CAR

Centre for Air pollution, energy and health Research

## Position paper

# An evidence-based approach for nationally consistent air quality reporting and public health advice

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Centre for Air pollution, energy and health Research

# A proposed evidence-based approach for achieving nationally consistent air quality reporting and associated public health advice

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## Key points

### Air pollution is one of the most important environmental risk factors for poor health in Australia and globally [1, 2]

- In Australia, particulate matter of 2.5 micrometers in size and below ($PM_{2.5}$) from biomass combustion, like wood heaters and landscape fires (including planned burns and bushfires), is one of the most important sources of air pollutants with well documented serious community health impacts.[3-6]
- The hazard associated with landscape fire smoke is accelerating due to the environmental changes associated with a warming climate.[7-9]

### CAR welcomes initiatives that propose nationally consistent reporting of air quality through hourly or near real-time concentrations of $PM_{2.5}$

- Air pollution conditions can change rapidly, especially with air pollution from landscape fires. [10] Real-time air quality reporting reflects these rapid changes
- Real-time, or near real-time, information promotes an understanding of a person's individual sensitivity to smoke. [11]
- Real-time, or near real-time, information supports decisions for self-management such as when to seal or when to open and ventilate a home, change locations or take medication. [12]

**The evidence shows 1) there is no 'safe' lower concentration of $PM_{2.5}$, 2) health impacts are seen at relatively low $PM_{2.5}$ concentrations and 3) health impacts occur rapidly after small increases in $PM_{2.5}$**

- There is no 'safe' lower concentration of $PM_{2.5}$ below which there are no population level health effects. [4, 13-15]
- Serious health impacts like hospital admissions and deaths, mostly occur in individuals who are at higher risk because of chronic respiratory and cardiovascular conditions. [16, 17]
- Serious population health impacts are measurable in the same hour that $PM_{2.5}$ concentrations increase. Small (5-10 $\mu g/m^3$) increases in hourly $PM_{2.5}$ can precipitate serious health outcomes including myocardial infarction, cardiac arrest and ambulance call-outs for breathing difficulties. [18-21]
- The magnitude of the health risks due to air pollution is greatest at the lowest concentrations of $PM_{2.5}$. [14, 22, 23]
- Relatively modest changes in the usual day-to-day and seasonal patterns of air pollution concentrations can have a far greater influence on overall community health than less common exposures to severe and extreme concentrations. [5]

**The development of a national framework for providing public information on hourly or near-real time pollution concentrations should:**

- Have the overarching aim of reducing the health burden attributable to air pollution in Australia.
- Be informed by the best available evidence about the health impacts of air pollution, existing systems for providing near real-time air quality information, public health interventions to mitigate exposure and health impacts, and communication strategies for people at higher risk from air pollution.
- Be appropriate for and tailored towards the air pollution concentrations commonly experienced in Australian communities, including usual daily and seasonal variation in $PM_{2.5}$, in addition to rare extreme events.
- Be easy to interpret and implement.
- Be linked with information that empowers individuals to understand their personal vulnerability and inform actions to protect their health, especially as air pollution rises and falls during prolonged events such as landscape fires or seasonal woodsmoke.
- Have messaging that is appropriate for both brief and prolonged durations in each category of exposure, as a one-hour average is a 'point in time' measure, and does not provide information about duration of exposure. Consideration should be given to displaying an indicator of the direction (rising, falling or stable) of changes in $PM_{2.5}$.
- Be regularly evaluated and updated against the above criteria.

# Rationale

## The need for national consistency in air pollution information and associated health messages

- CAR welcomes and supports the current steps being taken by jurisdictions to provide nationally consistent air quality reporting and associated health messages.
- The general public expects guidance from government agencies during periods of poor air quality but the current inconsistencies across jurisdictions on the air pollutants reported, the time periods reported on, the use of an Air Quality Index (AQI) or otherwise, the differing thresholds for air quality categorisations and health messaging associated with these categories generates confusion. This was clear in the evidence provided by various groups to the Bushfire Royal Commission.
- In the absence of consistent and easily understood information on current air quality conditions, the public is relying on easily accessible international apps and websites, many of which are not scientifically validated or transparent in the methods used to assign air quality, and often report air quality against international standards that are not relevant for the Australian public.
- Air quality can change rapidly because of temporal variations in wind and temperature and the source of the pollution itself (for example during bushfires).
- There is a clear need for a unified approach to air pollution reporting across Australian jurisdictions.

# Evidence

## No 'safe' lower threshold for the health effects of $PM_{2.5}$

- There is overwhelming consistency in the literature of no 'safe' lower threshold concentration of $PM_{2.5}$ at sub-daily, daily or yearly average concentrations, below which there are no measurable health effects in the population, including mortality.[1, 13-15]

## Health impacts are measurable within the hour following incremental increases in $PM_{2.5}$ (e.g. 5-10 $\mu g/m^3$)

- Studies of both urban air pollution and bushfire smoke demonstrate that health effects including cardiac arrest, myocardial infarction and ambulance callouts for respiratory problems are seen within the hour after exposure to poor air quality.[18-21, 24]

- People most vulnerable to the impacts of air pollution need to be able to take timely action (e.g. through closing doors or preventative medication) as soon as air quality deteriorates. Therefore, the most useful data for the general public are real-time, hourly air pollution data, with associated and appopriate health messaging.

