

Review

Potential Impacts of Extreme Heat and Bushfires on Dementia

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Abstract. Australia often experiences natural disasters and extreme weather conditions such as: flooding, sandstorms, heatwaves, and bushfires (also known as wildfires or forest fires). The proportion of the Australian population aged 65 years and over is increasing, alongside the severity and frequency of extreme weather conditions and natural disasters. Extreme heat can affect the entire population but particularly at the extremes of life, and patients with morbidities. Frequently identified as a vulnerable demographic in natural disasters, there is limited research on older adults and their capacity to deal with extreme heat and bushfires. There is a considerable amount of literature that suggests a significant association between mental disorders such as dementia, and increased vulnerability to extreme heat. The prevalence rate for dementia is estimated at 30% by age 85 years, but there has been limited research on the effects extreme heat and bushfires have on individuals living with dementia. This review explores the differential diagnosis of dementia, the Australian climate, and the potential impact Australia's extreme heat and bushfires have on individuals from vulnerable communities including low socioeconomic status Indigenous and Non-Indigenous populations living with dementia, in both metropolitan and rural communities. Furthermore, we investigate possible prevention strategies and provide suggestions for future research on the topic of Australian bushfires and heatwaves and their impact on people living with dementia. This paper includes recommendations to ensure rural communities have access to appropriate support services, medical treatment, awareness, and information surrounding dementia.

Keywords: Bushfire, climate change, dementia, extreme heat, wildfire

INTRODUCTION

Australia often experiences natural disasters and extreme weather conditions such as: flooding, sandstorms, heatwaves, and bushfires [1]. Frequently identified as a vulnerable demographic in natural disasters, there is limited research that focuses specifically on older adults and their capacity to deal with unforeseen circumstances [2]. Over the last two decades, the proportion of Australian population aged 65 years and over increased from 12.3% to 15.9% [3].

Alongside the frequency and severity of natural disasters within Australia, the percentage of people aged over 65 years is projected to increase rapidly over the next decade [4, 5].

A considerable amount of literature suggests mental disorders, such as dementia, depression, schizophrenia, and cognitive impairment, are associated with a significantly increased vulnerability to extreme heat [6–10]. Overall prevalence estimates for dementia is 1-2% by age 65 years and 30% by age 85 years [5]. Combining these predictions with the increased risks associated with older adults who have dementia, leads to an assumption of rising rates of injury or death from extreme weather conditions specifically, heatwaves and fire [9]. There

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is a paucity of research highlighting the potential dementia-specific bushfire risks [11]. Fountain et al. (2019) suggests specific risk factors of injury or death from bushfire are living alone, being aged 60 and over, disability, impairment, and/or dementia. Furthermore, Hansen et al. (2008) states that heatwaves potentially exacerbate behavioral and cognitive disorders.

The combination of risk factors and increasing predictions of people living aged 60 and over with dementia suggests that the risk of injury or death from fire will continue to rise [12]. However, the extent to which fires and extreme heat increases and/or exacerbates dementia is currently unknown. The purpose of this review is to gain a better insight into the impact of Australian bushfires and extreme heat on people living with dementia.

DEMENTIA

Dementia, originally derived from the Latin term “out of one’s mind”, is a neurodegenerative disorder of the brain [13]. Early research by Esquirol (1838) characterized dementia as ‘a weakening of understanding, sensibility, and will’. This definition highlighted the cognitive features of the disorder but also other manifestations such as deterioration in social behavior [14]. Modern diagnostic criteria, such as *International Classification of Diseases* [15] and *Diagnostic and Statistical Manual of Mental Disorders* [16], characterize dementia as a global decline of memory and other cognitive functions [17] (Kim, 2012). However, dementia is often accompanied by behavioral or personality changes and therefore presents as a heterogeneous disorder [14]. The ever-changing definitions of dementia reflect the most recent developments in our understanding of the disorder.

