Public health messaging during landscape fire smoke events

A synthesis review

June 2022

Acknowledgements

Citation

Executive summary

This report summarises content from recent publications focussed on public health messaging during landscape fire smoke events. Material for this report was synthesised from a literature review, and contextualised for the Australian setting through conversations with representatives from state government agencies responsible for developing public health information for fire smoke events.

The following key themes emerged from this synthesis.

1. *Delivery of public health messaging during landscape fire smoke events is standard government practice, with an established pathway for information delivery.* There is a clear understanding of the multidisciplinary and complex nature of these events due to interagency responses required for both fire and smoke hazards.

2. *There is little or no evaluation of how information is perceived or acted upon by the wider community.* While there is abundant literature on optimum content and delivery methods that increase engagement, there is a need for greater understanding of how public health messages may lead to health protecting actions and behaviours. We need to ask the question: Is this messaging successful in reducing the health burden of smoke exposure?

3. *There is little understanding of the types of resources or methods of delivery needed by key vulnerable groups.* Populations vulnerable to the health impacts of smoke exposure include those with existing medical conditions (especially respiratory and cardiovascular conditions), the elderly, the very young, pregnant women, and those that cannot seek shelter from smoke in their ordinary course of life (for example, outdoor workers and the homeless). When exposed to periods of landscape fire smoke, these groups carry a disproportionate burden of illness, experience greater personal impacts, and are overrepresented in health care costs. Furthermore, those with physical disabilities, including vision and hearing impairment, and those with a low level of English understanding or literacy, are at greater risk of not receiving commonly delivered messages if they are not communicated effectively and in a manner that can be understood.

This synthesis report identifies key research and policy needs based on these themes, with an emphasis on improving and enhancing existing communication methods and practices.

Background

Increasing frequency and length of landscape fire smoke events, both globally and nationally, has prompted a need for greater understanding of how the wider community perceives, understands, and acts on public health advice related to minimising smoke exposure and therefore protecting health. In the Australian context, the 2019-20 'Black Summer' fires further highlighted a number of local knowledge gaps related to public health messaging about these types of events. The Royal Commission into National Natural Disaster Arrangements (1) noted that 'there are confusing and unnecessary inconsistencies in some of the information provided to the public' (p.28) and that 'governments should educate people and provide accessible information to help them make informed decisions and take appropriate action' (p.21). Similarly, the NSW Bushfire Inquiry made two recommendations to improve public health messaging and air quality alert systems (2).

In light of these events, and the findings of the Royal Commission and NSW Inquiry, this review sought to understand the current state of existing knowledge, decision-making tools and research projects to better understand the immediate and ongoing research needs regarding public health messaging during landscape fire smoke events.

In Australia, state government agencies have primary responsibility for public health messaging during smoke events. National guidance for public health messaging during these events is provided through the document 'enHealth Guidance for public health agencies: Managing prolonged smoke events from landscape fires' (3) (the enHealth report). While this document was under development prior to the 2019-20 Black Summer fires, the impetus created by this event increased the urgent completion of a nationally consistent messaging framework, including messaging suitable for prolonged smoke events. The guidelines were endorsed and released in December 2021.

In addition to these guidelines, each Australian jurisdiction has a government agency website outlining bushfire smoke preparedness and response actions (see Table A1 in Appendix A).

Research questions

The main research questions under investigation through this review are:

1. How is information on the health impacts of poor air quality from landscape fires currently communicated to the general public at a national and international level?
2. What is the level of understanding of this risk in vulnerable population groups and the wider community (both nationally and internationally)?
3. Are there any local or international case studies or research demonstrating successful tools or resources for communicating air quality-related health risks?
4. Are there any local or international case studies or research demonstrating tools, resources or campaigns leading to behaviour change, resulting in reduced exposure to poor air quality?

