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Understanding the impact of bushfire on people with chronic diseases

A systematic review

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Executive Summary

Objective of the rapid review	The objective of this rapid review was to critically examine the literature to understand the impact of bushfire on people with chronic disease.
Specific review objectives	1. Describe the impact of bushfires on people with chronic diseases 2. Identify the chronic disease that put people at greater risk during bushfires 3. Identify strategies for reducing the impact of bushfires on people with chronic diseases
Methodology	A systematic review of the literature was undertaken to provide a synthesis of the available research evidence related to the impact of bushfire on people with chronic diseases.
Evidence sources	A total of nine articles were included in the review, five of which were secondary evidence (one systematic review and four literature reviews), one was a newspaper report, and the remaining three were primary quantitative evidence (observational study design).
Answers to review objective 1	Relevant articles described the impact of bushfire on people with the following chronic conditions: asthma, chronic obstructive pulmonary disease (COPD) and cardiovascular disease. Increased hospital admission or emergency visit, exacerbation of symptoms, increased use of rescue medication and dispensation of drug, and elevated sputum eosinophils were reported for individuals with asthma following their exposure to bushfire smoke. Similar adverse health outcomes were observed for individuals with chronic obstructive pulmonary disease (COPD). Increased mortality in individuals with pre-existing pulmonary diseases or COPD was also reported. On the other hand, the association between bushfire exposure and cardiovascular disease was unclear, with some studies describing a positive relationship whereas others reported no clear associations.
Answers to review objective 2	Certain population groups were identified to be at a particular risk for developing adverse outcomes following exposure to bushfire pollution. Individuals with chronic conditions such as asthma and other respiratory diseases are at an increased risk of experiencing symptoms from smoke exposure. Individuals with cardiovascular disease may also be at risk; however, the evidence from the literature is less conclusive.
Answers to review objective 3	Only four of the nine articles reported strategies for reducing the impact of bushfire on chronic diseases. Public health strategies, policy framework and use of protective equipment (e.g. face mask) were described. An action plan and some important considerations in response to acute events have

	also been described.
Gaps in literature	Significant gaps in the literature were identified including: limited evidence base relating to the impact of bushfire on other chronic conditions such as cancer, diabetes, and renal conditions; lack of consistency in the literature regarding the effect of bushfire on individuals with cardiovascular diseases; lack of research evaluating and comparing health outcomes during the 'very acute' and 'acute exposure' to bushfire, including long term outcomes; limited information about the degree or level of pollution that can cause adverse health effects. Research evaluating the effectiveness of strategies to reduce the impact of bushfire on health outcomes is also needed.

Introduction

Background

Bushfire is an inevitable occurrence in Australia. Climate change indicates that Australia is likely to become hotter and drier in the future, and therefore episodes of bushfire weather is expected to become more frequent (Lucas et al. 2007). A study which examined the potential impact of climate change on fire weather at 17 sites in southeast Australia indicated that the number of 'very high' and 'extreme' fire danger days could increase up to 4-25% by 2020 and 15-70% by 2050 (Hennessy et al. 2005). These events have raised concerns about the adverse health impacts of bushfire exposure.

Exposure to bushfire can pose a threat to an individual's health, both in the short term and in the long term. For example, during bushfire, large amount of air pollutants such as carbon monoxide, nitrous oxides, hydrocarbons, particulate matter and volatile organic compounds are released (Dennekamp & Abramson 2011), which may compromise the respiratory health of healthy individuals and those with pre-existing conditions. There have also been a few studies which reported increased mortality as a result of bushfire smoke exposure (Kochi et al. 2011). Other health effects of bushfire include physical trauma, dehydration, burns, heat-induced illness, cardiovascular effects, ophthalmic effects and psychological trauma (Finlay et al. 2012). These outcomes will not only impact on the health experiences of individuals but will also have significant implications on the Australian health care system because of the increased demand on health services and local resources.

Understanding the potential health effects of bushfire particularly to those with chronic health conditions is becoming increasingly important. Although there is a growing body of research around the ill-effects of bushfire, there is still lack of good quality evidence concerning the health impacts of bushfire. Understanding the effects of bushfire can help ensure that health services are sufficiently equipped to manage the health outcomes associated with bushfire exposure.

