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## Original article

# The effect of the Australian bushfires and the COVID-19 pandemic on health behaviours in people with multiple sclerosis



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## ABSTRACT

**Background:** Crises and disasters disproportionately impact people with chronic health conditions such as multiple sclerosis (MS).

**Objective:** To assess the impact of the COVID-19 pandemic and the Australian Black Summer Bushfires on health behaviours in people with MS.

**Methods:** People with MS, carers, healthcare and advocacy professionals were recruited online between May-July 2020 for an online survey and telephone interviews.

**Results:** Survey items relating to health behaviours were completed by 113 people with MS, and 18 people with MS, 4 MS advocates, 5 healthcare professionals, and 2 carers were interviewed. The bushfires affected 34.5% and the pandemic affected 74.3% of survey participants with MS. The pandemic and bushfires caused a decrease in physical activity in 53.8% and 55.3% of participants respectively, as well as increases in unhealthy eating (43.6% and 24.3% respectively) and alcohol consumption (35.4% and 10.5% respectively), and a decrease in typical sleeping patterns (40.5% and 39.5% respectively). Conversely, 27.5% of participants reported an increase in physical activity during the pandemic. Interview data detailed the circumstances and motivations for changes in health behaviours, as well as consequences, including reduced mobility, fitness, mood disturbances, and weight gain.

**Conclusion:** There is a need to increase support and health promotion for people with MS to maintain or initiate positive health behaviours, especially in times of adversity.

## 1. Introduction

The COVID-19 pandemic has resulted in unprecedented changes in societies worldwide, including restrictions in movement and social contact. Further, the pandemic was preceded in Australia by the *Black Summer bushfires* in late 2019 and early 2020, affecting every State and Territory of Australia but with varying degrees of spread, intensity and impact; including loss of lives and destruction to flora, fauna, homes, and infrastructure. During the *Black Summer bushfires* approximately 1.8 million people were evacuated, and an estimated 11 million people were impacted by the bushfire smoke, putting a major strain on the healthcare

system (Biddle N et al., 2020, Duckett et al., 2020). The presence of multiple crises (such as pandemics, fires, floods, droughts, and conflict) threatening communities within a short time frame is a pressing threat to public health globally (Edgeley and Burnett, 2020) as well as Australia (Victorian Health Promotion Foundation 2020).

Crises and disasters commonly disproportionately impact disadvantaged people (Victorian Health Promotion Foundation 2020, Shapira et al., 2020), including people with disabilities or chronic health concerns such as multiple sclerosis (MS). Reports from Europe and the USA, where infection rate and restrictions varied from those of Australia, confirm the impact of the COVID-19 pandemic on hospitalisation and

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mortality (Salter et al., 2021, Louapre et al., 2020), psychological distress (Capuano et al., 2020, Stojanov et al., 2020, Chiaravalloti et al., 2020), as well as on access to healthcare, and treatment regimens (Sastre-Garriga et al., 2020) for people with MS. Restrictions have been very successful in Australia to reduce community transmission of COVID-19, but they may also have collateral consequences for rehabilitation and health behaviours, which impact health outcomes of people with MS (Leocani et al., 2020).

MS management commonly comprises a combination of pharmaceutical and allied health care. Clinical advice, mostly focused on pharmaceutical management of MS during the pandemic, was published early on (in March 2020) (Brownlee et al., 2020, Willis and Robertson, 2020, Giovannoni et al., 2020). Calls for increased focus on the promotion of rehabilitation, wellness, and health behaviours for people with MS during the COVID-19 pandemic emerged also (Leocani et al., 2020, Motl et al., 2020). The importance of positive health behaviours such as exercise on neurorehabilitation and managing MS symptoms is well known (Dalgas et al., 2019, Vollmer et al., 2012). Adverse health behaviours and factors such as physical inactivity, excessive alcohol consumption, overweight, and smoking are common, and associated with worse health outcomes in people with MS (Marrie et al., 2009, Beier et al., 2014, Paz-Ballesteros et al., 2017). Further, smoking and obesity are linked to increased risk for severe COVID-19 infection in the general population (Gupta et al., 2021), while prehabilitation (e.g. exercise, nutrition, smoking cessation, and stress reduction) may improve the immune system response to future stressors such as infection (Silver, 2020). However, in 2016 most Australians with MS did not meet the minimum exercise guidelines for people with MS (Marck et al., 2020), or the Australian dietary guidelines (Marck et al., 2021). Recent crises may have further impacted on these health behaviours, which have consequences for long-term health outcomes for people with MS.

