Received: 13 April 2022 | Revised: 12 April 2023 | Accepted: 28 May 2023

DOI: 10.1002/hpja.756

Health Promotion Journal of Australia | Australian Health Promotion Association | WILEY

COMMENTARY

Asthma—The canary in the Australian coalmine: Making the links between climate change, fossil fuel and public health outcomes

Rebecca Patrick[1] | Martin Hensher[2] | Cenk Suphioglu[3] | Rachel Huxley[4]

[1]School of Health and Social Development, Faculty of Health, Deakin University, Burwood, Victoria, Australia

[2]School of Medicine, University of Tasmania, Hobart, Australia

[3]NeuroAllergy Research Laboratory (NARL), School of Life and Environmental Sciences, Faculty of Science, Engineering and Built Environment, Deakin University, Waurn Ponds, Victoria, Australia

[4]Faculty of Health, Deakin University, Burwood, Victoria, Australia

Correspondence
Rebecca Patrick, University of Melbourne, Melbourne, Australia.
Email: rebecca.patrick@unimelb.edu.au

Handling editor: Rosie Nash

KEYWORDS: air pollution, asthma, climate change

1 | INTRODUCTION

In the aftermath of the catastrophic 2019–2020 bushfires, the corona virus disease of 2019 pandemic and recent devastating floods in New South Wales and Queensland, Australians voted for climate action in the 2022 Federal election, and a new Climate Change Bill[1] has already passed the House of Representatives. Climate change is recognised by scientists, public health experts, Indigenous leaders, economists and the Australian public at large as the most pressing issue at our doorstep.[2–5] As we consider the veracity of net zero emission election commitments and the architecture of a post-pandemic recovery in Australia, we use science, public health expertise and a common chronic condition to explain the links between key issues and outline a road map for action in Australia.

In this commentary, we highlight current evidence on the relationships between climate change, air pollution, fossil fuel use and their associated impacts on public health. We use asthma as a case study to examine the economic and human health burden arising from this climate-air pollution-fossil fuel triad. Australia's dependence on fossil fuels and gaps in energy policy are underscored as drivers of negative climate and public health outcomes. We provide a roadmap for action consisting of a mandate for: rapid de-carbonisation of Australia's energy systems; adoption of a healthcare without harm framework; and preparing public health systems to prevent and control asthma exacerbations.

1.1 | Climate change

Climate change is the greatest threat to public health of the 21st century.[6] The planet has warmed significantly over the past century by on average 0.8°C, largely as a result of increased global emissions of carbon dioxide and other greenhouse gases (GHG).[7] Human activity and fossil fuel-based, carbon intensive energy systems have contributed substantially to global heating. Climate change is having profound effects on weather systems, exemplified by the increased frequency and duration of extreme weather events including floods, drought and bushfires. Climate change also adversely impacts on atmospheric air quality and air pollution.[1]

1.2 | Air pollution

The relationship between climate change and air quality is bi-directional: climate change can exacerbate or increase existing air pollutants (e.g., atmospheric heating increases ground level ozone); air polluting emissions influence the climate (e.g., release of carbon-based materials such as black soot have a heating effect); several sources of air pollution are sources of GHGs (e.g., methane locks heat in the atmosphere, triggering climate change). Incomplete combustion of fossil fuels is a primary source of air pollutants (e.g., particulate matter

[PM]$^{2.5}$) and is harmful to human health.[8] Higher temperatures and carbon dioxide levels arising from climate change also increase airborne allergenic pollens contributing to allergic asthma.[9]

1.3 | Fossil fuels

The energy sector is the largest contributor to GHG emissions in Australia.[8] Australia's primary energy consumption is dominated by fossil fuels (i.e., coal 40%, oil 34% and gas 22%)[10] and its electricity system is founded on centralised, carbon-intensive coal-fired generation. Australia's coal burning (and exports) contributes to climate change and air pollution and hence health impacts. Every step of coal's lifecycle produces air pollutants that affect human health. Burning coal produces fly ash and particulate matter ($PM^{2.5}$), which lodge in the lungs, causing irritation and inflammation.[11]

Transport (energy) is the second largest source of emissions after electricity production.[12] The road transport sector, including passenger and commercial vehicles, is reliant on petroleum-based fossil fuels and is a significant contributor to air pollution in cities and regions.[13] For example, petrol and diesel emissions arising from road traffic are a major culprit in asthma exacerbations: Nitrogen dioxide (NO_2) exposure and living in close proximity to a major road are associated with an increase in the likelihood of asthma in children and adults.[14,15]