## Modest increases above usual air pollution have a much greater influence on community health than less common extreme pollution episodes

- The concentration-response curve is steepest for lower $PM_{2.5}$ concentrations.[14, 22, 23]
- In Australia, the vast majority of hourly averaged concentrations of $PM_{2.5}$ are below 50 $\mu g/m^3$ - the area of the exposure range where the association with health effects is the greatest (see Attachment A).
- This means that, over time, the greatest burden of disease due to air pollution, including hospital admissions and deaths, in Australia occurs at hourly concentrations lower than 50 $\mu g/m^3$ and more detailed air quality information should be provided for concentrations in this range. See examples that illustrate this point in Box 1.
- Interventions are implementable and health gains are possible at incremental rises above background (e.g. 10 $\mu g/m^3$) hourly and daily averaging periods. [18-21, 24]

**Box 1: Examples of the relative burden of disease from biomass smoke***

*1. Distribution of air quality and mortality in Tasmania.*

The health impacts from biomass smoke in Tasmania is driven by several months of the year when 24-hourly average $PM_{2.5}$ is elevated between 5-20 $\mu g/m^3$ due to wood-heater smoke. Deaths and admissions are much higher from smoke at these concentrations than from the extreme bushfire smoke episodes seen in 2016 and 2019 - despite having some of the most extreme air pollution recorded in Australia during those bushfires. Over a 19 year period, most of the mortality was associated with maximum daily $PM_{2.5}$ concentrations under 25 $\mu g/m^3$. [5]

*2. Black summer bushfires, air quality and mortality in Australia.*

Over 400 deaths were attributable to this pollution episode based on 24-hour average data. More than 80% of the deaths attributable to this episode were at concentrations of $PM_{2.5}$ at or below 50 $\mu g/m^3$ despite 24 hourly averages exceeding 1000 $\mu g/m^3$ in some places. This is because many more days affecting many more people were at these lower concentrations. [7]

*3. Prescribed burns in Western Australia.*

Repeated smoke impacts from prescribed burns exceeding 24-hourly air quality standards had slightly greater health impacts than less frequent but more severe smoke impacts from bushfires over a 15 year period [25]. The repeated impacts of 'moderate' air quality can add up over time leading to a significant population health burden.

*Based on evaluation of daily averages, however the same principle applies for hourly averages.

## People who are vulnerable to increased air pollution use real-time information to take timely action and prefer simple, accessible information

- Ease of use and navigation are important factors for individuals seeking air quality information. [12] See CAR's recommendation to how air pollution data should be presented for general audiences for ease of use in Table 3 of its Submission to the Royal Commission's Issues Paper: Health arrangements in natural disasters (Attachment B)
- Real-time information enables vulnerable people to:
    - take timely action to reduce their exposure or manage their health condition, appropriate to their needs.[11, 12]
    - benchmark their symptoms against air quality to understand their personal threshold for health impacts.[11]

# Proposed approach

CAR proposes that changes to air quality reporting amongst jurisdictions be evidence-based. Reflecting the scientific evidence presented above, CAR's proposed approach to air pollution reporting is as follows:

## 1) Provide information and advice based on pollutant concentrations and not an index.

- The use of an air quality index (AQI) as well as $PM_{2.5}$ concentrations is confusing for the public. See CAR's Submission to the Royal Commission's Issues Paper: Health arrangements in natural disasters (Attachment B).
- The AQI is calculated differently by different states, territories and countries and despite having the same name, each AQI is not comparable amongst jurisdictions.
- The AQI is a combined indicator meant to represent a single, easily understood measure of air quality to the public. However, the AQI includes criteria, such as visibility, which are not directly relevant to health outcomes.
- 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 summer ozone events, and nitrogen dioxide levels where appropriate.

## 2) Categories and information should focus on incremental increases in $PM_{2.5}$ above background concentrations with progressively widening exposure categories at higher concentrations.

- Early advice on increases in air pollution provide the greatest opportunities for vulnerable persons to take preventive action such as closing doors to reduce exposure or using preventive medication. These actions are less effective when implemented after air pollution has substantially increased.
- Consistent with the evidence of the steeper dose response relationship at lower air pollution concentrations, we propose an increased number of categories and health advice at lower $PM_{2.5}$ concentrations and fewer at higher concentrations- see Table 1.
- CAR also proposes that the colours used reflect increased risk for sensitive groups as $PM_{2.5}$ concentrations increase. For example we recommend that the 'fair' category (12.5 to <25 $\mu g/m^3$) be yellow to indicate that $PM_{2.5}$ has increased from background and there is minimal risk but those in the sensitive group should be ready to act if necessary. We also propose that orange or similar is used above 25 $\mu g/m^3$ (see Table 1).

