



# Managing respiratory effects of air pollution



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## BACKGROUND

Exposure to air pollution (both indoor and outdoor) has many potential adverse effects on human health.

## OBJECTIVE

This article looks at the adverse respiratory health effects of air pollution and gives some guidance about management of exposure in susceptible individuals.

## DISCUSSION

Motor vehicle and industrial emissions are the primary contributors to outdoor air pollution in Australia. High levels of ozone and other pollutants can cause respiratory symptoms in susceptible individuals. Air quality advisory systems exist in most states. Clinicians can incorporate the health effects of air pollution, and awareness of advisory systems in the education of their susceptible patients and their carers. Asthma and chronic airways disease management plans should include provision for possible exposure to high pollution events and steps that can be taken to reduce exposure.

The health effects of air pollution are increasingly recognised as a major public health concern. The respiratory deposition and absorption of pollutants has a demonstrated detrimental effect on health. As clinicians we need to be aware that air pollution may impact on health in general and particularly the health of susceptible individuals. While air pollution has diverse adverse effects on both human health and the health of ecosystems, this article focusses on the respiratory effects of air pollution exposure.

The World Health Organisation (WHO) states that free access to air of acceptable quality is a fundamental human right, however in 2002 they ranked indoor pollution from combustion of solid fuels as one of the top 10 risk factors for the global burden of disease.<sup>1</sup> Indoor air quality continues to be a major issue for the developing world where organic matter burned in the home is often the only fuel for heating or cooking.

There has been extensive research on the scope of health effects of air pollution. The WHO has produced air quality guidelines that synthesise much of the available evidence.<sup>2</sup> People living in environments with poorer air quality are at greater risk of developing health effects related to their exposure. A

large US cohort has demonstrated increases in lung cancer mortality associated with living in increasingly polluted urban environments.<sup>3</sup> In some instances it has been estimated that motor vehicle emissions may be responsible for twice as many deaths as motor vehicle accidents.<sup>4,5</sup>

Relative to many industrialised nations, levels of urban air pollution in Australia are low. Despite the improvement in urban air quality with changes in technology and regulation of industrial emissions since the 1970s, recent Australian studies have continued to demonstrate associations between exposure to air pollution and increased respiratory symptoms, hospital admissions and mortality due to respiratory disease (asthma, pneumonia and chronic obstructive pulmonary disease).<sup>6-9</sup>

## Major air pollutants

The main types of air pollution can be broadly grouped based on the source of generation:

- indoor (fuel and coal combustion for heating and cooking, environmental tobacco smoke, household chemicals and breakdown of construction materials)
- outdoor/industrial/urban (motor vehicle emissions, fossil fuel burning for electricity)

generation, heavy industry, home heating wood and coal burners), and

- extreme events (bushfire/dust storms).

The main pollutants of concern vary between these sources (*Table 1*). Co-factors that contribute to the effects of these pollutants on the individual include:

- the presence of more than one type of pollutant (eg. particulate matter combined with sulphur dioxide)
- level of exercise
- smoking
- extremes of heat, humidity and cold, and
- pre-existing respiratory disease such as asthma or a respiratory viral infection.

In addition to outdoor pollution from emissions and ozone production, there are other sources of potential concern for people living in Australia.

### Bushfires

The effects of bushfire smoke as an air pollutant were dramatically demonstrated by the events of the southeast Asian bushfire crisis in the late 1990s. A study of a population close to the fires reported a 50% increase in respiratory presentations (predominantly asthma) and a 2–4 times increase in local mortality figures.<sup>10</sup> Those with pre-existing respiratory conditions reported a greater increase in respiratory symptoms. In Australia, a recent study demonstrated that when fine particle concentrations were high from bushfire smoke, asthma presentations to hospital were more than double that of unaffected days (*Figure 1*).<sup>11</sup> Other Australian studies have been unable to demonstrate significant impact of bushfire events on hospital attendance.<sup>12–15</sup>



Figure 1. Bushfire haze, Albury 2003 (Photo courtesy The Border Mail)

