Submission No 34

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

Organisation: Centre for Air pollution, energy and health Research (CAR)

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Submission on the Inquiry into the health impacts of exposure to poor levels of air quality resulting from bushfires and drought

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Thank you for the opportunity to comment on the Inquiry into the health impacts of exposure to poor levels of air quality resulting from bushfires and drought. CAR is well positioned to respond to the inquiry, having a dedicated bushfire research theme and a strong track record of investigating the health effects of bushfire smoke. Much of the evidence in this submission is derived from research conducted by CAR researchers.

Key points

- Exposure to bushfire smoke is associated with increased illness and deaths. Bushfire smoke affects the respiratory, cardiovascular and immune systems and alters some metabolic functions
- Certain groups are more at risk than others. For example, bushfire smoke exacerbates respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD). Additional vulnerable groups include pregnant women, children, those with cardiovascular disease and the elderly
- The long-term effects of bushfire smoke are largely unknown. There is also limited research into the effects of long-term exposure to bushfire smoke (e.g. weeks and months versus days).
- The 2019-20 bushfire season saw several recommended strategies to minimise the community's exposure to bushfire smoke. All have limitations and further research is required to investigate the most suitable for 'real-world' applications
- A key strategy to reduce the community's exposure to bushfire smoke is to reduce the severity and frequency of bushfires. Tackling climate change is essential
- CAR is proposing a comprehensive suite of research work which will address many of the questions proposed in the committee's terms of reference
- CAR is hosting a two-day forum in May 2020 to showcase the latest scientific research on the health and economic impacts of bushfire smoke and to discuss policy challenges and ways forward. We welcome attendance by members of the committee or relevant staff

Health impacts of poor air quality from bushfires on the general population

The 2019-20 bushfire season saw many communities affected by bushfire smoke and shone a spotlight on the need to further understand how smoke impacts the body both in the short and long-term. The importance of this is reinforced when considering that such extreme bushfire events are likely to become more common as a consequence of climate change.

Bushfire smoke is an irritant that in most people leads to irritation of the airways, nose and eyes via an inflammatory response. Bushfire smoke is made up of a complex mix of hundreds of different components. The most important for health is suspended fine particulate matter ($PM_{2.5}$) [1]. These particles, less than 2.5 micrometres in size, are able to penetrate deep into the lungs and cause inflammation. They are also able to directly enter the blood stream to affect different body organs. $PM_{2.5}$ typically affects the respiratory, cardiovascular and immune systems and changes some metabolic functions [2]. Studies of large cohorts of people have found that exposure to smoke from bushfire events in Australia leads to increased mortality rates [3-5]. Studies have also found that bushfire smoke exposure leads to short-term increases in respiratory symptoms and hospital admissions for cardiac and respiratory diseases [3, 5-9].

In an example of one such study, CAR researchers estimated that in Sydney over the period of 2001-2013, smoke from 184 bushfire incidents was associated with 197 premature deaths, 436 cardiovascular hospitalisations, and 787 respiratory hospitalisations [4].

For the 2019-20 bushfire season, we expect the more extensive community exposure to smoke to result in a higher incidence of morbidity and mortality. Research published today from some of our researchers has used computer modelling to estimate that exposure to smoke during the 2019-20 season resulted in approximately 400 premature deaths in the eastern states [10]. Additionally it is estimated that smoke exposure led to around 1000 additional hospital admissions for cardiovascular conditions, around 2000 admissions for respiratory conditions and 1300 hospital attendances for asthma [10].

However, to establish a more comprehensive picture of the health impacts, CAR has proposed a comprehensive suite of work to further investigate the acute and delayed effects of the 2019-20 bushfire smoke. We propose to investigate the additional number of deaths, hospitalisations, visits to Emergency Departments and respiratory exacerbations resulting from exposure to bushfire smoke. This proposal is currently subject to funding.

CAR is also hosting a two-day forum on 28 and 29 May 2020 to showcase the latest scientific research on the health impacts of bushfire smoke and to discuss policy challenges and key next steps (see Attachment A). We very much welcome attendance by members of this committee or relevant staff.

Long-term impacts of bushfire smoke exposure

The long-term effects of bushfire smoke exposure are largely unknown. Most studies focus on the immediate effect of bushfire smoke (same day of exposure or a lag of some days) rather than longer-term effects, months or years after exposure. Additionally, most research on bushfire smoke exposure in Australia is limited to bushfire incidents which last days rather than weeks or months.