Objective and review questions

The objective of this systematic review is to summarise the evidence regarding the impact of bushfire on people with chronic conditions and determine strategies that can reduce the impact of bushfire in this population. The specific review objectives are:

1. To describe the impact of bushfires on people with chronic diseases
2. To identify the chronic disease that put people at greater risk during bushfires
3. To identify strategies for reducing the impact of bushfires on people with chronic diseases.

Methodology

Approach

The systematic literature review was undertaken using a rigorous systematic approach to provide ADEA with a transparent process underpinning the systematic review process (as shown in Figure 1). The review drew evidence from a number of diverse but equally relevant sources and methodological designs (e.g. reviews, quantitative, qualitative studies, etc.).

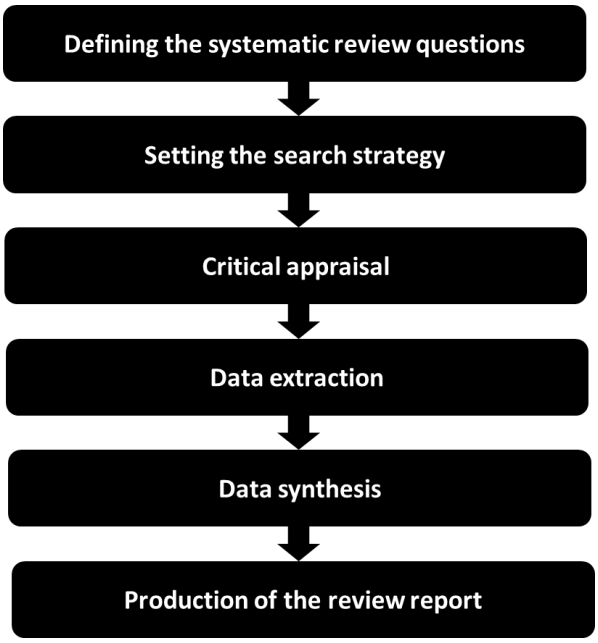

Figure 1: Flowchart of the rapid review process

Criteria for considering studies in this review

Specific criteria for inclusion in the review will be considered using the PECOT framework (Population, Exposure, Comparison, Outcomes, Time). Only articles published in the English language will be included in the review, with no publication date restriction.

***P**atient population*

Adults with chronic conditions including cancer, cardiovascular disease, chronic respiratory disease, diabetes and renal disease (Note: These conditions were selected on the basis that they are the chronic diseases with the highest burden in Australia and those at greatest risk during the first four weeks after a disaster, the 'acute phase' (Health Council of the Netherlands 2006)).

***E**xposure*

Any study or article which reports about the impact of bushfire on people with a chronic disease, or describes a strategy for reducing the negative impact of bushfire were considered

***C**omparison*

Not applicable

Outcomes	A range of outcomes were considered including: • Health (symptoms, complications, hospital admissions, etc.) • Self-management skills • Preparedness
Time	Short and long term impact
Type of studies	Peer-reviewed journal articles including reviews, experimental studies, observational studies, qualitative studies, case studies, commentaries, discussion papers, and concept papers; grey literature was also considered. Conference abstracts were excluded.
Search strategy	In order to ensure methodological rigour in the searching process, two independent reviewers examined all available data sources to maximise the scope of the search and to reduce errors/bias in accessing evidence
Peer reviewed databases	OVID (Medline, PsychINFO, Embase), EBSCOhost (Academic Search Premier, Australian and New Zealand Reference Centre, CINAHL, Psychology and behavioural sciences), Health and medical complete, Scopus, and Web of Science
Pearling	Reference lists of retrieved articles were searched to maximise the retrieval of relevant publications.
Grey literature	A grey literature search in Google was also undertaken.
Key words	A combination of search terms from concepts 1 and 2 was used to identify relevant publications from the included databases.

Concept 1	**Concept 2**
Bushfire	Chronic disease
bushfire wildfire forest fire	chronic disease (illness/condition) cancer diabetes renal cardiovascular cardiorespiratory

Appropriate truncation symbols, wildcards and Boolean operators (AND, OR, NOT) were used for relevant databases.

