Submission to Senate Enquiry

Name of committee	The impacts on health of air quality in Australia
Organisation making submission	Centre for Air quality and health Research and evaluation (CAR)
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Terms of reference	The impacts on health of air quality in Australia, including: (a) particulate matter, its sources and effects; (b) those populations most at risk and the causes that put those populations at risk; (c) the standards, monitoring and regulation of air quality at all levels of government; and (d) any other related matters.
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1 Importance of air pollution as a contributor to the burden of disease

Worldwide, there were over three million deaths attributable to exposure to excessive levels of particulate air pollution in 2010 (1). This is similar to the number of deaths attributable to diabetes.

In the figure below, the 20 leading causes of burden of disease worldwide in 2010 are listed. The burden of disease includes deaths among young people and the disability that a condition inflicts without causing death. Worldwide, ambient particulate air pollution was ninth in this list, although it ranked lower in the Australasian region. Most of the disease attributable to exposure to ambient particulate air pollution was heart disease (mid-blue), pneumonia (pink), chronic respiratory disease (asthma and chronic obstructive pulmonary disease, pale blue) and cancer (dark blue). The non-communicable diseases (NCDs) that result from these causal factors are attracting increasing attention globally (2) as the burden of disease shifts from infectious diseases to NCDs (3). Consequently, particulate air pollution is a matter of serious health concern.

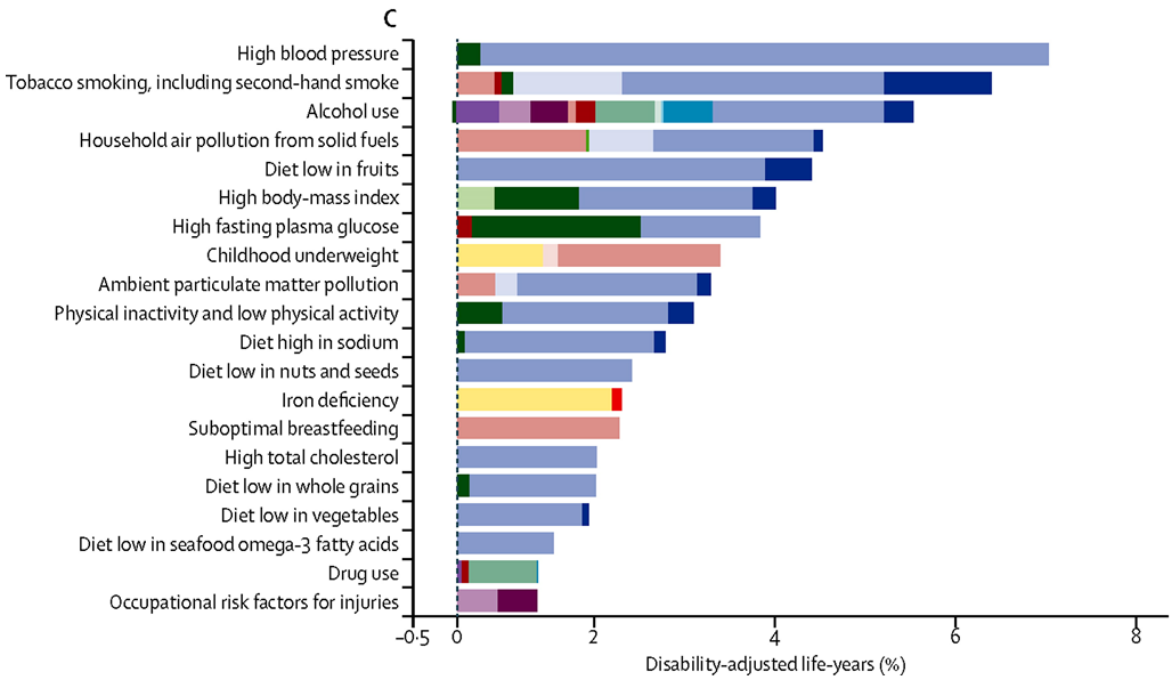

Figure 1: Burden of disease attributable to 20 leading risk factors in 2010, expressed as a percentage of global disability-adjusted life-years for both sexes (C). Extracted from (1)

2 Particulate matter, its sources and effects

Particulate matter refers to everything in the air that is not a gas. It includes both solid particles and vapours (liquid particles). Particulate matter in the air is highly heterogeneous in size and composition. The particles that are of most concern for health are those that can

enter the lungs, namely particles less than 10 μm[1] in diameter (PM_{10}) and particles less than 2.5 μm in diameter ($PM_{2.5}$).