The most relevant Australian research is the Hazelwood Health Study (www.hazelwoodhealthstudy.org.au) an ongoing study which includes several CAR researchers. It is investigating the long-term health outcomes of populations exposed to six weeks of smoke from the 2014 Hazelwood coal mines in Victoria. The duration and level of $PM_{2.5}$ exposure is comparable to the recent 2019-20 bushfire season. Note however, the source of smoke was coal compared to vegetation from bushfires.

Results from the Hazelwood Health Study have found evidence of longer-term health impacts. For example, in adults, exposure to $PM_{2.5}$ at the time of the mine fire was associated with an increase in self-reported respiratory symptoms 2.5 years after the fire event [11]. The strongest associations were with chronic cough and phlegm and current wheeze. Those most affected were males 18-65 years and those who lived in non-brick homes with tin roofs (e.g. weatherboard houses).

Children born to mothers who were exposed to mine fire smoke during pregnancy had a higher risk of acute respiratory infections at age two to four years [12]. In infants who were aged less than two years at the time of the fire, exposure to mine fire smoke was associated with increased use of antibiotics one year after the fire [13]. This implies an increase in the incidence of respiratory infections, since it is the most common reason antibiotics are prescribed in this age group. In the same age group, the study also found a link between mine fire smoke exposure and small increases in lung stiffness, measured using a special test of lung function, three years after the fire [14]. Lung stiffness is a sign of lung pathology.

It is likely that the health effects of the recent 2019-20 bushfire season will extend to several years, but this needs to be researched. Hence, there is a need for further studies to investigate the effects of a) bushfires which last longer than several days and b) health effects which may emerge months or years after exposure.

Health impacts of poor air quality from bushfires in at-risk groups

While anyone can be affected by bushfire smoke, some people, such as pregnant women, infants and children, older people and those living with respiratory or heart disease or with Type 2 Diabetes, appear to be more vulnerable than others [15, 16].

There are limited studies that specifically investigate the effect of bushfire smoke in those with pre-existing conditions compared to other members of the community. However, when looking at population-wide, cohort studies, there is evidence of an association between

exposure to bushfire smoke and increases in Emergency Department attendances and mortality for some of these conditions.

Apart from these groups, there is also concern that those in lower-socio economic groups may be more vulnerable to bushfire smoke because they may have poorer housing, health literacy, and less means to avoid bushfire smoke exposure [17].

The evidence regarding the health effects of bushfire smoke on vulnerable groups is outlined below. Recommendations on actions specifically for these groups which we published during the 2019-20 bushfire season are found in CAR's Bushfire Smoke Factsheet available at www.car-cre.org.au/factsheets

Pregnant women

What pregnant women are exposed to can influence the development of the unborn child. Studies have found that exposure to bushfire smoke during pregnancy is associated with a higher incidence of pre-term pregnancy and lower birthweight upon delivery [18, 19]. Additionally, pregnant women exposed to bushfire smoke are also more likely to have gestational diabetes and hypertension, especially when exposure is during the first trimester of pregnancy [19]. Results from the Hazelwood Health Study support this, showing an increase in gestational diabetes mellitus, mainly associated with exposure in the second trimester [20].

To understand if such effects are also seen in the 2019-20 bushfire season, we are proposing to investigate the association between smoke exposure with the occurrence of gestational diabetes in mothers, stillbirth, pre-term labour, weight for gestational age at birth, neonatal intensive care admission and mortality.

People with respiratory conditions

People with chronic respiratory conditions appear to be the most sensitive to bushfire smoke [7]. This is likely to be mediated by inflammation in the airways [21]. There is strong evidence that short-term increases in bushfire smoke lead to increases in respiratory hospital admission and Emergency Department visits, particularly for those with asthma and COPD [5, 7-9, 22, 23]. In fact, it appears that $PM_{2.5}$ from bushfires has a greater association with worsening asthma symptoms than particulate matter from mixed urban sources, such as vehicle emissions [22].

Apart from increases in hospital admissions, exposure to bushfire smoke is associated with increases in asthmatic symptoms and use of asthma medication [8].

People with heart disease

Studies on the effect of smoke on cardiovascular disease show a mixed picture. Some studies have shown that increases in bushfire smoke exposure are associated with

increased cardiovascular mortality and Emergency Department admissions [3, 7]. Likewise, another study showed that high $PM_{2.5}$ levels from 2006-07 Victorian bushfires were associated with an increased risk of cardiac arrests and Emergency Department admissions for ischemic heart disease [24].

But other studies have shown limited evidence or no increases in cardiovascular admissions with bushfire smoke exposure [9, 23]. It may be that while the most immediate health effect of bushfire smoke is via inflammation of the respiratory system, the cardiovascular system is affected in more subtle ways which may not be immediately apparent after exposure to bushfire smoke [21].