One significant change from DSM-IV to DSM-5 is the classification of Major Neurocognitive Disorder (NCD) which corresponds to the condition previously referred to as *dementia* [18]. This new term encompasses a range of disorders in which the primary manifestation is significant cognitive decline from a previously higher level of cognition in one or more cognitive domains (executive functioning, learning and memory, complex attention, perceptual-motor, or social cognition), which interfere with independence in daily living and do not occur exclusively in the context of delirium, or better explained by another mental disorder (criteria A, B, C, D [16]).

Grouped under NCD in DSM-5, are several specifiers of dementia: Alzheimer’s disease, vascular dementia, frontotemporal dementia, Lewy body dementia, Korsakoff syndrome, and younger onset dementia [16]. These six forms of dementia account for the majority of NCD cases in the general population [16]. Alzheimer’s disease, characterized by the presence of amyloid plaques and tau tangles on brain cells, accounts for approximately 70% of cases and is the most common form of dementia in Australia [19]. Lewy body dementia, related to Alzheimer’s disease and Parkinson’s disease, is caused by the degeneration and death of nerve cells in the brain [20]. The damage to brain cells in both Alzheimer’s disease and Lewy body dementia, is suspected to be caused by several factors including genes, lifestyle, and environment [21]. Vascular dementia, the second most prevalent form of dementia accounting for 17%, is associated with problems of blood to brain circulation and results in the death of brain cells from oxygen deprivation [22]. Most people who develop dementia are aged 65 years or over; however, frontotemporal dementia and younger onset dementia are rarer forms of dementia that typically develop in earlier years. Korsakoff syndrome is considered an alcohol-related dementia, characterized by severe memory loss, due to a lack of thiamine, known as vitamin B1 [23, 24]. Despite various specifiers of NCD, the diagnostic criteria for dementia are analogous in the ICD-11.

Overall prevalence estimates for major NCD, which is congruent with dementia, are approximately 1-2% at age 65 years and 30% by age 85 years [20]. However, evidence suggests that the DSM-5 criteria are more lenient and therefore identify more cases [25]. The prevalence of different symptoms can therefore influence how common dementia is diagnosed when different criteria are used [4]. Accordingly, the various diagnostic criteria lead to markedly different prevalence rates for dementia in the general population [4]. Numerous longitudinal studies have reported on memory deterioration and cognitive changes in normal aging [26–32], concluding that numerous dementia syndromes can occur in the elderly; however, there is no evidence for a discrete break between normal aging and dementia [31, 33]. Dementia Australia (2020) states early symptoms of a dementia diagnosis can mimic normal aging and thus, obtaining a diagnosis of dementia is a difficult, intensive, and lengthy process. Dodge et al. (2011) states the causes of dementia continue to be the subject of huge research efforts. There is a large body of literature to suggest that the current knowledge about dementia is

limited and, accordingly, impacts our understanding of the onset of this disease process [26].

Recent research by Doyle et al. (2014) suggests an association between dementia and post-traumatic stress disorder (PTSD). PTSD is classified under the DSM-5 as a trauma- and stressor-related disorder and is the development of symptoms after exposure to a traumatic event (e.g., natural disaster, car accident, sexual assault, etc.), which threatened an individual's life or safety [16]. The proposed association between PTSD and dementia is the most recent in accumulating evidence that lifestyle and life experiences can lead to cognitive impairment [34]. So far there is no causal relationship between PTSD and dementia; however, the cognitive changes seen through its association with alterations in the hypothalamic pituitary-adrenal axis function and reduced cortisol levels and allosteric downregulation of glucocorticoid system leads to increased cognitive decline, and could predispose people to dementia [35]. Accordingly, the cognitive changes seen in people with PTSD have the potential to be early markers for dementia in later life [36, 37]. Furthermore, PTSD shares common risk factors with dementia such as limited education, low IQ, traumatic brain injury, and substance abuse [35]. Recent studies have focused efforts on investigating the understandings of the underlying mechanisms that link the two disorders. These studies found the risk of dementia in war veterans diagnosed with PTSD was almost doubled compared to that in non-PTSD affected veterans [38–40]. However, among civilian populations increasing numbers are also experiencing PTSD as a result of severe weather events (heatwaves, bushfires, storms, drought, floods) and natural disasters (earthquakes, tsunamis) [35]. The current changing climate in Australia highlights the need for longitudinal studies to understand the affects these stressful life events have on the diagnostic rates of dementia.

