MONASH University

Medicine, Nursing and Health Sciences

Outdoor and Indoor Air Pollutants

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World Cup 1999

Objectives

Following this lecture, participants will know:

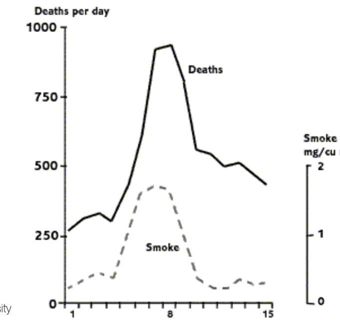
1. The outdoor "criterion" air pollutants
2. The health effects of these air pollutants
3. The health effects of some common indoor air pollutants
4. How these effects can be minimised

Outdoor "Criterion" Air Pollutants

- Carbon Monoxide (CO)
- Oxides of Nitrogen (NO_x = NO, NO_2)
- Ozone (O_3)
- Sulphur Dioxide (SO_2)
- Particulates (PM_{10}, $PM_{2.5}$, $PN_{0.1}$)
- Lead (Pb)
- Air toxics (Carcinogens)
  - Benzene, Benzo α-pyrene, Formaldehyde, Toluene, Xylene

London 1952: fog clears after days of chaos

LONDON KILLER FOG 1952



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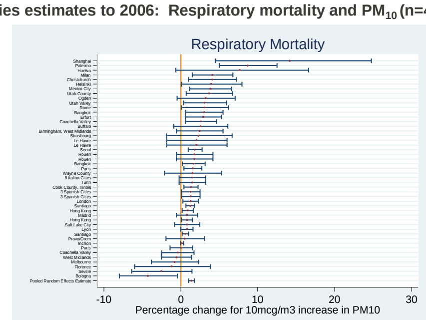
Time-series estimates to 2006: Respiratory mortality and PM_{10} (n=47)



Source: Air Pollution Epidemiology Database, St George's, University of London

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Smog in Taiwan

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Source: John Tarantino, http://en.wikipedia.org/wiki/Pollution

Smog in Mumbai

Source: http://www.lbl.gov/Science-Articles/Archive/sabl/2008/Feb/Maharashtra.html

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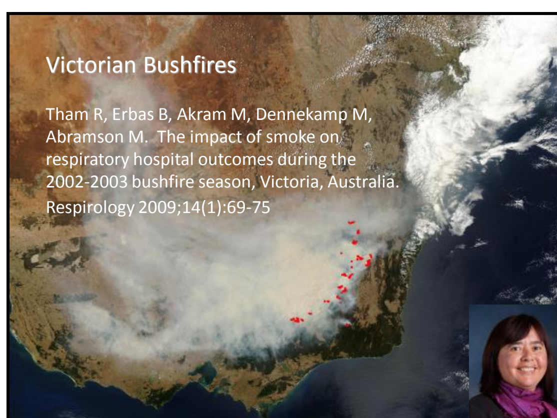
Victorian Bushfires

Tham R, Erbas B, Akram M, Dennekamp M, Abramson M. The impact of smoke on respiratory hospital outcomes during the 2002-2003 bushfire season, Victoria, Australia. Respirology 2009;14(1):69-75

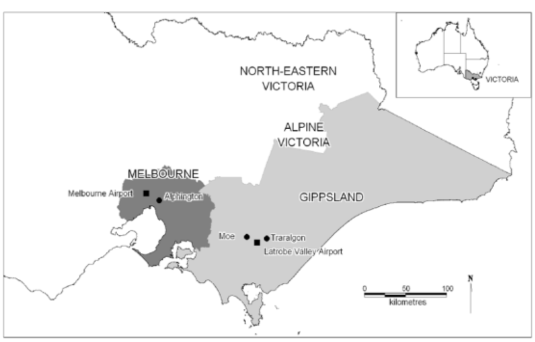


Background

- Uncontrolled bushfires can result in adverse effects on physical health, death and loss of property and livelihood.
- There are increasing concerns that global warming will increase the frequency and severity of bushfires in the future.
- Bushfire smoke contains particulate matter, gases and VOC that disperse over long distances and can cause respiratory problems in communities not directly threatened by fire
- In 2003 bushfires burnt over 1.12 Mha in north-eastern and Alpine Victoria and smoke spread over the state
- The major pollutants produced were respirable particles (PM_{10}), visibility-reducing particles (API) and O_3