Children

There are few studies that have examined the effect of bushfire smoke on children's health [7]. Some studies have found that children are less likely than adults to attend hospital for asthma during periods of bushfire smoke exposure [7, 22, 23].

In contrast, findings from the Hazelwood Health Study suggest that that early life exposure to mine fire smoke is associated with physiological abnormalities of both the lungs and the blood vessels and more reports of minor illnesses and antibiotic prescribing (see previous section on long-term impacts).

Older adults

The elderly are more vulnerable to adverse health effects of smoke exposure than younger people because they are more likely to suffer from chronic medical conditions. International studies have shown that those over 65 years of age are more likely to be hospitalised for all conditions and specifically for asthma symptoms during bushfires [22, 23, 25].

There are still many unanswered questions about the effect of bushfire smoke on vulnerable populations, in particular, the prolonged exposure seen in the 2019-20 bushfire season. We are therefore proposing to undertake research to understand the association between bushfire smoke exposure and increased deaths, hospitalisations and Emergency Department attendances to identify vulnerable groups.

Health impacts for those exposed to poor outdoor air quality in the workplace

There has been community concern about the health impacts of bushfire smoke on outdoor workers such as baggage handlers, sportspeople and those in the trades.

To our knowledge there have been no studies focusing specifically on the health effects of bushfire smoke in outdoor workers. Outdoor workers without personal protective equipment are likely to have greater exposure to bushfire smoke than those who work indoors. Therefore, they are at risk of having worse health outcomes.

One outdoor workforce which has been studied is firefighters. Most studies have investigated the health of fire fighters in the United States, which have led to the development of guidelines on the use of personal protective equipment to minimise their exposure to smoke on the frontline. One concern is that these findings may not be applicable to Australian fire fighters because of differences in the two countries' vegetation and fire conditions which would affect smoke composition [26].

CAR is therefore proposing to undertake research specifically on volunteer fire fighters engaged in combating bushfires during the 2019-20 bushfire season. We plan to investigate the long-term effects of exposure on the respiratory system as well as track signs of general inflammation.

Effectiveness of various protective materials and strategies to mitigate the health impacts of exposure

During the 2019-20 bushfire season, the community was provided with inconsistent messages on ways to protect themselves from bushfire smoke. This is largely because the effectiveness, particularly in real-world settings, of these interventions is still unknown. All suggested strategies have advantages, disadvantages and unknowns that must be clearly communicated to the public to allow informed decision making [17].

For example, some authorities recommended wearing face masks and members of the public did resort to using both surgical and P2/N95 masks. However, CAR did not recommend the use of face masks. This is because there is limited evidence on their real-world effectiveness as they require the correct filter and fitting to work well. Unlike surgical masks, the material in P2/N95 masks do filter out $PM_{2.5}$. However, the seal around the mouth and nose must be perfect for them to work well. This can be difficult to achieve, especially for those with facial hair or those who have a small face [27]. In fact, a study from Beijing concluded that commercially available facemasks do not provide protection from pollution because of typically poor facial fit [28]. Where a good seal is achieved, it is usually hot and uncomfortable to wear for long periods of time and breathing may become laboured. Additionally, wearing a face mask may provide a false sense of security, meaning people stay outdoors for longer than what is safe [29].

There is evidence that high efficiency particulate air (HEPA) filters in indoor air purifiers are effective for reducing exposure to smoke particulates. Their effectiveness relies on having the appropriate filter capacity for the room size in which it is used [2]. However, they are expensive and there were reports of them quickly being sold out during the 2019-20 bushfire season. There are therefore equity questions around how lower SES households, who typically also suffer from worse health outcomes, could access such purifiers when smoke levels are high.

Another recommendation was to stay indoors. While this is effective for short time periods, this becomes impractical during weeks and months of poor air quality as was seen during the 2019-20 bushfire season. Additionally, there are questions as to its effectiveness when

many older Australian houses are very leaky, allowing outdoor air to easily enter. This also applies to the use of indoor air filters. While indoor air quality may improve when the filter is on, air quality may decline when it is switched off.

There is some scientific interest in 'safe havens' — dedicated public buildings which are able to maintain good indoor air quality during periods of high air pollution. However, there are questions around whether these would be specifically built for such a purpose or whether they would be in buildings already accessible to the public (such as libraries) and the logistics of using safe havens during prolonged periods of bushfire smoke.

What is clear is that there isn't a single 'go to' strategy that is both evidence-based and practical for mitigating the health effects of bushfire smoke. We therefore need to investigate better ways to protect our community from bushfire smoke. Specifically, using an experimental smoke chamber would go some way to testing existing and new interventions that reduce personal smoke exposure.

