Hazelwood
HEALTH STUDY

Volume 3

Hazelwood Health Study:

10 Year Review

Appendices

Version 1.1

19 September 2024

Contents

i. Foreword

This is the 3rd volume, from a set of three, submitted to the Victorian Department of Health in fulfillment of the Hazelwood Health Study's 42nd contractual milestone. Combined, the three volumes represent an overview of the Hazelwood Health Study's activities and findings in the ten years since the Study's inception on 30 October 2014.

Volume 1. Hazelwood Health Study: 10 Year Review is the primary report, providing an overview of the background to the Study, research questions and further information requested by the Department of Health, governance structure, research streams and methods, key findings, community engagement activities, and the influence of Study findings on policy and practice.

Volume 2. Hazelwood Health Study: 10 Year Review Summary is a high-level summary of the details provided in Volume 1.

Volume 3. Hazelwood Health Study: 10 Year Review Appendices contains all of the Appendices referred to in Volumes 1 and 2, including a list of all previously completed contractual milestones, governance committee memberships, the Study's Outputs Directory, all lay language Research Summaries and the Study's 2023 Community Flyer.

This work was funded by the Victorian Department of Health. The findings represent the views of the authors and not the views of the Department.

The Hazelwood mine fire, February 2014.
Photo courtesy of Keith Pakenham, Country Fire Authority Victoria, Australia

ii. Document History

Version Number	Date	Approved By	Brief Description
1.0	19 Sept 2024	HHS Senior Project Manager	Submitted to the Department of Health
1.1	31 Jan 2025	HHS Senior Project Manager	Minor revisions

iii. Authors and contributors

A large, diverse and dedicated group of academic, clinical and administrative staff from several Institutions have contributed to the Hazelwood Health Study. A full list is provided in Volume 1.

iv. Abbreviations

AEA	Australasian Epidemiological Association
ATS	American Thoracic Society
OAM	Medal of the Order of Australia
HHS	Hazelwood Health Study
CO	Carbon monoxide
COPD	Chronic obstructive pulmonary disease
COVID-19	Coronavirus Disease 2019
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVD	Cardiovascular disease
ELF	Latrobe Early Life Follow-up Study
ERS	European Respiratory Society
FOT	Forced oscillation technique
ISEE	International Society for Environmental Epidemiology
MBS	Medicare Benefits Schedule
NAPLAN	National Assessment Program - Literacy and Numeracy
PBS	Pharmaceutical Benefits Scheme
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 2.5 microns (thousandths of a millimetre) or less
SPHPM	Monash University School of Public Health and Preventive Medicine
TSANZ	Thoracic Society of Australia and New Zealand

Appendix 1: Hazelwood Health Study contractual milestones

Since commencement of the Hazelwood Health Study (HHS) in November 2014, and prior to the submission of this *10 Year Review*, 41 contractual milestones have been completed.

	Contractual milestone	Delivered
1	Project plan	17 December 2014
2	Community and stakeholder engagement strategy	17 December 2014
3	Organisational agreements with sub-contractors	9 February 2015
4	Research ethics submission	9 February 2015
5	Advisory groups established	10 March 2015
6	Outline of Ageing Policy Review	8 May 2015
7	1st Interim Report	15 June 2015
8	1st Annual Community Briefing	11 August 2015
9	1st Annual Report	13 November 2015
10	1st Recruitment Report	15 March 2016
11	2nd Interim report	15 June 2016
12	Ageing Population Policy review	30 November 2016
13	2nd Annual Community Briefings	29 November 2016
14	2nd Annual Report	15 November 2016
15	2nd Recruitment Report	19 March 2017
16	3rd Interim report	15 June 2017
17	Strategic Overview and Revised Project Plan	17 July 2017
18	3rd Annual Community Briefings	9 Oct 2017 Morwell & 10 Oct 2017 Sale
19	3rd Annual Report	16 November 2017
20	4th Interim Report	22 June 2018
21	4th Annual Community Briefing	22 August 2018
22	4th Annual Report	16 November 2018
23	5th Interim Report	21 June 2019
24	5th Annual Community Briefing	11 June 2019
25	Contract Review & Revised Project Plan	17 July 2019
26	5th Annual Report	15 November 2019

	Contractual milestone	Delivered
27	6th Interim Report	19 June 2020
28	6th Annual Community Briefing	10 November 2020
29	6th Annual Report	20 November 2020
30	7th Interim Report	16 June 2021
31	Contract Review and Revised Project Plan	23 July 2021
32	7th Annual Community Briefing	11 November 2021
33	7th Annual Report	19 November 2021
34	8th Interim Report	18 May 2022
35	8th Annual Community Briefing	18 October 2022
36	8th Annual Report	18 November 2022
37	9th Interim Report	18 May 2023
38	9th Annual Community Briefing	28 September 2023
39	9th Annual Report	16 November 2023
40	10th Annual Community Briefing	17 February 2024
41	10th Interim Report	15 May 2024