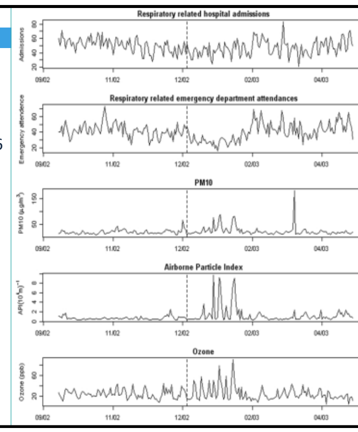
Methods

- Ecological study using routinely available data
- Victorian hospital admissions and emergency department (ED) attendances for selected respiratory conditions known to be affected by smoke:
  - acute bronchiolitis, bronchitis not specified as acute or chronic,
  - simple and mucopurulent chronic bronchitis ,
  - Emphysema, other chronic obstructive pulmonary disease (COPD),
  - Asthma, status asthmaticus, bronchiectasis
- EPA air quality data: PM_{10}, Airborne Particle Index (API), O_3
- Bureau of Meteorology data: maximum temperature, rainfall, wind speed and average relative humidity.
- The bushfire season defined as October 2002 to April 2003.



Results

- PM_{10} levels elevated from mid-January to mid-March 2003 with 6 days exceeding the NEPM one-day standard of 50μg/m³.
- 2 extreme spikes due to a dust storm on 19-20 March 2003
- 12 days when API exceeded the EPA standard of 2.35



Semiparametric models of respiratory outcomes in Melbourne

Outcome	RR§	PM_{10} 95% CI	p	RR§	API 95% CI	p	RR§	Ozone 95% CI	p
Hospital admissions									
Model A	**1.011**	**0.999 – 1.022**	**0.06**	**1.011**	**1.003 – 1.019**	**0.01**	**1.027**	**1.001 – 1.053**	**0.01**
Model B	1.003	0.989 – 1.015	0.69	1.005	0.995 – 1.013	0.33	0.988	0.950 – 1.026	0.50
Emergency department attendances									
Model A	**1.028**	**1.015 – 1.040**	**<0.001**	**1.010**	**1.000 – 1.021**	**0.02**	1.026	0.996 – 1.056	0.07
Model B	**1.018**	**1.004 – 1.033**	**0.01**	1.008	0.996 – 1.019	0.2	0.988	0.943 – 1.034	0.57

RR for IQR increase in pollutant
Model A adjusted for day of week and trend
Model B also adjusted for temperature and relative humidity

Discussion

- Elevated levels of PM_{10}, rather than API or O_3, increased the risk for exposed people to attend an ED for respiratory conditions
- Although this study had limited sample size, it used appropriate statistical models including nonlinear effects of time trend and other confounders. Therefore, the results are valid even though the observed increased risks were small
- No significant associations between PM_{10}, API and O_3 on respiratory hospital outcomes in residents from Gippsland could be due to smaller population, greater distances to hospitals hence greater reliance on primary health care, or better knowledge of how to manage exposure to bushfire smoke

Conclusions

- Considering the growing population potentially exposed to bushfire smoke, this is an important public health issue
- Population health effects of bushfire smoke, even those remote from the bushfire itself, need to be considered when planning health and emergency services and designing public health messages
- With abrupt changes in weather patterns combined with high air pollution days and changes in urban/regional boundaries where populations move about regularly, it is time to establish surveillance models to monitor and predict the environmental burden on various health outcomes.
- Estimated effects and predictions should be routinely incorporated into the planning of community, primary health care and hospital services particularly with regard to the management and allocation of resources to provide appropriate patient care, support and disease management