Consumer-driven research and initiatives are essential to developing understanding and reducing the impact of crises, and build resilience for future crises; in particular for vulnerable communities (Villeneuve et al., 2021). Therefore, this mixed-methods study, a collaboration between researchers, consumers, carers, MS advocates, and healthcare practitioners, aims to understand the impact of recent crises; the Australian Black Summer Bushfires and the COVID-19 pandemic, on health behaviours of Australian people with MS. This paper reports on a study conducted as part of the larger Crisis Resilience In people with Multiple Sclerosis (C-RIMS) project, which aims to ascertain the impacts of crises on access to health services and information also.

## 2. Materials and methods

### 2.1. Study design

This component of the C-RIMS project included a quantitative survey and semi-structured interviews. The study was approved by the Murdoch University Human Ethics Committee (2020/039) and ratified by the University of Melbourne Human Research Ethics Committee (2056720.1).

### 2.2. Recruitment

People living in Australia with a diagnosis of MS, and MS community members (MS healthcare professionals, carers, and advocates) were eligible to participate in the study. A survey for participants with MS as well as MS community members was advertised via MS societies and advocacy organisations' social media and newsletters, and further promoted via email lists. Survey participants with MS and MS community members were asked to indicate if they would be willing to participate in follow-up online or phone interviews. The research team then selected participants for interviews based on whether their survey responses indicated they had experienced impact of bushfires and or the COVID-19 pandemic, and whether their health behaviours changed as a result of

these. We further ensured diversity in sex, geography (e.g., state and rurality), and (for participants with MS) the severity of disability as assessed by the well-validated Patient Determined Disease Steps (Leaermonth et al., 2013). We aimed to select persons who met as many criteria as possible, thus selection was based on diversity of experience to the crises and apparent willingness to provide qualitative input.

### 2.3. Data collection

The short 30-40 question online survey was open from 1<sup>st</sup> of May until 30<sup>th</sup> July 2020. Participants with MS were asked if they were directly or indirectly affected by the bushfires or COVID-19 pandemic (yes/no), intentionally worded in a manner open to interpretation by the participant. The survey also assessed demographic characteristics of all participants, clinical characteristics and health behaviours (for participants with MS only), concerns about healthcare access and information needs for the MS community (reported elsewhere) and assessed willingness to participate in interviews. Semi-structured interviews were conducted between 19<sup>th</sup> May and 3<sup>rd</sup> August 2020, audio-recorded and transcribed verbatim. Data collection occurred several months after the bushfires had been extinguished and while a range of COVID-19 restrictions were in place, varying by state and month.

### 2.4. Data analysis

The current study focuses on the analysis of data related to demographic characteristics of all participants, and the report changes in health behaviours of participants with MS (tobacco smoking, medication adherence, alcohol consumption, physical activity engagement, unhealthy eating, or typical sleeping pattern) originating from the survey; as well as interview data from people with MS, MS healthcare professionals, carers, and advocates representing MS patient organisations. Respondents who had completed less than 50% of the survey (n=10) were excluded from the sample as they had missing data on most relevant items (e.g. health behaviours). Stata version 16.0 was used to analyse the survey data and report frequencies of changes in health behaviours. NVivo version 12 was used to code the qualitative data and analyse the interview data using thematic analysis guided by a coding framework. Predefined themes included health behaviours and changes to health outcomes as a results of the crises.

## 3. Results

### 3.1. Participants

The survey was completed by 113 participants with MS, of which 77 indicated willingness to be interviewed. In addition, 65 MS community members also completed a survey (findings reported elsewhere) of which 36 volunteered to be interviewed. After screening for eligibility, 35 participants were invited for interview; of which 6 declined or were unavailable, and 29 participants were interviewed; 18 people with MS, 4 MS advocates, 5 healthcare professionals, and 2 carers (Table 1).