Literature selection	The titles generated by the electronic databases were scanned to identify potentially relevant papers and where titles did not allow determination of relevance to the topic, abstracts were reviewed. Full text copies of potentially relevant papers, based on title and abstract, were retrieved for a more detailed examination against the inclusion criteria. Only

publications which met all the inclusion parameters were considered in the review.

Critical appraisal

Two reviewers independently appraised the methodological quality of all included articles. The Assessment of Multiple Systematic Reviews (AMSTAR) tool (Shea et al. 2007) was used to appraise systematic reviews and the McMaster Critical Appraisal Tool for (Law et al. 1998; Letts et al. 2007) for primary quantitative studies. Differences in opinion were resolved by discussion.

For literature reviews, as there is no critical appraisal tool available for such articles, no formal critical appraisal process was undertaken.

Data extraction

Customised data extraction forms were developed for this rapid review; key elements considered pertinent to the review objectives and questions were extracted. Data domains extracted from each review include:

- Evidence source (author, publication year, country of origin, research design)
- Characteristics of the participants
- Health outcomes assessed
- Short term impact and long term impact of bushfire
- Strategies reported to reduce impact of bushfire on chronic disease
- Effectiveness of strategies

Data synthesis

The findings from individual studies were synthesised descriptively in a narrative summary and emergent findings were reported.

Results

Search results

The search strategy identified a total of 836 publications which were reviewed by *i*CAHE researchers. After removal of duplicates (199), review of titles and abstracts resulted in the exclusion of 91 articles. Twenty one articles were retrieved for full examination. After scrutiny, 12 were further excluded, leaving 9 articles for inclusion in the systematic review. Figure 1 shows the process involved in the selection of articles for this review.