1.4 | Asthma—Case study

Asthma is one of the most common and costly of all chronic disease conditions affecting more than 260 million people globally, and both its prevalence and incidence is strongly associated with air quality and atmospheric pollution[16] In 2021, 2.7 million people (10.7%) of the Australian population had asthma, making it a common non-communicable disease[17] and accounting for 417 deaths in 2020.[18] Nationally, there were over 37 000 hospitalisations with asthma as the principal diagnosis in 2016 and around 2% of all general practitioner encounters were for asthma, representing the 14th most common reason for a general practitioner consultation in that year.[19,20] As asthma is a lifelong condition, the costs associated with the condition are high, both to the individual as well as to the health service, where it accounts for $770 million in direct expenditures annually.[19]

1.5 | Fossil fuels and asthma

Studies of coal mine fires and coal town residency illuminate the fossil fuel, air pollution and asthma relationship. The Hazelwood coal mine fire in the Latrobe Valley, Victoria in 2014 created plumes of smoke and ash with high $PM^{2.5}$ for 45 days. Guo et al.[21] found increased risks of all-causes, respiratory diseases, and asthma related emergency presentations and hospital admissions. Casey et al.[11] found living near coal-fired power plants is linked to higher rates of respiratory disease and increased asthma exacerbations, while shutting down a coal plant or upgrading emission controls decreases inhaler use, emergency department visits and hospitalisation for asthma among local residents. Gas has also been associated with childhood asthma: one study of Australian children reported the population attributable fraction for childhood asthma associated with household gas stoves (which release $PM^{2.5}$, NO_2) for childhood asthma was approximately 12%, corresponding to over 2700 disability adjusted life years.[15]

1.6 | Bushfires and asthma

Climate change is increasing the frequency and intensity of bushfires in Australia. Smoke from bushfires is a major risk factor for asthma exacerbations: the 2019–2020 summer bushfires have been linked to 429 premature deaths, more than 2000 hospitalisations for respiratory health issues and 1500 emergency department presentations with asthma.[235] The health-related economic costs of the 2019–2020 bushfires was estimated AU$1.95 billion, with the majority due to the economic costs of premature mortality associated with the bushfires; AU$25 million of healthcare costs, $24 million for cardiovascular and respiratory hospitalisations, and AU$1 million for asthma emergency department attendances.[22]

1.7 | Thunderstorm asthma

Climate change effects allergic diseases.[23] Thunderstorm asthma is an allergic asthma response to airborne allergenic pollens that rupture due to osmotic shock following a thunderstorm event, and thereby allowing smaller allergenic sub-pollen particles to reach the lower airways to trigger the potentially deadly allergic response[24] (see Figure 1). In November 2016, the phenomenon of thunderstorm asthma caused 10 deaths in Australia and more than 3300 ED presentations.[19,24]

Several studies have shown that plants growing in highly polluted air produce more allergenic pollen.[25] When combined with pollen rupture, it results in a volatile mix that turns such pollens into 'biological time bombs'. Knox et al.[26] have shown that the major allergen of rye grass pollen has the capacity to directly interact with diesel exhaust carbon particles (DECP). They assert allergen-loaded DECP has the capacity to penetrate the lower airways and prompt an episode of asthma. Figure 1 describes the relationship between air pollution, climate change, fossil fuels and thunderstorm asthma as a public health issue.

1.8 | Healthcare systems, GHG's and asthma

Healthcare—one of the world's largest industries—contributes to climate change and air pollution. The Australian healthcare system is responsible for ~7% of national GHGs.[27] In the United States, one study has estimated that healthcare-related air pollution was responsible for 9% of respiratory disease burden from PM emissions.[28] Similar