### 3.2. Impact of bushfires and COVID-19 pandemic on health behaviours: survey data

The bushfires directly or indirectly affected 39 out of the 113 survey participants with MS (34.5%). In contrast, at the time of the survey, 84 respondents (74.3%) reported that the pandemic had directly or indirectly affected them. The survey results showed that the COVID-19 pandemic, and to a lesser extent the bushfires, had impacted health behaviours. The majority of participants reported a decrease in physical activity due to the bushfires and the pandemic. Further, an increase in unhealthy eating was reported by half and a quarter of the sample during the bushfires and the pandemic respectively. A decrease in typical sleeping patterns was reported by 40% due to both the bushfires

**Table 1**  
Survey and interview participant demographic and clinical characteristics.

Variable	Category	Health behaviour survey participants n (%)	Interview participants n (%)	
Participant type	Person with MS	113 (100.0)	18 (62.1)	
	Healthcare provider	0 (0)	5 (17.2)	
	MS advocate	0 (0)	4 (13.8)	
Gender	Female	99 (87.6)	23 (79.3)	
	Male	14 (12.4)	6 (20.7)	
Age in years	18-20	1 (0.9)	0 (0)	
	20-29	3 (2.7)	3 (10.3)	
	30-29	19 (17.0)	6 (20.7)	
	40-49	27 (24.1)	7 (24.1)	
	50-59	31 (27.7)	3 (10.3)	
	60-69	26 (23.2)	8 (27.6)	
	70+	5 (4.5)	2 (6.9)	
State or territory	Victoria	41 (36.6)	10 (34.5)	
	New South Wales	27 (24.1)	7 (24.1)	
	Western Australia	12 (10.7)	4 (13.8)	
	Queensland	11 (9.8)	4 (13.8)	
	South Australia	11 (9.8)	1 (3.4)	
	Tasmania	9 (8.0)	2 (6.9)	
	Australian Capital Territory	0 (0)	1 (3.4)	
	Northern Territory	1 (0.9)	0 (0)	
	Level of disability	Mild	61 (54.0)	14 (77.8)
		Moderate	40 (35.4)	1 (5.6)
MS type	Severe	12 (10.6)	3 (16.7)	
	Relapsing remitting	75 (66.4)	15 (83.3)	
	Progressive MS	27 (23.9)	3 (16.7)	
	Other/ unsure	11 (9.7)	0 (0)	

and the pandemic. Alcohol consumption increased for 10% of participants during the bushfires, and 35% of participants during the pandemic; while tobacco smoking and medication adherence were mostly unchanged (Table 2).

### 3.3. Australian Black Summer bushfires: interview data

Some participants reported they were impacted by the 2019/2020 Australian bushfires; mostly through the associated smoke which covered large areas for weeks or months. Some participants commented on how the smoke impacted on health behaviours. The impact on ability to participate in physical activity and exercise was most commonly mentioned. Participants reported changed behaviour due to the poor air quality which prohibited people from going outside, combined with the fear of adverse health effects of the smoke. The bushfires also caused stress, which one participant said resulted in 'stress eating'. Very few commented on changes in other health behaviours.

**Table 2**  
Changes in health behaviours during disasters.

	Bushfires, n (%)			Pandemic, n (%)		
	Increase	No change	Decrease	Increase	No change	Decrease
Physical activity	3 (7.9)	14 (36.8)	21 (55.3)	22 (27.5)	15 (18.8)	43 (53.8)
Unhealthy eating	9 (24.3)	26 (70.3)	2 (5.4)	34 (43.6)	38 (48.7)	6 (7.7)
Normal sleeping pattern	2 (5.3)	21 (55.3)	15 (39.5)	6 (7.6)	41 (51.9)	32 (40.5)
Alcohol consumption	4 (10.5)	34 (89.5)	0 (0)	28 (35.4)	49 (62.0)	2 (2.5)
Medication adherence	3 (8.3)	31 (86.1)	2 (5.6)	8 (10.4)	66 (85.7)	3 (3.9)
Tobacco smoking	2 (5.4)	35 (94.6)	0 (0)	2 (2.8)	69 (97.2)	0 (0)

### 3.4. The COVID-19 pandemic: interview data

Many of the participants with MS, as well as the healthcare professionals, commented on how the COVID pandemic impacted on health behaviours. Some participants reported that they had improved their health behaviours, because there was more opportunity due to reduced commuting time or changed circumstances. Others commented that their motivation to be fit and healthy increased because they thought this would help them recover better if they contracted COVID-19. Advocates and healthcare professionals also commented that people with MS were often resilient and highly motivated to maintain healthy behaviours, and resuming their routines when restrictions lifted. Many people engaged in other types of exercise, or exercised at home instead of the gym.

