy use carries risks of burns and poisoning. Safety of interventions should not be assumed: approaches to minimize exposure to emissions should be taken in a way that incorporates safety concerns.

• Interventions need to be available and affordable, or harms may result from energy poverty.
General considerations

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• Local ambient air quality (from homes and other sources) affect indoor air quality: this must be considered in order to achieve clean indoor air.
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• Household energy use carries risks of burns and poisoning. Safety of interventions should not be assumed: approaches to minimize exposure to emissions should be taken in a way that incorporates safety concerns.
• Interventions need to be available and affordable, or harms may result from energy poverty.
Questions addressed in recommendations:

1. What device and fuel emission rates are required to meet WHO air quality guideline for PM$_{2.5}$ (annual mean) and for CO (24 hour mean)?

2. In light of the acknowledged challenges in securing rapid adoption and sustained use of very low emission household energy devices and fuels, what approach should be taken during this transition?

3. Should coal be used as a household fuel?

4. Should kerosene be used as a household fuel?
**Rec. 1(a): Emission rate targets (PM$_{2.5}$)**

**Recommendation**
For **90%** of homes to meet the WHO AQGs for PM$_{2.5}$, emission rates should not exceed the emission rate targets (ERTs) set out below.

<table>
<thead>
<tr>
<th>Emissions rate targets (ERT)</th>
<th>Emission rate (mg/min)</th>
<th>Percentage of kitchens meeting AQG (10 µg/m$^3$)</th>
<th>Percentage of kitchens meeting AQG IT-1 (35 µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unvented</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>1.75</td>
<td>9%</td>
<td>60%</td>
</tr>
<tr>
<td>Final</td>
<td>0.23</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Vented</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>7.15</td>
<td>4%</td>
<td>60%</td>
</tr>
<tr>
<td>Final</td>
<td>0.80</td>
<td>90%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Rec. 1(b): Emission rate targets (CO)

**Recommendation**

For 90% of homes to meet the WHO AQG for CO, emission rates should not exceed the emission rate targets (ERTs) set out below.

<table>
<thead>
<tr>
<th>Emissions rate targets (ERT)</th>
<th>Emission rate (g/min)</th>
<th>Percentage of kitchens meeting AQG (7 mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unvented</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>0.35</td>
<td>60%</td>
</tr>
<tr>
<td>Final</td>
<td>0.16</td>
<td>90%</td>
</tr>
<tr>
<td><strong>Vented</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>1.45</td>
<td>60%</td>
</tr>
<tr>
<td>Final</td>
<td>0.59</td>
<td>90%</td>
</tr>
</tbody>
</table>
Focus on emissions reductions – why?

• Outdoor ↔ indoor
• Evidence base stronger than for other approaches
• Implementation practicality – via design, production, standards, etc
• Some options (clean fuels), are relatively independent of user behaviour.
Rec. 3: Household use of coal

Recommendation:
Unprocessed coal should not be used as a household fuel

• Rationale:
  – It is very difficult to burn coal cleanly in home
  – IARC Monograph: emissions from household use of coal are a Group 1 carcinogen
  – Coal often contains toxins (fluorine, arsenic, mercury, etc.) which are not destroyed on combustion.

• There should be further assessment of so-called ‘clean’ and ‘smokeless’ coal
Rec. 4: Use of kerosene

**Recommendation:**
Household combustion of kerosene is discouraged while further research into its health impacts is conducted.

**Rationale:**
- High levels of emissions of PM and other health-damaging emissions.
- Epidemiologic studies suggest links to tuberculosis, cancer, respiratory disease, adverse birth outcomes, etc., but are not of adequate consistency/quality.
- Kerosene use carries substantial risks of burns and poisoning.
Good Practice Rec: Securing health and climate co-benefits

**Recommendation:**
Considering the opportunities for synergies between climate policies and health, including financing—governments and agencies who develop & implement policy on climate change mitigation should consider action on household energy and carry out relevant assessments to maximize health and climate gains.
Guidelines implementation

• **Guidance/tools, including:**
  – Country-based needs assessment
  – Interactive versions of emissions model (allowing regionally derived inputs)
  – Tool for assessing health impacts and costs of intervention options (IER functions) - HAPIT
  – Tool for planning policy for effective adoption
  – Methods for monitoring and evaluation

• **Country support:**
  – General support for all countries
  – Work with a few countries to develop and evaluate guidance and tools
Healthy Interventions for Home Heating

• **Fuel Switching**
  - Banning sale and distribution of coal (particularly bituminous coal)

• **Heater and Wood Stove Exchanges**
  - Replacing older stoves with certified wood stoves or other appliances

• **District heating**
  - With emphasis on biofuels over heating oils

• **HEPA filters**
Regulatory and Voluntary Measures

- **Regulatory Emissions Limits**
  - Ecodesign standards for solid fuel space heaters and boilers

- **Fuel Switching Incentives**
  - Shifting toward pellet or wood-chip stoves

- **“No burn” days**
  - Voluntary or regulatory

- **Heater Exchange Regulations**
Thank you!

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