**Table 1: Proposed thresholds and associated advice for near real-time or hourly $PM_{2.5}$**

| PM $_{2.5}$ ($\mu g/m^3$) | Category | Health advice for hourly $PM_{2.5}$ |
|---|---|---|
| 0 to <12.5 | Good | All – Enjoy the outdoors and continue with usual activities |
| 12.5 to <25 | Fair | Sensitive groups – Air pollution is a bit higher than usual. Keep track of conditions so you can take early action if the pollution continues to get worse or if you notice any symptoms. Otherwise enjoy the outdoors and continue with usual activities.<br>All - If air pollution has recently been worse and is now improving, open and ventilate your home to help eliminate polluted air that may have seeped indoors earlier. |
| 25 to <50 | Moderate | Sensitive groups – Consider taking steps that will help you to reduce breathing smoky or polluted air* (link to advice).<br>Closely manage your health** (link to advice), especially if you have a serious medical condition or develop symptoms.<br>The longer the air pollution has been increased, the more important it is to act. |
| 50 to <100 | Poor | Sensitive groups – Take steps to reduce the amount of smoky or polluted air that you breathe* and carefully manage your health**.<br>Others – Healthy people who are not in a higher risk group can continue their usual activities but should consider taking steps to decrease time in polluted air. The longer the air pollution has been increased the more important it is to protect your health*. |
| 100 to <250 | Very poor | Sensitive groups – Take steps to reduce the amount of smoky or polluted air that you breathe* and carefully manage your health**<br>Others - take steps to decrease time in polluted air*.<br>Organisers of outdoor events should obtain advice and air quality forecasts if available, and consider cancelling these events unless air quality is rapidly improving |
| 250+ | Extreme | Everyone – take steps to protect yourself and others from the harmful effects of air pollution* **<br>Outdoor events should not take place |

*Link to detailed information about all the ways to reduce exposure –staying indoors and managing houses to avoid ingress of smoke and ventilating when appropriate, reducing outdoor physical activities, travelling to cleaner air venues, using HEPA filters, and the benefits and limitations of face masks and types of masks. [10]

**Provide information about asthma action and other health management plans, taking early action to address symptoms of all conditions including asthma COPD and angina, people with diabetes paying closer attention to blood glucose control,[12] calling an ambulance if difficulty breathing or signs of a heart attack.

- Focussing the health messaging on severe air pollution concentrations misses the bulk of community impacts and does not reflect the flattening of the exposure-response curve at higher air pollution concentrations.
- A one-hour average is a 'point in time' measure. It does not provide information about duration of exposure. Messages should take into account that air pollution could be rapidly rising, falling, or stable. Considerations should be given to displaying an indicator of the direction (rising or falling) of $PM_{2.5.}$
- Air pollution might be a brief episode (a few hours) and/or episodes that are fluctuating over months. Therefore, messaging should highlight that the longer air pollution is elevated, the greater the need to take action.

## 3) Categories and information should have the overall aim of supporting personal decisions for taking action to protect health

- The most important decision for an individual to make if they notice air pollution is increased, or they can see or smell smoke, is:

  1. *Am I in immediate danger from a fire?*
  2. *Am I, or are those I care for, in a sensitive group?*

  Advice on how to find out the answers to these two questions should accompany any information about $PM_{2.5}$ concentrations as they are essential for interpreting the advice.

- Categories should not be prescriptive about which specific exposure reduction or health protection actions should be taken at each category because every person's situation is different. Higher risk people should adopt a combination of strategies appropriate to their needs. We propose that at 'moderate' air pollution the language is to 'consider action', while at 'poor' levels the language is to 'take action' (see Table1).
- Categories and advice should link to more detailed information. For example, closing doors is generally not sustainable and less effective over longer periods such as several days compared with a few hours. Such explanations should be in an easily accessible form.
- Information should also include reassurance to those in low risk groups where the main risk is the accumulated exposure over time, rather than the precipitation of serious health events due to exacerbations of known illnesses.

## 4) An accompanying air pollution public education campaign is essential

- The proposed changes will have limited effect if a public awareness campaign around air pollution is not undertaken in parallel. Unlike the effects of ultra-violet (UV) radiation or tobacco, most Australians have limited knowledge of the health effects of air pollution or the preventive actions they can take to minimise their exposure.

- A public health campaign (similar to the Sun Smart campaigns of the 1990s) has previously been proposed in CAR's submission to governments and by other groups such as the Public Health Association of Australia and Asthma Australia. We also note that it is part of Recommendation 35 of the recently released NSW Bushfire Inquiry report.
- The categories and advice provided in our proposed thresholds cannot possibly capture the diversity of health conditions and specific risks for every member of the public. Therefore, a public awareness campaign would allow members of the public to understand what the reported air pollution levels mean and tailor this information to their own circumstances and health conditions. This would empower people to self-manage and take action to protect their health. It would be analogous to individuals accessing the UV index in the morning and making decisions about which actions on the 'slip, slop, slap' recommendations they take based on their own particular circumstances.
- We strongly recommend the inclusion of experts in air pollution, bushfires and public health research translation be included in the design of this, and any other, public education campaign.

## About 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 have 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 vision for a healthier community is the driving force behind our research.