CAR is planning to address some of these questions by undertaking a systematic review to establish policy guidance on changing building standards to make buildings more airtight and therefore more resistant to the entry of outdoor smoke.

The effectiveness of governments' plans for improving air quality by

1) Measurement, reporting and public awareness

One of the main strategies to improve public awareness of air quality conditions is to provide consistent, real-time readings across jurisdictions.

Currently some jurisdictions report a 24-hour rolling average of air quality. Instead, real-time, hourly air quality readings are necessary because air quality can change rapidly with changes in temperature and wind conditions. Real-time air quality readings allow people to alter their behaviour to avoid exposure to smoky conditions. We welcome developments that NSW now provides hourly PM_{10} and $PM_{2.5}$ averages.

Some jurisdictions also provide an Air Quality Index (AQI). The AQI is an agglomerate measure meant to represent a single, easily understood measure of air quality to the public. However, the AQI includes criteria, such as visibility, which are difficult to translate to health outcomes. Instead for the purposes of health, a focus should be on reporting on individual pollutants relevant to the nature of the pollution event. For example, $PM_{2.5}$ and PM_{10} levels during bushfires, dust storms, and general pollution events, ozone levels during ozone events, and nitrogen dioxide levels where appropriate. We further recommend that there be consistency in reporting of $PM_{2.5}$ and PM_{10} levels across all jurisdictions in Australia, as part of a coordinated health response and to streamline public messaging.

An example of a successful measure to communicate air quality readings is the AirRater app (www.airrater.org). AirRater, developed by a team which includes CAR researchers, is a

mobile phone app which provides location specific, hourly PM_{10} and $PM_{2.5}$ readings. It allows users to input their symptoms and is useful for those with respiratory conditions. Its large user base of over 50,000 suggests that those in the community are seeking information not readily available or sufficiently user-friendly from government agencies. AirRater is currently funded to operate in Tasmania, ACT and Northern Territory.

Effective public health messaging in such bushfire incidents is crucial to reduce morbidity and mortality. In the 2019-20 bushfire season, communities received messaging which was inconsistent and not sufficiently nuanced for different groups in the community. CAR believes that public health communication should be timely, consistent across jurisdictions, nuanced and easily accessible and digestible.

As part of our research, we are proposing to investigate the effectiveness of the public health response during the 2019-20 bushfire season. We plan to do this via an embedded journalism approach, with the results being in depth articles in the media and synthesis of evidence into policy advice to partners.

In addition, we will be discussing air quality reporting and public health messaging on Day 2 of our bushfire forum in May 2020. Specifically, we will discuss such questions as:

- Do current systems for describing air quality and health risk make sense in an era of escalating fire smoke risk?
- Do our current systems for communicating air quality and health risk work?
- How do we best communicate evidence-based health messages to the community?

2) Addressing climate change

One of the principal strategies to minimise poor air quality from bushfire smoke is to reduce the number and ferocity of bushfires themselves.

In Australia, the last 30 years have seen an increase in the number of high Forest Fire Danger Index (FDI) days [30]. FDI is an indicator of conditions associated with dangerous bushfires [30].

While most studies linking bushfire risk to climate change have come from North America, the scientific consensus is that climate change will lead to an increase in fire risk around the world [31, 32]. In south-east Australia, it is estimated that the number of fire danger days will increase strongly by 2100 and the fire season is expected to start earlier, leading to a longer fire season [31]. Specifically, modelling suggests that the days conducive to extreme bushfires will increase by 20 to 50 per cent in western United States and south-east Australia [33].

Therefore, governments must act now on climate change to curtail the increasing risk of extreme bushfires and therefore air pollution events. By maintaining the status quo, extreme bushfire events and associated health impacts will continue to accelerate.

About the Centre for Air pollution, energy and health Research (CAR)

CAR is a Centre of Research Excellence funded by the National Health and Medical Research Council (NHMRC). The centre brings together more than 30 researchers at the forefront of their fields, investigating the health impacts of air pollution and new forms of energy.

We are well placed to respond to the inquiry, having a dedicated bushfire research theme and a strong track record on understanding the health effects of bushfire smoke and wood burning and mitigation strategies.

Our centre's vision for a healthier community is the driving force behind our research.

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For more information

This submission has been produced by the Centre for Air pollution, energy and health Research (CAR).

For more information about CAR and our work in the health impacts of bushfires as well wood heaters: contact us at car@sydney.edu.au or visit our website www.car-cre.org.au

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