Appendix 2: Governance Committee memberships

Project Steering Committee Membership		
Prof Michael Abramson	Principal Investigator	2014-2023
Prof Karen Walker-Bone	Principal Investigator	2023-2024
Dr Matthew Carroll	Principal Co-Investigator (Gippsland)	2020-2024
	Lead, SPHPM / Gippsland liaison	2014-2024
	Lead, Psychological Impacts Stream	2017-2024
Prof Darryl Maybery	Lead, Psychological Impacts Stream	2014-2017
Prof Judi Walker	Principal Co-Investigator (Gippsland)	2014-2019
	Lead, Older Persons Policy Review	2014-2016
Brigitte Borg	Lead, Respiratory Stream	2019-2024
Prof Bruce Thompson	Lead, Respiratory Stream	2014-2019
Dr Tyler Lane	Co-Stream Lead, Cancer Stream	2023-2024
	Senior Research Fellow	2022-2024
	Lead, Adult Survey	2023-2024
Prof Malcolm Sim	Lead, Cancer Stream	2014-2021
Prof Dion Stub	Lead, Cardiovascular Stream	2022-2024
Prof Danny Liew	Lead, Cardiovascular Stream	2017-2021
Dr Martine Dennekamp	Lead, Cardiovascular Stream	2014-2016
Prof Yuming Guo	Lead, Hazelinks Stream	2017-2024
Prof Fay Johnston	Lead, Early Life Follow-up Study	2014-2024
Prof Graeme Zosky	Acting Lead, Early Life Follow-up	2020-2021
Dr Sue Yell	Lead, Community Wellbeing Stream	2017-2024
Dr Michelle Duffy	Lead, Community Wellbeing Stream	2016-2017
A/Prof Pamela Wood	Lead, Community Wellbeing Stream	2014-2016
Dr Jillian Blackman	Senior Project Manager	2015-2024
	Lead, Adult Survey	2015-2023
Gillian Ormond	Project Manager	2015
Dr Sharon Harrison	Executive Officer, HHS	2016-2024
Shaun Mallia	Communications and Engagement Adviser	2017-2018

Project Management Group Membership		
Prof Michael Abramson	Principal Investigator	2014-2023
Prof Karen Walker-Bone	Principal Investigator	2023-2024
Dr Matthew Carroll	Principal Co-Investigator (Gippsland)	2020-2024
	SPHPM / Gippsland liaison	2014-2024
Prof Judi Walker	Principal Co-Investigator (Gippsland)	2014-2019
Prof Malcom Sim	Lead, Cancer Stream	2017-2021
Dr Jillian Blackman	Senior Project Manager	2015-2024
Dr Sharon Harrison	Project Manager	2022-2024
Dr Tyler Lane	Senior Research Fellow	2022-2024
Dr Martine Dennekamp	Senior Research Fellow	2014-2016
Gillian Ormond	Project Manager	2015
Dr Phillip Thompson	Project Manager	2014-2015

Clinical Reference Group Membership		
Dr Fred Edwards	General Practitioner	2015-2020
Dr Ryan Hoy	Respiratory and Sleep Physician, SPHPM, Monash University	2015-2020
A/Prof Paul Lee	Psychiatrist, Latrobe Regional Hospital	2015-2020
Dr Jo McCubbin	Paediatrician, Sale	2015-2020
Angela Scully	Head of Child & Maternal Health Services, Latrobe Regional Hospital	2015-2020
Dr Ian Webb	General Practitioner	2015-2020
Jeanette Douglas	Gippsland Primary Health Network	2017-2020
Prof Dion Stub	Cardiologist, SPHPM, Monash University	2017-2020
Dr Julian Rong	Gastroenterologist, Latrobe Regional Hospital	2018-2020
A/Prof Alistair Wright	Physician & Clinical Dean, Monash Rural Health	2015-2018
A/Prof Joseph Tam	Monash Rural Health, Monash University Director Department of Paediatrics, Latrobe Regional Hospital	2015-2017
Prof Andrew Tonkin	Cardiologist, SPHPM, Monash University	2015-2017
Dr David Monash	General Practitioner, Sale	2016