**Table 1. Major air pollutants and health effects**

Pollutant group	Source	Health effects	Vulnerable groups
<b>Particulate matter</b>	Organic matter and fossil fuel combustion <ul style="list-style-type: none"> <li>• Cars/trucks</li> <li>• Wood heaters</li> <li>• Bushfires/dust storms</li> <li>• Environmental tobacco smoke</li> <li>• Industry</li> </ul>	Irritation of upper airways, and inflammation of lower airways (reduced lung function) Increased serum inflammatory markers with increased coagulability of blood and effects on cardiac conductivity Lung cancer	People with chronic respiratory and cardiac disease People with asthma
<b>Nitrogen oxides</b>	<ul style="list-style-type: none"> <li>• Cars/trucks</li> <li>• Industry</li> <li>• Gas appliances</li> </ul>	Airway inflammation, increased susceptibility to respiratory infection, exacerbation of asthma	People with asthma or chronic respiratory disease
<b>Ozone</b>	Product of sunlight reaction with other pollutants <ul style="list-style-type: none"> <li>• Cars</li> <li>• Industry</li> </ul>	Upper airway and eye irritant, reduced lung function and exercise capacity, exacerbation of asthma	People with asthma or chronic respiratory disease
<b>Carbon monoxide</b>	Organic matter and fossil fuel combustion <ul style="list-style-type: none"> <li>• Cars</li> <li>• Wood heaters</li> <li>• Gas appliances</li> </ul>	Headache, nausea, dizziness, breathlessness, fatigue, confusion, coma, death Low birth weight (fetal exposure)	People with ischaemic heart disease Pregnant women
<b>Sulphur dioxide</b>	Industry <ul style="list-style-type: none"> <li>• Metal smelting</li> <li>• Coal power stations</li> </ul>	Respiratory tract irritation, exacerbation of respiratory disease including asthma	People with asthma or chronic respiratory disease

### Environmental tobacco smoke

Environmental tobacco smoke (ETS) is arguably the most important indoor pollutant in Australia. Young children are particularly vulnerable to its effects. Smoking by either parent increases the risk of developing asthma in children, and those with asthma who are exposed to ETS in the home generally have more severe disease.<sup>16</sup> It is often cited as an asthma trigger in adult asthmatics and can potentiate the adverse health effects of other air pollutants.

### Home heating

Unflued gas heaters are a common, low cost form of heating. However, operation of these heaters when ventilation is inadequate or heater size is mismatched to room volume can result in a build up of indoor nitrogen dioxide and other pollutants. Children with asthma or individuals with chronic respiratory conditions may experience increased respiratory symptoms in this situation.<sup>17,18</sup>

### Respiratory health effects of air pollution

The health effects of air pollution have been demonstrated for both acute and long term exposure.<sup>2-4,6-9</sup> Toxicological studies show direct mechanisms for some health effects, while others such as the association between relatively low levels of urban air pollution and observed increases in cardiorespiratory mortality, are less straightforward. As such it is difficult to state whether there is a threshold concentration for these pollutants below which no health effects are likely. There is evidence of an incremental dose response for some pollutants starting at relatively low levels.<sup>2</sup> The American Thoracic Society has published the respiratory health effects of air pollution they consider to have adequate supportive evidence from the literature (*Table 2*).

### Air quality standards

In Australia, the National Environment Protection Council set uniform air quality standards (national environment protection measures [NEPMs]) for the six major air

**Table 2. Respiratory health effects of air pollution<sup>19</sup>**

- Increased mortality
- Increased lung cancer incidence
- Increased frequency of symptomatic asthma attacks
- Increased incidence of lower respiratory tract infections
- Exacerbation of chronic cardiopulmonary diseases resulting in reduced ability to cope with daily activities, increased hospitalisation, increased medical visits and medication, and decreased pulmonary function
- Reduction in FEV1 or forced vital capacity in association with clinical symptoms
- Increased wheezing (unrelated to colds) or on most days or nights
- Increased occurrences of chest tightness
- Increased occurrences of cough/phlegm production requiring medical attention
- Increased incidence of acute upper respiratory tract infections
- Eye, nose and throat irritations
- Awareness of odours

pollutants (including lead).<sup>20</sup> These standards supersede the previously published National Health and Medical Research Council guidelines for air quality. While health effects were considered in setting the Australian standards they are not the only criteria considered, and as such the standards are not all set at or below cut-off levels for possible health effects. Air quality monitoring occurs in all states and daily air pollution advisory systems are in place for most major urban centres (excluding ACT/NT) (see *Resources*).