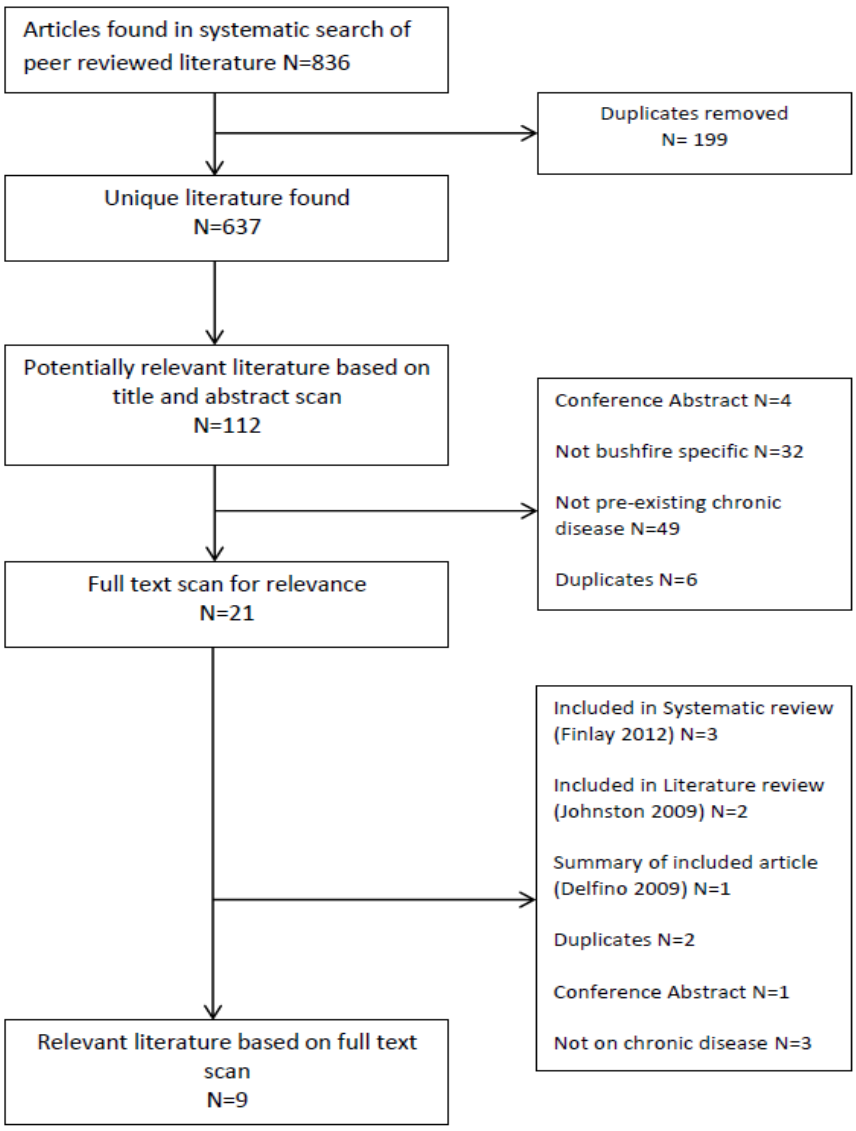

Figure 1: Flowchart of the study selection process

Characteristics of included studies

All studies included in this review were published from the year 1999 to 2013. One newspaper report was published in 1999 (CDC 1999), one study in 2006 (Reisen & Brown 2006), one study in 2008 (Hanigan, Johnston & Morgan 2008), two studies in 2009 (Johnston 2009; Reisen & Brown 2009), three studies in 2012 (Finlay et al. 2012; Henderson &

Johnston 2012; Rappold et al. 2012) and one study in 2013 (Martin et al. 2013).

Of the included primary studies two conducted their research in Australia (Martin et al. 2013; Hanigan, Johnston & Morgan 2008) and one in America (Rappold et al. 2012). The systematic review by Finlay et al. (2012) included studies which reported wildfires in Indonesia, Malaysia, Singapore, Lithuania, Canada, California, Australia, Russia, Finland, Greece, Spain and England. Of the four literature reviews, Henderson and Johnston (2012) discussed studies from Greece, Spain, California, Canada, America and Australia; Johnston (2009) explored studies from Australia, America and the Netherlands and Reisen and Brown (2006 & 2009) evaluated the health impacts of bushfires in North America, Australia and South-East Asia.

Five of the included studies were secondary evidence, of which one was a systematic review (Finlay et al. 2012) and the other four were literature reviews (Henderson & Johnston 2012; Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009). One of the included studies was a newspaper report (CDC 1999) and the remaining three were primary quantitative evidence with observational study design (Martin et al. 2013; Rappold et al. 2012; Hanigan, Johnston & Morgan 2008).

Methodological quality of included studies

Secondary research

There was one systematic review (Finlay et al. 2012) included in this report which was appraised using the AMSTAR tool. The review provided a 'priori' design, performed a comprehensive literature search, had no conflict of interest and used appropriate methods to combine the findings of the included studies. However the review did not provide a list of the included studies, outline the characteristics of the included and excluded studies, report on the quality of the included studies, use the quality measure to report on the conclusions and assess the likelihood of publication bias. In addition, it was not possible to tell if the review had duplicate study selection and data extraction or if the status of the publication used as an inclusion criteria.

There were four literature reviews (Henderson et al. 2012; Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009) and one magazine article (CDC 1999) included in this report which were not subjected to critical appraisal.

Primary research – quantitative studies

The three primary quantitative studies (Hanigan, Johnston & Morgan 2008; Martin et al. 2013; Rappold et al. 2012) included in this report were appraised using the McMaster critical appraisal tool for Quantitative

studies (Letts et al. 2007).

All three studies stated a clear purpose, described relevant background literature, had a design appropriate to the research question and described the sample and intervention in detail. All reported results in terms of statistical significance, used appropriate analysis methods and reported the clinical importance of the results. The sample was not described in detail in any of the included studies. Informed consent was obtained in all studies except one (Rappold et al. 2012) which did not report on this criterion.

Reliability of the outcome measures was not reported in any of the studies while validity was reported in one study (Hanigan, Johnston & Morgan 2008). The criteria that were not applicable to the any of the studies due to their design were intervention description, clinically meaningful difference between groups and participant drop outs during the course of the study. Conclusions were appropriate give study methods and results in all studies except one (Hanigan, Johnston & Morgan 2008).

Evidence mapping

Table 2 shows the evidence base mapped against the review questions.

