Submission
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INQUIRY INTO HEALTH IMPACTS OF EXPOSURE TO POOR LEVELS OF AIR QUALITY RESULTING FROM BUSHFIRES AND DROUGHT

Organisation: Doctors for the Environment Australia

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Health impact of exposure to poor levels of air quality resulting from bushfires and drought.

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T.O.M.S PLACE,
1 Tripovich Street
Brunswick VIC 3056

admin@dea.org.au
www.dea.org.au

ABN: 80 178 870 373

Healthy planet, healthy people

Doctors for the Environment (DEA) is a non-profit national organisation of Australian doctors and medical students with an emphasis on preserving health and wellbeing with respect to the environment.

It is our stance that human health is indivisible from environmental health. DEA has concern that deteriorating air quality has pervasive and important effects on human health, and that the bushfire crisis comes after recent years during which air quality was already deteriorating.

ToR 1a & c

What is in fire smoke?

Pollutant	details	Principal effect	Reported by ambient monitors
NO2	Created during combustion	Respiratory irritant	Yes
Ozone	Secondary pollutant created from NO2 and VOC and sunlight	Respiratory irritant, and oxidative stress	Yes
Particles TSP	Total suspended particles		no
Particles PM10	The respirable subset of TSP	Respiratory effects	yes
Particles PM 2.5	The smaller subset of PM10	Cardiovascular and systemic inflammatory effects	yes
Polycyclic aromatic hydrocarbons (eg Benzo(a)pyrene)		Some are carcinogens	no
Formaldehyde. Acrolein	Exposure for firefighters	Respiratory and eye irritant.	No
carbon monoxide	Firefighters	Acute toxicity. Impairs judgement.	No
VOC (benzene, toluene, xylenes, phenol)	Firefighters	Carcinogens. Also contributes to ozone formation.	No

Fire smoke contains a range of pollutants, principally particles, but also nitrogen dioxide, ozone, and complex organic molecules. The particles are generally measured and reported by size class as the different size particles impact different parts of the human respiratory system. All particles together are measured as TSP total suspended particles. The subset less than 10 microns in size are reported as PM10 and are of interest because this size enters the airways and deposit primarily in the nose, throat and large airways. The subset less than 2.5 microns have the most important health effects as they penetrate furthest into the lungs and can cross to the blood stream leading to systemic effects. The range of smoke components is important because while particles can be filtered the gases are not filterable. Gases may be trapped in activated charcoal masks.

Health impacts of exposure to fine particle air pollution

Mortality

Exposure to fine particle pollution causes increased risk of death, which is mostly from heart attacks and strokes although cancers also contribute.

There is no safe level of exposure, current scientific opinion is that the health risk extends right down to any level above zero exposure and there is a clear health benefit to reducing fine particle pollution as much as possible. A small amount gives a small risk, and a large amount gives a large risk right across the range. The best estimate of risk for all cause mortality is relative risk 1.06 per 10 $\mu g/m^3$, derived from the long term follow up of the American Cancer Study,(Krewski 2009) and applies to adults aged 30 and above.

> **Jargon:** Relative risk of 1.06 means that when comparing a high and low exposure group there will be 6% more deaths if the high exposure group has air that is 10 $\mu g/m^3$ worse. If their air is 20 $\mu g/m^3$ worse the difference is 1.06 squared, ie 1.1236 so 12.36% higher. The term hazard ratio has very similar meaning.

Diabetes

Diabetes, defined as the inability to regulate glucose metabolism, occurs in three forms known as type I, type II and gestational diabetes. Type I and type II have quite distinct pathophysiology and causes so should be considered as different diseases. There has long been thought to be a role for systemic inflammation in the causation of type II diabetes so associations with air pollution exposure have been examined. A systematic review of the published literature up to 2014 found 7 studies that could be combined in quantitative meta analysis, and estimated a summary RR of 1.10 (95% ci 1.02 to 1.18) per extra 10 $\mu g/m^3$ of PM 2.5.(I.Eze, Hemkens et al. 2015) These studies were all conducted in Europe and North America where air quality is more like Australia than would be found in Asian countries.

More recently a large and definitive study has been conducted in North America with a sample of 1.7 million US veterans.(Bowe, Xie et al. 2018) This study is convincing because it has a very large sample size, good characterisation of demographic confounders, studied new cases (incident) rather than prevalent diabetes, and applied appropriate adjustment for confounders. The concentration-response function showed that an extra 10 $\mu g/m^3$ of PM2.5 was associated with a hazard ratio 1.15 (95% ci 1.08, 1.22) for incident type II diabetes.

