Human Effects of the 2019-20 Bushfire Season on the Community of the Australian Capital Territory

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Summary

Bushfire is a natural and essential part of Australian ecosystems. However, in 2019-20 south-eastern Australia experienced one of the most severe and devastating bushfire seasons in recorded history. In the Australian Capital Territory (ACT) fires burnt large areas of bushland and thick smoke blanketed residential areas, resulting in hazardous levels of air pollution for prolonged periods. The effects of these bushfires and smoke were wide-reaching, impacting the health, wellbeing and daily lives of the ACT community.

Research identified bushfire smoke had acute negative impacts on the health of almost all (97%) people living in and around the ACT. This included eye and throat irritation, coughing and respiratory symptoms such as wheezing and breathlessness, and worsening of existing health conditions. The potential long-term health effects of exposure to these hazardous levels of bushfire smoke were also of concern. Some groups in the community were more vulnerable to the effects of smoke including people with existing medical conditions, the elderly, pregnant women, parents and renters.

Fire and smoke also strongly impacted mental health and wellbeing, with surveys identifying over half of the ACT population experienced anxiety or felt depressed, and about a third experienced elevated levels of psychological distress during the bushfire season. Mental health impacts were consistently higher for women compared to men. The mental health of people directly affected by bushfire was particularly impacted.

These health impacts increased the burden on the ACT health system as people sought advice from general practitioners for smoke-related symptoms; bushfire and particularly smoke-related hospital presentations and admissions for both physical (especially respiratory-related conditions) and mental health conditions were increased; and use of bushfire specific Medicare-subsidised mental health services were high throughout 2020 and early 2021. The cost of the smoke-related health burden in the ACT was estimated at $98.19 million.

Smoke persisted for long periods, infiltrating homes and workplaces. Almost everyone (>98%) surveyed took measures to protect their health from smoke, including staying inside, shutting and sealing windows and doors, using air conditioners and purifiers, and wearing face masks. However, this was limited by supply issues, accessibility and cost. Community members experienced considerable uncertainty with only 41% of people feeling confident that they knew how to protect their health from smoke following the bushfire season. Even those that knew what to do felt that under the conditions there was little they could do. Activities such as exercise, sleep, work, study, travel, socialising and diet were all disrupted. People were also impacted by concern about the environmental impact of bushfires, and potential long-term damage to places they cared about.

Despite the wide-reaching disruption and health impacts of the fires and smoke, the ACT community showed great resilience. Most people, when direct fire impact was low, have not experienced long-lasting effects on their mental health. The impacts of bushfire and smoke on people's physical health, mental health and daily lives, and on health and community support infrastructure need to be considered holistically. This will enable improved preparedness and response planning to equip and support the ACT community to minimise the effects of future bushfire seasons. This is particularly important as the severity and duration of fire seasons are projected to increase with anthropogenic climate change.

Contents

The 2019-20 Bushfire Season

Throughout the 2019-20 summer, south-eastern Australia experienced one of the most severe bushfire seasons in recorded history. Over 8 million hectares of land were burnt in Australia's south-east, more than 3500 homes were lost, and bushfire smoke-related air pollution reached hazardous levels in major metropolitan areas. Bushfires contributed directly to the deaths of 34 people, and to an estimated further 445 deaths as a result of smoke (1).

In the Australian Capital Territory (ACT), thick smoke caused hazardous levels of air pollution throughout December 2019 to February 2020. Early smoke came from fires burning around Braidwood in New South Wales (NSW), to the east, and later in January from fires burning in the Territory itself. Bush and grass fires burnt 424 hectares of land around Pialligo, ACT. The Orroral Valley fire ignited in the ACT on 27 January, threatening southern areas of the Territory. Over the next month, more than 86 000 hectares of land, or approximately 30% of the ACT, was burnt (1).

Bushfires are associated with a wide range of health and wellbeing issues from direct exposure to the fire itself or smoke-related air pollution (2). The intensity or type of exposure influences the severity of impact, including psychological trauma, with more "direct" or "severe" exposure usually being associated with more severe outcomes. How this exposure is defined varies. One survey identified that more than half of people living in the capital region (58%) during the 2019-20 bushfire season experienced some direct exposure to fire (3). This included being in an area with fire nearby, having to evacuate due to bushfire, or damage or loss to an area of significance other than their home. This was particularly pronounced in Tuggeranong South with over half of people reporting that their property/home had been at direct risk of fire (4). About 8% of Canberrans experienced more severe exposure, including loss of or damage to property, or direct contact with fire such as via firefighting or protecting property (3).

While exposure to smoke is different to the acute impact of active fire, its significance as a public health concern is being increasingly recognised. Given that suspended aerosols can be transported over long distances, smoke is often the most widespread impact of bushfires, impacting populations over large areas including urban populations and those that are geographically separated from fires (5,6). Indeed, the most common impact of the 2019-20 bushfire season on ACT residents was smoke, with almost all ACT residents (99%) impacted by poor air quality, including inside their homes and workplaces (4). The concentration of fine particulate matter (i.e., particles <2.5µm ($PM_{2.5}$) or <10 µm (PM_{10}) in diameter) is used as a key gauge of air pollution levels and can reach extremely high levels in bushfire smoke (6). In addition, bushfire smoke contains a range of potentially harmful chemicals that can be particularly detrimental to health, more so than similar levels of air pollution from other sources (7–9).

Throughout the 2019-20 bushfire season the ACT experienced the worst air quality recorded in Territory history, and on some days the worst air quality in the world. Figure 1 shows the concentration of fine particulates ($PM_{2.5}$) measured at Canberra air quality monitoring stations over this period. Concentrations of fine particulate matter were persistently above levels considered safe (10) throughout December 2019 and January 2020, with daily mean $PM_{2.5}$ and PM_{10} concentrations of 45.80gm/m^3 and 66.97gm/m^3, respectively (11). At its peak, the hourly $PM_{2.5}$ concentration reached 2,496µg/m^3 at the Florey air monitoring station (on 5 January 2020) (12). Not only were ACT residents exposed to these exceptionally high concentrations of air pollution, but these persisted over an unusually prolonged period, and coincided with periods of intensely high summer temperatures. Air quality was “poor” every day between mid-December 2019 and mid-January 2020 (daily maximum $PM_{2.5}$ >50 µg/m^3), reaching “extremely poor” levels on half those days (daily maximum $PM_{2.5}$ >300 µg/m^3) (12).

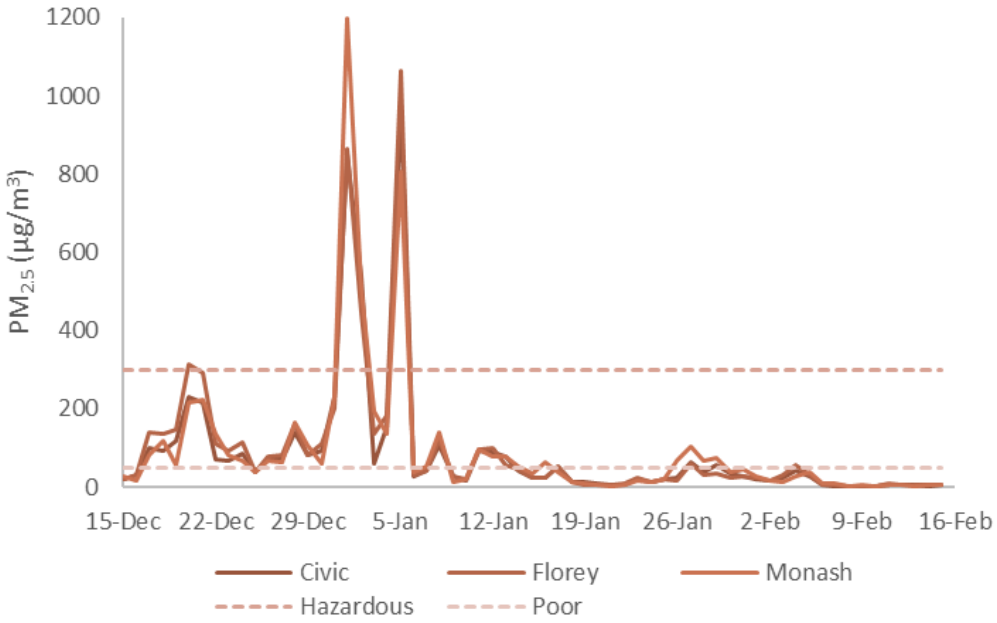

Figure 1: Daily average fine particulate matter concentrations ($PM_{2.5}$ µg/m^3) for ACT air-monitoring stations at Civic, Florey and Monash during for the period 15 December 2019 to 15 February 2020. Poor (≥50 µg/m^3) and extremely poor (>300 µg/m^3) air quality thresholds (13)*, are indicated.*

There was substantial public concern about the short- and long-term physical health impacts of smoke exposure, especially in higher risk groups (e.g., the elderly, children, people with pre-existing medical conditions). Public health messaging in response to smoke primarily focused on staying indoors, closing and sealing doors and windows, using or visiting places using air-conditioning, and reducing outdoor exercise (14). These recommendations have been designed in response to relatively short exposures, however many people found them less effective as the bushfire smoke episode went on.