Community Advisory Committee Members		
Community Members		
Carolyne Boothman	Community Member (Morwell)	2015-2020
Vicki Hamilton OAM	Community Member (Morwell)	2018-2020
Geoff Duffell	Community Member (Morwell)	2019-2020
Denise Collis	Community Member (Morwell)	2019-2020
Shane Wilson	Community Member (Morwell)	2017-2019
Tracie Lund	Community Member (Morwell)	2015-2018
Ron Ipsen	Community Member (Morwell)	2017-2018
Andrew Wood	Community Member (Morwell)	2015-2016
Marg Harty	Community Member (Sale)	2017-2018
Bill Redmond	Community Member (Sale)	2017-2018
Alda Dunlop	Community Member (Sale)	2016-2017
Dr Iain Nicholson	Community Member (Sale)	2016-2017
Marilyn Mathieson	Community Member (Sale)	2015
Organisational Representatives		
Cr Kellie O'Callaghan	Latrobe Regional Hospital Board, Latrobe City Council	2015-2020
Ellen-Jane Browne	Gippsland Region Department of Health	2017-2020
A/Prof Kate Moore	Federation University	2017-2020
Chelsea Caple	Latrobe Regional Hospital	2018-2020
Sharon Houlihan	Wellington Shire Council	2018-2020
Mark Biggs	Latrobe Community Health Service	2018-2020
Ruth Churchill	Central Gippsland Health Service	2015-2019
Dr Glenys Butler	Wellington Shire Council	2015-2018
John Guy OAM	Latrobe Community Health Service	2015-2018
Ian Gibson	Latrobe Regional Hospital	2016-2017
Cr Dale Harriman	Latrobe City Council	2015-2017
Tim Owen	Public Health Officer, Department of Health Gippsland	2015-2017
A/Prof Wendy Wright	Federation University	2015-2017
Ex-officio Members		
Prof Michael Abramson	HHS Principal Investigator	2015-2023
Dr Matthew Carroll	HHS Co-Principal Investigator (Gippsland)	2020-2024
Prof Judi Walker	HHS Co-Principal Investigator (Gippsland)	2015-2019
Dr Clare Looker	Victorian Chief Health Officer	2023-2024
Prof Brett Sutton	Victorian Chief Health Officer	2019-2023
Prof Charles Guest	Victorian Chief Health Officer	2016-2019
Sean Mallia	HHS Communications and Engagement Advisor	2017-2018
Prof Michael Ackland	Acting Victorian Chief Health Officer	2016
Dr Rosemary Lester	Victorian Chief Health Officer	2015

Latrobe Health Assembly Hazelwood Health Study Sub-Committee Membership		
Diane Wilkinson (Chair)	Latrobe Health Assembly / Rotary Club of Moe	2021-2024
Carolyne Boothman	Community Member	2021-2024
Geoff Duffell	Community Member	2021-2024
Tracie Lund	Morwell Neighbourhood House / Latrobe City Council	2021-2024
Ellen-Jane Browne	Executive Officer Latrobe Health Assembly	2021-2024
Josephine Manco	Latrobe Health Assembly	2021-2024
Damen Francis	Latrobe Health Assembly	2021

Scientific Reference Group Membership		
Prof Ross Coppel (Chair)	Director of Research, Faculty of Medicine, Nursing and Health Sciences, Monash University	2015-2024
Dr Melita Keywood	Research Scientist, Climate and Atmosphere, CSIRO	2015-2024
Assoc Prof Rebecca Kippen	Demographer, Monash Rural Health, Monash University	2015-2024
Prof Sandy McFarlane	Director, Centre for Traumatic Stress Studies, University of Adelaide	2015-2024
Prof Rory Wolfe	Biostatistician, SPHPM, Monash University	2015-2024
Prof Anna Hansell	Environmental Epidemiologist, Imperial College London / University of Leicester	2017-2024
Prof Graeme Zosky	School of Medicine, University of Tasmania	2017-2024
Prof Michael Ackland	SPHPM, Monash University	2018-2024
Dr Beth Edmondson	Former Senior Lecturer, School of Arts, Humanities and Social Sciences, Federation University	2018-2024
Danny Brazzale	Senior Respiratory Scientist, Austin Hospital	2020-2024
Prof Sherene Loi	Medical Oncologist, Peter MacCallum Cancer Centre & University of Melbourne	2022-2024
Prof John Attia	Director of the Clinical Research Design, IT and Statistical Support Unit, University of Newcastle	2019-2023
A/Prof Jane Ford	Principal Research Fellow Medicine, Northern Clinical School, University of Sydney	2017-2021
Michael Keating	Respiratory Scientist, Latrobe Valley	2015-2019
Prof John McNeil	Former Head, SPHPM, Monash University	2015-2019
Prof Margaret Alston	Former Head, Department of Social Work, Monash University	2017-2019
Prof Dennis Moore	Faculty of Education, Monash University	2015-2017
Prof Brian Priestly	Toxicologist, SPHPM, Monash University	2015-2017
A/Prof Christine Roberts	Perinatal Epidemiologist, University of Sydney	2015-2017