AUSTRALIAN CLIMATE

Heatwaves, characterized by five consecutive days above a maximum temperature threshold of 35°C or three consecutive days at 40°C, are Australia's most deadly natural hazard, causing 55% of all-natural disaster related mortalities [41–45]. Recent research suggests that heatwave events are growing in frequency, duration, and intensity across many regions of Australia [46–48].

Research by Cowan et al. (2014) incorporated the Couple Model Intercomparison Project phase 5 (CMIP5) climate models to project on the frequency, duration, and intensity of heatwave events in Australia. Results suggest Australia will endure more frequent, hotter, and longer heatwaves by the end of the twenty-first century, with the largest heatwave frequency to occur across the Northern regions of Australia [49]. For the same time interval, the Australian continent has warmed 0.9°C more compared to that of the global average 0.7°C [50]. Perkins-Kirkpatrick et al. (2016) states heatwaves are a key contributor to bushfires.

Bushfire risk is dependent on the amount of fuel, likelihood of ignition, dryness, and prevailing weather [1]. Weather trends from 1973 to 2010 showed a significant increase in fire risk [3]. Accordingly, climate forecasts predict more frequent heatwaves and bushfire weather in the future [3].

POTENTIAL IMPACT OF EXTREME HEAT AND ASSOCIATED EVENTS ON DEMENTIA

Given the predicted increase in frequency, intensity, and duration of extreme-heat events as a result of climate change there is a growing concern around the associated health-related impacts [51]. Research by Jorm et al. (2005) suggest dementia to be a heat-sensitive illness and with the current global climate, estimates a 231% rise in new dementia cases per year by 2050 [52].

Bi et al. (2011) found that the effect of heat on mortality and morbidity is determined by the duration and intensity of heat events [53]. American studies on the physiological effects from heat and humidity, indicated that higher temperatures are associated with increased mortality [54–58]. Further research on the impact higher temperatures have on individuals' health found an increased number in hospitalization and emergency room visits during an extreme-heat event [59–62].

Recent Australian studies have adapted this research approach and used hospital admissions to quantify the effects of heatwaves on mortality and morbidity [63–68]. Results suggest individuals with pre-existing dementia and heart disease had increased mortality risks during heatwaves.

While natural disasters arbitrarily happen, the impacts are often disproportionately borne by those already identified as vulnerable and/or experiencing

248 social isolation [69]. One population group identified
 249 as vulnerable in extreme weather events is older
 250 people [70]. As Australia's population ages there is
 251 particular concern surrounding the growing number
 252 of older people in communities vulnerable to extreme
 253 weather events [70]. Several researchers have identified
 254 factors that place older people at risk during
 255 extreme weather events: disability, social isolation,
 256 lack of access to resources, physical and mental well-
 257 being, communication difficulties, and inability to
 258 use modern technologies [69, 71, 72].

259 Research by Hansen et al. (2008) studied the effect
 260 of Australian heatwaves on mental health by examin-
 261 ing hospital admissions and mortalities. Using health
 262 outcome data from Adelaide, South Australia, the
 263 goal of the study was to identify behavioral, mental,
 264 and cognitive disorders that may be triggered or
 265 exacerbated during heat waves. Results indicated a
 266 positive association between hospital admissions for
 267 behavioral and mental disorders and a threshold of
 268 26.7°C and above, with a 7.3% increase of hospital
 269 admissions during heatwaves [9]. Additional find-
 270 ings suggest that extreme heat events pose a salient
 271 risk to the health and well-being of older populations
 272 with an increase in dementia-related deaths in peo-
 273 ple aged 65 years and over [9]. Previous research
 274 on the effects of global warming on neurodegenera-
 275 tive disorders suggests that climate change has the
 276 most stressful effects and negative outcome on human
 277 biological systems [73]. It has been well researched
 278 that increased heat stress has degenerative effects on
 279 neurons, for example, during stroke the brain temper-
 280 ature is higher than the rest of the body [73, 74]. More
 281 specifically, increasing body temperature above 40°C
 282 can push organisms beyond their optimal homother-
 283 mic temperature and result in profound health effects
 284 such as cell necrosis [73, 75].