Box 1: Increasing Impact of Disasters in a Changing Climate

Bushfires are a natural part of Australian ecosystems; however, as the number of hot and dry days increase with climate change, the severity and duration of fire seasons are projected to be more severe (16,17). The number of days of high-risk bushfire weather has increased by at least 30% since 1900 as a result of anthropogenic climate change (18). Furthermore, the impacts of climate change on global fire patterns are already being observed, with increased frequency, severity and destructiveness of bushfires (19,20). These changes to bushfire patterns are expected to increase the health and community impacts of bushfire and smoke, resulting in increased health burden and associated costs unless effective adaptation measures are implemented. The increase in smoke-related health costs in south-eastern Australia has been estimated to increase by 1–16% by 2070 (16). As disasters become more common, the overlapping or cumulative effects of multiple events may exacerbate the negative impacts on health and wellbeing.

Box 2: 2020 - A Year of Disruption

"The prolonged fire season and presence of the fires burning nearby for months on end this season clearly had the community on edge for a long time and we felt that too. The smoke haze affected people in a new and very different way to just dealing with the threat of fire. The Canberra region experience was very clearly then exacerbated by the subsequent hail damage and now COVID-19."

- Community member aged 30-39

In addition to the bushfire and smoke events of the 2019-20 bushfire season, on January 20, 2020, Belconnen and the inner north areas of the ACT experienced a severe hailstorm that caused significant damage to houses, workplaces, vehicles and greenspaces (1). This was shortly followed by the early stages of the COVID-19 pandemic. This brought unprecedented disruption to normal life as people were required to physically distance, social gathering and public events were restricted or cancelled, non-essential services shut, travel restrictions and stay-at home orders were put in place, schools moved to online home learning, and quarantine and isolation practices were implemented (21). Many people had impacts on work and associated financial stress and almost all experienced high levels of uncertainty. During the early stages of the pandemic, nationally, there were heightened levels of depression and anxiety, particularly influenced by disruptions to work and social functioning (22).

Major life stressors following bushfire have been associated with worse mental health outcomes in Australian communities (23,24). Research in the early stages of the COVID-19 pandemic identified exposure to bushfire smoke, but not recent exposure to bushfires themselves, was correlated with reduced psychological wellbeing (22). Much of the research drawn on in this report to examine the effects of bushfire, particularly on mental health and lifestyle, was conducted in the months following the 2019-20 bushfire season, hailstorm and during the start of the COVID-19 public health response. While these studies were designed to focus on the effects of bushfire, complete separation of the effects of bushfire from these other factors is unrealistic and it is inevitable that the findings, particularly regarding mental health and wellbeing, may have been influenced by elements of exposure to these other disasters.

"I think Canberra has been through an unbelievable sequence of horrors in the last four months... fire, smoke, hail, storms and now coronavirus. The mental health impacts must be substantial."

- Community member aged 50-59

Approach

This report summarises the effects of the 2019-20 bushfire season on the health, wellbeing and lives of people living in and around the ACT. It draws on published literature, government reports and data, and analysis of research data to describe the human effects of fire and bushfire smoke; this includes impacts on physical health, mental health and wellbeing, use of medical services, and disruption to daily life. Common views are illustrated by written quotes from community members sharing their lived experience, and their friends' and family's experiences, during this time. These were provided community members living in around the ACT through the *Bushfire Health Study* (15), described by Rodney et al. (3). They can be identified throughout the report by ***bold italicised text***. Minor edits have been made to some quotes for spelling or grammar, without altering the content or meaning.

Using a range of information and data sources including regularly measured, prospective data, and new, research question-specific data, from health records, environmental records, surveys, government reports, and scientific research helps construct a comprehensive understanding of the human impacts of bushfires. This multidimensional approach allows for data corroboration, contextual insights, inclusion of diverse viewpoints, and consideration of both short-term and long-term effects, enabling communities, policymakers, and healthcare professionals to make informed decisions and implement effective response and recovery strategies.

Human effects of bushfire and smoke

The impacts of bushfire are often measured in terms of land burnt, houses destroyed, or in extreme cases, lives lost. However, bushfire and bushfire smoke can severely disrupt daily life and have considerable effects on physical health, mental health, and medical services. These human effects of bushfire can persist well beyond when the fire is extinguished, or the smoke has cleared. The 2019-20 bushfire season was one of the worst on record. The effect on residents of the ACT, particularly from smoke, was profound. Here the effects of the 2019-20 bushfire season on health, wellbeing, medical services use, and lives of the ACT community are summarised.

Physical health

Exposure to bushfires and bushfire smoke-related air pollution can have considerable short- and long-term adverse health outcomes including burns, heat exhaustion, dehydration, smoke inhalation and psychological trauma. High levels of bushfire smoke-related air pollution can impair respiratory and cardiovascular functioning, exacerbate respiratory disease (including asthma and chronic obstructive pulmonary disease (COPD)), and alter immune function (2,25). Depending on the level of pollution and exposure, many people will experience subclinical, limited or transient symptoms; whereas others will have more severe symptoms requiring medical intervention (12,26). High levels of fine particulate matter present in smoke have been associated with elevated rates of hospital presentations and admissions, especially for cardiovascular and respiratory conditions including asthma (27,28). Across Australia, increased hospital presentations have been associated with days of more intense air pollution (28). Bushfire smoke has also been associated with increased mortality (29), and an estimated 340 000 deaths can be attributed to bushfire smoke globally each year (30). The total smoke-related physical health costs of the 2019–20 bushfire period were estimated to be AU$1.95 billion (27).

The effects of smoke can be more severe in vulnerable populations such as the very young, older adults, pregnant women and those with pre-existing medical conditions including cardiovascular disease or respiratory conditions (25,28,31–34). Urban exposure to bushfire smoke is generally brief (a matter of days at most) and unlikely to have negative health effects. However, the prolonged exposure to poor air quality experienced in Canberra and other urban centres throughout the 2019-20 bushfire season may be more hazardous and the long-term health impacts of such exposure are not well understood.

Physical Health Impacts

Bushfire smoke had acute negative impacts on the physical health of almost all (97%) people surveyed living in and around the ACT during the 2019-20 bushfire season (3). People experienced eye and throat irritation, coughing and respiratory symptoms such as wheezing and breathlessness, and headaches (Figure 2). Almost a third of Canberrans (31%) reported worsening of an existing physical health problem and 16% had difficulty managing an existing health condition as a result of smoke and/or fires (4).