*"Lots of the people with MS started finding other ways to exercise, they were bicycling and walking to keep up their exercise. Trying to find ways that they could exercise outside. The MS patients had quite a resilient response to the COVID pandemic."* Healthcare professional from Queensland

*"I'm one of those people that has set a lot of that up at home already, I had bought lots of exercise equipment and just kept on going business as usual from that perspective. So exercising each day like I've normally done."* Person with MS from New South Wales

*"Sleep's improved because of the world slowing down. So the fatigue reduced because I could all of a sudden sleep 10 hours."* Person with MS from Victoria

*"If anything, it [healthy behaviour] has improved over that time, because I've just been so, so, conscious of needing to get to my best possible health, because of the risk if you did get coronavirus."* Person with MS from Victoria

Most participants, however, commented that the impact of the pandemic had harmful effects on their health behaviours, most commonly physical activity and exercise behaviour. Some of these changes were caused by closed gyms or other facilities, breaking routines in positive health behaviours. Others reported an increase in unhealthy eating, alcohol consumption or reduction in typical sleeping patterns due to stress or boredom caused by the pandemic. One health care professional reported that several patients reported an increase in alcohol consumption.

*"Yes, one of the things that I have taken up to manage my MS and to manage my symptoms a little bit is exercise, and my gym has obviously closed, and so I've needed to exercise more at home – which for me is more difficult to do than removing myself from the house to go somewhere else and do it."* Person with MS from Victoria

*"I'm frustrated, I haven't found a park that's got a flattish path and a toilet. So in terms of me building my endurance with walking, I can't do it from home. I wanted to expand what I was doing a little bit, work on my endurance with my walking, and I thought well I just have to wait 'til they decide it's safe to open these parks that do have toilets and shelter."* Person with MS from Queensland

*"I've been doing more of both (eating and drinking). When you're home all the time, and you know sometimes you get a bit boring, bored, and you're like am I hungry or am I bored, so go and try it out, eat something, no I wasn't hungry, I'm just bored."* Person with MS from Victoria

For those who experienced negative impacts on their healthy behaviours due to the pandemic, some detailed the consequences of that to

their health in the short term. Reduced fitness and mobility, weight gain and mood changes were reported by participants with MS as well as by healthcare providers when speaking about their patients. There was an intention to resume health behaviours again, however, participants expressed concern that this may be difficult, in particular due to increasing physical disabilities. Some expressed concerns that the disruptions to their routines may lead to long term consequences for physical and mental health.

*“I’ve stopped sport, because organised sport has stopped, so have I gotten lazy, yes, and I’ve probably gotten fatter, yes, have I got my lung and heart capacity reduced, yeah. But I anticipate it’ll come back once I get going again. [So is that a big concern for you?] Yeah, because I mean if a healthy person stops sport for a month, they can come back. The rate at which I lose fitness and the battle to get it back – see I’ve been trying to do as much, you know – my motto in life is as much as I can for as long as I can until I can’t. So if I lose fitness during this 3 month lockdown, it’s going to be so much harder to get back than a regular healthy person. So that’s my number one concern as well.”* Person with MS from Victoria

*“After 14 weeks of not moving about, her [patient with MS] mobility has really declined, it’s deteriorated with not being able to get out and exercise and just in her daily work routine, as opposed to sitting and working from home at the computer at home, she found she wasn’t doing her normal walking that she would do, and that she was getting worse.”* Healthcare professional from Western Australia

*“A lot of the sporting clubs shut down and for many that was a way of being physical active, but that social contact is quite important for people as well you know so they lost that..., and I think that probably, the loss of that contributed to changes in mood as well.”* Healthcare professional from Queensland

#### 4. Discussion

Participants of this exploratory mixed-methods study report significant changes to health behaviours in people with MS as a result of recent crises; the Australian Black Summer bushfires and the COVID-19 pandemic. Our research provides new insights as our mixed methodology and consumer-driven information highlights a need for further focused resources and education on outcome expectations from health behaviours in people with MS at times of unexpected health threats.

Even in the face of restrictions, some participants with MS found other opportunities to maintain their health behaviours; over a quarter of participants (28%) reported an increase in physical activity during the COVID-19 pandemic, and 8% reported increased physical activity during the bushfires. The concept of resilience, the capacity to recover and even thrive when faced with adversity, was mentioned by several participants and has previously been linked to health behaviours such as exercise and healthy diet (Ploughman et al., 2020). The concept of prehabilitation (Silver, 2020), i.e. wanting to be as fit and healthy as possible to counter MS symptoms or possible infection with COVID-19, seemed to drive maintenance or increase of positive health behaviours such as physical activity engagement. Such positive affirmations towards increased or maintenance of physical activity have been noted in the general population during the pandemic in Australia (Victorian Health Promotion Foundation 2020), the United Kingdom and the United States (Ding et al., 2020).