## For more information

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


*Suggested citation*

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For more information about CAR and our work, contact us at car@sydney.edu.au or visit our website: car-cre.org.au

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Table of the distribution of hourly $PM_{2.5}$ from selected stations in Australia between Sept 2018 and Aug 2020. Data from Environment Agencies in each State/Territory

| Station name | Hours (N) | Percentage of all hours $PM_{2.5}$ in each category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <12.5 | 12.5-25 | 25-50 | 50-100 | 100-250 | 250-500 | >500 |
| ACT CIVIC | 14220 | 83.8 | 9.9 | 2.5 | 1.8 | 1.3 | 0.3 | 0.3 |
| ACT FLOREY | 15446 | 74.9 | 14.1 | 6.6 | 2.2 | 1.3 | 0.5 | 0.5 |
| NSW CHULLORA | 12733 | 80.7 | 15.0 | 3.0 | 1.1 | 0.3 | 0.0 | 0.0 |
| NSW EARLWOOD | 12822 | 83.6 | 12.3 | 3.0 | 0.9 | 0.2 | 0.0 | 0.0 |
| NSW LIVERPOOL | 12752 | 76.5 | 17.8 | 4.2 | 1.1 | 0.3 | 0.1 | 0.1 |
| NSW NEWCASTLE | 12742 | 81.5 | 14.4 | 2.8 | 1.0 | 0.3 | 0.0 | 0.0 |
| NSW RICHMOND | 12133 | 81.5 | 13.3 | 3.4 | 1.4 | 0.3 | 0.1 | 0.1 |
| NSW ROZELLE | 12919 | 85.0 | 11.3 | 2.7 | 0.8 | 0.2 | 0.0 | 0.0 |
| NSW WOLLONGONG | 12581 | 85.9 | 11.0 | 2.0 | 0.9 | 0.1 | 0.0 | 0.0 |
| NT PALMERSTON | 14906 | 81.1 | 12.9 | 4.6 | 1.3 | 0.1 | 0.0 | 0.0 |
| NT STOKES HILL | 14805 | 79.5 | 14.5 | 4.8 | 1.1 | 0.1 | 0.0 | 0.0 |
| QLD BRISBANE CBD | 11860 | 83.2 | 13.2 | 2.6 | 0.9 | 0.1 | 0.0 | 0.0 |
| QLD ROCKLEA | 11841 | 88.7 | 8.2 | 2.5 | 0.5 | 0.1 | 0.0 | 0.0 |
| QLD SOUTH BRISBANE | 11962 | 89.4 | 7.8 | 2.0 | 0.6 | 0.1 | 0.0 | 0.0 |
| QLD SOUTH GLADSTONE | 11856 | 91.4 | 6.9 | 1.6 | 0.1 | 0.0 | 0.0 | 0.0 |
| SA CBD | 3956 | 91.7 | 7.8 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| SA LE FEVRE 1 | 3316 | 94.9 | 4.2 | 0.9 | 0.1 | 0.0 | 0.0 | 0.0 |
| SA NETLEY | 5305 | 92.6 | 5.6 | 1.8 | 0.1 | 0.0 | 0.0 | 0.0 |
| TAS GEEVESTON | 16580 | 81.4 | 10.4 | 5.6 | 1.1 | 0.7 | 0.4 | 0.4 |
| TAS LATROBE | 16160 | 79.0 | 10.6 | 7.6 | 2.5 | 0.3 | 0.0 | 0.0 |
| TAS NEW TOWN | 16689 | 94.7 | 3.7 | 1.2 | 0.3 | 0.0 | 0.0 | 0.0 |
| TAS SOUTH LAUNCESTON | 16560 | 89.8 | 6.3 | 3.3 | 0.4 | 0.1 | 0.0 | 0.0 |
| Vic ALPHINGTON | 16544 | 86.1 | 10.5 | 2.6 | 0.6 | 0.2 | 0.1 | 0.1 |
| Vic DANDENONG | 16626 | 93.2 | 4.8 | 1.2 | 0.4 | 0.4 | 0.1 | 0.1 |
| Vic FOOTSCRAY | 16484 | 87.9 | 9.7 | 1.6 | 0.4 | 0.3 | 0.0 | 0.0 |
| Vic GEELONG SOUTH | 11286 | 89.9 | 7.7 | 1.6 | 0.2 | 0.5 | 0.1 | 0.1 |
| Vic MELBOURNE CBD | 16155 | 87.5 | 10.2 | 1.6 | 0.4 | 0.2 | 0.0 | 0.0 |
| Vic TRARALGON | 16357 | 82.4 | 13.6 | 3.2 | 0.3 | 0.5 | 0.1 | 0.1 |
| Vic WANGARATTA | 15869 | 83.6 | 8.6 | 4.2 | 1.8 | 1.2 | 0.2 | 0.2 |
| WA ALBANY | 7303 | 63.0 | 32.0 | 4.3 | 0.7 | 0.0 | 0.0 | 0.0 |
| WA BUNBURY | 10342 | 85.8 | 10.0 | 3.3 | 0.7 | 0.0 | 0.1 | 0.1 |
| WA CAVERSHAM | 15450 | 87.7 | 10.7 | 1.3 | 0.2 | 0.1 | 0.0 | 0.0 |
| WA GERALDTON | 15526 | 84.4 | 14.6 | 0.8 | 0.1 | | 0.0 | 0.0 |

# Submission to the Issues Paper: Health arrangements in natural disasters

By Ana Porta Cubas, Fay Johnston (UTAS), Bin Jalaludin (UNSW), Jane Heyworth (UWA), Michael Abramson (Monash Uni), Christy Geromboux, Graeme Zosky (UTAS) Guy Marks (UNSW) on behalf of the Centre for Air pollution, energy and health Research (CAR)

26 June 2020

Thank you for the opportunity to comment on the Bushfire Royal Commission's Issues Paper: Health arrangements in natural disasters. As leaders in researching the health impacts of bushfire smoke and air pollution more generally, we are well placed to respond to the paper. This response is an extension to CAR's submission to the Bushfire Royal Commission which can be found in Attachment A.