285 A possible explanation to consider for the results
 286 in Hansen et al.'s 2008 study is the interference that
 287 medications for mental disorders have with individu-
 288 als' physiological homeostasis. Psychotropic drugs
 289 with thermoregulatory side effects, cholinesterase
 290 inhibitors (ChEIs) and memantine, given to dementia
 291 patients [76] have the potential to modify cognitive
 292 awareness and vigilance levels [77] for necessary
 293 adaptive behaviors to avoid extreme heat condi-
 294 tions [6, 10, 77, 78] (Fig. 1). ChEIs and memantine
 295 are a class of drugs that are used to treat NCD
 296 [79]. ChEIs and memantine block the action of
 297 acetylcholinesterase, an enzyme that breaks down
 298 acetylcholine, the main neurotransmitter found in the
 299 body, which has important functions in the central

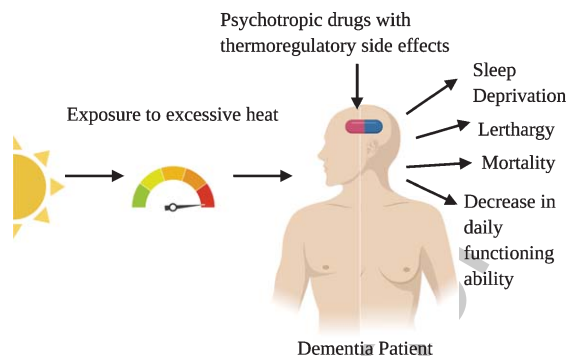


Fig. 1. Schematic showing how excessive heat can affect outcomes for patients on psychotropic drugs in dementia patients.

nervous system and peripheral nervous system [80]. Donepezil, rivastigmine, and galantamine are three common ChEIs, each with varying modes of actions, and have been approved for mild-to-moderate NCD [81]. Conversely, research has shown an association between these medications and a significant increase of heat-related hospitalization and mortality [77, 82]. Several studies have shown the association between people with mental disorders and the increased vulnerability to heatwaves, demonstrated by increases in mortalities and hospital admissions and morbidities [10, 57, 78, 83–85].

Evidence has shown that excessive heat and humidity may exacerbate psychiatric conditions [86]. Exposure to extreme heat can increase stresses of daily living by lethargy, sleep deprivation, and inability to function normally [9]. These effects from sustained heat, accompanied by bushfires, droughts, and power outages, have the potential for significant implications across the public health sector [9]. However, there is limited research on specific mental disorders (Major NCD) that may be exacerbated by bushfires. Furthermore, there is paucity of literature surrounding the particular difficulties faced by people with dementia in regional areas and especially indigenous populations.

Bushfires, heat waves, and drought are recognized as posing threats to Australian regional and rural communities [87]. Previous studies have highlighted the impacts of climate change and the exacerbation of natural hazards in rural areas in Australia [88–91]. Accordingly, it is proposed that rural areas and communities will experience an increase in bushfire frequency and intensity [92]. This projected increase in bushfire frequency has direct relevance to the vulnerability of daily living for the growing population living in bushfire-prone rural-regional areas [92].