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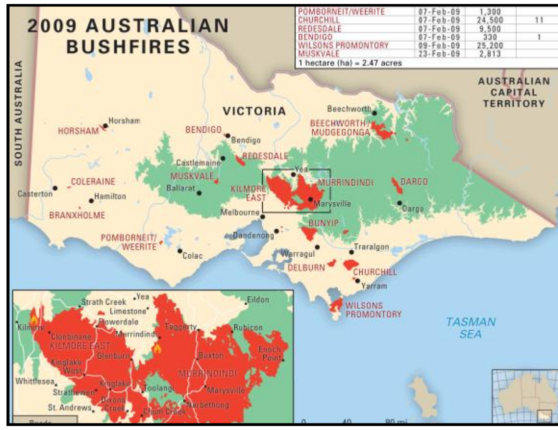
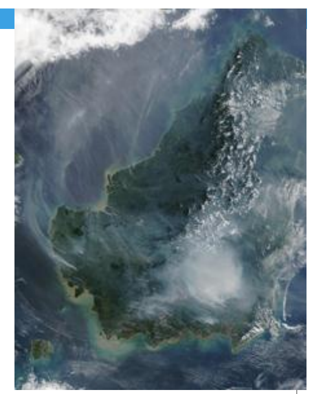


Bushfires in Borneo



Source: http://www.nasa.gov/topics/earth/features/asian_fires.html

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Indoor Air Pollutants

- Carbon Monoxide (CO)
- Oxides of Nitrogen (NO_x = NO, NO_2)
- Particulates (PM_{10}, $PM_{2.5}$, $PN_{0.1}$)
- Air toxics
  - Benzene, Formaldehyde, Toluene, Xylene
- Environmental Tobacco Smoke
- Bioaerosols
  - Allergens: House dust mite, Cat, Mould,
  - Dirt: Bacteria, Endotoxin, Viruses etc

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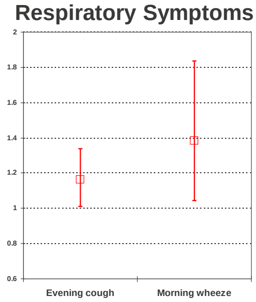
Exposure to “Low-NOx” unflued gas heaters

- **Objective**: to compare the respiratory health effects and air quality consequences of exposure to low-NOx unflued gas heaters with exposure to flued gas heaters in school classrooms
- **Design**: double-blind, cluster-randomized, crossover study in 400 primary school students attending 22 schools in NSW, Australia
- **Exposure**: NO_2, formaldehyde measured by passive diffusion badges
- **Outcomes**: Lung function, symptoms, medication use
- **Results**: NO_2 concentrations were 1.8 times higher [95%CI 1.6-2.1] and formaldehyde 9.4 ppb higher (95%CI, 5.7-13.1) during exposure to unflued gas versus flued gas heaters
- 27% of children had doctor diagnosed asthma, 15% current asthma
- No significant adverse effect on lung function (FEV_1, PEF)

MONASH University Presentation title 28th February 2011 | 24

Effect of "Low-NOx" unflued gas heaters on Respiratory Symptoms



- Association with wheeze was stronger in atopic subjects
- "Low NOx" unflued gas heaters still produce unacceptable concentrations of NO_2
- Alternative sources of school heating are required to protect child health

Marks GB, Ezz W, Aust N et al. EHP 2010;118(10):1476

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Biomass smoke

- Major source of indoor particulates in developing countries
- Exposure associated with COPD in non-smoking women
- Associated with acute respiratory infections in children
- Source: cgh.uchicago.edu/page/health-environment-and-vulnerable-populations

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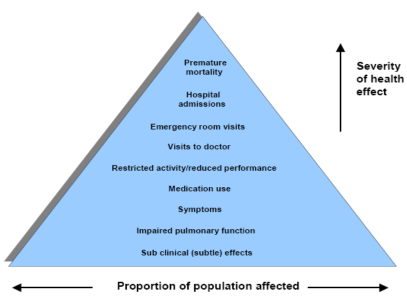
The Air Pollution Health Effects Pyramid (AIRNET WG 4 2004)



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Conclusions

- High levels of fine particles and acid aerosols cause deaths from cardiac and respiratory diseases
- Controls on burning coal and fixed sources have substantially reduced this pattern of air pollution in developed countries
- Bushfire smoke is associated with hospital admissions and emergency presentations for respiratory disease
- Research is continuing into the effects of planned fuel reduction burning
- Unvented gas appliances are associated with high indoor levels of NOx and cause respiratory symptoms in children
- Biomass smoke is a substantial public health issue in developing countries
- Alternative cleaner sources of cooking and heating are urgently needed

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