Birthweight

The most convincing evidence for an effect of air pollution comes from China where during the Beijing Olympics in 2008 extraordinary measures were put in place to reduce air pollution during the 6 weeks of the games.(Rich David, Kaibo Liu et al. 2015) Cars and trucks were heavily restricted, and many industries including a steel works and four coal fired power stations were closed for the duration. Comparison of the weights of babies born during the clean air weeks, compared to the same weeks in 2007 and 2009 showed an average 23 g increase. Every one of those babies is set up for slightly better health during their life, as good birth weight is associated with less risk of many childhood and adult illnesses.

The mechanism by which air pollution affects foetal growth is thought to be via effects on the foetal thyroid,(Janssen, Saenen et al. 2017) or by changing placental vascular resistance. (Carvalhoa, Bernardesa et al. 2016)

The Beijing evidence is convincing, but the clean air month was a reduction from 10 times Australian values to 5 times. Exposures more like Australian levels were studied in the ESCAPE cohorts (Pedersen 2013) with pooled data from 14 cohorts in 12 countries. This showed a 39% increase for low birth weight (less than 2500g in full term babies born after 37 weeks) per extra 10 $\mu g/m^3$ of PM2.5.

Cardiac Arrest

Out of hospital cardiac arrest has been studied in Japan, with the biggest ever series recently published by Prof Negishi of Sydney University. The increase in risk was 1.6% for an extra 10 $\mu g/m^3$ on the same day, but substantially higher at 3.3% for an extra 10 $\mu g/m^3$ averaged over the previous 4 days. It looks like the risk for cardiac arrest is cumulative over several days. Sudden cardiac death while fighting a fire is not an uncommon story which may well be due to the fine particles as well as other components of smoke. Exposure for firefighters could be 1000 $\mu g/m^3$, which, if the effect is linear, would increase the risk of cardiac arrest by 25 times.

Other impacts

Associations have also been found between particle air pollution and respiratory disease such as asthma, COPD and reduced lung growth in children, dementia, and lung cancer.

Acute and chronic effects

Air pollution has both acute and chronic health effects, however the effects of long term exposure on health are approximately 5 times greater. It is well established that on bad air days there are more heart attacks, but there is also an effect that bad air over months and years accelerates the progression of cardiovascular disease, and the resultant heart attack may well happen on a good air day. Fine particle air pollution adds to the risk from all other known risk factors such as obesity, diabetes, smoking, family history, cholesterol, and renal disease. It is unlikely to ever be the sole cause of a health event. Thus, the sum of acute effects across the year is not the same as the chronic effect.

> For exact numbers quantifying this effect, a very large study examining deaths in the entire American Medicare population for 12 years and 22million deaths (Di, Dai et al. 2017) showed that for every extra 10 μg/m^3 of daily PM2.5 on the day of death and the day preceding death, the risk of death increased by 1.05%. The effect of chronic exposure is much larger, with the widely quoted American Cancer Study)(Pope, Burnett et al. 2002) showing that for every extra 10 μg/m^3 in annual average PM2.5 the risk of dying from any cause increased by 6%.

Applying the known risks to observed air quality in NSW

Fine particle air pollution is measured at multiple sites in central NSW where most of the population lives. The data is publicly available on the website of OEH. It is possible to estimate an expected number of adverse health outcomes from the degree of risk listed above, and the observed air quality over the recent summer. The usual approach to reporting air quality is to estimate annual average values by calendar year, but as the fire season crosses calendar years, it is better to examine July to June years. The average PM2.5 observed across the 26 monitoring sites in the 2 years 2017-18 & 2018-19 was 8.06 μg/m^3. The average of the same monitoring sites over the recent period of 224 days from July until the 9th February when the big rain put out fires was 14.47 μg/m^3, an extra 6.41 μg/m^3.

Prior analysis conducted for Environment Justice Australia and published in the 2018 report The Health Burden of Fine Particle Pollution From Electricity Generation in NSW examined the estimated health burden that would be expected from fine particle air pollution in a normal year(Ewald 2018).

The study area was 71 local government areas in Sydney and central NSW, with a combined population of 6.5 million people and the study examined the health events of deaths, low birth weight, and new onset type two diabetes. This work can be used as the basis for an estimate of the extra chronic health burden from the increased air pollution over the 2019-20 summer, assuming that from the second week of February air quality returns to normal.