Table 2: Evidence map

No		*Q1* Impact of bushfire on people with chronic disease	*Q2* Chronic disease at greater risk during bushfire	*Q3* Strategies for reducing the impact of bushfire
1	CDCP 1999	✓	✓	
2	Finlay et al 2012	✓	✓	✓
3	Hanigan et al 2008	✓	✓	
4	Henderson & Johnston 2012	✓	✓	
5	Johnston 2009	✓	✓	✓
6	Martin et al 2013	✓	✓	
7	Rappold et al 2012	✓	✓	
8	Reisen & Brown 2006	✓	✓	✓
9	Reisen & Brown 2009	✓	✓	✓

Describe the impact of bushfires on people with chronic diseases

Overview of evidence

Nine articles of varying quality and research designs described the impact of bushfire on people with different chronic conditions including asthma, chronic obstructive pulmonary disease (COPD) and cardiovascular disease (Finlay et al. 2012; Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009; Henderson & Johnston 2012; Hanigan, Johnston & Morgan 2008; Martin et al. 2013; Rappold et al. 2012; CDCP 1999).

Figure 2 summarises the findings on the impact of bushfire on people with chronic diseases.

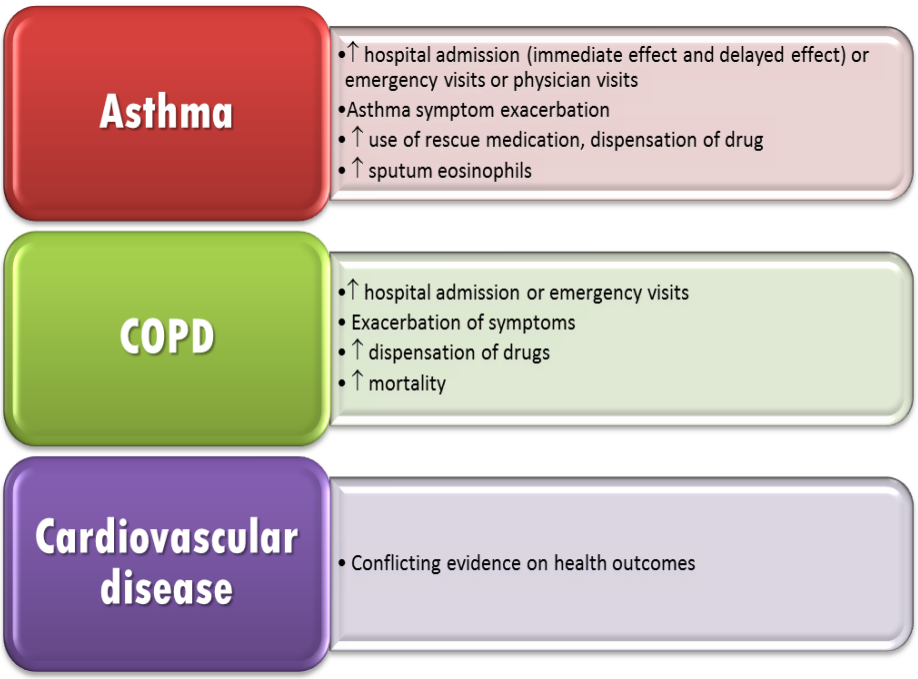

Figure 2 Summary of findings

Asthma

In patients with ***asthma***, a positive association between exposure to particulate matter from bushfire and respiratory signs and symptoms was consistently reported in the literature. For example, the review by Finlay et al (2012) found an increase in adult asthma-related admissions with raised particulate matter (PM10) levels from bushfire smoke. Adverse effects from increased PM10 particles were also reported for children with a history of wheeze (Finlay et al. 2012). Delayed effects have also been postulated as increases in hospital attendances for respiratory conditions and asthma peaked a month after vegetation fire started (Finlay et al. 2012). Four other reviews showed asthma exacerbations and increased hospital and emergency visits with elevated levels of particulate matter from bush fire or forest fire (Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009; Henderson & Johnston 2012). Henderson & Johnston (2012) also described other objective signs of asthma attacks following exposure to forest fire smoke, including an increase in the use of rescue medication and dispensation of drug, elevated