Methods

We performed a literature search for papers published from 1 June 2020 to 20 April 2022, searching abstracts with the following terms:

- *fire* AND health mess* NOT firearm*
- *fire* AND communicat* NOT firearm*
- smoke AND health mess* NOT tobacco
- smoke AND communicat* NOT tobacco

Databases searched included PubMed, ProQuest and Web of Science.

The dates for inclusion were chosen to capture the most recent new research not included in two comprehensive reviews published in 2021 (4, 5). We also included studies cited in any retrieved papers if they directly addressed one of our objectives and were published in the study timeframe. To contextualise findings from the literature review, feedback was sought from two Australian state agencies responsible for public health communications during landscape fire smoke events. Feedback and reflection from these conversations is shared here with permission to provide greater relevance to the Australian context.

Key findings

A total of 33 published papers were retrieved, of which 14 were included following a full review of the paper. The majority of excluded papers assessed the health impacts of fire smoke while also mentioning public health messaging, but did not fully evaluate this messaging as a focus of the research.

Of the 14 papers included in this review, two were reviews (4, 5), two were workshop reports (6, 7) and ten were original research. The latter group comprised content analyses of agency messaging (8-10), qualitative studies of people affected by

serious smoke episodes (11, 12), community surveys (13, 14), an evaluation of alternative messaging related to fire smoke events (15) and two user evaluations of phone apps designed to communicate information about air quality to support individual action to protect health (16, 17).

Responses of representatives from two Australian agencies were synthesised and cited as personal communications (18).

All 14 papers included in the review (references 4-17) are listed in Appendix B, including publication type, location and key findings.

Research question 1

Key findings to research question 1 were developed into three distinct themes. Sources for these findings are identified by a reference number.

How is information on the health impacts of poor air quality from landscape fires currently communicated to the general public at a national and international level?

Communication channels and sources

- Common sources of agency messages in Australia and internationally include: TV, radio, newspapers, hotlines community meetings, websites, word of mouth and social media (4, 8, 9)
- There is increasing use of social media platforms (4), especially for women, younger and urban populations (5), with source preference changing by age, rurality and stage of disaster (4)
- TV and radio have greater uptake from older populations (5)
- Radio is vital in rural/remote communities, for tradespeople/outdoor workers and for Indigenous groups (4, 8)
- Direct and personal communications are preferred in rural and remote communities (5)
- Smartphone apps provide potential to target messages by location and vulnerability (5)
- There is opportunity for designated air quality reports by news outlets (8)
- For greatest uptake, information is best delivered from a pre-established and familiar source: Government (e.g. public health authorities, emergency services), trusted organisations (e.g. academic bodies, voluntary organisations), trusted community members (e.g. GPs) and trusted media (ABC) (4-6, 9, 11)
- There is an interest from agencies to expand existing approaches to deliver messaging (e.g. primary care networks) (6, 18)
- Where formal government channels are used, there are standard procedures in place with clearly outlined roles and responsibilities (18)
- There is a large reliance on media releases and social media platforms such as Facebook (18)
- There is a concentration on message platforms that are likely to 'get the most exposure to the most people' (18)

Message content

- A trusted source origin (see above) increases uptake (5, 10) including use of clear branding (4)
- For greatest uptake, messages must include clear guidance, timeframes, locations, specific hazard(s), information source and provision of local context (4)
- Messages should include content for at-risk/higher risk individuals, culturally appropriate information, and be available/accessible (4)
- Messages should contain updates rather than directives (4)
- For greatest uptake, messages need to be clear, short, reliable, specific, simple, practical, understandable, accurate, factual, timely, unbiased, certain, locally relevant, free from jargon and use consistent language (4, 5, 8, 9, 11)
- Negligence, inconsistency, poor timing or exaggeration in messaging lowers trust and engagement (5)
- Messages should address the compounding health issues of prolonged smoke events (reduced physical activity, staying indoors in heat, indoor air pollution) (5)
- Through some channels, message content misinformation is high (7)
- Messages should communicate health impacts to be relevant to the public (13)
- Messages are more credible when risk of exposure is explained and acknowledged (15)
- There is little in the way of preparation messaging delivered for bushfire smoke, although this does exist for heatwaves at the start of summer (18)