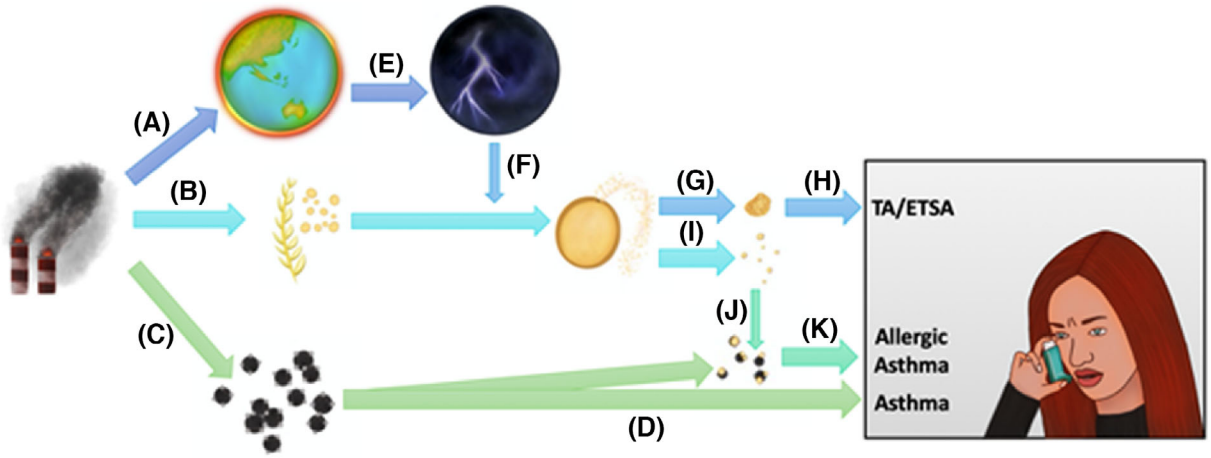

FIGURE 1 The paradigm between pollution, climate change and allergic asthma. Pollution contributes to climate change (A), increase in the allergenic content of pollens (B) and accumulation of DECP in the air (C), which alone can cause asthma (D). Climate change in return contributes to unstable weather and higher incidence of thunderstorms (E) that in return causes more frequent pollen rupture (F), generating allergen loaded micronic sub-pollen particles (G) that triggers TA and ETSA (H), and free pollen allergen molecules (I) that are known to bind DECP (J) that may trigger allergic asthma (K). DECP, diesel exhaust carbon particles; TA, thunderstorm asthma; ETSA, epidemic thunderstorm asthma.

estimates of disease impact are not available locally, but Australian healthcare is responsible for around 3% of national PM footprint.[29] Paradoxically, some asthma treatments are significant contributors to GHGs. Metered-dose inhalers for asthma contribute an estimated 3.9% of the total carbon footprint of the UK National Health Service,[30] due to the extremely potent GHGs used as propellants in some delivery systems. Australian estimates are not available, but the same products are widely used in this country. This scenario demonstrates perverse feedback loops—air pollution and climate change drive each other, and both drive increasing asthma incidence through various pathways, while treating asthma can itself further drive climate change through GHG emissions.

2 | ROADMAP FOR ACTION

This is a critical decade. Linear, single issue and reductionist approaches will not cut through the complex public health challenges arising from the climate change, air pollution and fossil fuel triad. Here we offer the new federal government and health sector a three-point roadmap for action. The roadmap highlights key public health-oriented interventions, which will prevent health-harming emissions, promote a healthy recovery from the pandemic and help Australians prepare for increasing asthma prevalence due to environmental triggers.

2.1 | Direction 1—Decarbonising energy systems

Australia remains heavily dependent on fossil fuels and is unlikely to keep its commitments to the Paris Agreement to which it is a signatory. Since 1990, there has only been a 10% reduction in the share of electricity generation produced from non-renewable fuels (89.9% in 1990 to 80.2% in 2019) with more than half of total generation still reliant on coal.[31] Stopping fossil fuel development and decarbonising energy systems are the most urgent and far reaching challenges of this decade.[32] To prevent health harming air polluting emissions and to meet the goals of the Paris Agreement, Australia requires a coherent and timely policy framework that enables disinvestment in fossil fuels and a rapid transition to renewable energy. Central to this policy framework are climate change mitigation targets—an essential upstream and long-term public health strategy for managing the underlying causes of the increasing bushfire risk and thunderstorm asthma. This critical, foundational government policy framework will also support emission reduction efforts within the Australian healthcare sector.[33] Action must be taken now, as limiting global heating to 1.5°C will require deep emissions reductions of at least 45% from 2010 levels by 2030.[7]

2.2 | Direction 2—Adoption of a healthcare without harm framework

Australia's healthcare sector needs to reduce its total emissions to net zero. By 2030, an 80% reduction in emissions is required for healthcare to help meet the 1.5°C Paris Agreement commitments and minimise the predicted catastrophic public health consequences of climate change.[33,34] Australian hospitals and health systems must implement interventions which will decarbonize healthcare delivery to 'first do no harm' whilst maintaining and improving health. Healthcare systems can take cost-effective action to transition toward zero emissions energy, buildings, travel and transport, waste management as well as low emissions pharmaceuticals, sustainable food system ectera.[35] There are multiple health service level examples of successful action (see Global Green and Health Hospitals[36]) and state and territory government policy leadership can support compliance and implementation.