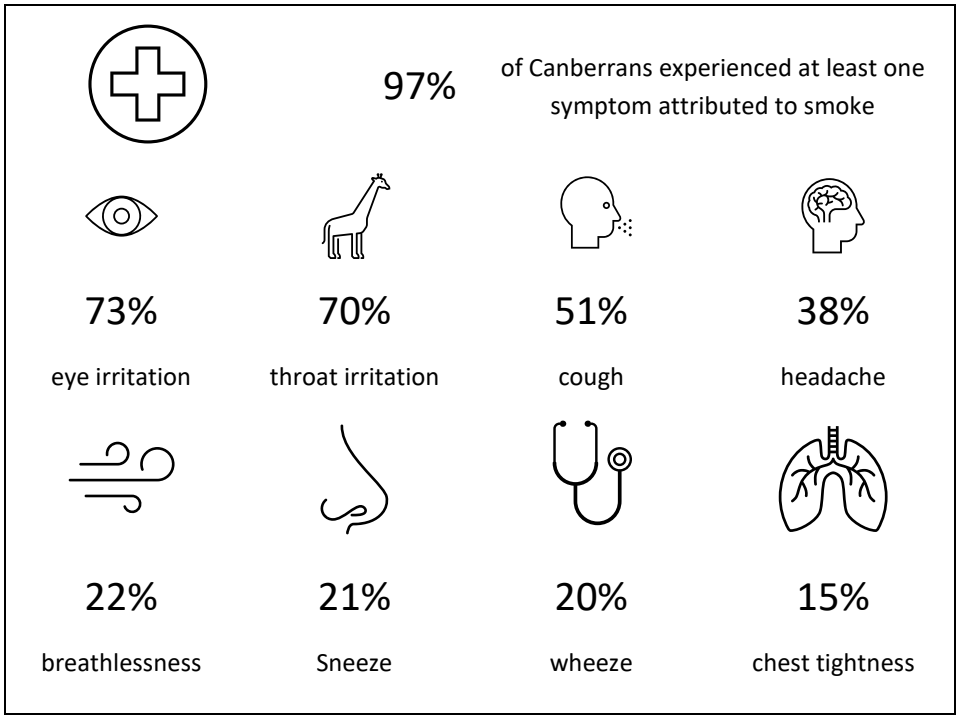

Figure 2: The proportion on Canberrans experiencing common symptoms attributed to smoke during 2019-20 bushfire season (Data from Rodney et al., 2021)

Emergency Department Presentations and Hospital Admissions

It was estimated that during the 2019-20 bushfire season, within the ACT, bushfire smoke was responsible for 31 excess deaths, over 200 excess hospitalizations for cardiovascular and respiratory problems, and 89 presentations to emergency departments with asthma[1] (35). Hospital data identified that emergency department presentations and hospitalisations for asthma and respiratory conditions increased throughout most of December and January compared with previous years (11,36) (Figure 3). Increases in presentations and hospitalisations coincided with days of, or immediately following, higher fire activity or air pollution (11,36).

Aligning with peak period of poor air quality, the greatest increases in weekly emergency department presentations were 230% for asthma, 58% for respiratory conditions, and 155% for breathing difficulties compared with the previous year (36). Hospitalisations for respiratory conditions increased by 52% compared to the same period in previous years (Figure 3). Hospitalisation for select heart conditions and cerebrovascular conditions also increased throughout some of the 2019-20 bushfire period (37).

Other analyses show that the total number of emergency presentations at the then Calvary Public Hospital in Bruce in December 2019 and January 2020 didn't change, but there were significantly more people presenting with respiratory concerns (554 up from 390) and less with injury-related presentations (2194 vs 2322) compared with the same period in the previous year (11). More people were also admitted to hospital with respiratory conditions.

[1] ACT hospitals and health services provide care for residents of the ACT as well as people living in the surrounding region of New South Wales.

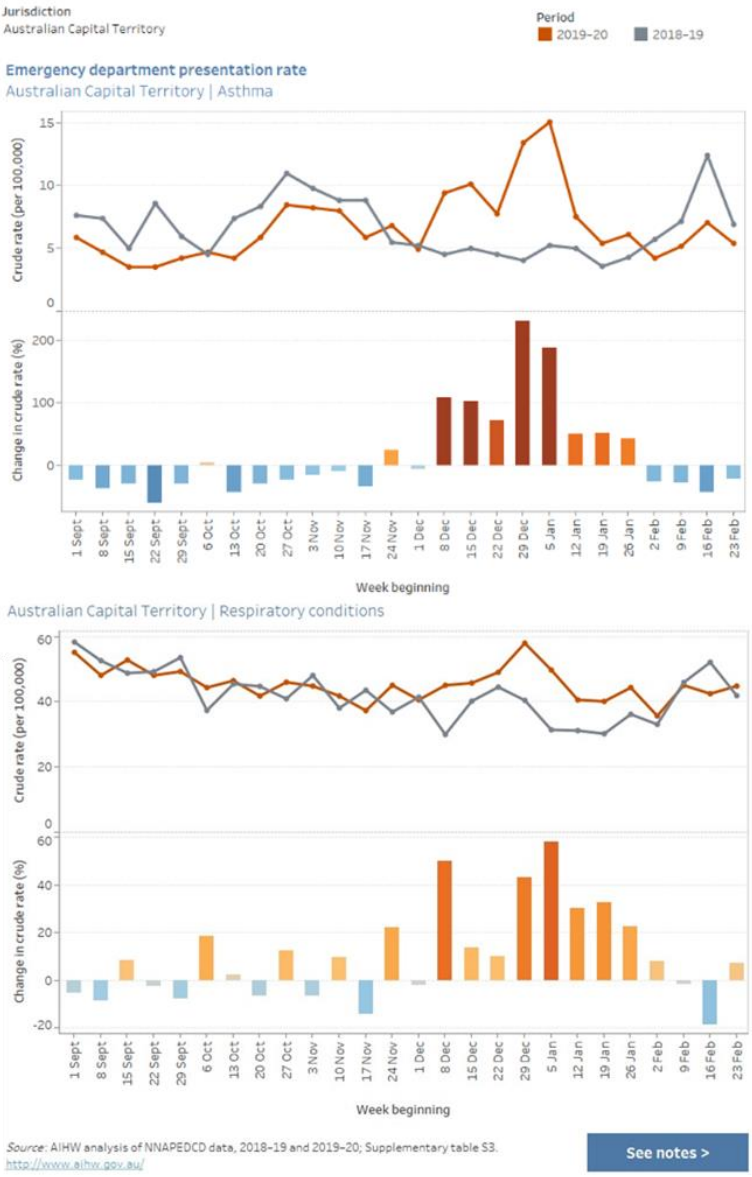

Figure 3. Increases in emergency department presentations for asthma(top) and respiratory conditions(bottom) in the ACT, weekly between 1 September 2019 and 29 February 2020, compared with the same period in 2018-19.

Concern About Long-Term Health Effects

In addition to the acute effects experienced, community members have described concerns about the potential long-term health effects of prolonged exposure to hazardous levels of bushfire smoke. In interviews/surveys conducted with ACT residents in the months following the 2019-20 bushfire season, community members noted developing adverse conditions following the fires that have persisted beyond the period of smoke (38). They were worried about the potential impact of these on their ongoing health, including susceptibility to other conditions such as COVID-19.

"Still feeling effects of bushfire smoke, with respiratory symptoms, cough and sinus irritation. Quite a few of my friends experience this too, and it is not severe enough to see medical advice. I am worried that the bushfire exposure makes people more vulnerable to coronavirus lung damage"

- Community member aged 50-59

Groups that were particularly concerned about the long-term health effects of smoke exposure included parents and pregnant mothers. 60% of parents and carers said the decisions they made about health protection measures were influenced by their children or dependants, particularly parents of younger children (15). This was likely due to a combination of concern for health and the challenges of keeping children entertained indoors for long periods.

"My primary concern and the anxiety I felt during this time was/is for the short- and long-term health impacts on my children…, rather than myself. … The secondary issue … was the strain of being confined/confining my children (toddler in particular) over an extended period of time. I felt trapped in our house as there didn't seem to be many alternative indoor options…"

- Community member aged 18-29

Pregnant women were particularly concerned about the effects of smoke on their pregnancy and baby, but found information hard to find, further heightening anxiety and stress (39). 83% of pregnant women surveyed in the ACT said their pregnancy influenced their health protection decisions, with all but one indicating they were more responsive to smoke because of their pregnancy (15). There is limited information about the effects of bushfire smoke on maternal and child health. Possible associations have been identified between exposure to bushfire smoke and adverse outcomes such as decreased birth weights, premature birth, and increased risk of gestational diabetes (40,41). However, more robust research is needed on the effects of fire and smoke on pregnant women and their babies.

"Being pregnant, I was highly concerned about my health and the impacts on my baby. Information seemed scarce and restricting myself indoors so frequently was concerning and disruptive to my wellbeing."

- Community member aged 18-29

Mental health and wellbeing

Bushfires, smoke, and other natural disasters can affect the mental health and wellbeing of community members and those on the frontline (42). During the 2019-20 bushfires, feelings of anxiety and distress were likely driven by the unpredictability of the situation, as well as the perceived and actual threat to life and wellbeing. After the event, individuals may have continued to experience distress because of personal, material, and/or environmental loss, as well as post-traumatic stress. Understanding rates and patterns of psychological distress experienced by individuals during and after bushfires, smoke and other natural disasters is important for designing and implementing effective public health strategies to ensure the provision of appropriate and timely support, and to minimise the levels of distress experienced. Australian research following communities affected by the 2009 Victorian bushfires indicates that the prevalence of mental health concerns following a bushfire is proportional to the level of bushfire impact (43). The research found that the prevalence of mental health disorders decreased over time, yet even a decade after the fires, was still more than twice as high as in communities that were less affected by fire.