Optimisation of messages

- Distribution across as many platforms as possible (and a combination of multiple platforms) increases uptake (4, 5, 11)
- Using different media at different stages of the disaster (pre, during, post) increases community resilience (4, 9)
- Dialogue between authorities and the public is useful during the event (4, 9), although this is rare (9, 18)
- Providing more frequent information prior to the disaster increases preparedness, especially to vulnerable groups (4, 5, 8)
- Lower educational attainment hampers understanding of messages (8)
- There is usefulness in differentiating between fire threat and smoke threat warnings to different locations and target groups (11)
- Framing messages from the public's perspective increases uptake (15)
- Media releases and warnings are of a discretionary nature, based on temporal/spatial context; for example, there may be less attention given to smoke where there is a greater risk of immediate threat from concurrent events, such as bushfires or heatwaves, or background events such as Covid (18)

Research question 2

While the published literature demonstrated there was high recognition of the need to provide tailored information (including translated messages) to specific at-risk groups (4, 5, 7, 8) there was little evidence that this was actively delivered as standard practice (18), with a low consideration of equity of access to materials

What is the level of understanding of this risk in vulnerable population groups and the wider community (both nationally and internationally)?

(18). However, this tension was acknowledged, with the enHealth report providing messaging guidance for 'sensitive people' (3, 18). As an exception, specific messaging was provided to childcare centres, schools and GPs over Black Summer (18).

Similarly, while there was recognition that communication to vulnerable populations through trusted sources should commence in advance of the fire season (allowing increased time to act) (5), there was little evidence this was delivered. Social inequity was acknowledged as a barrier in responding to preparedness messages (7).

Outdoor workers were identified as a group with specific needs, as the ability to protect health was dependent on supervisor or workplace culture, and often limited to protection options versus workplace safety (14). Furthermore, the risk to those with lung conditions was more broadly recognised, and less so for those with heart conditions (18).

Research question 3

The literature review identified one example of a specific tool/resource for communicating the risk of smoke exposure during landscape fire events. Humphreys et al. (12) provided a template for content, distribution location, medium and method for a smoke and wellbeing toolkit based on findings of a qualitative study that included

Are there any local or international case studies or research demonstrating successful tools or resources for communicating air quality-related health risks?

community members and agency representatives who had experienced smoke events (see Figure 1). Recency of publication of this template precludes an evaluation of efficacy, although modification and application in the Australian context would appear possible.

Content	Distribution location	Medium	Messenger

• Health and social service organizations
• Free filter programs
• Resources and/or training to prepare healthcare workers to communicate about WFS events
• Stress reduction and the importance of prosocial interactions
• Links to scientific studies and organizations
• Indoor community clean air space (does not yet exist)
• Hotline for connection with resources or information (does not yet exist)
• WFS impacts on asthma
• Mask wearing and when to seek medical attention
	• Community centers
	• Healthcare clinics
	• Libraries
	• Churches
	• Pool
	• Restaurants/Cafes
	• Markets and stores
	• Museum
	• Post office
	• Schools
	• Senior centers
	• Local service providers
		• Flier/brochure/pamphlet
		• Online website
		• Both online and print
		• Three-ring binder
		• Development of a hotline
			• Local social or health service providers
			• Social media
			  • TikTok (youth)
			  • Facebook
			• Bulletin boards
			• Newspaper
			• Radio station
			• Public outreach
			• Youth outreach

Figure 1: Suggested content, distribution location, medium, and messenger for a wildfire smoke and wellbeing toolkit (adapted from 12)

Research question 4

We identified three case studies of resources and tools that demonstrated potential for stimulating behaviour change during poor air quality events.

Are there any local or international case studies or research demonstrating tools, resources or campaigns leading to behaviour change, resulting in reduced exposure to poor air quality?