However, most participants reported reduced physical activity because of the bushfires and COVID-19 pandemic (55% and 54% respectively). An Israeli study reported similar changes in physical activity behaviour due to the COVID-19 pandemic, with 51% of participants with MS reporting a decrease in leisure time physical activity, and 38% reporting an increase (Kalron et al., 2021). Reduced physical activity is particularly problematic given a previous report that the majority of people with MS were not meeting physical activity recommendations (Marck et al., 2020). Survey data from more than 5200 people from the general Australian population showed similar patterns with 43% reporting less exercise and 35% reporting more

exercise (Phillipou et al., 2020). Decreased motivation, concerns about COVID-19 infection and reduced access to exercise space or equipment were cited as reasons to reduce physical activity in another Australian study (Victorian Health Promotion Foundation 2020), similar to our results.

Reported increase in unhealthy behaviours such as increased alcohol consumption (35%), unhealthy eating (44%), and a reduction in typical sleeping pattern (41%) in response to the COVID-19 pandemic in our survey were in line with the aforementioned Australian survey in which 31% of participants reporting drinking more alcohol, 35% eating more, and 44% sleeping less (Phillipou et al., 2020). Another Australian study detailed similar findings and reported that boredom, loneliness and stress commonly motivated the increase in unhealthy food and drinks consumption (Victorian Health Promotion Foundation 2020). Results from a large survey in North America also reported increased alcohol use in response to the psychological distress related to the COVID-19 pandemic (Rodriguez et al., 2020). These patterns were similar in response to the bushfires among our participants, although an increase in unhealthy eating was reported by only 24%.

Notably, our results indicate that these changes in health behaviours have already resulted in reduced physical and mental health, such as reduced mobility, fitness, weight gain and mood concerns in people with MS. Participants with MS and MS healthcare professionals also indicated concern about long term consequences for health outcomes. Some of these adverse consequences may also increase risk factors for more severe COVID-19 disease, such as vascular comorbidities and obesity (Salter et al., 2021, Louapre et al., 2020). Impact of reduced physical activity was also reported in the aforementioned Israeli study, with 32% reporting a notable reduction in fitness (Kalron et al., 2021). Several guidelines for managing MS recommend the promotion of health behaviours such as exercise, diet, smoking cessation and stress or mood management including referral to allied health professionals to optimise health outcomes for people with MS. However, the extent to which this is implemented in clinical care in Australia, and especially during times of crises needs further investigation. Australia has universal healthcare with reimbursed medication costs, a high standard of living and healthcare, and active national and state MS organisations. However, responsibilities for healthcare provision is split between states and federal governments, which can lead to inequities, in particular for more regional or remote areas where healthcare provision may already be limited. There are, to our knowledge, no centralised resources which prepare or assist people with chronic conditions, such as MS, to maintain or initiate health behaviours which impact on their long-term health outcomes during times of crises.

It is not surprising that existing inequalities are amplified during times of crises (Marmot and Allen, 2020). Australian reports have detailed that people already facing hardship were much harder hit by the COVID-19 pandemic; including people with low income, people from bushfire affected communities, Indigenous people, and people with disabilities (Victorian Health Promotion Foundation 2020). People with disabilities have been particularly impacted in terms of economic hardship, access to healthcare and supports to maintain participation and activities of daily living by the pandemic and Black Summer Bushfires (Biddle N et al., 2020, Duckett et al., 2020, Victorian Health Promotion Foundation 2020, People with Disability Australia 2020, Kavanagh et al., 2020). Indeed a previous study linking higher resilience to more healthy behaviours in people with MS, also reported this was associated with greater social support and financial security (Ploughman et al., 2020). Notably, more than a quarter of our sample indicated not being impacted by the COVID-19 pandemic at the time of the survey. This may reflect the relatively minor impact the pandemic had on some parts of Australia, perhaps combined with the adaptive nature and circumstances of individual participants.

While Australian guidelines have been developed to promote the return to physical activity for people who have recovered from COVID-19 infection (Jewson et al., 2020), our results imply that more efforts

need to focus on promoting return to (or uptake of) physical activity for people who have been impacted indirectly by the COVID-19 pandemic. Through most of the COVID-19 restrictions, Australians were explicitly allowed and encouraged to exercise outside the home each day by the authorities (Australian Department of Health 2020). However, many people with disabilities who rely on health professionals for support, supervision and/or motivation, or facilities to exercise were unable to continue their activities and as a consequence their existing health conditions may have worsened. In particular, people with disabilities or chronic health conditions are likely to need more support to improve health behaviours as countries around the world emerge from lockdowns, and there may be inequities depending on place of residence. Further, future crises such as fires, floods, droughts, and pandemics, are increasingly likely and will continue to impact on healthcare systems. Preparing for these while ensuring optimal health outcomes for all people with chronic health concerns is critical, and consumer input into disaster and recovery planning is paramount (Villeneuve et al., 2021).