	sputum eosinophils, and more frequent physician visits. Two observational studies in Australia demonstrated positive associations between asthma admissions and same day estimated ambient PM10 (Hanigan, Johnston & Morgan 2008; Martin et al. 2013). Martin et al. (2013) reported that same day asthma admissions increased by 12% [OR: 1.12, 95% CI: 1.05-1.19]. Hanigan, Johnston & Morgan (2008) also reported an increase in asthma admissions the day after the exposure, with 16.27% increase for Indigenous patients and 8.54% for non-Indigenous patients. In another study, the strongest association was observed on the day of exposure, with 66% increase in emergency visits for those who have been exposed (Rappold et al. 2012). In another article, emergency visits during a wildfire in Florida increased considerably for patients with asthma (91%) (CDCP 1999).
Chronic obstructive pulmonary disease or pre-existing respiratory conditions	Patients with ***COPD or pre-existing respiratory conditions*** were found to be at an increased risk of being affected by bushfire. Two observational studies in Australia found positive associations between hospital admission and same day estimated ambient particulate matter (PM10) (Martin et al. 2013; Hanigan, Johnston & Morgan 2008). These findings are supported by a systematic review which summarised the evidence regarding human health impacts from global wildfire experience (Finlay et al. 2012). This review found an increase in hospital admissions among patients with COPD including those with pre-existing cardiopulmonary conditions following exposure to bushfire smoke (Finaly et al. 2012). These findings are, however, in contrast to the negative associations with COPD admissions and lagged (one or two or three days after the exposure) estimated ambient particulate matter (Hanigan et al. 2008). Direct associations between bushfire and COPD were also described in a number of literature reviews (Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009; Henderson & Johnston 2012). Exacerbation of respiratory symptoms (e.g. shortness of breath, coughing) (Johnston 2009; Henderson & Johnston 2012; Reisen & Brown 2009), increased dispensation of drugs (Henderson & Johnston 2012), increased hospital or emergency admissions (Henderson & Johnston 2012) and increased mortality (Reisen & Brown 2006) in individuals with pre-existing pulmonary diseases or COPD were reported.
Cardiovascular disease	The association between exposure to bushfire and ***cardiovascular disease*** was less clear. Two literature reviews reported that individuals with pre-existing cardiac disease are susceptible to the adverse health effects associated with bushfire exposure (Reisen & Brown 2006; Johnston 2009). Johnston (2009) argued that airborne particles from bushfire and wood smoke can exacerbate ischaemic heart disease by promoting inflammation and coagulation and increasing oxidative stress. In a systematic review by Finlay et al. (2012), increased levels of particulate matter from wildfire were associated with a range of negative health outcomes such as increased emergency admissions for patients with ischemic heart disease, increased cardiovascular mortality rates and increased rate of hospital admission due to cardiac failure or

cardiovascular complaints and complications. On the contrary, three observational studies showed no clear associations between exposure to particulate matter from bushfire and cardiovascular outcomes (Hanigan, Johnston & Morgan 2008; Rappold et al. 2012; Martin et al. 2013). For example, Martin et al (2013) noted that smoke events were not associated with cardiovascular admissions nor any subgroups of cardiovascular disease in any of the participating cities in Australia. In another study, Hanigan, Johnston & Morgan 2008 found no relationship between ambient particulate matter and cardiovascular (e.g. ischemic heart disease) admissions. Rappold et al. (2012), on the other hand, examined the risk for emergency admission of patients with congestive heart failure and found no changes to their risk even after exposure to wildfire smoke.

Identify the chronic disease that put people at greater risk during bushfires

Findings

Nine articles of varying quality and research designs identified chronic diseases which can put people at greater risk during bushfire (Finlay et al. 2012; Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009; Henderson & Johnston 2012; Hanigan, Johnston & Morgan 2008; Martin et al. 2013; Rappold et al. 2012; CDCP 1999).

There are certain population groups who seemed to be at a particular risk for developing adverse outcomes following exposure to bushfire pollution. Individuals with chronic conditions such as asthma and other respiratory diseases are at an increased risk of experiencing symptoms from smoke exposure. Individuals with cardiovascular disease may also be at risk, although evidence from the literature is less conclusive.