The AirRater smartphone app was developed by the University of Tasmania and is available free of charge across Australia (19). AirRater provides users with timely and location-specific information on particulate matter ($PM_{2.5}$) and temperature, sourced from government agency air quality monitoring networks. Pollen information is also available in some locations. AirRater encourages users to enter their health symptoms related to exposure from environmental hazards (for example, sneezing, headaches or breathing difficulties), helping users to identify potential triggers over time. The app was evaluated after extensive uptake during the Black Summer bushfires, with evaluation findings demonstrating that users engaged the app to inform their decision-making on activities during the smoke-affected period (16). Behaviours included staying inside, rescheduling or planning outdoor activities, changing locations to less affected areas and informing decisions on medication use.

The SmokeSense smartphone app was developed by the US EPA, and is available across the United States (20). Similar to AirRater, SmokeSense provides users with timely and location-specific information on air quality ($PM_{2.5}$ and ozone) and encourages users to report their health symptoms related to the environment. SmokeSense also provides information on how to protect health during prolonged

smoke events. Data provided by SmokeSense participants has been evaluated to provide further insight into perception of health risk from smoke, and motivating behaviours to provide health protection based on perspective trait (17).

The 'Love My Air' campaign is located in Denver, Colorado, USA (21). This campaign consists of community and school-based education programs, deployment of low-cost sensor networks, online dashboards, and a phone app. It aims to "empower Denver's communities to live better, longer by reducing air pollution and limiting exposure through behavior change, advocacy, and community engagement". The goal of the campaign is to reduce exposure to air pollution from all sources, not exclusively landscape fires. The program has been in place since 2018, and includes a 'replication toolkit' to launch the campaign in other locations. At this point there does not appear to be any published evaluations of the program.

Other key observations

Conversations with agency representatives raised the following additional points.

- It was recognised that multiple and complex partnerships exist between health agencies, environmental monitoring agencies and fire and emergency services agencies, highlighting the complex and interdisciplinary nature of landscape fire smoke events.
- There was general acknowledgement of a lack of understanding about the health impacts of prolonged smoke events, both at a public and policy level. This lower level of recognition may lead to decreased justification for advanced preparedness messaging (for example, when compared to extreme heat preparation and messaging information). Similarly, smoke events are less common than heatwaves, so there is less perceived value in issuing preparation messages for smoke events.

Identified research and policy needs

Based on outcomes of the literature review, and from conversations with agency representatives, we identified several research and policy needs for Australia. These were mainly themed around evaluating and understanding current methods of communication, with a view to developing enhanced and optimal communication delivery pathways and tools, especially to vulnerable people.

Future research

1. Conduct comprehensive evaluations of existing public health messaging efficacy, uptake, accessibility and understanding: Who receives messages, through which channel, and are these acted upon or perceived as credible? How is technical information best delivered? How is hard copy printed or verbal information related to and perceived?

2. How are vulnerable populations engaging with smartphone apps, radio and information provided through health care agencies/providers? Are there other avenues to engage vulnerable populations?
3. Epidemiological research is needed to fill gaps in basic knowledge. For example, what is the health impact of medium-term fire smoke events, and how can agencies best adapt content and delivery of practical guidance for these of events as opposed to short-term events?

Policy interventions

4. Develop additional tailored resources and delivery methods for at-risk populations, specifically people with disabilities (including those with visual and hearing impairments), CALD populations, children, outdoor workers and those who are homeless.
5. Improve integration of fire and smoke messages through interagency collaboration.
6. Develop additional tailored resources for GPs, clinicians and other providers who work directly with people in higher risk groups.

Conclusion

This report provides a synthesis of the current and emerging research on the use and understanding of air pollution information as relating to landscape fire smoke events. Research and policy needs were identified and will be used to inform future Hub co-design processes.