#### 4.1. Limitations

Due to our small volunteer sample, recruited primarily via social media, our findings may not represent broad views from the Australian MS community. In particular people who are non-English speaking, without access or ability to use the internet were not included in this study, and people with more severe levels of disability may be under-represented. Our data did not include measures of socio-economic status, social support, or other social determinants of health, which would add valuable information about how crises impact on existing inequalities. Our results are cross-sectional, and changes in health behaviours may have fluctuated throughout the crises (Villeneuve et al., 2021). Further, more detailed data about health behaviours (e.g. changes in the amount of alcohol consumption, physical activity, sleep duration (as both insomnia and hypersomnia are potential negative changes in sleep behaviour) and quality would allow a more detailed analysis. Follow-up data to understand long-term changes and perhaps recommencement of healthy behaviours would add valuable understanding also.

#### 5. Conclusion

Our findings indicate that health behaviours of people with MS have been impacted by the Australian bushfires and to a greater extent the COVID-19 pandemic. In particular the reduction in physical activity, increase in unhealthy diet and alcohol consumption have already led to changes in health outcomes. These findings indicate that there is a need for efforts to increase health promotion for people with MS to maintain or initiate positive health behaviours, especially in the face of adversity.

#### CRedit authorship contribution statement

**CH Marck:** Writing – original draft, Data curation, Formal analysis, Conceptualization, Project administration, Methodology, Funding acquisition, Writing – review & editing. **A Hunter:** Data curation, Formal analysis, Writing – review & editing. **B Heritage:** Conceptualization, Project administration, Methodology, Funding acquisition, Data curation, Formal analysis, Writing – review & editing. **L Gibbs:** Project administration, Methodology, Writing – review & editing. **AG Kermode:** Project administration, Methodology, Writing – review & editing. **DI Walker:** Project administration, Methodology, Writing – review & editing. **YC Learmonth:** Data curation, Formal analysis, Conceptualization, Project administration, Methodology, Funding acquisition, Writing – review & editing.

#### Declaration of Competing Interest

The authors declare no conflict of interest.