On-road motor vehicles and off-road engines, such as generators, mining and earthmoving equipment and ships are the major sources of particulate pollution in Australia. Among these sources, diesel-powered engines are the main contributor to fine PM emissions. From time to time in Australia the levels of particulate pollution increase dramatically due to airborne crustal dust (dirt), sea salt and smoke from bushfires (including hazard reduction burning).

People exposed to the short-term bursts or long-term higher levels of particulate pollution suffer a range of adverse effects, including:

- Increased risk of deaths, particularly due to heart and lung diseases,
- Increased risk of hospitalisation for heart and lung diseases, and
- Increased risk of asthma attacks (4).

Importantly, current evidence does not support a threshold for PM_{10} or $PM_{2.5}$, meaning that there is no evidence for a "safe" level of exposure.

The effects of particulate matter on health vary substantially between settings (for example between the east and west coasts of the USA). At least in part, the variation is explained by variation in the chemical composition of the particulates (5, 6), which in turn is related to the local sources.

2.1 Ultrafine particles

Particles that are less than 0.1 μm in diameter are known as ultrafine particles (UFPs). They are the most numerous in ambient air but, because of their small size, measures of PM_{10} and $PM_{2.5}$ are not a good indicator of the concentration of UFPs in the local environment. Also UFP concentrations are highly variable over short distances. The main contributor to UFPs in the ambient air in urban areas is motor vehicle traffic, in particular diesel-powered vehicles, though newer fuel technologies may also contribute (7).

Epidemiological evidence about the adverse health effects attributable to exposure to UFPs, as distinct from the effects attributable to other particles (measured as PM_{10} and $PM_{2.5}$) is limited at present. However, toxicological studies in animals and humans have shown diverse effects on cardiovascular, blood, respiratory and brain function (summarised in 7). Further evidence is required to establish the relevance of these toxicological findings to population health and hence to gauge the importance of control measures specifically targeting UFP emissions.

2.2 Susceptible populations

All populations are susceptible to the adverse effects of exposure to high levels of particulate pollution. However, the most susceptible groups are:

- Older people,
- Children,
- People with pre-existing heart or lung disease, and
- People with low income and/or low educational attainment (8).

[1] 1 μm = 1 thousandth of a millimetre

2.3 Evidence from Australia

Epidemiological studies conducted in Australia have shown consistent adverse health effects associated with exposure to ambient concentrations of nitrogen dioxide (NO_2). The following outcomes have been linked to short-term or long-term variation in NO_2:

- Deaths (9),
- Hospital admissions for heart and for lung disease (10),
- Lung function (11), and
- Asthma and wheeze (11).

Although these studies have shown inconsistent relationships between particulates and these outcomes, there is evidence that urban concentrations of $PM_{2.5}$ are associated the risk of out-of-hospital cardiac arrest (12).

The associations with NO_2 may seem surprising as levels of this pollutant are relatively low in Australia. However, the main source of ambient NO_2 in Australia is motor vehicle emissions. It is plausible that the NO_2 is actually a marker for other, more hazardous pollutants associated with vehicle emissions, possible UFPs, which are not currently measured.

Particulate emissions associated with fire smoke are an important airborne hazard in Australia. This source is associated with an increased risk of hospital admission for lung disease (13) and deaths (14). Reductions in smoke haze associated with biomass burning for winter heating were associated with a reduction in deaths due to heart and lung disease in Launceston (15). This has important implications for impact of hazard reduction burning.

3 Populations most at risk and the causes that put those populations at risk

Populations most at risk are those who are:

a) Most exposed
b) Most susceptible to exposure.

In view of the evidence cited above, the populations most exposed are people living in close proximity to:

- Transport corridors, especially those with heavy total traffic or heavy diesel traffic, Off-road sources of diesel emissions, and
- Industrial pollution sources.

Populations most susceptible are:

- Children and the elderly,
- Those with pre-existing heart and lung disease, and
- Socio-economically disadvantage groups.

The highly urbanised nature of Australia means that a high proportion of the population are co-located with major transport corridors and hence highly exposed to transport-related emissions.