References

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Appendix A: Current Australian public health messaging for smoke events

Table A1: Australian jurisdictional websites for smoke exposure preparedness and response

New South Wales

www.health.nsw.gov.au/environment/air/Pages/bushfire-protection.aspx

Victoria

www.epa.vic.gov.au/your-environment/air/smoke/bushfire-smoke-and-your-health

Queensland

www.qld.gov.au/health/staying-healthy/environmental/after-a-disaster/bushfires/bushfire-smoke-and-your-health

South Australia

www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/public+health/bushfires/bushfire+smoke+and+your+health

Australian Capital Territory

www.health.act.gov.au/public-health-alert/heavy-smoke-and-hot-conditions-act#heavysmoke

Tasmania

www.health.tas.gov.au/health-topics/environmental-health/air-quality

Northern Territory

www.health.nt.gov.au/news/smoky-conditions-health-alert

West Australia

www.healthywa.wa.gov.au/Articles/S_T/Smoke-hazard-from-bushfires

Appendix B

Reference	Publication type	Location	Key findings
Heaney et al. 2021 (4)	Review		**Communication methods and sources** • Heavily used or common methods include: TV, radio, newspapers, hotlines, community meetings, websites, word of mouth. • Radio especially vital in rural and remote communities. • Distribute across as many platforms as possible or use a combination of platforms to increase delivery/uptake (both social and traditional) • There is an increasing importance to social media (especially Facebook and Twitter), including retweeting/sharing from trusted sources (e.g. emergency response orgs) • Real-time dialogue between authorities and public is useful • Trusted sources include Govt, trusted individuals, academic bodies and voluntary organisations • Better uptake if use different media at different stages of disaster (pre, during post) • Distinct source preferences by age, rurality, stage of disaster (pre, during, post) • Word-of-mouth is common across age, culture, country **Optimisation of communication** • Crucial information to include: clear guidance, timeframes, locations, specific hazard(s), information source, provision of local context. Include messaging for at-risk/higher risk individuals, culturally appropriate and available/accessible • Updates rather than directives • Guide public towards actions that prioritise health and safety • Inclusion of source hyperlinks does not increase engagement • Clear, specific, accurate, certain and consistent language increased uptake, free from jargon

Reference	Publication type	Location	Key findings
			• Disaster/hazard described in a manner that highlights health and wellbeing impact. • Terms including 'evacuate', 'now' and 'update' increase uptake • Information needs to be factual, timely and unbiased, consistent over time (explaining changes from previous messages), avoid conflict of information, be clear across administrative boundaries (eg state lines), and consistent across information sources • Terms that induce panic/fear to be avoided • Use clear branding from official sources • Allow dialogue for relevant questions • Utilisation of social media and websites prior to disasters to increase disaster literacy/preparation • Provide info before a disaster occurs • Provision of information to specific at-risk groups (those with pre-existing conditions, older, younger, pregnant, Indigenous) have potential to provided improved health outcomes. Limitations • Limited resources for at-risk populations (those with disabilities, CALD, children). Although information for these groups is similar, the delivery methods need to be tailored (e.g. language specific). • Appropriate information for visually impaired and hard-of-hearing populations is rare • Misleading (fake) information is common • Structural communication failures (power outages, website failures, overwhelmed call centres) hamper delivery • Findings and recommendations from this review may be less reflective of lower/middle income and/or more linguistically/culturally diverse countries in Europe, South America, Asia, and Africa, given gaps in research location and populations represented
Keegan et al. 2021 (5)	Review	International	• A variety of channels is best (traditional and modern) • Locally relevant information is important