	Annual number attributable to PM2.5 in a normal year.	Extra outcomes attributable to an extra 6.41 μg/m^3 over 224 days.
Mortality	1469	793
Low birth weight	1258	679
Diabetes	1906	1028

These estimates are a first approximation of the problem but are not claimed to be precise due to the following limitations: There is no information about exposure of people living away from monitors, such as the North and South coasts. The average of monitor values is not the same as average population exposure, as each monitor represents different numbers of people. There is uncertainty about the linearity of effects, ie whether the risk increase from annual average influenced by a small number of very high days is the same as more stable exposure. There is also uncertainty about the lag effects. Chronic effects such as diabetes and mortality due to cardiovascular disease or cancer take many years to occur. The predicted extra 793 deaths may happen over 1 year or 20 years.

We assume that NSW health will be analysing the acute health events on days with high smoke exposure and look forward to seeing the results. The above calculation estimates the expected sum of acute plus chronic health effects.

2. The effectiveness of the NSW Government to plan for and improve air quality including:
(a) the measurement, reporting and public awareness;

Public awareness grew during the bushfire smoke event due to media coverage of the issue and as people were directly impacted, however more needs to be done – especially by NSW department of health in educating the community about the dangers of air pollution. There was mixed response in terms of community groups delaying/cancelling sports activities on bad air pollution days, with anecdotal stories of sports events going ahead despite air pollution in the hazardous levels. More deliberate public awareness campaigns would be beneficial in ensuring that everyone has the correct information, and is aware of the health risks and recommended actions.

The NSW Daily Air Quality Index (AQI) table is a good communication tool in amalgamating air pollution information into easily interpretable numbers and risks, but an extension to advice based on hourly PM2.5 is warranted. The community needs a simple message about when air pollution reaches levels at which outdoor sporting events should be cancelled. There is not much epidemiological data about 1 hour exposures to fine particles, so setting a threshold is not based on strong science. For PM2.5 choosing a value of 50ug/m^3, ie double the 24 hour standard seems reasonable, and NSW has recently introduced an interim 1 hour standard of 62. Examining the hourly data for 13 Sydney sites from July 2019 to March 2020 shows that of hours that were over 50, 70% to 82% were also over 62 so the choice of cut point in this range is not critical. More precise prediction of air quality based on local meteorology would help the community plan outdoor activity ,including sports, manual labour, and active transport.

NSW for many years had Australia's best network of monitors, and the most open public access to current and historical data, with other states only recently catching up. This resource could be improved by more monitoring sites, especially at towns that host polluting industries with Lithgow and southern Lake Macquarie the most obvious blind spots.

NSW publishes an annual air quality review. This document would be easier for the public to understand if it included presentation of how many people live in postcodes with annual fine particle air pollution above the national standard. The general public does not want to understand micrograms per cubic metre but can easily understand if 30% lived in air worse than the standard last year and this year it's only 25%. Not every postcode has a monitor, but there are simple methods to extrapolate to adjacent areas without monitors.

Increasing monitoring stations would have several benefits – firstly to allow communities to know their local air pollution levels which helps in decision making with sports events, schools, outdoor work and individual choices in terms of their risk; and secondly to improve knowledge around the benefits of air pollution reduction measures and aid in further research opportunities. These monitors need to be situated in areas that both measure background levels, and also in populated air pollution hotspots. DEA has previously advocated for roadside monitoring in key hotspots that have likely high population exposure, such as next to busy roads.

NSW launched a review of its air quality strategy with a consultation paper "Clean Air for NSW" in 2016, followed by public meetings, but has yet to finalise a strategy to tackle controllable sources of air pollution. The air pollution from a catastrophic bushfire season is difficult to avoid and control, however there are many known sources of air pollution that continue to pollute at higher levels than necessary and contribute to the burden of air pollution in NSW. Reducing controllable sources would have clear public health benefits, both in and out of bushfire seasons.

Recommendations from previous inquiries that have yet to be implemented include:

- Reduction of air pollution from key pollution sources such as **coal fired power stations**. Coal fired power stations are NSW's greatest source of NO2 and Sox pollution, both of which can be significantly reduced by installation of pollution reduction technologies such as sulphur dioxide scrubbers and selective catalytic conversion for NO2, Many other countries including USA, China, Japan and Europe mandate these technologies , which can cut air pollution by up to ~97%. Expanding the load-based licencing scheme with fees that more accurately reflect the health burden of air pollution would add an incentive to power plant operators to reduce their pollution.