Recent literature has found that factors such as socio-economic status, lower education levels, environmental risks to drought, bushfires, and heatwaves, and limited access to health services, are key factors that impact rural communities' overall health outcomes [93]. These factors are associated with poor health such as environmental dangers, obesity, diabetes, personal injury, smoking, and heavy alcohol consumption, and are risk factors for dementia [93]. Population research by Wu et al. (2017) estimates that by 2050, 3.8% of the population living in rural areas will have dementia, compared with 2.9% in the balance of capital cities.

Consistent with the current proportion of people in Australia living with dementia, an increase in the proportion of people in rural areas living with dementia is expected to increase in the next decade [12]. However, Corrada et al. (2010) states the imbalance in dementia rates is custom to change as "*dementia prevalence rates follow an exponential growth rate with age*" [94]. Rural areas have a lower life expectancy to urban regions by up to 7 years [95]. Accordingly, risk factors for dementia in urban areas are projected to exceed that of rural areas due to the lower life expectancy [95]. In contrast, Costello (2007) found the average age profile of rural populations is increasing at a rapid rate, led by the emigration of younger people to urban areas for employment, education, and lifestyle opportunities [96]. These factors highlight the aging populations of rural and regional areas compared to that of urban and metropolitan centers. However, Qiu et al. (2009) suggests an epidemiology study is fundamental to accurately determine the prevalence rates of dementia in rural areas [97].

Recent research conducted by the Indigenous Dementia Project focused its efforts on the issues surrounding dementia in the Northern Territory, identifying the service gaps, unmet needs, and diagnosis of dementia [98]. Current research on prevalence rates of dementia within Aboriginal and Torres Strait Islander people indicates that dementia rates are 3 to 5 times higher than the general Australian population [99]. Furthermore, Aboriginal and Torres Strait Islander people present with symptoms of dementia at an earlier age compared to the general population, in combination with the steady growth of older Aboriginal and Torres Strait Islander people, the number of people effected by dementia is projected to grow significantly in the next decade [100]. Accordingly, the high rate of Indigenous people living with dementia requires urgent attention.

Although higher rates of dementia have been reported within Indigenous communities, dementia is viewed and experienced differently by Aboriginal and Torres Strait Islander people and is regularly overlooked or unrecognized as a medical condition [101]. Research by Arkles et al. (2010) discovered Indigenous communities commonly view behavioral changes associated with dementia as "madness" or "childlike" or "sickness" with many people avoiding medical assistance until the behavior breaks cultural norms. Research by Smith et al. (2010) conducted in rural Western Australia identified the diverse perspectives Indigenous people have regarding the causes of dementia [102]. Smith et al. (2010) concluded Aboriginal and Torres Strait Islander communities regard causes of dementia to include lack of family visits, sustained head injury, old age, and changes in the brain. The reasons for higher rates of dementia in rural Australia and indigenous communities is still uncertain; however, a lack of education and awareness by community members and health workers, geographical constraints in the provision of services and the prevalence of other chronic health conditions, have all been identified as considerable barriers to the recognition of dementia as an urgent and emerging health issue [103].

One problematic barrier identified is the access to services in rural Australia [104]. Research by Australian Institute of Health and Welfare [105] on Aboriginal and Torres Strait Islander people with dementia found the highest rate of difficulty in accessing services was reported in the Northern Territory (40.4%). Participants living in remote and rural areas reported more difficulty accessing services (42.0%) compared to participants residing in urban and metropolitan areas (23.7%) [105]. Participants in remote areas identified barriers to accessing services were waiting time too long (15.9%), transport or distance (18.7%), limited services in area (20.5%), and no service provided in area (23.7%) [105]. Greater access, awareness, and education of dementia is fundamental for health providers to adequately support Indigenous populations and people living in rural Australia [106].

PREVENTION

Previous literature suggests that socio-demographic factors such as social isolation, ethnicity, education level, age, transportation availability, and socio-economic status, influence the mortality and

438 morbidity risks of individuals to bushfires [107].
439 Evans et al. (2016) stated there is a large number
440 of individuals who have dementia and live alone;
441 however, there is limited research related to the daily
442 difficulties and challenges faced by these individuals
443 [108].

