No safe level of air pollution
Distribution of air pollution workshop, UNSW

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Take home statement
As air pollution increases, risks for the population increase monotonically with no jumps
Who I am

- BSc Statistics, University College London 1991–94
- PhD Maths, University of Queensland 1999–2002
- Queensland University of Technology 2007–censored

- Editorial boards of *Epidemiology, Environmental Health Perspectives* and *BMJ Open*
- Interested in epidemiology, statistics and cost-effectiveness
- Fields of hospitals, funding and environment
There is a safe level

Individual thresholds

- **Safe**
- **Not safe**

![Graph showing the relationship between air pollution and disease risk. The graph indicates that there is a safe level of air pollution below which disease risk is low.](image-url)
Multiple heterogeneous individuals
Older people to left, younger people to right

Air pollution

Disease

Safe for most

Not safe for most

Yes

No

0 10 20 30 40 50

Safe for

Not safe
Disease counts

Yes

Safe for most

Not safe for most

No

Air pollution

0 10 20 30 40 50

Yes

Safe for most

Not safe for most

No

Air pollution

0 10 20 30 40 50
Disease counts for a large population

Distribution of thresholds

- Safe for most
- Not safe for most

Population Risk

Disease counts vs. Air pollution

0 10 20 30 40 50

Air pollution

0 10 20 30 40 50

Disease counts
Two threshold distributions

Distribution of thresholds

Distribution of thresholds (vulnerable)

New risk

Previous population risk

Air pollution

Disease counts

0 10 20 30 40 50

Air pollution

20 30 40 50

Previous population risk

New risk

Distribution of thresholds

Distribution of thresholds (vulnerable)
2010 Russian wild fires
Combination of heat and pollution

- PM$_{10}$ levels over 300 $\mu$g/m$^3$ on several days

"Moscow, Yasenevo, August 6 2010" by Акутагава - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons
## 2010 Russian wild fires

- **Estimated excess deaths**

<table>
<thead>
<tr>
<th>Age</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 65</td>
<td>1,908</td>
</tr>
<tr>
<td>&gt; 65</td>
<td>8,868</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,859</strong></td>
</tr>
</tbody>
</table>

Shaposhnikov et al, Mortality Related to Air Pollution with the Moscow Heat Wave and Wildfire of 2010, *Epidemiology* 2014
“East West Link (Eastern Section) - comprehensive impact statement”
Victoria Government

- Quotes from report concerning modelled pollution levels:
  - “Further consideration has been given as to whether any increase in PM10 concentrations contributed by the project [...] would present an unacceptable risk to human health. In this regard, the ambient air quality criteria included in the National Environment Protection Measures and the SEPP are considered relevant.”
  - modelled increases “comfortably fall within SEPP (AQM) criteria”

- Lots of other examples

- A previous report on the NEPM standards recognised that compliance with the standards, “may not achieve the desired outcome of ‘adequate protection’” (NEPC 2011).
Misusing pollution standards as thresholds

“East West Link (Eastern Section) - comprehensive impact statement” Victorian Government

- Quotes from report concerning modelled pollution levels:
  - “Further consideration has been given as to whether any increase in PM10 concentrations contributed by the project [...] would present an unacceptable risk to human health. In this regard, the ambient air quality criteria included in the National Environment Protection Measures and the SEPP are considered relevant.”
  - modelled increases “comfortably fall within SEPP (AQM) criteria”

- Lots of other examples

- A previous report on the NEPM standards recognised that compliance with the standards, “may not achieve the desired outcome of ‘adequate protection’” (NEPC 2011).
If the NEPM levels are safe
People are resilient to air pollution

![Graph showing disease counts vs air pollution levels](image-url)
Australian data and standards

Daily air pollution levels in Brisbane 2010–13

![Graphs showing pollution levels for co, no2, pm10, pm2.5](image)
Some published risks for Australia

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Disease</th>
<th>Ages</th>
<th>Risk (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-hr BSP</td>
<td>Pneumonia + acute bronchitis</td>
<td>0</td>
<td>2.1</td>
</tr>
<tr>
<td>1-hr SO₂</td>
<td>Respiratory admissions</td>
<td>0</td>
<td>3.2</td>
</tr>
<tr>
<td>24-hr PM₂.₅</td>
<td>Respiratory admissions</td>
<td>1–4</td>
<td>1.7</td>
</tr>
<tr>
<td>24-hr NO₂</td>
<td>Arrhythmia</td>
<td>15–64</td>
<td>5.1</td>
</tr>
<tr>
<td>24-hr NO₂</td>
<td>Cardiac failure</td>
<td>65+</td>
<td>6.9</td>
</tr>
</tbody>
</table>


Barnett et al (2005), The Effects of Air Pollution on Hospitalizations for Cardiovascular Disease in Elderly People in Australian and New Zealand Cities, *Environmental Health Perspectives*
Hypothetical
Move current pollution levels to just below thresholds

Extra deaths per year:

<table>
<thead>
<tr>
<th>Cities:</th>
<th>Brisbane</th>
<th>Melbourne</th>
<th>Sydney</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>800</td>
<td>2,600</td>
<td>2,600</td>
</tr>
</tbody>
</table>

Pollutants: NO$_2$ O$_3$

|         | 5,300     | 700       |

Extra hospitalisations per year:

<table>
<thead>
<tr>
<th>Cities:</th>
<th>Brisbane</th>
<th>Melbourne</th>
<th>Sydney</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7,400</td>
<td>5,800</td>
<td>7,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age groups (years):</th>
<th>0</th>
<th>1–4</th>
<th>5–14</th>
<th>15–64</th>
<th>65+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4,500</td>
<td>9,000</td>
<td>500</td>
<td>1,600</td>
<td>5,200</td>
</tr>
</tbody>
</table>

It’s safe to say there is no safe level of air pollution *ANZJPH* 2014 38(5)
More informed decisions
Cost-effectiveness plane

Costs incurred for worse health
Costs incurred for better health
Cost saved for worse health
Costs saved for better health

$64,000 per QALY
More informed decisions
Cost-effectiveness plane

Costs incurred for worse health

Costs incurred for better health

Costs saved for worse health

Costs saved for better health

QALY

Cost ($)
More informed decisions
Cost-effectiveness plane

Cost ($)

Costs incurred for worse health

Costs incurred for better health

QALY

Cost saved for worse health

Costs saved for better health
More informed decisions
Cost-effectiveness plane

Cost ($)

Costs incurred for worse health

Costs incurred for better health

QALY

Cost saved for worse health

Costs saved for better health
Quick aside
Drive-through workers

- Fast-food drive-through workers get very high levels of air pollution
- June 2012 WHO declared diesel exhausts as a known carcinogen
- Simple fix

Image courtesy of tiverylucky at FreeDigitalPhotos.net