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Through the consumer lens
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When the air becomes toxic: The health costs of air pollution and bushfire smoke

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Overview

• Australia has had good air quality compared to OECD
• Some poor air quality ‘hotspots’
  – **Upper Hunter** - global sulphur dioxide hotspot due to power stations and industries burning coal and oil\(^1,2\)
  – **Liverpool, Sydney** - exceeded annual national air quality standards in 2010-11 for exposure to particulate pollution by 25\(^3\)
• Air pollution adversely affects respiratory, immune and cardiovascular health
• There is no ‘safe’ level of air pollution
• Climate change will worsen air quality and health risks
1. Air quality in Sydney before and during the 2019-20 “Black Summer” fires.
2. Where do those most vulnerable live?
3. The health costs of poor air quality
4. Policy implications
Section 1

Air pollution & Black Summer
Sources of Air Pollution

- Particulate matter less than 2.5 micrometres
- Total volatile organic compounds
- Particulate matter less than 10 micrometres
- Carbon monoxide
- Lead and compounds
- Oxides of nitrogen
- Sulfur dioxide

Average daily PM2.5 in Sydney

- Worst inland - due to sea breezes, topology of Sydney, industrial activity & higher density living
- Pollutants from traffic and industrial facilities can impact large areas and cause adverse health risks
- Average daily PM2.5 Liverpool 2010-11 10.1 μg/m³
  National standard 8 μg/m³

Source: Centre for Air Pollution, Energy and Health Research 2010/11 data from [3]
Quiz Time

Q1
## Main sources of PM2.5 emissions

<table>
<thead>
<tr>
<th>Activity</th>
<th>% PM2.5 Emissions Sydney 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Wood Heating</td>
<td>36%</td>
</tr>
<tr>
<td>Prescribed Burning and Bushfires</td>
<td>26%</td>
</tr>
<tr>
<td>Shipping</td>
<td>5%</td>
</tr>
<tr>
<td>Road, Brake &amp; Tyre Wear</td>
<td>4.5%</td>
</tr>
<tr>
<td>Diesel Vehicle Exhaust</td>
<td>4.5%</td>
</tr>
</tbody>
</table>


Concentration of PM2.5 in Sydney

- Changes in weekly maximum levels of PM2.5 in Sydney from 2019 – February 2020
- Seasonal fluctuation in PM2.5 concentration
- Spikes in high PM2.5 shown to start in October 2019
- PM2.5 slower to disperse in Western Sydney

Source: Authors’ compilation of NSW Department of Planning, Industry, and Environment data
Black Summer vs Air pollution guidance

- WHO Air quality guideline values for PM2.5
  - 10 µg/m³ annual mean
  - 25 µg/m³ 24-hour mean (daily average)
- Canberra daily average 1 January 2020: 855.6 µg/m³ - 34x guideline
- Sydney November 2019: 790 µg/m³ - 31x guideline
- Black Summer 2019-20 Sydney:
  - Hazardous on 28 days (PM2.5 >= 200µg/m³ or 8x guideline)
  - Very poor on 21 days (PM2.5 >= 37.5µg/m³ or 1.5x guideline)
  - Poor on 32 days (PM2.5 >= 25µg/m³ or over the WHO guideline)
Section 2

Air pollution & Health
Air pollution and health

PM2.5 can penetrate lung barrier and enter blood system

**Short-term exposure to low levels of PM2.5 increases risk**
- Risk of cardiac arrest increases 4% per 10-unit increase in PM2.5 levels
- Over 90% of cardiac arrests occurred at levels <25 µg/m³

**Chronic exposure** increases risk of:
- Cardiovascular disease, respiratory disease and lung cancer
- Affects reproductive, urological and neurological systems
  e.g. decreased birth weight of babies exposed in utero
- **COVID-19** infection and serious illness. 1 µg/m³ extra PM2.5 associated with 15% higher death rate.
Air pollution and health

Extreme exposures are less well understood.

• 2014 Hazelwood power station fire
• Covered surrounding areas in smoke for 6 weeks.
• Victorian DHHS longitudinal study (see https://hazelwoodhealthstudy.org.au/) found:
  - respiratory symptoms more than a year after exposure in adults
  - respiratory tract infections and small increases in lung stiffness among children exposed to smoke either in utero or in their first two years of life
Who is vulnerable to air pollution?

Research identifies risk factors that increase vulnerability to air pollution.

Eg:
- living in a walkable local area means lower risk of chronic diseases, such as obesity, diabetes, heart disease\textsuperscript{22}.
- High road density is inversely correlated with walkability\textsuperscript{23}.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant women</td>
<td>16,17,19,20</td>
</tr>
<tr>
<td>Children</td>
<td>16,17,19,20</td>
</tr>
<tr>
<td>Elderly people</td>
<td>10,16,17,19</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>16, 18,</td>
</tr>
<tr>
<td>Comorbidities</td>
<td>16,17,19,20</td>
</tr>
<tr>
<td>Gender</td>
<td>19</td>
</tr>
<tr>
<td>Neighborhood walkability and road density</td>
<td>22,23,24,25</td>
</tr>
</tbody>
</table>
Air Pollution Vulnerability Index