## Key points

Despite living in a country prone to bushfires and the common exposure of our communities to bushfires smoke, the 2019-20 bushfire season was unprecedented and highlighted various gaps in our knowledge, our air pollution reporting mechanisms and our public health response. The unprecedented nature came not only because of the high levels of air pollution generated by the smoke but because of the prolonged period that our communities were exposed to that smoke.

Below, we provide a list of recommendations which summarise our response to the Issues Paper.

We also invite members of the Commission and supporting staff to attend our Landscape fire smoke workshop on 8th and 9th October 2020. The workshop will bring together key researchers and policy makers to discuss the latest evidence on bushfire smoke science, policy challenges and future directions. Many of the questions posed in this Issues paper will be discussed on the day. Details are in Attachment B.

**Table 1: CAR recommendations**

| Recommendation | Details |
|---|---|
| **1. Standardise reporting of air quality by adhering to set reporting requirements** | Negotiated across jurisdictions through cross governmental bodies with inclusion of experts in air pollution, bushfires and public health research translation. Reporting requirements should include:<br>• Real-time (minimum of hourly) data<br>• Replacement of AQI with concentrations<br>• Standardisation of 'dangerous' and 'hazardous' categories<br>• Accessibility<br>• Visual, dashboard display<br>• Linked to public health messaging<br>• Consolidated to one website |
| 2. **Improve public health messaging to be consistent and accessible** | • Public education campaign on air quality<br>• Research on effective public health communication during bushfire events and effective interventions |
| **3. Prioritise research in the following areas regarding bushfire smoke**<br>i. Exposure<br>ii. Short-term effects<br>iii. Long-term effects<br>iv. Toxicological effects<br>v. Interventions<br>vi. Public health response | These research questions have not yet been addressed at a population-wide level under current MRFF proposals |

## Question 4: Should a standard approach to reporting and categorising air quality across Australia be implemented, and if so, how?

As described in our submission and outlined in the Issues Paper, there are concerning inconsistencies in reporting of air quality amongst jurisdictions. Differences include the:

- time period over which air quality is updated (10 minutely, hourly or 24-hour rolling averages)
- species reported and concentrations reported (or not)
- the use of an Air Quality Index (AQI) and the differences in 'dangerous' and 'hazardous' categorisations
- provision of health advice associated with each category
- the way that air pollution data is displayed (tables vs maps vs dashboard)
- level of scientific literacy needed to understand the information

Table 2 summarises how air quality is reported in Department of Environment/EPA websites in each jurisdiction and the inconsistencies that are present.

**Table 2: Reporting of air quality on Department of Environment websites by jurisdiction**

| | NSW[1] | VIC[2] | QLD[3] | SA[4] | WA[5] | NT[6] | TAS[7] | ACT[8] |
|---|---|---|---|---|---|---|---|---|
| **AQI** for -region | Y | N | N | Y | N | N | N | N |
| -$PM_{2.5}$ | Y | Y | Y | N | Y | Y | N | Y |
| **Timing** of data ($PM_{2.5}$) | Hourly 24h avg | Hourly | 24h avg | Hourly | 24h avg | 24h avg | 10 min, Hourly | 24h avg |
| **Concentration** of $PM_{2.5}$ ($\mu g/m^3$) provided | Y, if searched | Y | Y | Y | N | Y | Y | Y |
| **Health advice** provided | Y but limited | Y but limited | N | N | N | Y but limited | Y but limited | N |
| **Easy to understand** for general audience | N | Y | N | N | N | N | N | N |

[1] https://www.dpie.nsw.gov.au/air-quality/current-air-quality
[2] https://www.epa.vic.gov.au/for-community/airwatch
[3] https://apps.des.qld.gov.au/air-quality/
[4] https://www.epa.sa.gov.au/data_and_publications/air_quality_monitoring
[5] https://www.der.wa.gov.au/your-environment/air/air-quality-index
[6] http://ntepa.webhop.net/NTEPA/Default.ltr.aspx
[7] https://epa.tas.gov.au/epa/air/monitoring-air-pollution/real-time-air-quality-data-for-tasmania#table
[8] https://www.health.act.gov.au/about-our-health-system/population-health/environmental-monitoring/monitoring-and-regulating-air

Note that this table on air quality likely underestimates the lack of consistency as many jurisdictions present air quality and health data in two different sites: Department of Environment/EPA and Health Department. Often these sites are not consistent with each other. The public's interpretation of air quality therefore depends on which of the two sites are looked at.

Anecdotally these inconsistencies have caused confusion and caused disproportionate anxiety within communities, especially during high air pollution events. In particular, the impenetrable way that the data is displayed, and lack of public health advice means the public are unlikely to know which actions to take to ensure their safety.