Data from studies conducted in the ACT following the 2019-20 bushfire season showed that the bushfire and smoke events had significant mental health impacts on ACT residents.= Collectively, the studies identified increases in anxiety, depression, psychological distress, emergency department presentations, hospitalisations for mental health care needs, increased use of bushfire-specific Medicare-subsidised mental health services, and qualitative reports of the impacts of the bushfires on mental health and wellbeing. These findings are summarised as follows.

Mental Health Impacts

In the months following the 2019-20 bushfire season (March-April 2020), 55% of people living in the capital region who participated in the *Bushfire Health Study* led by the Australian National University self-reported

symptoms of anxiety (45.3%) and/or feeling depressed (21.4%) due to smoke and its effects on daily life (3). On validated mental health measures, 31.9% of people reported elevated levels of psychological distress, 10.5% of people reported clinical levels of depression and 14.3% of people reported clinical levels of anxiety (15). Adverse mental health impacts were consistently higher for women compared to men.

Similar self-reported rates of anxiety and depression were reported in the *Living well in the ACT region: Exploring the wellbeing of ACT residents in 2019-20* study conducted by the University of Canberra (4). This study was conducted in April-May 2020, finding that 36% of ACT residents often felt anxious or worried in response to the 2019-20 bushfires, and a further 52% reported feeling anxious occasionally but not often. Feelings of helplessness was also reported by 38% of participants, while 74% reported being worried about the safety of people they cared about. In terms of impacts on existing mental health conditions, 36% of participants reported that the smoke and/or fires worsened existing depression or anxiety, 33% indicated that they triggered new depression or anxiety, and 26% reported that the smoke/fires triggered traumatic memories or emotions from previous fires. Younger people were more likely than older people to report fires triggering psychological distress, consistent with what has been seen in New South Wales (NSW) (44). Following the bushfire, few ACT residents (10%) reported persistent mental health challenges because of, or worsened by, the fires. A much larger proportion of participants reported being worried about the environmental impacts of the fires (78%) and future bushfire seasons like the 2019-20 season in future years (71%) (see box 3).

Consistent findings were also reported in the *Impact of the 2019/2020 bushfires on a cohort of older adults* report conducted as part of the *PATH Through Life* Study (38,45). In this study of a longitudinal cohort of ACT residents aged 59-65, people reported worsened mental health during the period of the bushfires but that symptoms returned to pre-bushfire levels following the bushfires.

Taken together, these studies suggest that for most members of the ACT community, mental health was affected during the acute phase of a bushfire/smoke event but that once the event was over, provided actual fire impact was low, most people did not have long lasting effects on their mental health. However, as outlined above, the research following the devastating 2009 Victorian Bushfires demonstrated that adverse mental health impacts can continue to be experienced many years after a bushfire event (43). It is therefore important to understand for whom poorer mental health may persist and what qualifying factors influence mental health outcomes in order to provide support to those most at risk (23,43). For example, those that experience high levels of impact or loss may have higher rates of long-term mental health impacts (43). This is supported by findings from the *Impact of the 2019/2020 bushfires on a cohort of older adults* study (45) in which ACT participants directly exposed to the bushfires reported significantly worse mental health effects compared to people not or indirectly exposed. Participants who felt prepared for natural disasters reported better mental health outcomes after the bushfires than those who did not feel prepared (45).

Qualitative research on the mental health effects of the bushfires also highlights the significant impacts of the fires and smoke on the wellbeing of ACT residents (46). Bushfires triggered feelings of anxiety, fear, trauma, helplessness, upset and worry in a sample of 59-65 year old adults (38). This was especially the case for women. Participants suggested that media coverage significantly exacerbated feelings of uncertainty and anxiety. Participants also reported feelings of distress associated with being on alert and having to pack up and prepare for evacuation, particularly people with prior exposure to major bushfires, such as the 2003 Canberra bushfires (box 3). These participants reported feeling fearful, not being able to relax, or not knowing when it would end. Feelings of helplessness were also common, both in terms of being able to assist and support friends or contribute to efforts to fight the fires. Participants also expressed fears for friends and family, including for those on the frontline, and fears about the possible negative health effects of prolonged bushfire smoke exposure.

"Felt anxious but took steps to manage it. Turned off news shows, mindfulness practice. Undertook activities to distract myself. Looking out the window allowed me to see the smoke coming with the easterly, complete outdoor tasks and get inside before the worst of the smoke arrived."

- Community member aged 50-59

"I felt extremely low during the period - I was so unwell and felt incredibly depressed at the thought that perhaps this is how all summers will be from now on. I didn't get to celebrate Christmas or travel to see my family, and I felt robbed of what should've been a really happy time. I also felt so powerless to stop the destruction all around me, and hopeless at the thought that things could be like this forever."

- Community member aged 18-29

"I felt more anxious about the fires specifically and the climate more generally than I did about the smoke. I also care for my …mother with dementia, but she lives in her own home alone …, a lot of my anxiety was about her safety and evacuation."

- Community member aged 30-39

Emergency Department Presentations and Hospital Admissions

The significant mental health effects of the bushfires and smoke on ACT residents is reflected in objective data on hospital presentations and admissions (12). Generally, emergency department presentations for mental health in the ACT during the 2019-20 bushfire period were higher compared to the same period in 2018-19. There was a 35% increase in emergency department presentations for mental health in the week beginning 26 January 2020 (an extra 30, or 6 per 100 000 people) than in the previous bushfire season. A similarly elevated general increase in mental health hospitalisations in the ACT during the bushfire period was also observed, compared to the previous 5-year average. Although, it should be noted that it is difficult to establish if this observed increase was solely due to bushfires and bushfire smoke.

Bushfire Specific Mental Health Medicare-Subsidised Services

In response to the 2019-20 bushfires, several additional Medicare Benefits Schedule (MBS) subsidised mental health items were introduced. These new MBS items commenced in January 2020 and were targeted at Australians whose mental health had been negatively affected by bushfire events that occurred in the 2019-20 financial year. Services were provided by a range of eligible professionals including psychologists, general practitioners (GPs), medical practitioners, social workers, and occupational therapists. People accessing these services were not required to have a GP mental health treatment plan, referral or diagnosed mental health condition. The ACT had the highest weekly rate of bushfire-specific MBS claims per capita for much of the period explored between January 2020 and February 2021 (Figure 4). It is important to note that people affected by the bushfires may have also accessed other MBS items for mental health treatment, so the number of MBS delivered services could be even higher than those reported here.

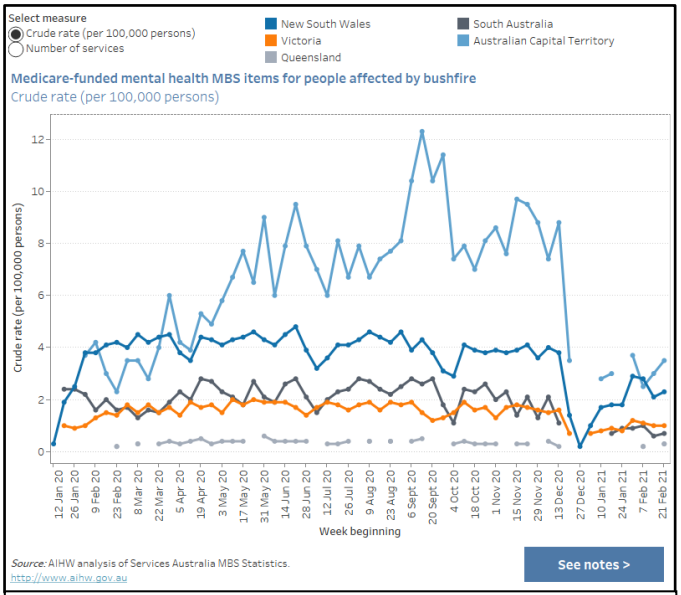

Figure 4. Medicare-funded mental health MBS bushfire-specific items. Presented nationally and by select jurisdiction, weekly for the period 12 January 2020 – 6 March 2021.

Box 3: A Resilient Community - Legacy from Canberra 2003 Fires

"The way that the fire season started immediately brought back anxiety from 2003. Never will be complacent about bushfires again."