### How does air pollution influence patient management?

The health effects of pollution are most critical for children or the elderly with asthma,<sup>21</sup> and those with chronic respiratory or cardiovascular disease. Providing information to individuals and their carers about the potential adverse health effects from high pollution exposure will allow them to self manage this risk, and should be integral to providing quality care (*Table 3*). Key advice to help reduce these effects includes:

- Be aware of specific exposure situations that might exacerbate respiratory symptoms, eg. walking along busy roads, exercising in the afternoon during high ozone summer days (ie. during smog episodes), being indoors when people are smoking, outside activity during bushfire events (when particulate

pollution is high outdoors)

- Encourage sensitive patients to regularly check local pollution advisory systems so they can learn what levels are likely to be a problem for them
- Reinforce the message to sensitive patients that they should have ready access to reliever medication on high air pollution days and, if pollution episodes are likely to be prolonged, consider increasing preventer medication
- Recommend consideration of lower emission heating sources such as electric or flued gas heaters. Aim to identify other potential emission sources in the home.

As clinicians we can encourage actions to reduce population exposure to air pollution such as reducing motor vehicle use, eliminating environmental tobacco smoke, and using low emission products about the home. The choice of active transport (walking/cycling/public transport) also has benefits for cardiovascular fitness and decreasing obesity.

### Resources

- National Asthma Council Australia. Asthma and air pollution: a guide for health professionals: [www.NationalAsthma.org.au](http://www.NationalAsthma.org.au)
- NSW Health air warning site with links to air quality fact sheets and patient information brochures: [www.health.nsw.gov.au/living/airpollution.html](http://www.health.nsw.gov.au/living/airpollution.html)
- The Environment Protection and Heritage Council: [www.ephc.gov.au/index.html](http://www.ephc.gov.au/index.html)
- The enHealth Council: <http://enhealth.nphp.gov.au/>

- Smokefree Zone: [www.smokefreezone.org](http://www.smokefreezone.org)
- The Australian Lung Foundation: [www.lungnet.com.au](http://www.lungnet.com.au)
- The National Heart Foundation: [www.heartfoundation.com.au/](http://www.heartfoundation.com.au/)
- The Australian Government Department of Environment and Heritage atmosphere and air quality site: [www.deh.gov.au/atmosphere/index.html](http://www.deh.gov.au/atmosphere/index.html)

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**Table 3. Six simple steps to help protect you from air pollution<sup>22</sup>**

1. Get to know how sensitive you are to air pollution
  - Take note of pollution levels – as you do the daily temperature or UV index
  - See if you get symptoms on days when the pollution level is higher, or 1–2 days after, and whether you feel better when it is low
2. Plan activities when and where air pollution levels are lower
  - If you are sensitive to ozone, avoid exercising in the afternoons or outdoors on sunny days when ozone is likely to be high
  - Fine particle pollution is harder to avoid, but it will be lower away from busy roads and even lower in air conditioned buildings
3. Change your activity level
  - If pollutant levels are high you can reduce how much air pollution you breathe by choosing an activity that is less demanding (eg. walk instead of jog or exercise for a shorter time)
4. Listen to your body
  - If you get symptoms during exercise, stop your activity. Find a less demanding activity or wait until pollution levels have dropped
  - Make sure you have reliever medication at hand to use on high pollution days and monitor your peak flows more frequently so medication can be adjusted if necessary
5. Create a clean 'indoor air zone'  
Eliminate sources of air pollution from inside your home:
  - Don't allow anyone to smoke inside, and don't smoke yourself
  - Use electric or flued gas heating
  - Choose low emission paints (for other home decorating needs, choose low emission products)
  - Open windows when cooking or use a kitchen exhaust that is ducted outdoors

If you can reduce indoor air pollution then closing windows and doors and using a reverse cycle air conditioner on high air pollution days may help reduce pollution levels in your home
6. Talk with your doctor
  - Be aware of how air pollution will effect your asthma management plan
  - If you have an increase in symptoms ask your doctor if air pollution could be effecting you

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