Reference	Publication type	Location	Key findings
			• Health messaging to commence in advance of bushfire season to susceptible populations
			• Short messages, with non-technical advice, were recalled and complied with more easily, augmented with visual clues
			• Improve consistency of messages/interagency collaboration needed e.g. AQ indices reported
			• There is high trust in government health authorities
			• Messages need to be targeted to vulnerable groups e.g. homeless/outdoor workers
			• More research on efficacy of messages is needed
			• There is potential for apps to provide targeted messages
			• Trust is critical: negligence, inconsistency, poor timing or exaggeration lower trust
			• TV has widest reach
			• Increasing preference for online and apps among younger, women and urban residents
			• Older populations use traditional comms radio or TV
			• Direct and personal comms in remote and rural communities are preferred
			• Commence comms to vulnerable pops at lower threshold (time to act) and in advance of season
			• Address compounding health issues of prolonged smoke events (reduced physical activity, staying indoors in heat, indoor air pollution) Gaps in understanding include: • how people interpret and respond to content • how best to deliver relevant technical information, such as using air-conditioners on reverse cycle, air filters or respirator masks • preference for and actual use of all comms channels • how susceptible populations are engaging with relevant smartphone apps, information provided through health and care service providers and radio. • how to adapt content and delivery in consideration of increasing duration of smoke events (e.g. how to facilitate susceptible populations to carry out daily activities whilst minimising exposure)

Reference	Publication type	Location	Key findings
			• lack of data on the health impacts of landscape fire smoke in medium-term exposures

Rice et al. 2021 (6)	Workshop report	United States	• Provision of clear and consistent messaging is needed on:
			    ○ risk variation among individuals
			    ○ smoke posing a health risk to all
			    ○ that preparedness and prevention can minimise harm
			• Messages from trusted sources, e.g. clinician/GP are useful, although few GP focused resources exist
			• Public health agencies can educate local authorities and/or equip them with resources to advise health risks/mitigation strategies
			• There is a need for forecasts of short- and long-term smoke conditions and health risks, within specific geographic regions
			• Comms through familiar and trusted sources is essential to be effective

Cowie et al. 2021 (7)	Workshop report	Australia	• Public health advice provided in 2019-20 (Australian Black Summer) was impractical as tailored to short-term events • Lack of adequate public health information impacted on individual's ability to reduce smoke exposure • Recognised tension between provision of broad scale public health messaging or targeted messaging to vulnerable groups. Overall, target advice recommended • Different time frames of exposure complicate messages • Dissemination of information is based on crisis communication. Too much information can erode efficacy of messaging • Levels of misinformation around risk is high • Social inequity reduces capacity of individuals to respond
Shellington et al. 2022 (8)	Research – Survey evaluation of public health communications concerning wildfire smoke events	Canada	• Common sources of information include internet, social media, radio and TV • Radio is important for tradespeople, Indigenous people, and for people living in smaller population centres • People with lower educational attainment have a poorer understanding of messages • Recommendations for improvement include:

Reference	Publication type	Location	Key findings
			o designated air quality reports by news outlets o tailored messages for specific communities o more frequent messaging before and during fire season o simplified messages, with additional details online o translation of messages to native and immigrant languages, especially for outdoor/farm workers
Atkinson et al. 2021 (9)	Research - Content analysis of social media posts by public agencies	Australia	• Key trusted organisations/sources during a crisis include government agencies (emergency services organisations, rural fire services) and ABC • Sustained engagement and communications prior to, during and after an event leads to greater community resilience • During an event, a dialogic (two-way), rather than a didactic (one-way) style is preferred to build trust/confidence and therefore promote improved outcomes • For social media uptake during a crisis, organisations need to have a strong pre-established presence on multiple platforms. In times of crisis, people go to a source they are already familiar with and trust • Best-practice crisis communication is based on community engagement principles and practices, which means extensive community involvement during all phases of the crisis life cycle • Govt use social media purely as a one-way communication channel, not for increasing participation, collaboration or resilience
Van Deventer et al. 2021 (10)	Research - Content analysis of smoke risk communications by government	United States	• Health risk information is the most dominant message type • There is less information communicated about personal interventions (e.g. advice to change activity, close doors and windows, wear masks) and administrative interventions (e.g. cancellation of events) • HEPA filters get very low mentions • No mention of evacuation • Some information addressed to vulnerable populations, except homeless • Consistency (especially with reference to air quality index used) could be improved • Lack of understanding about who received messages/whether these were acted upon/perceived as credible