- Community member aged 60-69

On 18 January 2003, Canberra experienced a devastating bushfire that swept through urban bushland and suburbia in southwest Canberra, burning almost 160 000 hectares of land, destroying over 450 houses and damaging many more, triggering the evacuation of over 5000 people, and causing four deaths (47,48). At the time, this was one of the most destructive bushfires in Australia in terms of property damage (48). It also resulted in a large, acute burden on the Canberra emergency department and health care system (48).

Three years after the 2003 fire there was a higher prevalence of fair-to-poor self-rated health and psychological distress experienced by Canberrans who had been fire-affected than in the general population. In a survey, 41% of fire-affected people felt the bushfires were still having a lasting negative effect on their overall health (including increased feelings of anxiety, nervousness and sadness) and 39% felt that their lives were more difficult than before the bushfire, most commonly associated with financial or work situations, suggesting bushfires were having persistent negative impacts on their lives (47). While these numbers are concerning, the majority of people (61%) didn't experience lasting negative effects of the fire, and for many there were even positives outcomes, including enhanced community and family relationships, and spiritual beliefs or beliefs in humanity.

In surveys conducted following the 2020 fires, 43% of participants had been exposed to the 2003 fires (3) and just over a quarter (26%) reported that the smoke and/or fires in 2019-20 triggered traumatic memories from past fire exposure (4). This was even higher for people living in Tuggeranong South and Weston Creek (43% and 48%, respectively), which were areas most affected during the 2003 fire. For some individuals, even though the experience of smoke was different to that of active fire, the 2019-20 fires brought back trauma or stressors from their past experience.

"Having lost everything in the 2003 fires made me very anxious during the fire season. It brought everything back."

- Community member aged 60-69

Despite these individual experiences, at a community level, exposure to the 2003 Canberra fires didn't predict poorer mental health in Canberrans following the 2020 fires (15,49). This demonstrates the resilience and strength of the Canberra community. However, more can be done to understand factors contributing to this resilience and to identify and support people who are experiencing ongoing negative impacts.

"Looking back, I feel the experiences also made me and my family stronger and more resilient. That is demonstrated by the way we approach the next crisis: Covid-19"

- Community member aged 50-59

Box 4: Environmental Connection and Loss

"The smoke was nothing like I had ever experienced before… I was very worried for our environment, seeing beloved places surrounding Canberra being burnt."

- Community member aged 18-29

The intensity and reach of the 2019-20 bushfires resulted in extreme environmental destruction across large areas in south-eastern Australia. Almost 19 million hectares were burnt; more area was burned in NSW and Victoria than in any fire season over the past two decades, and over 1 billion animals were estimated to have been killed (50). Following the fires (as of April-May 2020) the majority of Canberrans surveyed were concerned about the environmental impact of the fires and about whether the fires had caused long-term damage to places they cared about (4,38). People were unsure if the environment would, or could, recover. One in five ACT residents said they sometimes avoided going near places that were burned to avoid being faced with the impacts (4).

Such environmental loss can result in psychological distress as people experience important places or ecosystems dramatically changed or irreversibly lost. Such environmental distress is a possible contributor to the often long-lasting increases in mental health concerns communities experience following bushfire events. Recent work has identified that solastalgia, the feeling of distress about changes to your environment (51), mediates the relationship between bushfire impact and adverse mental health and wellbeing outcomes, including for Canberrans following the 2019-20 bushfire season (49). Solastalgia was associated with mental health outcomes regardless of an individual's bushfire exposure, suggesting that while directly experiencing the impacts of bushfire increases the likelihood of distress due to environmental change or loss, individuals do not have to be directly affected by fire to feel concern about environmental degradation. People spoke about the effects that media imagery depicting loss and destruction from fire had on them.

"I was at times filled with a sense of dread. Triggered my chronic depression and I found myself addicted to social media and news. Needed to know everything and was often distraught at news of destruction. Death of animals affected me as much as anything."

- Community member aged 30-39

For many people, the 2019-20 bushfires were an illustration of the destructive effects of climate change, inciting or aggravating climate anxiety. There was also concern that this fire season was indicative of what was to come in the future with climate change. Anticipatory solastalgia (current distress about expected future changes to the environment) has been identified in some populations (51).

It should be noted that feeling sadness or loss in response to environmental destruction is reasonable and does not always result in adverse outcomes. It has even been suggested that solastalgia or eco-anger could contribute beneficially to bringing communities together through shared experience, motivating action on environmental degradation and climate change, and encouraging disaster preparedness (49,52).

"My feelings about the smoke were related to my eco-anxiety. While it was uncomfortable to be kept inside for so long, my family and I had good air quality at home due to our purifier and I was not worried for our health. The thick, daily smoke was a constant reminder of the climate crisis which remains worryingly unaddressed and often ignored! My heart breaks for all the species that have been lost or made more vulnerable over summer."

- Community member aged 18-29

Health services use

The increase in bushfire and particularly smoke-related hospital presentations and admissions for both physical (especially respiratory-related conditions) and mental health conditions contributed to a substantially increased burden on the ACT health system during the bushfire season. The cost of the smoke-related health burden in the ACT was estimated at $98.19 million in 2019-20 vs $1.21 million average between 2011-12 and 2018-19 fire seasons (27).

The increased presentations to emergency departments in response to bushfire smoke were consistent other locations in Australia (28,53). Poor air quality within the hospital itself may have also negatively affected, or complicated recovery for, people who were admitted for other reasons. While hospital presentations and admissions data are the most frequently used measure of health burden, it is likely that using these measures alone would have greatly underestimated the true health burden experienced by the community during this period. Despite almost all people surveyed experiencing symptoms they attributed to bushfire smoke, only 17% of people sought advice from a health professional or medical service for their symptoms (3). This was most commonly from a GP, pharmacist, or mental health professional. Almost twice as many females sought health advice than males (21% vs. 11%).

In the ACT, the weekly age-standardised rate of GP visits was mildly elevated between September 2019 and February 2020 compared with the same time the previous year (Figure 5). There were a few weeks with greater increases: a 22% increase during the week staring 29 September 2019, and a 26% increase during the week starting 22 December 2019; though both these periods were followed by weeks of comparatively decreased visits year-on-year (12). Additionally, 7% of Canberrans reported having to cancel health appointments due to the fires (4). This could have been due to medical practices being shut due to smoke, or people following health advice to stay indoors, particularly for less serious illnesses.

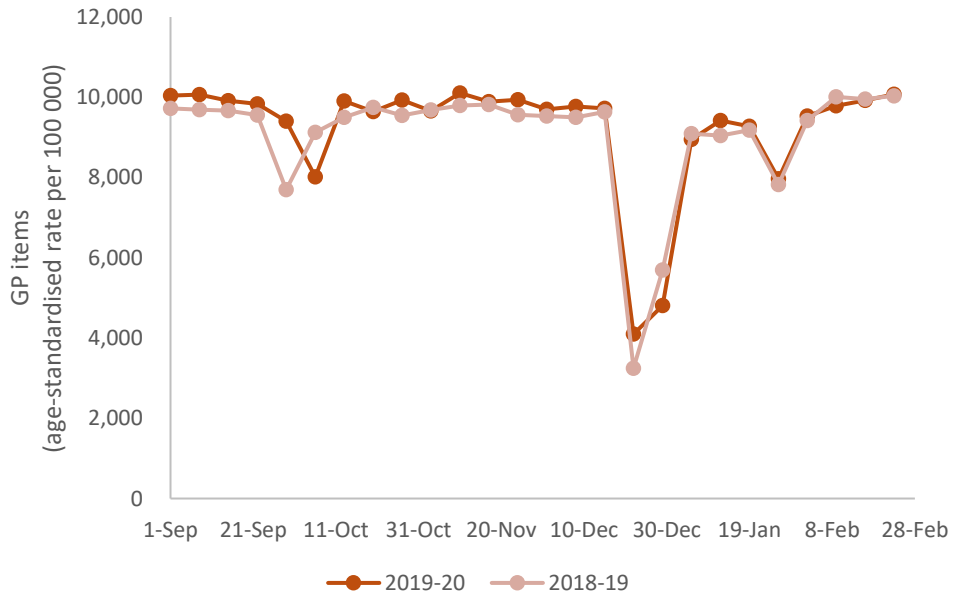

Figure 5. Rates of GP and respiratory test item claims under MBS by week in the Australian Capital Territory, 2018–19 vs 2019–20. Source: AIHW analysis of MBS data

As previously discussed, the use of bushfire-specific Medicare-funded mental health items were substantially higher in the ACT (per 100,000 population) in the year following the 2019-20 bushfires than elsewhere in the country, including other bushfire-affected jurisdictions (Figure 4). Further, a nationwide survey of psychologists showed that the ACT was among the states and territories most likely to have experienced increases in

psychologist waitlists and workloads as a result of the 2019-20 bushfires (unpublished data from Macleod et al. (54)). Understanding the anticipated health system burden of bushfire and smoke can help with planning and resource allocation to ensure health services are not overstretched and can meet demand. This should be matched with appropriate public health advice and provision of needed services and equipment to reduce individual's smoke exposure, minimising the number of people needing acute medical care.