Substitution of high emission products with more climate friendly alternatives and incentivising the production of green medications is another key strategy. This is particularly relevant to asthma medication. Alternative delivery mechanisms to metered dose inhalers without the high global heating potential propellants, such as dry powder based inhalers, are available and suitable for the majority of patients.[35] Wilkinson et al.[30] study found that switching to low global warming potential asthma inhalers has co-benefits for reducing GHGs and drug costs.

Many peak health and medical bodies have declared a climate emergency. We support the call by Australia's peak associations including Doctors for the Environment Australia, Australian Medical Association, Royal Australian College of Physicians and the Climate and Health Alliance for the establishment of an Australian Sustainable Healthcare Unit to lead and coordinate initiatives and collaboration nationwide.[33]

2.3 | Direction 3—Preparing public health systems for asthma exacerbations

Australia's recent bushfire smoke-related and thunderstorm asthma epidemics were climate change and air pollution driven disasters of national and/or state level significance. Both events tested public health system preparedness and responsiveness and capacity to prevent and control environmental health hazards. We support the Royal Commission into National Natural Disaster Arrangement's recommendations, specifically those pertaining to community education, air quality and health.[37] Further, we endorse Vardoulakis et al.'s[38] perspective that consistency of air quality information and related public health advice across jurisdictions in Australia is essential. We support their call for an independent national expert committee on air pollution and health protection to be established to support environmental health decision making in Australia. Likewise, the impact of climate change (longer pollen seasons, more extreme weather events) on asthma prevalence and severity needs to prioritised in public health planning and surveillance efforts. Notably, the current National Asthma Strategy (2018) is mute on climate change and air pollution.

3 | CONCLUSION

Australians voted for action on climate change in the 2022 federal election. The evidence is clear, we need rapid transition from fossil fuel toward renewable-energy powered systems, including net zero healthcare systems, which will provide benefits for public health, climate and economy. Yet, it remains to be seen whether the pace of change envisaged in the Climate Change Bill 2022 is sufficiently fast, or whether new coal and gas generation and mining projects will be phased out.

Continued failure to rapidly act on the climate-air pollution-fossil fuel triad in Australia is likely to result in increased asthma prevalence and severity and exert an inexorable toll on the health, social and economic wellbeing of future generations. Asthma is just the tip of the iceberg. Health and medical groups have a key role in helping chart a new course with the incoming federal government to avert the cascading impacts of this ubiquitous climate-driven public health crisis.

ACKNOWLEDGEMENT

Open access publishing facilitated by Deakin University, as part of the Wiley - Deakin University agreement via the Council of Australian University Librarians.

FUNDING INFORMATION

None.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest except Rebecca Patrick.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ORCID

Rebecca Patrick https://orcid.org/0000-0002-5537-243X

Martin Hensher https://orcid.org/0000-0001-6444-6827

REFERENCES

1. Prime Minister of Australia. Albanese Government passes climate change bill in the house of representatives. Media Release 4th August 2022. Available from: https://www.pm.gov.au/media/albanese-government-passes-climate-change-bill-house-representatives.
2. Cissé G, McLeman R, Adams H, Aldunce P, Bowen K, Campbell-Lendrum D, et al. Health, wellbeing, and the changing structure of communities. In: Pörtner H-O, Roberts DC, Tignor M, Poloczanska ES, Mintenbeck K, Alegría A, et al., editors. Climate change 2022: impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change. Cambridge, UK and New York, NY: Cambridge University Press; 2022. p. 1041–170. https://doi.org/10.1017/9781009325844.009
3. Patrick R, Armstrong F, Capon A, Bowen K, Lo SN, Thoms A. Chapter 4 health promotion in the Anthropocene: the ecological determinants of health. Medical Journal of Australia. 2021;214:S22–6. Available from: http://gateway.webofknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcApp=PARTNER_APP&SrcAuth=LinksAMR&KeyUT=WOS:000646003400005&DestLinkType=FullRecord&DestApp=ALL_WOS&UsrCustomerID=a045e4b2bb1f2b747c68c720ec8913b7.
4. HEAL Network & CRE-STRIDE. Climate change and aboriginal and Torres Strait islander health, Discussion Paper, Lowitja Institute, Melbourne, 2021. https://doi.org/10.48455/bthg-aj15
5. Martin P. One issue matters more to top economists than any other this election: climate change, The Conversation. 2022. Available from: https://theconversation.com/one-issue-matters-more-to-top-economists-than-any-other-this-election-climate-change-180948.
6. Costello A, Abbas M, Allen A, Ball S, Bell S, Bellamy R, et al. The lancet commissions: managing the health effects of climate change. Lancet and University College London Institute for Global Health Commission. Lancet. 2009;373:1693–733. https://doi.org/10.1016/S0140-6736(09)60935-1
7. IPCC. Summary for policymakers. Global warming of 1.5°C. an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways,