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#### References

- Biddle N, E.B., Herz, D., Makkai, T., McAllister, I., 2020. Australian National University Poll. The Environment, and Optimism For The Future, Bushfires <https://dataverse.ada.edu.au/dataset.xhtml?persistentId=doi:10.26193/S1S919> (2020, accessed 19/02/2021).
- Duckett S., Mackey W. and Stobart A. The health effects of the 2019-20 bushfires, <https://grattan.edu.au/submissions/learning-the-lessons-from-the-2019-20-bushfires/> (2020, accessed 20/02/2021).
- Edgeley, C.M., Burnett, J.T., 2020. Navigating the wildfire-pandemic interface: public perceptions of COVID-19 and the 2020 wildfire season in Arizona. *Fire (Basel)* 3. <https://doi.org/10.3390/fire3030041>, 2020/10/29.
- Victorian Health Promotion Foundation. VicHealth Coronavirus Victorian Wellbeing Impact Study: Follow-up survey, [https://www.vichealth.vic.gov.au/-/media/ResearchandEvidence/20210208\\_Summary\\_Report.pdf](https://www.vichealth.vic.gov.au/-/media/ResearchandEvidence/20210208_Summary_Report.pdf) (2020, accessed 06/03/2021).
- Shapira, S., Aharonson-Daniel, L., Clarfield, A.M., et al., 2020. Giving a voice to medically vulnerable populations: a mixed-methods investigation of their unique perceptions and needs in emergency situations. *Health Soc. Care Community* 28, 811–822. <https://doi.org/10.1111/hsc.12911>. DOI: <https://doi.org/10.1111/hsc.12911>.
- Salter, A., Fox, R.J., Newsome, S.D., et al., 2021. Outcomes and risk factors associated with SARS-CoV-2 infection in a North American Registry of Patients With Multiple Sclerosis. *JAMA Neurol.* <https://doi.org/10.1001/jamaneurol.2021.0688>.
- Louapre, C., Collongues, N., Stankoff, B., et al., 2020. Clinical characteristics and outcomes in patients with coronavirus disease 2019 and multiple sclerosis. *JAMA Neurol.* 77, 1079–1088. <https://doi.org/10.1001/jamaneurol.2020.2581>.
- Capuano, R., Altieri, M., Bisecco, A., et al., 2020. Psychological consequences of COVID-19 pandemic in Italian MS patients: signs of resilience? *J. Neurol.* 1–8. <https://doi.org/10.1007/s00415-020-10099-9>, 2020/07/30.
- Stojanov, A., Malobabic, M., Milosevic, V., et al., 2020. Psychological status of patients with relapsing-remitting multiple sclerosis during coronavirus disease-2019 outbreak. *Mult. Scler. Relat. Disord.* 45, 102407 <https://doi.org/10.1016/j.msard.2020.102407>, 2020/07/24.
- Chiaravalloti, N.D., Amato, M.P., Bricchetto, G., et al., 2020. The emotional impact of the COVID-19 pandemic on individuals with progressive multiple sclerosis. *J. Neurol.* 1–10. <https://doi.org/10.1007/s00415-020-10160-7>, 2020/08/20.
- Sastre-Garriga, J., Tintoré, M., Montalban, X., 2020. Keeping standards of multiple sclerosis care through the COVID-19 pandemic. *Mult. Scler. J.* 26, 1153–1156.
- Leocani, L., Diserens, K., Moccia, M., et al., 2020. Disability through COVID-19 pandemic: neurorehabilitation cannot wait. *Eur. J. Neurol.* 27, e50–e51. <https://doi.org/10.1111/ene.14320>, 2020/05/14.
- Brownlee, W., Bourdette, D., Broadley, S., et al., 2020. Treating multiple sclerosis and neuromyelitis optica spectrum disorder during the COVID-19 pandemic. *Neurology* 94, 949–952. <https://doi.org/10.1212/WNL.0000000000009507>, 2020/04/04.
- Willis, M.D., Robertson, N.P., 2020. Multiple sclerosis and the risk of infection: considerations in the threat of the novel coronavirus, COVID-19/SARS-CoV-2. *J. Neurol.* 267, 1567–1569. <https://doi.org/10.1007/s00415-020-09822-3>.
- Giovannoni, G., Hawkes, C., Lechner-Scott, J., et al., 2020. The COVID-19 pandemic and the use of MS disease-modifying therapies. *Mult. Scler. Relat. Disord.* 39 <https://doi.org/10.1016/j.msard.2020.102073>, 102073–102073. 2020/03/27.
- Motl, R., Ehde, D., Shinto, L., et al., 2020. Health behaviors, wellness, and multiple sclerosis amid COVID-19. *Arch. Phys. Med. Rehabil.* 101, 1839–1841. <https://doi.org/10.1016/j.apmr.2020.06.001>, 2020/09/02.
- Dalgas, U., Langeskov-Christensen, M., Stenager, E., et al., 2019. Exercise as medicine in multiple sclerosis-time for a paradigm shift: preventive, symptomatic, and disease-modifying aspects and perspectives. *Curr. Neurol. Neurosci. Rep.* 19, 88. <https://doi.org/10.1007/s11910-019-1002-3>, 2019/11/14.
- Vollmer, T.B.R., Bennett, S., Motl, R.W., White, A.T., Bombardier, C.H., Hebert, J.R., 2012. Exercise as prescriptive therapy in multiple sclerosis. A consensus conference white paper. *Int. J. MS Care* 14.
- Marrie, R., Horwitz, R., Cutter, G., et al., 2009. High frequency of adverse health behaviors in multiple sclerosis. *Mult. Scler. J.* 15, 105–113. <https://doi.org/10.1177/1352458508096680>.
- Beier, M., D'Orio, V., Spat, J., et al., 2014. Alcohol and substance use in multiple sclerosis. *J. Neurol. Sci.* 338, 122–127. <https://doi.org/10.1016/j.jns.2013.12.029>, 2014/01/15.
- Paz-Ballesteros, W.C., Monterrubio-Flores, E.A., de, Jes.us, Flores-Rivera, J., et al., 2017. Cigarette smoking, alcohol consumption and overweight in multiple sclerosis: disability progression. *Arch. Med. Res.* 48, 113–120. <https://doi.org/10.1016/j.arcmed.2017.03.002>, 2017/06/05.