The lack of real-time data is particularly concerning for vulnerable groups who need to act long before official air quality warnings are released by agencies. For example, it is known that in vulnerable groups there are increases in ambulance callouts within the same hour that air pollution begins to rise. [9,10]

In the absence of consistent and clear air quality information, people are relying on 'easy to use' albeit potentially incorrect unofficial air pollution sites in which air quality data is not scientifically validated, or is standardised to international air quality guidelines that are not appropriate for Australia

CAR recommends the provision of real-time, easily accessible and consistent air quality data across jurisdictions. This would allow people to plan their day during high smoke periods to avoid exposure and potentially decrease the health toll of poor air pollution in the community.

We recommend that official air quality reporting should be standardised to have the requirements described in Table 3.

[9] Yao, Y., Brauer, M., Wei, J., McGrail, K.M., Johnston, F.H. and Henderson, S., 2020. Sub-Daily Exposure to Fine Particulate Matter and Ambulance Dispatches during Wildfire Seasons: A Case-Crossover Study in British Columbia, Canada. *Environmental Health Perspectives, 128(*6), p.067006-1

[10] Edwards, L.J., Williamson, G., Williams, S.A., Veitch, M.G., Salimi, F. and Johnston, F.H., 2018. Did fine particulate matter from the summer 2016 landscape fires in Tasmania increase emergency ambulance dispatches? A case crossover analysis. *Fire, 1*(2), p.26

**Table 3: Standardised reporting requirements for air quality information across jurisdictions**

| Requirement | Detail |
|---|---|
| **Timely** | Real-time data (at least hourly). Air quality conditions change rapidly so 24-hour averages are not useful |
| **Remove AQIs** | As stated in our submission this agglomerate measure is inaccurate. Instead use the concentration of individual pollutants relevant to the nature of the pollution event ($PM_{2.5}$ and $PM_{10}$ during bushfires) |
| **Categorisation** | Categories based on PM concentrations ($\mu g/m^3$) (rather than AQI) and be consistent and evidence- based. Need to be negotiated across jurisdictions |
| **Increased spatial coverage through (1) increased monitoring and (2) modelling** | Increased monitoring in regional areas and the use of validated data modelling where needed to fill in gaps (especially in areas not close to monitors). Clear display when modelled versus real data is displayed. |
| **Consolidated** | Air pollution and associated health messaging should be on one website rather than divided between Department of Health and Environment/EPA sites to minimise confusion |
| **Accessible** | Online and app formats. Apps allow users to access air quality information even when away from a desktop. Apps should be compatible with Apple and Android devices |
| **Understandable** | Visual, dashboard layout. Use of 'plain English' for non-technical audiences. Look and feel should be similar across jurisdictions |
| **Public health messaging** | Linked to clear, and easy to find public health messaging outlining what actions community members should take. Should represent a 'one-stop-shop' for the public |
| **Forecasts** | Air quality forecasts to allow people to plan their day to avoid exposure |

Many of these requirements have been met by the AirRater app, the development of which has been led by CAR's A/Prof Fay Johnston. Importantly, the AirRater app has been developed and is continuously validated by Australian air quality experts. Other examples of accessible air quality information in useful dashboard formats include Breezometer, Air Matters, Purple Air and AQICN which are either international not for profit or commercial sites. It is important to note however that some of these sites are not led by air quality experts and provide a 24-hour air quality reading standardised to United States' Air Quality Index so may not be reliable nor relevant for the Australian public.

Mechanisms to standardise air quality by adhering to the requirements on Table 2 could be negotiated through the National Environment Protection Council (NEPC), the Environmental Health Standing Committee of the Australian Health Protection Principal Committee (AHPPC) or the newly formed National Federation Reform Council (NFRC). There are some elements that would need to be negotiated amongst jurisdictions such as cut-offs for categories, data collection protocols and standardisation of equipment and measures. We strongly recommend the inclusion of experts in air pollution, bushfires and public health research translation be included in these processes to ensure evidence-based decision making.

In the absence of standard reporting of air quality data, and the need for such data for research purposes, CAR has built a national database for air pollution linked to health outcomes data. To our knowledge, we are the first in Australia to do this. Standardised air pollution data from each jurisdiction will be made publicly available through CAR's data platform (CARDAT). CARDAT it available through the CAR website https://www.car-cre.org.au/.

## Question 5: How should public health information about bushfire smoke be improved?

Clear public heath messaging in any disaster is key to minimise health impacts and therefore morbidity and mortality. CAR recommends that public health communication during bushfire smoke events should be timely, consistent across jurisdictions, tailored for different groups, easily accessible and understood. It should also be linked to air quality reporting (see Question 5) so that it becomes a 'one-stop- shop' for the public.

However, there is a wider issue to consider outside of peak smoke periods. Australian communities are commonly exposed to bushfire smoke and the health impacts are cumulative. Much of the health impacts occur at low-moderate concentrations of $PM_{2.5}$, even during bushfire episodes. For example, it is estimated that most of the deaths over the latest bushfire season did not occur on days with 'hazardous' air quality (in press)[11], yet very little attention or advice was provided to the public on these days. While consistent advice on extreme days is essential, this is not sufficient to reduce the serious impacts of bushfire smoke on the community.