Activities to reduce exposure and protect health

Health advice regarding smoke-related air pollution, including that provided by ACT Health, recommends minimising exposure by staying indoors, closing windows and doors and reducing outdoor physical activity during periods of smoke. It also recommends using air-conditioning, visiting air-conditioned places, such as libraries or shopping centres, or relocating out of area if possible (14).

During the 2019-20 bushfire season almost everyone (>98%) surveyed as part of the *Bushfire Health Study* participated in at least one activity to protect their health from smoke-related air pollution, with most taking greater measures on smokier days (15) (see Figure 6). People used a range of different approaches, including combinations of both technical (such as using air-conditioning or are purifiers) and non-technical (such as staying indoors on smoky days) interventions (55). Being able to do something was an important coping mechanism that aided wellbeing (55).

"It was an extremely anxious time. I felt much better when I had more control, which came after I purchased additional air purifiers and multiple real time air quality monitors so I could be happier with the pollution levels where I was."

- Community member aged 30-39

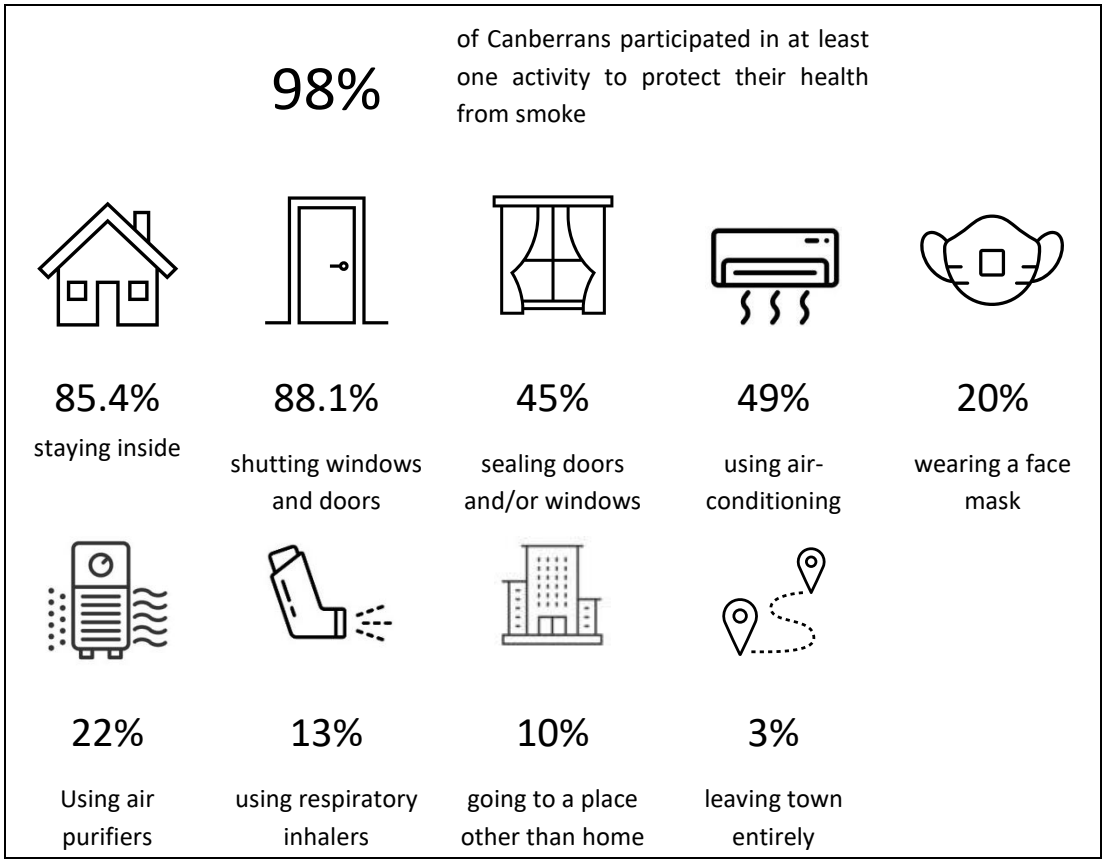

Figure 6. Measures Canberrans used frequently to reduce or mitigate exposure to bushfire smoke during the 2019-20 bushfire season. Data from Rodney et al. (15).

Most people regularly stayed indoors and shut windows and doors, however, when smoke persisted at hazardous levels over prolonged periods this became difficult. People had to leave their homes to go to work, study or undertake normal activities; people felt cooped up in their houses; and over time bushfire smoke infiltrated homes and workplaces. Two thirds of people reported smoke in their homes and a third reported it in their workplaces (4). Public health messaging focused on staying indoors assumes houses can be kept airtight and free from air pollution. However, many Australian homes are leaky (i.e. not air-tight) compared to other countries such as the USA and indoor air pollution can reach extremely poor levels during bushfire smoke events (13,56,57). Canberra homes are slightly less air-tight than the national average (57), likely due to a history of government-built housing with vulnerabilities to leakage (55). Quality of housing is often strongly correlated with socioeconomic status. Canberra rental properties are more likely to be these older, government-built residences (55) and renters expressed frustration or stress living in "leaky" houses yet having limited control to make modifications to reduce smoke infiltration. This lack of control, commonly combined with financial barriers to accessing other protective measures (e.g. air purifiers), resulted in feelings of powerlessness (55) and poorer mental health outcomes for renters (15).

"Inability to effectively seal smoke out of our 1960s Canberra home with rattly windows - even after deploying an unholy amount of gaffa tape - caused us considerable stress. Smoke was visible in our home. A service or subsidy to fit out older homes with leaky windows/doors would have been (and would now be) so useful. Protection for those renting who are unable to do anything much to the houses they're in should also be considered."

- Community member aged 30-39

Air purifiers and air conditioners can be effective in decreasing indoor $PM_{2.5}$ concentrations, even in extreme smoke events, when fitted with appropriate high-efficiency particulate air (HEPA) filters (58,59). However, their effectiveness will depend on outdoor smoke concentration, room size, and building design and ventilation (60). In a small Australian study, air purifiers with HEPA filters reduced indoor PM2.5 by 30-74% (60). During the 2019-20 bushfire season about half of ACT residents surveyed regularly used air conditioning, and almost a quarter regularly used air purifier/s to reduce indoor exposure to smoke. However, the cost of air purifiers and significant supply issues were inhibitory for many (15). Purifiers were a source not only of physical relief as they cleared the air and improved respiratory outcomes, but also provided emotional relief as people could quantifiably see the air quality in their homes improving as they used them (55).

"I live in an old, leaky house. During the bushfires I confined myself, mostly, to my bedroom where the air purifier and A/C were set up, and where the windows are more heavily covered. I thought my air purifier was working well. The air in my room smelt clean and as soon as I left my room, I could smell smoke in the rest of the house"

- Community member aged 50-59

"We spent [hundreds of dollars] on air purifiers. When first turned on (January) it read 185 $PM_{2.5}$. It reduced this to 28 – 30 in 12 hours. This improved my breathing and my stress levels."

- Community member aged 50-59

Discomfort from smoke was compounded as many found it difficult to alleviate the summer heat. Evaporative cooling systems are common in Canberra, but require circulation of air from outside, contradicting the recommendation to close and seal windows and doors. This left those with evaporative cooling, or who use passive air flow, to choose between dealing with heat or higher levels of air pollution in their homes.