- Gupta, A.K., Nethan, S.T., Mehrotra, R., 2021. Tobacco use as a well-recognized cause of severe COVID-19 manifestations. *Respir. Med.* 176, 106233 <https://doi.org/10.1016/j.rmed.2020.106233>, 2020/12/01.
- Silver, J.K., 2020. Prehabilitation could save lives in a pandemic. *BMJ* 369, m1386. <https://doi.org/10.1136/bmj.m1386>, 2020/04/08.
- Marck, C.H., Learmonth, Y.C., Chen, J., et al., 2020. Physical activity, sitting time and exercise types, and associations with symptoms in Australian people with multiple sclerosis. *Disabil. Rehabil.* 1–9. <https://doi.org/10.1080/09638288.2020.1817985>, 2020/09/18.
- Marck, C.H., Probst, Y., Chen, J., et al., 2021. Dietary patterns and associations with health outcomes in Australian people with multiple sclerosis. *Eur. J. Clin. Nutr.* <https://doi.org/10.1038/s41430-021-00864-y>, 2021/02/04.
- Villeneuve, M., Abson, L., Pertiwi, P., et al., 2021. Applying a person-centred capability framework to inform targeted action on Disability Inclusive Disaster Risk Reduction. *Int. J. Disaster Risk Reduction* 52, 101979. <https://doi.org/10.1016/j.ijdrr.2020.101979>.
- Learmonth, Y.C., Motl, R.W., Sandroff, B.M., et al., 2013. Validation of patient determined disease steps (PDDS) scale scores in persons with multiple sclerosis. *BMC Neurol.* 13, 37. <https://doi.org/10.1186/1471-2377-13-37>, 2013/04/27.
- Ploughman, M., Downer, M.B., Pretty, R.W., et al., 2020. The impact of resilience on healthy aging with multiple sclerosis. *Qual. Life Res.* 29, 2769–2779. <https://doi.org/10.1007/s11136-020-02521-6>, 2020/05/22.
- Ding, D., del Pozo Cruz, B., Green, M.A., et al., 2020. Is the COVID-19 lockdown nudging people to be more active: a big data analysis. *Br. J. Sports Med.* 54, 1183–1184. <https://doi.org/10.1136/bjsports-2020-102575>.
- Kalron, A., Dolev, M., Greenberg-Abrahami, M., et al., 2021. Physical activity behavior in people with multiple sclerosis during the COVID-19 pandemic in Israel: results of an online survey. *Mult. Scler. Relat. Disord.* 47 <https://doi.org/10.1016/j.msard.2020.102603>.
- Phillipou, A., Meyer, D., Neill, E., et al., 2020. Eating and exercise behaviors in eating disorders and the general population during the COVID-19 pandemic in Australia: Initial results from the COLLATE project. *Int. J. Eat. Disord.* 53, 1158–1165. <https://doi.org/10.1002/eat.23317>.
- Rodriguez, L.M., Litt, D.M., Stewart, S.H., 2020. Drinking to cope with the pandemic: The unique associations of COVID-19-related perceived threat and psychological distress to drinking behaviors in American men and women. *Addict. Behav.* 110, 106532 <https://doi.org/10.1016/j.addbeh.2020.106532>, 2020/07/12.
- Marmot, M., Allen, J., 2020. COVID-19: exposing and amplifying inequalities. *J. Epidemiol. Community Health* 74, 681–682. <https://doi.org/10.1136/jech-2020-214720>.
- People with Disability Australia. People with disability and COVID-19., [https://pwd.org.au/experiences-of-people-with-disability-during-covid-19-survey-results/\(2020, accessed 02/02/2021\)](https://pwd.org.au/experiences-of-people-with-disability-during-covid-19-survey-results/(2020, accessed 02/02/2021)).
- Kavanagh, A., Dickinson, H., Carey, G., et al., 2020. Improving health care for disabled people in COVID-19 and beyond: lessons from Australia and England. *Disabil. Health J.*, 101050 <https://doi.org/10.1016/j.dhjo.2020.101050>.
- Jewson, J., McNamara, A., Fitzpatrick, J., 2020. Life after COVID-19: the importance of a safe return to physical activity. *Aust. J. Gen. Pract.* 49 <https://doi.org/10.31128/ajgp-covid-40>, 2020/12/01.
- Australian Department of Health. Exercising and staying active during coronavirus (COVID-19) restrictions., <https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/ongoing-support-during-coronavirus-covid-19/exercising-and-staying-active-during-coronavirus-covid-19-restrictions> (2020, accessed 24/2/2021).