in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva, Switzerland: World Meteorological Association; 2018. p. 32. Available from: https://www.ipcc.ch/site/assets/uploads/2018/10/SR15_SPM_version_stand_alone_LR.pdf.
8. Dean A, Green D. Climate change, air pollution and health in Australia. Grand Challenges. Sydney: UNSW; 2007.
9. Zhang Y, Steiner AL. Pollen season is getting longer and more intense with climate change – here's what allergy sufferers can expect in the future, The Conversation. 2022. Available from: https://theconversation.com/pollen-season-is-getting-longer-and-more-intense-with-climate-change-heres-what-allergy-sufferers-can-expect-in-the-future-179158.
10. GeoScience Australia. Applying geoscience to Australia's most important challenges [webpage on internet]. 2020. Available from: https://www.ga.gov.au/scientific-topics/energy/basics.
11. Casey JA, Su JG, Henneman LRF. Improved asthma outcomes observed in the vicinity of coal power plant retirement, retrofit and conversion to natural gas. Nat Energy. 2020;5:398–408. https://doi.org/10.1038/s41560-020-0600-2
12. Department of Environment and Energy. Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2019. Incorporating emissions from the NEM up to June2019. 2019. Available from: https://www.environment.gov.au/system/files/resources/6686d48f-3f9c-448d-a1b7-7e410fe4f376/files/nggi-quarterly-update-mar-2019.pdf.
13. WHO. Air pollution and climate change [webpage on internet]. 2020. Available from: https://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/data-and-statistics/air-pollution-and-climate-change2.
14. Bowatte G, Erbas B, Lodge CJ, Knibbs LD, Gurrin LC, Marks GB, et al. Traffic-related air pollution exposure over a 5-year period is associated with increased risk of asthma and poor lung function in middle age. Eur Respir J. 2017;50:1602357. https://doi.org/10.1183/13993003.02357-2016
15. Knibbs LD, Cortés de Waterman AM, Toelle BG, Guo Y, Denison L, Jalaludin B, et al. The Australian child health and air pollution study (ACHAPS): a national population-based cross-sectional study of long-term exposure to outdoor air pollution, asthma, and lung function. Environ Int. 2018;120:394–403. https://doi.org/10.1016/j.envint.2018.08.025
16. World Health Organisation (WHO). Asthma. Available from: https://www.who.int/news-room/fact-sheets/detail/asthma.
17. Australian Bureau of Statistics (ABS). Asthma. Available from: https://www.abs.gov.au/statistics/health/health-conditions-and-risks/asthma/latest-release18.
18. National Asthma Council Australia. Asthma deaths remain stubbornly high in Australia, Media Release. Available from: https://www.nationalasthma.org.au/news/2021/asthma-deaths-australia.
19. AIHW. Asthma: web report. NSW: Australian Institute of Health and Welfare; 2020. Available from: https://www.aihw.gov.au/reports/chronic-respiratory-conditions/asthma/contents/asthma.
20. Britt H, Miller GC, Henderson J, Bayram C, Harrison C, Valenti L, et al. General practice activity in Australia 2015–16. General practice series no. 40. Sydney: Sydney University Press; 2016.
21. Guo Y, Gao CX, Dennekamp M, Dimitriadis C, Straney L, Ikin J, et al. The association of coal mine fire smoke with hospital emergency presentations and admissions: time series analysis of Hazelwood health study. Chemosphere. 2020;253:126667. https://doi.org/10.1016/j.chemosphere.2020.126667
22. Johnston FH, Borchers-Arriagada N, Morgan GG, Jalaludin B, Palmer AJ, Williamson GJ, et al. Unprecedented health costs of smoke-related PM2.5 from the 2019–20 Australian megafires. Nat Sustain. 2020;4:42–7. https://doi.org/10.1038/s41893-020-00610-5