4 Standards, monitoring and regulation of air quality at all levels of government

The current model for control of air pollutants is to:

a) Identify apparently safe thresholds for specific hazardous air pollutants and set these as air quality targets (Air National Environment Protection Measures [NEPM]);
b) Regulate sources of these pollutants to attempt to achieve these targets.

Unfortunately, there is no "safe" level of exposure to air pollutants. Available evidence suggests that, at least for particulates and for NO_2, there is a linear dose response relationship over a large range of exposure levels. This means that, even at levels below the current targets, further health gains can be achieved by further reduction in pollutant levels. The current model of air pollution regulation does not encourage emission reductions that would achieve these health gains.

Another limitation of the current emission control regimen is that there is no systematic measurement of pollutants other than those for which targets have been set. In the absence of such measurements, it will never be possible to undertake the epidemiological analyses required to establish whether these exposures, such as to UFPs, are hazardous.

Finally, we note that the current regulatory framework has important gaps in the range of sources that can be adequately controlled. For example, while transport-related emissions can be controlled by state and territory agencies responsible for registering motor vehicles, no such agency exists to control emissions from off-road diesel engines, which, as we have noted above, are an increasingly important source of particulate pollution.

Based on these observations we make the following recommendations:

a) A regulatory framework for emission controls should be established that encompasses all major emission sources, not just those that are currently regulated.
b) Priority should be given to interventions that reduce exposure for large populations, particularly those most at risk.
c) Urban planning frameworks should incorporate consideration of the air quality and health impact of decisions; for example, by taking steps to minimise exposure of residential areas to emissions from major transport corridors.
d) A broader range of pollutants should be measured. Specifically,
    a. The current advisory NEPM for $PM_{2.5}$ should be made enforceable
    b. UFP should be measured systematically and the data should be used to investigate exposure-response relationships with important disease outcomes.
e) Consideration should be given to moving beyond the current threshold-based approach to regulation of air quality to
    a. An incremental approach, in which targets are set at specified increments above the background levels;
    b. A continual improvement approach in which emissions are regulated with the intention of achieving the lowest possible pollutant levels.

4.1 Cases studies

4.1.1 Hunter Valley

The air pollution consequences of the mining and associated activities have attracted considerable attention in recent years. This is a good example of a complex problem arising in a non-urban environment. Particular features of this environment include:

- Multiple, over-lapping sources of air pollutants
    - blasting,
    - off-road diesel equipment,
    - truck and rail transport,
    - nearby power stations and

- natural sources such as crustal particles and sea salt,

making it difficult to apportion pollution to specific sources.

- A planning model that assesses each new development for its incremental (or marginal effect); a strategy which may allow cumulative impacts to approach or exceed air quality standards.

4.1.2 Planned burning

Fuel reduction burns are a necessary component of the strategy to control the hazard of uncontrolled bushfires. However, they do generate substantial amounts of smoke (particulates), which pose a potential hazard to health (16). It is important that particulates generated by planned burning for any purpose including hazard reduction, forestry or agricultural practices are regulated within the same regime as all other sources of particulates.

4.1.3 Transport & Urban Planning

In its current form, the transport and urban planning policy framework does not facilitate consideration of the health impact of new transport infrastructure or urban developments. Planning of new developments and associated services impacts on transportation needs of new communities and also on opportunities for local residents to engage in physical activity in safe environments.

Studies conducted in Sydney indicate that, while small scale traffic diversions or interventions may impact on local air quality, there are unlikely to be substantial improvements in air quality unless city-wide changes in traffic are implemented (17). This means that measures which are widespread in their impact are necessary to make real gains in reducing air pollution in urban areas. This may be achieved by reducing the number of vehicles on roads, reducing the kilometres travelled per vehicle, and/or reducing emissions from vehicles.

5 The Centre for Air quality and health Research and evaluation (CAR)

The Centre for Air quality and health Research and evaluation (CAR) is a Centre of Research Excellence funded by the National Health and Medical Research Council (www.car-cre.org.au/). This centre's role is to enable research on the impact of air pollution on human health and to translate that research into contributions to policy that aims to mitigate that impact. CAR is creating opportunities for researchers, operating in diverse but related disciplines, to create and apply knowledge about air pollution and health of both national and international interest. CAR is a collaboration among senior researchers in the fields of epidemiology, toxicology, air physics and chemistry, biostatistics and clinical respiratory medicine based at universities in Queensland, NSW and Victoria.

CAR investigators are currently undertaking research in many of the fields alluded to in this submission.

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