There is a consistent association between exposure to particulate matter from bushfire and chronic respiratory diseases. People with ***asthma*** and ***chronic obstructive pulmonary disease*** (COPD) have been shown to be vulnerable to the effects of bushfire, as described by a number of observational studies (Hanigan, Johnston & Morgan 2008; Martin et al. 2013) and literature reviews (Finlay et al. 2012; Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009; Henderson & Johnston 2012). Previous investigations found that particulate matter from bushfire triggers asthma attacks or COPD episodes leading to increased emergency visits or hospital admissions or even increased mortality (Hanigan, Johnston & Morgan 2008; Martin et al. 2013; CDCP 1999).

Individuals with pre-existing ***cardiovascular condition*** (e.g. ischaemic heart disease) may also be at risk of experiencing unfavourable outcomes from bushfire exposure. While there have been conflicting reports on bushfire and cardiovascular outcomes (Reisen & Brown 2006; Johnston 2009; Finlay et al. 2012; Hanigan, Johnston & Morgan 2008; Rappold et al. 2012; Martin et al. 2013), the possibility of adverse outcomes such as increased symptoms, increased emergency or hospital admissions and increased mortality rate in individuals with pre-existing cardiovascular condition should not be ignored. Further investigation examining the relationship between cardiovascular conditions and bushfire exposure is required.

Identify strategies for reducing the impact of bushfire on people with chronic diseases

Overview of evidence

Four studies reported strategies for reducing impact of bushfire on chronic conditions (Finlay et al. 2012; Johnston 2009; Reisen & Brown 2006; Reisen & Brown 2009).

Six strategies were identified from the four studies.

Public health advisory

In Australia, public health advisory for bushfire protection is made available. Seventy four percent (74%) of those who were aware of health advisory messages were more likely to know what to do and reduce their exposure to smoke pollution (Johnston 2009).

In the United States (US) "Wildfire Smoke, a guide for public health officials", patients are advised to have at least a 5 day stock of medication available, as well as several days' worth of non-perishable food. In Scotland, published leaflets advising clear signage to rural properties are made available (Finlay et al. 2012).

Specific public health communication/instruction was reported in the review by Finlay et al. (2012):

"Ready, Set, Go" campaign in Texas

- Be ready for a fire threat
- Have situational awareness if a fire threat occurs and be "set" to leave if you need to
- Go early – leave at risk areas early

"Go in, stay in, tune in" in United Kingdom (UK)

- Although aimed at general emergencies, may be useful to prevent exposure to air pollution from fire smoke, as sheltering can reduce exposure; less advisable for those who are in the direct path of the fire, who may need to evacuate

Development planning/Policy framework

In UK, the National Planning Policy Framework provides scope to improve wildfire resilience in new and existing developments under both natural hazard and climate change (mitigation and adaptation) policies (Finlay et al. 2012). This includes:

- Residential, commercial and industrial properties,
- Nursing / care homes,
- Health care facilities (hospitals, care centres),

- Schools and other educational facilities,
- Emergency service centres,
- Transport infrastructure (road, rail, air and inland waterways etc.)
- Utility infrastructure (generation and movement of; water and sewage, gas, electricity, fuel, communications etc.)
- Other National and critical infrastructure facilities, structures and properties identified on National and
- Community Risk Registers

Where wildfire could be a risk to human life it must be mitigated within the Local Authority's Local Development Framework and agreed by the appropriate agencies and authorities.

Getting protected by staying indoors, and with proper air conditioning/cleaning devices

Staying indoors where there is air conditioning system is advised (Johnston 2009; Reisen & Brown 2006; Reisien & Brown 2009). Ensure that external doors and windows are shut (Reisen & Brown 2006). However, Reisen & Brown (2006) reported that "smoke particles exhibited deposition loss rates of 0.2–0.4 h−1 and estimated, for a building with natural ventilation and an air change rate of 1.3 h−1 (which would be common for Australian housing), that particle losses would be ∼20%. Note that recent research in Canadian communities downwind of bushfires determined a median indoor: outdoor pollutant concentration ratio of 0.91, indicating that staying indoors did not protect people from smoke exposure.