23. Lake IR, Jones NR, Agnew M, Goodess CM, Giorgi F, Hamaoui-Laguel L, et al. Climate change and future pollen allergy in Europe. Environ Health Perspect. 2017;125:385–91. https://doi.org/10.1289/EHP173
24. Price D, Hughes KM, Thien F, Suphioglu CJ. Epidemic thunderstorm asthma: lessons learned from the storm Down-Under. Allergy Clin Immunol Pract. 2020;9:1510–5. https://doi.org/10.1016/j.jaip.2020.10.022
25. Sedghy F, Varasteh A-R, Sankian M, Moghadam M. Interaction between air pollutants and pollen grains: the role on the rising trend in allergy. Rep Biochem Mol Biol. 2018;6:219–24.
26. Knox RB, Suphioglu C, Taylor P, Desai R, Watson HC, Peng JL, et al. Major grass pollen allergen lol p 1 binds to diesel exhaust particles (DECP): implications for asthma and air pollution. Clin Exp Allergy. 1997;27:246–51.
27. Malik A, Lenzen M, McAlister S, McGain F. The carbon footprint of Australian health care. Lancet Planet Health. 2018;2:e27–35. https://doi.org/10.1016/S2542-5196(17)30180-8
28. Eckelman MJ, Sherman J. Environmental impacts of the U.S. health care system and effects on public health. PLoS One. 2016;11:e0157014. https://doi.org/10.1371/journal.pone.0157014
29. Lenzen M, Malik A, Li M, Fry J, Weisz H, Pichler PP, et al. The environmental footprint of health care: a global assessment. Lancet Planet Health. 2020;4:e271–9. https://doi.org/10.1016/S2542-5196(20)30121-2
30. Wilkinson AJK, Braggins R, Steinbach I, Smith J. Costs of switching to low global warming potential inhalers. An economic and carbon footprint analysis of NHS prescription data in England. BMJ Open. 2019;9:e028763. https://doi.org/10.1136/bmjopen-2018-028763
31. DISER. Department of Industry, Science, Energy and Resources. Australian energy statistics, Table O. 2020. Available from: https://www.energy.gov.au/publications/australian-energy-update-2020.
32. TCFD. Task Force on Climate-Related Financial Disclosures. Recommendations of the task force on climate-related financial disclosures: final report. 2017. Available from: https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf.
33. DEA. Web Report. Net zero carbon emissions: responsibilities, pathways and opportunities for Australia's healthcare sector. Doctors for the Environment Australia. 2020. Available from: https://www.dea.org.au/wp-content/uploads/2020/12/DEA-Net-Zero-report_v11.pdf.
34. McGain F, Kayak E, Burch H. A sustainable future in health: ensuring as health professionals our own house is in order and leading by example. Med J Aust. 2020;213:381–381.e1.
35. HCWH. Global Road Map for Health Care Decarbonization. Chapter 5, charting a course: toward zero emissions health care, 55–86. Health Care Without Harm. 2021. Available from: https://healthcareclimateaction.org/sites/default/files/2021-04/HCWH%20Road%20Map%20for%20Health%20Care%20Decarbonization%20-%20Chapter%205.pdf.
36. Climate and Health Alliance. Global Green and Healthy Hospitals [Internet webpage]. 2021. Available from: https://www.caha.org.au/globalgreen_healthyhospitals.
37. Royal Commission into National Natural Disaster Arrangements. List of recommendations [Internet webpage]. Available from: https://naturaldisaster.royalcommission.gov.au/publications/html-report/list-of-recommendations.
38. Vardoulakis S, Jalaludin BB, Morgan GG, Hanigan IC, Johnston FH. Bushfire smoke: urgent need for a national health protection strategy. Med J Aust. 2020;212:349–53.e1. https://doi.org/10.5694/mja2.50511

How to cite this article: Patrick R, Hensher M, Suphioglu C, Huxley R. Asthma—The canary in the Australian coalmine: Making the links between climate change, fossil fuel and public health outcomes. Health Promot J Austral. 2023. https://doi.org/10.1002/hpja.756