Reference	Publication type	Location	Key findings
Marfori et al. 2020 (11)	Research - Qualitative analysis of interviews with fire-smoke affected individuals	Australia	• High acknowledgement of personal impacts of smoke exposure (physical, psychological and social) • There was tension between fire and smoke warnings/risk/threats. Media reporting and public acceptance that fire was the greater risk • Importance of differentiating fire and smoke hazards was not well understood • Seeking smoke information was incidental/secondary to seeking fire threat information • There were multiple sources of smoke-related information (social media through formal and informal channels), with strong emphasis on ABC radio as an official source • Mistrust of some sources on social media, with government and trusted community members receiving greater trust • Single source information was sought • Simple and understandable messages that reached vulnerable people were highly appreciated • Some new or additional information (e.g. how smoke affected health, or information on impacts on non-vulnerable populations) would have been useful • Some advice arrived too late to be effective/useful • Some advice not viewed as practical (e.g. relocation) • Literacy of AQ information was low, misunderstanding of AQ 'numbers' was high • Fire protective information clashed with smoke protective information (e.g. clear hazards around property vs stay indoors). • Recommendation: fire and smoke messaging needs to be better integrated
Humphreys et al. 2022 (12)	Research – Focus groups with community members recently impacted and key informant interviews with representatives from social services	United States	• Development of template for content, distribution location, medium and method for smoke and wellbeing toolkit.

Reference	Publication type	Location	Key findings
Williamson et al. 2022 (13)	Research - Survey of smoke-affected residents after extreme fire smoke event	Australia	• Health impacts need to be communicated clearly, including how to protect health • More can be done to assist vulnerable communities (identify, track and support vulnerable and socially isolated people)
Riden et al. 2020 (14)	Research - Qualitative analysis of interviews with vulnerable individuals (outdoor workers)	United States	• Outdoor workers (farm workers) are highly vulnerable to the health impacts of poor outdoor air quality, given their time outdoors, and the increased likelihood of being part of a casual workforce • Farm workers believe heat is a greater hazard than poor air quality • They understand that poor air quality has implications for health. • They have poor understanding of mitigation (e.g. mask use), and poor implementation even when supplied with masks by employers (barriers due to heat and discomfort) • Ability to protect health was dependent on supervisor/employer attitudes and workplace culture. Workers were unwilling to stop work if feeling ill, as need for money was greater than health concerns • Workers had a fear of losing work if they were insistent on protection or thought they should stop due to health concerns • Workers do not receive training on protection/worker rights/health and safety • Health promotion efforts, supported by employers, may be of benefit • Regulatory bodies overseeing employment conditions would be necessary
Claassen et al. 2021 (15)	Research – Consumer responses to public health messages provided for six different hypothetical smoke scenarios	The Netherlands	• Critical to take public perspective into account (i.e. frame message from the public's perspective) • Messages are considered more credible and consistent if the risk of exposure is explained and acknowledged, e.g. 'stay clear from the smoke, all smoke is harmful' • Risks associated with forest fires are perceived as less than those from a chemical fire
Campbell et al. 2021 (16)	Research - Survey of app users after extreme fire smoke event	Australia	• Most survey respondents (approximately 60%) found the app 'extremely useful', 'very useful' or 'quite useful' in managing symptoms associated with smoke during the event

Reference	Publication type	Location	Key findings

			• Almost all respondents (95%) reported they changed their behaviour as a result of information supplied in the app. For example:
			   o stayed indoors
			   o closed or opened windows
			   o rescheduled or planned outdoor activities
			• Respondents also reported being more aware of the link between air quality and health, making informed decisions about their medications, and talking to a health care professional

Hano et al. 2020 (17)	Research – Analysis of smartphone app user data to evaluate readiness to implement change behaviours	United States	• Five different 'perspective traits' were identified based on user perspectives of smoke risk to health • Different messaging needs were identified for each group