Reverse cycle air conditioners filter particles from the air and they should be set to recycle mode (Johnston 2009). In the review by Reisen & Brown (2006), stand-alone room air cleaning devices have become commercially available in recent years, especially for removal of fine particles. It was specifically reported that "*while it is important that these have a high one-pass efficiency (f, %) for removing the particle sizes of interest, the capability to deliver a sufficient volume of air (Q, m3 h−1) relative to the space (V, m3) in which the device operates is of greater importance. The 'effective air cleaning rate (R, h−1)'where:*

$R = f \cdot Q/100 \cdot V$

and showed that even for a device with low f (21%), it was possible to reduce respirable article levels in a space by nearly 80% if the device provided an R value 3 times higher than the ventilation rate of the space".

Similarly, the US standards recommend a 'clean air delivery rate' (CADR)

	that delivers 80% reduction of particle levels. This is the minimum performance criteria for commercial air-cleaning devices (Reisen & Brown 2009).
Written asthma action plan	To avoid increased exposure to pollution, a written asthma action plan is made available and people are commonly advised to avoid exercise in times of bushfire. However, the harm avoided by this strategy is not amenable to direct research (Johnston 2009).
Respirators and face mask	In Malaysia, a respirator with a suitable protection factor for the levels of air toxic was adopted (Reisen & Brown 2006; Reisen & Brown 2009). A particle respirator with a 10-fold protection factor would reduce exposure to one-tenth of the smoke levels. This level of protection has been selected since it is the maximum that can be provided by half-face respirators which are also comfortable to wear (Reisen & Brown 2006; Reisen & Brown 2009). The 10-fold protection will be inadequate for the reported worst-case scenario peak PM2.5 of 500–1000µgm−3. However, average PM2.5 levels will be much below these peak levels (Reisen & Brown 2006). Face masks can be used but the effectiveness of face masks has not been thoroughly evaluated and thus face masks are not part of the advisories in Australia (Johnston 2009).
Important considerations in response to acute events	Finlay et al. (2012) described the following important considerations: a. Emergency services and GPs preparation: i. Those with chronic respiratory illness may experience a worsening in their respiratory symptoms and may present at the emergency department. ii. Increased doses of anti-inflammatory and bronchodilator medication may be required. Stocks of drugs should be sufficient to accommodate for this. b. Access to homes, health care facilities and resources preparation i. Systems should be in place to ensure delivery of medication and provisions to those who need them, especially vulnerable groups. People living in areas prone to wildfires may be advised to keep a stock of 5 days' worth of non-perishable provisions and medications. ii. Measures to maximise access and safety of routes to and from vulnerable areas should be in place with well signposted iii. Housing and evacuation routes in rural areas should be clearly

signposted.

c. Communication preparation

i. Public health information should be clear and as accurate as possible

ii. An early warning system should be in place to allow communities to prepare for wildfires and, if necessary, evacuate threatened areas

- This may be enhanced using satellite data as has been used in Spain
- Early surveillance and models for fire prediction would also be useful

iii. People with pre-existing health conditions should be made aware of the potential adverse health impact of wildfire smoke. For example asthma sufferers could be advised to increase their medication if they are likely to be exposed to smoke.

Gaps in the literature

Commentary

The reviewers have identified a number of significant gaps in the literature which require further investigation in the future.

- While there are studies to establish the association between bushfire exposure and worsening of symptoms in individuals with pre-existing asthma and pulmonary conditions, the evidence base for other chronic conditions such as cancer, diabetes and renal conditions is limited.
- There is some emerging evidence linking bushfire exposure to cardiovascular outcomes, however there are inconsistencies in the evidence base. More research is required to establish consistency in the literature so that definitive conclusions can be made regarding the relationship between bushfire exposure and health outcomes in individuals with chronic cardiovascular conditions.
- Well-designed longitudinal studies are needed to evaluate and compare the outcomes during the very acute (1-3 hours) and acute exposures (24 hours) to bushfire, including its long term outcomes.
- Future investigations should also examine the degree or level of pollution that can cause adverse health effects to increase the evidence base available to the health sector responsible for developing resources and strategies to manage the impact of bushfire.
- Research evaluating the effectiveness of strategies to reduce the impact of bushfire on health outcomes is quite limited. This is an area for future investigation.

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