444 An important first step in getting dementia recog-
445 nized by family members, older populations,
446 Aboriginal and Torres Strait Islander communities,
447 and health professionals is through incorporation
448 of dementia into pre-existing preventative health
449 strategies [106]. Timely diagnosis of dementia and
450 culturally sensitivity will assist in identifying early
451 symptoms of the disease and facilitate earlier access
452 to medical services [106]. To ensure cultural appro-
453 priateness of services provided, mainstream aged care
454 and community services should work closely with
455 Aboriginal Community Controlled Health organiza-
456 tions where possible [109].

457 *“Living alone in the community is significant for*
458 *people with dementia, as they have to cope with a*
459 *deteriorating cognitive function and limited sup-*
460 *port”* [108].

461 As a result, individuals with dementia are more
462 likely to be isolated from society, health care, and
463 support systems [110]. However, obtaining a compre-
464 hensive understanding of the experiences and priority
465 intervention areas requires the viewpoints of the indi-
466 viduals who work with older adults with/without
467 dementia such as aged care, community services,
468 emergency services, and relevant government agen-
469 cies, who have been involved in disaster management
470 [5]. In relation to extreme weather conditions, litera-
471 ture has highlighted the vulnerability of older adults
472 as a cohort, though there is limited attention on how to
473 prevent the cohort from experiencing increased risk
474 [5]. With the exception of heatwaves, there has been
475 limited Australian publications focusing on issues of
476 prevention on pre-disaster contexts [111].

477 Fountain et al. (2019) developed two question-
478 naires intended for stakeholders involved with older
479 populations, with the aim to identify priority research
480 areas for disaster management in Australia among
481 older adults. This opportunity provides an under-
482 standing of the hazards experienced and the potential
483 to develop preventative methods [5]. Results found,
484 93% of respondents identified communication and
485 warnings as ‘important’ or ‘extremely important’.
486 Also identified was the increasing reliance on dig-
487 ital media for communications and warnings to
488 be received. Results also highlighted the need for

489 community inclusiveness in disaster planning and
490 preparing as, preparing can be financially and phys-
491 ically demanding for older people [5]. Research by
492 Fountain et al. (2019) echoed previous study results
493 [112, 113], by highlighting the importance of under-
494 standing the experiences and perspectives of older
495 adults living with/without dementia to better under-
496 stand their resilience and vulnerability.

497 Research to improve the safety and resilience of
498 individuals living with dementia during heatwaves,
499 bushfires, and other extreme weather events and dis-
500 asters, needs to consider the heterogeneous nature of
501 the disease and the impact extreme heat can have on
502 his/her capacity to cope. Accordingly, research pri-
503 orities should focus efforts on: 1) early symptoms
504 and manifestations of dementia, 2) understanding
505 the impact psychotropic drugs with thermoregulatory
506 side effects have on an individual’s ability to sur-
507 vive a heatwave and/or bushfire season, 3) advocacy
508 groups, emergency services and other stakeholders
509 to prevent additional vulnerability of older adults
510 living with dementia and reduce their risks from
511 disasters. This review highlights the need for addi-
512 tional research surrounding the impact Australian
513 bushfires and heatwaves have on individuals living
514 with dementia. Recent research has focused efforts
515 on understanding resilience and experiences lived by
516 the older community; however, there is no defini-
517 tive distinction between normal aging and dementia
518 [26]. Furthermore, several studies have explored the
519 morbidity and mortality rates of people living with
520 dementia through hospital admissions data.

521 It is recommended that research continues to iden-
522 tify the impacts extreme heat and bushfires has on
523 individuals living with dementia and the ways in
524 which stakeholders, emergency services, and other
525 government authorities can help reduce mortality and
526 morbidity rates within the older adults living with
527 dementia in Australia. In sum, we have highlighted a
528 potentially important association between Australian
529 heatwaves and bushfires on individuals living with
530 dementia and identified key areas for research on the
531 effects of extreme weather conditions and dementia.

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