CAR therefore recommends a comprehensive public education campaign on air quality that enables people to understand and mange periods of poor air quality in a way appropriate to their personal risk, and reduce the anxiety associated with extreme pollution days. In terms of personal risk, this could encompass ways to interpret reported air quality categories in light of personal circumstances. This is because there is considerable variation between

[11] See also a study from WA which found that fire smoke caused adverse health outcomes even at low concentrations: Borchers Arriagada, N., Palmer, A.J., Bowman, D.M. and Johnston, F.H., 2020. Exceedances of national air quality standards for particulate matter in Western Australia: sources and health-related impacts. *Medical Journal of Australia*

individuals in their sensitivity to smoke pollution, with high 'hazardous' concentrations not being necessarily dangerous for young healthy adults with no other risk factors.

A public education campaign has been also been recommended by the Public Health Association of Australia (PHAA) and would be analogous to the 'Sun Smart' campaigns of the 1990s. Ideally it would be a collaboration between air pollution researchers, public health agencies and not for profits, such as Asthma Australia, who have a wide reach into the community.

Key to the recommended campaign is understanding the best mechanisms to deliver public health information about poor air quality. However, we know little about the most efficient ways to deliver clear public health messages. CAR proposes therefore as a research priority (Question 6) to investigate the ways the public accessed and used health information during the last bushfire season. A particular focus should be on vulnerable groups such as older people, those with co-morbidities, children, pregnant women and outdoor workers. This would allow tailored but consistent advice to these groups and those caring for them such as primary health providers, childcare services, schools, aged care facilities and SafeWork Australia for the outdoor workforce.

Another focus should be on advice on strategies to minimise personal exposure to bushfire smoke such as the use of facemasks, air purifiers, air conditioners and staying indoors. The inconsistent messaging seen in the last bushfire season around their use is underpinned by the lack of evidence on their effectiveness. These interventions therefore require further research (Question 6) so that we can provide evidence-based health advice.

Clearly questions remain around 'what to say' and 'how to say it'. As a result, on Day 2 of our Landscape fire smoke workshop in October 2020 we will be discussing the following questions amongst researchers and policy makers:

- 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?

## Question 6: What should be the priority areas of research concerning the physical and mental health impacts of natural disasters?

Despite living in a continent that is frequently ravaged by bushfires and communities who are exposed to bushfire smoke, we known relatively little about their wider health effects. CAR received much media interest during the bushfire season on these health impacts. Some of these questions we were not able to answer with certainty because of a lack of research evidence. Below we present priority research areas to i) understand the community-wide health impacts of the 2019-20 bushfire season ii) investigate health impacts of bushfire smoke more generally iii) understand the best public health response to bushfire smoke

incidents (Table 4). Answering these questions are key to successful public health campaigns which protect our communities.

To our knowledge these questions have not yet been addressed under the recently announced MRFF research projects. For example, there is work currently underway to understand the effect of bushfire smoke at a cellular level through lab-based animal models and cell lines and tissues. However, there are no funded epidemiological studies to investigate the population-wide impacts of the latest bushfire season. That is, there are no studies which will investigate what happened in the 'real world' during the 2019-20 bushfire season. Similarly it appears that none of the MRFF projects will focus on much needed research on the long-term health impacts of bushfire smoke exposure, the potential role of low cost air cleaners to create cleaner air spaces, nor the public health response.

**Table 4: Priority areas of research for ascertaining health impacts of bushfire smoke**

| Theme | Research question | Detail | Notes |
|---|---|---|---|
| 1.**Exposure** | • What level and composition of air pollution were communities exposed to during the 2019-20 bushfire season? | • Detail the location, timing and composition of the bushfire smoke<br>• Produce high-resolution (1km$^2$) hourly and daily average maps of air pollution for affected communities | A pre-requisite to any subsequent health impact research below<br><br>CAR is the leader in techniques to derive these data. Other groups have approached us to source exposure maps for the 2019-20 season |
| 2.**Short-term effects** | • What health effects were seen shortly after communities were exposed to bushfire smoke?<br>• Which are the vulnerable groups?<br>• What were the effects after such prolonged exposure (weeks and months)? Are these different to when populations are exposed to just days of smoke? | • Using exposure maps above, investigate the relationship between smoke level and deaths, hospitalisations, ambulance call outs and respiratory symptoms<br>• Identify vulnerable communities and groups (such as those with | The issue of prolonged exposure is key. We have never been exposed to this level and duration of bushfire smoke |

| | | | |
|---|---|---|---|
| | | respiratory conditions, the elderly, pregnant women, children) | |
| 3.**Long-term effects** | • What are the lasting health effects of bushfire smoke exposure? | • Use well characterised cohorts with long follow up times to understand effect of the 2019-20 bushfire season<br>• Include cohorts with vulnerable populations | Key question which remains unanswered |
| 4.**Toxicological effects** | • Does bushfire smoke have the same health effects as other sources of air pollution?<br>• During the 2019-20 bushfire season, did location (and therefore chemical composition of smoke) change health outcomes? | • Lab-based toxicological experiments, and controlled exposure studies to understand the cellular and physiological effects of bushfire smoke<br>• Extending research in priority 2 to different locations and therefore different surrounding vegetation | This is an area we know little about. There was much in the media comparing cigarette smoking to exposure to bushfire smoke |
| 5.**Interventions** | • What mechanisms/tools can be used to minimise people's exposure to bushfire smoke?<br>• Do facemasks, air purifiers and medications work? | • Using an experimental smoke chamber suitable for human subjects is needed<br>• Variety of interventions to be tested: facemask, air | Will drive public health response and policy |

| | | | |
|---|---|---|---|
| | • Should houses be made more airtight?<br>• Do 'safe havens' work? | purifiers, sealing homes, pharmacological interventions | |
| 6.**Public health response** | • What is the best way to reach people about poor air quality conditions and interventions? | Work with the general public, vulnerable groups, communication and research translation professionals to understand how the community understood and used public health advice and information during the 2019-20 bushfires season | Essential for health departments and public health units to derive effective public health advice |