- Risk factors (SA2 geographic level, 2016)
  - Comorbidity (proxy: age standardised diabetes rate)
  - Socio-Economic Index for Areas (SEIFA)
  - Proportion of residents aged over 65
  - Proportion of residents aged 4 or under
  - Road density (km/km²)
Air Pollution Vulnerability in Sydney
Vulnerability vs Exposure

Vulnerability

PM2.5 Levels

KEY TO MAP
PM2.5
Average daily readings in micrograms per cubic metre (µg/m³)
- 2.15 – 3.5
- 3.51 – 4
- 4.01 – 4.25
- 4.26 – 4.5
- 4.51 – 4.75
- 4.76 – 5
- 5.01 – 5.25
- 5.26 – 39.75
Vulnerability vs Exposure

• Greater Western Sydney contains many vulnerable areas.
  – Air pollution is also worse west of the CBD
  – Population of Western Sydney will be 3 million by 2036\textsuperscript{26}.
  – This will increase emissions and further impact future air quality across the Sydney basin\textsuperscript{26}

• Adaptive capacity of Greater Western Sydney already challenged. eg: urban heat island challenges\textsuperscript{27}
Section 3

Health costs of air pollution
AIHW Burden of Disease Study

- Estimates for each Disease: Deaths, Years of Life Lost, Years Lived with a Disability, Disability Adjusted Life Years (DALYs)

% of total burden by disease group, 2015

- Cancer
- Cardiovascular
- Respiratory
- Neurological
- Infant/congenital
- Blood/metabolic
- Hearing/vision
- Reproductive/maternal
- Musculoskeletal
- Mental
- Injuries
- Gastrointestinal
- Endocrine
- Oral
- Infections
- Skin
- Kidney/urinary
Air pollution included as a Risk Factor for first time in 2015
Links to 5 diseases + asthma
0.8% disease burden ~ 40,000 DALYs
1.6% of deaths ~ 2,700 deaths
Quiz Time

Q2
Air pollution included as a Risk Factor for first time in 2015

Links to 5 diseases + asthma

0.8% disease burden ~ 40,000 DALYs

1.6% of deaths ~ 2,700 deaths

Comparable to

- sun exposure
- intimate partner violence
- opioid use
- amphetamines
Additional health impacts 2019-20

Immediate effects of bushfire smoke 2019-20 estimated as\(^3^0\)

- an **excess 400 deaths**
- over **3,000 hospital admissions** for cardiovascular and respiratory conditions
- over **1,300 emergency presentations** for asthma
## Estimated impact in 2019-20

<table>
<thead>
<tr>
<th></th>
<th>‘Typical’ air pollution levels</th>
<th>Extra cost of bushfire smoke</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospitalisations</strong></td>
<td>~25,000 hospital admissions</td>
<td>3,151 hospital admissions 1,305 asthma presentations</td>
</tr>
<tr>
<td><strong>Deaths</strong></td>
<td>~2,700</td>
<td>416</td>
</tr>
<tr>
<td><strong>DALYs</strong></td>
<td>40,347</td>
<td>6,213</td>
</tr>
<tr>
<td><strong>Health Expenditure $m</strong></td>
<td>$283 million</td>
<td>$37 million</td>
</tr>
<tr>
<td><strong>Burden of Disease $b</strong></td>
<td>$8.1 billion</td>
<td>$1.2 billion</td>
</tr>
</tbody>
</table>

### Data Sources:
1. ABS Consumer Price Index
2. AIHW Australian Burden of Disease Study 2015
3. AIHW Australian Hospital Statistics 2018-19
4. AIHW Disease Expenditure in Australia 2015-16
5. AIHW Health expenditure Australia 2017-18
8. IHPA The National Hospital Cost Data Collection (NHCDC) Round 22 2017-18
Section 4

Policy implications
Will air pollution be better or worse?

**Worse**
- Population growth
- Bushfires & Burn-off
  - Extreme fires 30-80% more likely than a century ago
  - 5x more likely avg temp rise 2°C
- Heat waves
  - Stagnant air, surface ozone

**Better**
- Car emission
- Renewable energy

? Wood fires?
Policy implications

Tackle Climate Change
• Include future healthcare costs in decision-making
• Switch to renewable can also address air pollution

Reduce air pollution near populations
• Can we better manage burn-offs?
• Emissions management
  - wood smoke
  - vehicles
  - industrial

Manage health risks
• Advice: high pollution days
• Preventative health eg: asthma plans
• Transparency: high pollution zones
Questions
References


9. Centre for Air pollution, energy and health Research (2019). Bushfire smoke: what are the health impacts and what can we do to minimise exposure?
References


16. Finlay et al. (2012) Health impacts of wildfires

17. Liu et al. (2015) A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke

18. Bowe et al. (2019) Burden of Cause-Specific Mortality Associated With PM2.5 Air Pollution in the United States

19. Tian et al. (2019) Association between ambient fine particulate pollution and hospital admissions for cause specific cardiovascular disease

20. Ciciretti et al. (2020) Relationship between wildfire smoke and children’s respiratory health in the metropolitan cities of Chile (under review)

21. Watson (2019) Screening for Cumulative Impacts in EJ Communities

References

23. Cowie et al. (2016) Neighbourhood walkability, road density and socioeconomic status in Sydney
24. Cook et al. (2011) Use of a total traffic count metric to investigate the impact of roadways on asthma severity: a case-control study
25. Zhang and Batterman (2013) Air pollution and health risks due to vehicle traffic