"A significant problem was that we have evaporative cooling which we couldn't use when there was a lot of smoke outside. This exacerbated the other effects of the bushfires; it was very difficult to keep cool"

- Community member aged 60-69

Visiting other places was a strategy used by about a quarter of people at some point and by 10% regularly (15). Most commonly people went to shopping centres, indoor activities such as cinemas and gyms, friends' houses,

and community venues such as libraries and museums. However, many of these shut over the holiday period and/or as a result of high levels of air pollution. Getting to these places may also not be an easy option for some people, such as those with chronic health or mobility issues (61). Some people spent more time at their workplace, though many workplaces were also shut over this period and/or were affected by smoke. A reasonable amount of people (19% at some point, but only 3% regularly) left town entirely, though their ability to do this was inhibited by cost and lifestyle constraints (15).

About a fifth of people regularly used face marks to reduce smoke exposure, and almost half used them at some point, though this was strongly impacted by availability (15). Some people felt self-conscious or embarrassed wearing them, although this may be less of a concern now following their extensive use throughout the COVID-19 pandemic.

In addition to reducing exposure, about one in five Canberrans used respiratory medications most commonly used to treat asthma to mitigate respiratory effects of smoke (15). This was reflected in increases in the amount of respiratory medications dispensed under the Pharmaceutical Benefits Scheme (PBS) and over-the counter pharmacy sales of inhalers (e.g. Ventolin, Asmol, Bricanyl) in the ACT (12).

Community members experienced considerable uncertainty about how to protect the health and wellbeing of themselves and their families from bushfire smoke (61). Following the 2019-20 bushfire season, only 41% of surveyed Canberrans felt confident that they knew how to protect their health from smoke (3). Most people (two thirds) found it easy to obtain information on air quality, but half were unsure how to use this to assess risks (4). This was made more difficult by Government sources of air quality reporting daily or rolling averages that were not regularly updated and had reasonably large geographic granularity. These were little help with real-time decision making or understanding personal exposure, which has since led to improvements being made to these systems. Many people relied on visual cues, avoiding going outside when smoke was dense enough to be smelled or be seen with the naked eye. People who had air purifiers relied on them to give some indication of the real-time air quality in their homes.

"The official air quality web sites gave time average quality indexes. This didn't give information about what the air quality was at the current time. Not so useful."

- Community member aged 50-59

Decision making in response to bushfire smoke generally rests with the individual. The level of uncertainty that existed about protecting health from bushfire smoke suggests there may be a need for both better information about air quality, coupled with more education about how to interpret and then act on this information to empower people to protect their own health. However, even when people knew what to do, many people (68%) felt unable to protect themselves from smoke (4).

"…despite knowing what to do, there was nothing we could do to protect our health. Despite staying indoors and closing windows and sealing gaps, the smoke was inside. There was nowhere to get away from it. I still have the cough from that time."

- Community member aged 50-59

Public health messaging has generally been developed in response to brief smoke episodes and may be less effective over more prolonged periods, especially where smoke is infiltrating houses and compromising indoor air quality (61). Health advice regarding air conditioner and purifier use was effective for some but was not practicable or possible for others, such as those with evaporative cooling, or those who couldn't access purifiers due supply issues or cost. Not being able to follow recommended health advice can become an additional cause of anxiety. Health advice for responding to longer, more intense periods of bushfire smoke is needed that is effective as well as feasible within community constraints. This will be even more significant as greater frequency and intensity of bushfires are expected as a result of climate change. Enhanced information will be important but must be matched with preparatory policies and provision of resources that enable people to act on this advice to protect themselves and their families from bushfire and smoke.

"I felt very aware of my inability to buy an air purifier, and the impact not having the purifier that might have on my son in terms of long-term health."

- Community member aged 40-49

Lifestyle

Bushfire and smoke impacts not only people's health, but the way they live their lives. As the ACT experienced prolonged, hazardous smoke everyday activities such as physical activity, sleep, work and study, travel, socialising, and diet were all disrupted (see Figure 7).

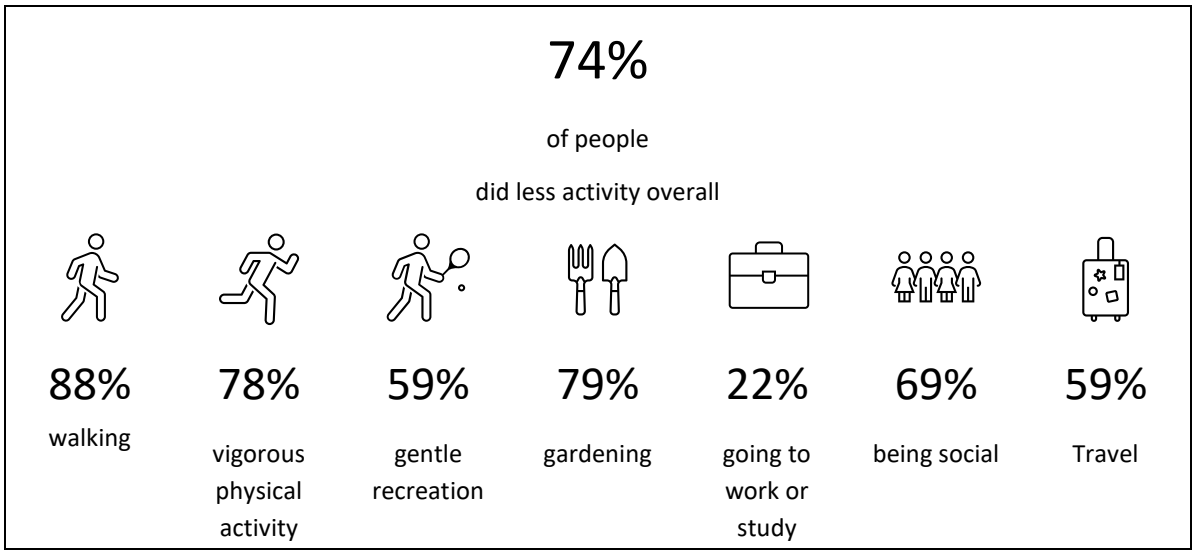

Figure 7: Reduction in daily activities for people living in the capital region during 2019-20 bushfire season. Data from Rodney et al. (15)*.*

Physical activity

Most Canberrans surveyed (74%) self-reported doing less activity overall, particularly walking and vigorous activity during the period of bushfire smoke (Figure 7), though a small number (<1%) did more activity. Outdoor exercise was particularly affected, though indoor activity was also reduced to a lesser extent (91% and 47% did less outdoor and indoor activity, respectively) (4). The amount of physical activity recorded by ACT users of Strava (physical activity tracking software) generally decreased between mid-December 2019 and the end of January 2020, corresponding with increased smoke-related air pollution (37). In the week beginning 30 December 2019 there was a 68% reduction in cycling and 64% reduction in running, walking or hiking trips logged compared with the same week in the previous year. In contrast, there was no impact of smoke on physical activity in a study of 59-65 year olds (45). Smoke also caused people to change the way they exercised, avoiding outdoor activities or moving to indoor activities, shifting the time they did activity, or wearing a face mask while exercising (15). Time spent doing other outdoor activities like gardening was also reduced (Figure 7). While avoiding outdoor exercise during periods of high air pollution aligns with public health guidelines, overall reduction in physical activity over long periods may be concerning as insufficient physical activity is a major risk factor for many chronic conditions (62). Furthermore, many people use physical activity as a coping mechanism during stressful situations, and limiting this may have exacerbated mental health issues.

"The biggest impact the bushfires had on me was by limiting outdoor exercise in nature, which meant my mental health suffered because the way I deal with anxiety (such as due to the constant smoke) is by exercising!"

- Community member aged 30-39

"I continued to exercise, but to a lesser extent. I guess it would have been helpful to understand long term risks to health. I felt I really needed to continue my exercise from a mental health perspective so on balance decided that risk to health was lower than benefits of running."

- Community member aged 40-49

"My exercise routine didn't change because I always exercise inside in a gymnasium. There were days when it was smoky inside but it didn't prevent me from exercising."

- Community member aged 50-59

Sleep

Fatigue or disrupted sleep affected half to two thirds of people during the period of smoke (3,4). Women, younger people, and people with poorer self-rated health or a previous diagnosis of a physical health condition had greater smoke-attributed impairments in sleep (3). Direct fire exposure also negatively affected sleep behaviours and was more pronounced with increasing severity of an individual's exposure to fire (3), although this was not seen within the PATH Study cohort of adults aged 59-65 (45). While some people recognised worry and anxiety impacting sleep, discomfort from people's inability to cool their houses (via opening windows or using evaporative cooling) was an important contributing factor.

Work and study

Throughout December 2019-February 2020, 22% of people surveyed spent less time at work or study due to bushfire and smoke (15). Many people who did go to work were concerned about the air quality in their workplaces, or exposure to air pollution as part of their work, particularly outdoor workers.