### 1. Exposure

The first step to understanding the health impacts of bushfire smoke is to describe the levels and composition of bushfire smoke pollution that communities were exposed to over the 2019-20 season. This is a key step to subsequent investigations to link levels of exposure to health outcomes. In essence, if we don't know what air pollution levels people were exposed to then we cannot draw any relationships with health outcomes.

This involves technical analysis using data from a variety of sources to produce high-resolution 'exposure maps' at the 1km$^2$ level.

### 2. Short-term effects

Our submission to the inquiry described research involving CAR's A/Prof Fay Johnston estimating that as many as 417 deaths and thousands of hospitalisations may have resulted from exposure to bushfire smoke during the last bushfire season. However, these data are derived from sophisticated computer modelling techniques where known relationships between air pollution and health impacts are used to derive a predicted number (rather than the actual) number of deaths and hospitalisations. It is important to know that as yet there has not been a nationwide epidemiological study on the latest bushfire event to uncover 'real world' effects.

There are therefore three questions which need to be addressed under this research priority:

- What were the health effects experienced directly after exposure to bushfire smoke during the 2019-20 season?

- What were the health effects of such prolonged exposure (weeks/months)? Are they different to shorter periods of exposure (days)?
- Who are most vulnerable to these effects?

These research questions would use smoke exposure maps (priority 1) linked to publicly available health data such as deaths, hospitalisations, respiratory symptoms and ambulance call outs. For pregnant women data as a vulnerable group data could include birthweight, gestational diabetes, prematurity and NICU admission.

### 3. Long-term effects

The long-term effects of bushfire smoke are a key unanswered question in this research field, and indeed one of the questions that we received much media interest about. As stated in our submission, most research 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. The only comparable research is limited to the Hazelwood Health Study, 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 mine fire in Victoria.

Research into the long-term effects of bushfire smoke could involve using well-characterised cohorts with long follow up times (examples include 45 and Up, Tasmanian Longitudinal Health study etc). The exposure of participants to bushfire smoke would be assigned using their addresses in the exposure maps in research priority 1.

### 4. Toxicological effects

During the 2019-20 season there was much comparison in the media between cigarette smoking and exposure to bushfire smoke. While both are a result of combustion, we do not know enough about the composition and health effects of bushfire smoke to draw many conclusions. There is therefore a need to answer the following question:

- Is bushfire smoke different to other sources of air pollution? Does $PM_{2.5}$ from bushfire smoke illicit different physiological effects than $PM_{2.5}$ from vehicle exhausts, coal fires, cigarette smoke etc?

This research question could be addressed by undertaking lab-based toxicological experiments to understand the cellular and physiological effects of bushfire smoke as compared to smoke from other combustion sources. It could also be addressed by comparing health effects (research priority #1 and #3) in populations located in different parts of the country. This is based on the premise that these populations live close to different vegetation types, leading to a different chemical makeup of bushfire smoke.

### 5. Interventions

Another major gap in our knowledge is evidence-based strategies to mitigate exposure to bushfire smoke. With climate change making protracted bushfire events and therefore smoke exposure more likely, understanding what works 'on the ground' is key to protecting our populations. The establishment of an experimental smoke chamber would allow the testing of interventions such as facemasks, air purifiers and pharmacological interventions in an experimental setting. To our knowledge there is no smoke chamber which has this capacity. Note that the University of Tasmania has an existing facility, but this is not currently equipped to test human subjects.

There is also a need to test interventions which can be deployed during protracted smoke periods. For example, the most common public health message during the 2019-20 bushfire season was to stay indoors with doors and windows closed, and to avoid outdoor exercise. While this is feasible during high smoke periods lasting days, it is not viable for periods of weeks and months as was seen during the latest bushfire season.

### 6. Public health responses

During emergency events such as the 2019-20 bushfire season, people access information from a variety of sources, from social media, government advisories, official media channels and word of mouth.

Currently, health protection interventions during bushfire smoke events primarily rely upon public advisories which are targeted at specific groups known to be at higher risk of adverse health effects. However, we have little evidence about how the public, and target groups, receive and understand information about poor air quality and health protection. The evidence underpinning much of the advice is patchy, and interpretation of the evidence is complicated.

There is therefore a need to work with stakeholders, especially vulnerable groups and communication specialists to understand current knowledge, attitudes and practices relating to personal health protection and air pollution. Vulnerable groups include older people, those with co-morbidities, children, pregnant women and outdoor workers.

This will help improve the reach and quality of public health advice to ultimately reduce the morbidity and mortality during high bushfire smoke events.

The research around this priority would investigate how the community understood and used public health advice and information during the 2019-20 bushfires season, and whether this information was effective.