- Reduction of **traffic air pollution** by implementing Euro 6 standards (for passenger and light vehicles) and Euro V1 (for heavy vehicles), which are mandatory in most wealthy countries; encouraging the update of electric and hybrid vehicles by providing incentives and infrastructure to support their use; phasing out diesel vehicles and similarly highly polluting vehicles.

- Reducing pollution from **wood heaters** (the top source of PM 2.5 in winter) including phasing out wood heaters in urban areas, consumer education, improving appliance standards and incentives to install less polluting heaters.

- Reducing pollution from **coal mines** (the top source of PM2.5 overall see https://www.epa.nsw.gov.au/your-environment/air/air-nsw-overview/managing-particle-pollution) by taking into account the air pollution and health impacts of all new proposals and extensions, including full economic analysis of the health burden of pollution, and with enhanced measures to stop new developments if they contribute to worsening air pollution.

(b) the provision of various protective materials including face masks and air purifiers;

Increased public education on the benefits of protective facemasks and which masks offer most protection (i.e. P2 masks with an exhale valve) would be beneficial. The exhale valve reduces condensation and allows the mask to stay comfortable for longer especially during physical activity.

Distribution of P2 masks in areas of air pollution hotspots – such as the NSW health distribution in community pharmacies in Southern NSW, Illawarra Shoalhaven and Murrumbidgee Local Health Districts – appears to be a good model. This needed to be expanded to other areas which also suffered hazardous levels of air pollution for several weeks.

Distribution could also be via GP clinics and emergency departments. Health professionals distributing P2 masks to their most at-risk patients would aid in protecting vulnerable people and prevent them wasting their effort with surgical masks that offer no protection against smoke particles.

The recent analysis of out of hospital cardiac arrest suggesting that the risk of acute cardiac events accumulates over multiple days of exposure has application to firefighters. This would support provision of higher grades of respiratory protection for crews with smoke exposure over more than 2 consecutive days. Investigation of options and provision of highly effective yet comfortable masks should be completed before the next fire season.

Anecdotal evidence of GPs working in low socioeconomic areas cite cost barriers and education barriers to people accessing P2 masks, and thus remaining at higher risk of health effects.

© the ability to ensure the health of at-risk groups;
The capacity of health services or government agencies to protect at risk groups is quite limited, so NSW must actively address the root cause of the bushfire emergency, which is the increasing frequency of severe fire weather due to climate change. This summer has been bad, but future years may have even worse fire weather. Protection of health requires rapid decarbonisation of the economy, and honest participation in global efforts to negotiate a solution to the climate crisis. NSW has an opportunity to be at the forefront of Australia's transition to a zero carbon economy, which needs to include transitioning away from our reliance on fossil fuels and embracing the economic benefits of renewable energy and low carbon emitting technologies.

Other measure that can help reduce the impact on peoples health are listed below, but it must be stressed that these are band-aid measures without serious plans to decarbonise the economy and tackle the root cause of worsening bushfire weather.

At-risk groups include those with chronic illness, the elderly, children and babies, pregnant women, outdoor workers and socio-economically marginalised people.

Measures to help protect the health of at-risk groups include:

- Increased public awareness – so that at-risk people know they are at risk, what the risks are, and have up to date information about the current air pollution levels and how to respond to keep themselves safe. This includes prompt distribution of air pollution exceedance alerts and advice.

- Upskilling of health professionals – so that this health education can be delivered by all frontline health professionals such as nurses, GPs, emergency department staff, pharmacists and community health workers.

- The distribution of P2 masks to vulnerable populations would also benefit in keeping the most at-risk people safe.

- Implementing a NSW Clean Air Strategy with a plan to reduce controllable air pollution sources. The lack of a Clean Air Strategy means that we are failing to keep vulnerable people safe from the health risks of air pollution.

Recommendations:

1. Public education and clear guidance about when and why to cancel/postpone sporting events and outdoor work on days of hazardous air pollution.
2. Public education and clear guidance on the use of personal protective measures such as use of masks and indoor particle filters for sensitive individuals, delivered by direct public awareness campaigns and via health services. Increased distribution of free P2 masks via pharmacies and GP clinics.
3. Improved respiratory protection for firefighters, especially for multi-day campaigns.
4. Finalisation and implementation of a NSW Clean Air Strategy to improve background air quality by tackling pollution from mining, power stations, vehicles, and wood fired heaters.
5. Extending the NSW network of air pollution monitors
6. Firm commitments to reduce greenhouse gas emissions in line with scientific recommendations to keep climate change within 2 degrees, or 1.5 degrees which will address the underlying cause of worsening bushfire weather.

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