"My workplace was uncertain about how to deal with the smoke, and I feel like I (as an outdoor worker) was put at risk due to their mismanagement."

- Community member aged 18-29

"On more than one occasion I left the workplace because the air quality in my building was worse than at home"

- Community member aged 50-59

Travel

The summer holidays are usually a period of increased travel and socialising, however travel was strongly disrupted by bushfires and smoke. Over half of the community (58%) travelled less, although almost one in five chose to leave town specifically to escape the smoke (as discussed above) (15). Travel was complicated by road closures and travel delays (4) and fires caused holidays to be altered or cancelled (38). Many Canberrans traditionally spend parts of the summer on the NSW South Coast, which was one of the areas most severely affected by fire.

Social connection

Bushfire and smoke negatively affected social connection with 69% of people spending less time being social (15). Specifically, about half of people weren't able to see family and friends as much as usual, and a quarter found it hard to stay in contact (4). For 11% of people, the impacts of bushfire led to increases in social contact by way of extra people staying in their homes for periods of time (4). Concern for others, including pets, was a real and substantial stressor for many. Social connectedness enhances bushfire resilience and recovery (Box 5), while social isolation and disruption to work has been shown to contribute to increased mental health problems when explored as a result of COVID-19 public health measures (22). It is important the social impacts of fire be considered in public health recommendations, particularly where disruption to daily life is prolonged.

"I suffered considerable concern about the situation of friends at [NSW South Coast] who nearly lost their house. I wished I could be there to support them, but the roads were closed."

- Community member aged 70-79

"The experience of the bushfires/smoke was perhaps especially isolating as none of my immediate family live in Canberra and my partner, friends and housemates had all left Canberra for the summer. I think having no one around to share the experience with contributed to some anxiety."

- Community member aged 18-29

"…our home became a haven for friends who live close by. This engendered conviviality (drinking and dark-humour) which was a stress reducer too. Being concerned and upset at friends and family being in harm's way was a major stress factor…"

- Community member aged 50-59

Diet, alcohol and smoking

21% of Canberrans surveyed reported eating more unhealthy food than usual, and a small number had difficulty accessing food and household supplies at the supermarket (4). 14% reported drinking more alcohol and 11% reported smoking more than usual during the bushfire period. Previous work has identified heavy alcohol use in bushfire affected communities, even several years after the fire (23).

Box 5: Preparing People and Communities for Recovery

Disaster preparedness can improve post-disaster recovery when employed at both individual and community levels. Preparedness can involve material preparedness (such as obtaining useful equipment and supplies), planning (such as having a bushfire survival plan), and knowledge and skills (63). In addition to physical preparedness, psychological preparedness, "an intraindividual and psychological state of awareness, anticipation, and readiness – an internal, primed, capacity to anticipate and manage one's psychological response in an emergency situation" (Malkina-Pykh and Pykh, 2013 p121), can also be associated with improved outcomes following disaster. Following the 2019-20 bushfire season, disaster preparedness was associated with improved mental health, but not physical health, outcomes in adults aged 59-65 (45).

Research shows that community connectivity is an important factor in resilience to natural disaster and bushfire. Social support is one of the strongest protective factors for preventing PTSD. Community cohesion was important for improved mental health and resilience following 2019-20 bushfire (64). People with more interpersonal and group relationships pre-disaster had better mental health outcomes post-disaster. Similar beneficial effects of social networks on resilience were also identified following the 2003 Canberra bushfires (65). Despite the disruption the 2019-20 bushfire season had on Canberran's lives, many people commented positively on elements of relationships, connection or solidarity.

"The most positive aspect of the bushfire experience that I had was the caring, assistance and support that came from people in my world...friends, family and wonderful caring people.....I am aware that for me a smile or sharing of good experiences is what brought me through"

- Community member aged 60-69

Preparedness approaches are needed that equip people and communities with resources and skills required to minimise the disruption caused by disaster. Furthermore, investment in social resources and infrastructure that encourage community connectedness and social-identity building both before, and during response to bushfire will improve mental health and wellbeing outcomes.

Box 6: Bushfire and Aboriginal and Torres Strait Islander People

Aboriginal scholars have discussed how Aboriginal and Torres Strait Islander people experience bushfire differently to non-Indigenous Australians due to their spiritual and cultural connection to Country, cultural heritage, legal rights and interests as Traditional Custodians, and the ongoing impacts of colonisation (66). Bushfire is recognised as essential to the health and healing of Country, while also posing a threat when too intense or frequent (67).

Aboriginal and Torres Strait Islander people comprise 3.2% of Australia's population but represent 5.4% of the population living in areas of NSW and Victoria that were affected by fires in 2019-20 (68). That is, Aboriginal and Torres Strait Islander people, and particularly children, are more highly represented in fire-affected populations (69). A nationwide survey following the 2019-20 bushfires found that bushfires appeared to exacerbate existing inequities and vulnerabilities for Aboriginal and Torres Strait Islander people (69). who experienced higher rates of depression, anxiety, and PTSD, but also higher rates of post-traumatic growth and resilience following fire, compared to non-Indigenous participants (68).

Despite bushfires impacting Aboriginal and Torres Strait Islander people to a greater extent than non-Indigenous Australians, because of their numerical minority and sustained discrimination stemming from colonisation, they are at risk of being overlooked in design and implementation of disaster response efforts. Aboriginal and Torres Strait Islander people and communities may have distinctive strengths in recovery and resilience following bushfire events including close community connection, as shown by their propensity for resilience following bushfire. It is also likely that Aboriginal and Torres Strait Islander people will have specific vulnerabilities that may be intensified as a result of bushfire (66). These specific strengths and vulnerabilities need to be recognised in fire recovery and response. The destructive 2019-20 bushfire season has increased discussion about Indigenous fire knowledge and practice, providing an opportunity to enhance representation and involvement in bushfire prevention, management, response and recovery (67).

Note: Because of the population size, little of the population-level work conducted in the ACT examining the effects of the 2019-20 bushfire season has collected identifying data on Aboriginal or Torres Strait Islander Status, and as such is not able to detect specific impacts of bushfire on these community members. This enhances the risk of these community members being overlooked in local bushfire responses. Culturally competent approaches should be used within the ACT community to identify the distinctive experiences, strengths and needs of Aboriginal and/or Torres Strait Islander people living or connected to this region in response to fire and smoke.

Conclusions

The 2019-20 bushfire season had substantial and wide-reaching impacts on the health, wellbeing and daily lives of the ACT community. This synthesis of research identified the acute impacts of smoke and bushfire on multiple elements of physical and mental health, despite people taking precautions to reduce their exposure. It also recognised that some groups in the community were more vulnerable to these effects including people with existing medical conditions, the elderly, pregnant women, parents and renters. It identified that extreme bushfire seasons will place extra stressors on the health system in multiple ways and that this will extend beyond acute fire events. The ACT community exhibited great resilience despite the wide-reaching disruption and health impacts of the 2019-20 bushfire season.

This work recognised some key opportunities to reduce adverse effects of future bushfire and smoke events on people living in the ACT. Public health strategies need to be appropriate for longer, more intense periods of bushfire smoke and be effective and feasible within community constraints. They need to ensure the provision of appropriate and timely support and resources to minimise smoke and fire exposure, in turn minimising the number of people needing acute medical care. This should be matched with an understanding of the anticipated health system burden which will help with planning and resource allocation to ensure health services are not overstretched and can meet demand. Human effects of bushfire and smoke need to be considered holistically and policies need also to support investment in social resources and infrastructure that reduce disruption to everyday life and encourage community connectedness and social identity building both before and during response to bushfire.

This work also highlighted some gaps in knowledge worthy of further exploration including: exploring the long-term effects of smoke exposure on physical and mental health trajectories, separate from fire; improving knowledge of baseline (pre-fire) community characteristics, allowing more accurate interpretation of the acute impacts during a bushfire event to quickly identify where support is needed; culturally appropriate approaches to understanding the bushfire experience of Aboriginal and Torres Strait Islander members of the ACT community; and improving understanding of fire and smoke on specific groups at risk of greater impact such as pregnant women and babies, and people with existing medical conditions.

Together, this will enable improved preparedness and response planning and execution to equip and support the ACT community to minimise the effects of future bushfire seasons. This is particularly important as the severity and duration of fire seasons are projected to increase with anthropogenic climate change.

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