Appendix 3: Hazelwood Health Study Outputs Directory

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
1. All	Nov 2015	1st Annual Report. Report: "Hazelwood Health Study Annual Report 1" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/1636311/hhs annualreport_final121115_v1.0.pdf
2. Community Wellbeing	July 2016	Abstract about social media use, presented at the 2016 Australia and New Zealand Communication Association conference. Conference Proceeding: Yell et al (2016) "Communities, authority and trust in the Fifth Estate: Social media use during the Hazelwood coalmine fire". Delivered at the 2016 Australia and New Zealand Communication Association conference on *Creating Space in the Fifth Estate*, Newcastle, 6-8 July. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations
3. All	Nov 2016	2nd Annual Report Report: "Hazelwood Health Study Annual Report 2" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/1636424/hazelwood-health-study-2nd-annual-report-v1.1-1.pdf
4. Exposure Assessment	Feb 2017	CSIRO report on the modelling of the smoke exposure providing information on $PM_{2.5}$ and CO and other chemical exposures for the mine fire period. Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/1636434/hazelwood_airqualitymodelling_december2016_final.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/1766055/Summary_AirQualityModelling_v1.1_13Feb2017.pdf
5. Older People	Feb 2017	Review of the impact of the Hazelwood mine fire on older people living in the Morwell community in the context of policy-driven decisions made at the time. Policy Review Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/1636384/policy-review-older-people-v1.0-website.pdf Policy Brief: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/1766072/Policy-Brief-Older-People-v1.1.pdf
6. Older People	May 2017	Abstract on older people and communications in future disaster events submitted to Australia and New Zealand Disaster and Emergency Management Conference. Conference Proceeding: Walker & Carroll (2017) Communications in future disaster events: best practice policy for older people. Presented at the Australia and New Zealand Disaster and Emergency Management Conference, Gold Coast May 2017. (Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations
7. Psychological Impacts (Schools)	June 2017	Initial findings from the first round of the Schools Study survey comparing students from Morwell schools with those from other Latrobe Valley schools. Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1636476/schools-study-analysis-of-round-1-key-quantitative-data-v1.0.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/1766070/Schools-Study-Year-1-key-findings-summary-v1-170627.pdf
8. Hazelinks	Sept 2017	Analysis of deidentified emergency presentations and hospital admission data (1st extraction) during the smoke event compared with before and after the fire. Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/1636483/2018-08-20-Hospital-analysis-extract-1-technical-report.ver1.2.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/1766069/20170904-Hospital-Admissions-research-summary.pdf
9. Adult Survey	Sept 2017	First round of analysis comparing 3096 Morwell and 960 Sale residents who completed the HHS Adult Survey. Technical Report Volume 1. Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1636395/hhsadultsurveyvol1_report_v1.1-compressed.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0007/1766077/20170904-Adult-Survey-research-summary.pdf
10. Hazelinks	Sept 2017	Analysis of cancer incidence data registered from 2009-2013 in Latrobe City compared to the surrounding local government areas to set the baseline for future comparisons. Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/1636482/20170919-cancer-analysis-data-extraction-technical-report-v1.0-1.pdf Research summary: https://www.monash.edu/__data/assets/pdf_file/0005/1766075/20170919-Baseline-Cancer-Analysis-research-summary-1.pdf
11. Community Wellbeing	Sept 2017	Paper on the use of social media during the Hazelwood mine fire. Academic paper: Yell & Duffy (2018) "Community Empowerment and trust: social media use during the Hazelwood mine fire." In the Australian Journal of Emergency Management available at https://knowledge.aidr.org.au/resources/ajem-apr-2018-community-empowerment-and-trust-social-media-use-during-the-hazelwood-mine-fire/ . Full text also available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0010/1986931/Community-Empowerment-and-Trust_Yell-and-Duffy_ajem-33-2-21.pdf_Citation and link also shown at https://hazelwoodhealthstudy.org.au/study-findings/publications
12. Older People	Nov 2017	Abstract describing the Older People Stream policy review. Conference Proceeding: Walker (2017). The impact of the Hazelwood mine fire in Australia on older people: review of policy-driven decisions made at the time. Aging and Society: Seventh Interdisciplinary Conference, November 2017. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
13. Older People	Nov 2017	Abstract about older people as active participants in disaster responses. Conference Proceeding: Carroll & Walker (2017). Beyond vulnerability: Older people as active participants in disaster responses. Presented at the 50th Australian Association of Gerontology National Conference, November 2017. Available at https://www.aag.asn.au/documents/item/2003 on page 37. Cited on the HHS website https://hazelwoodhealthstudy.org.au/study-findings/presentations
14. All	Nov 2017	3rd Annual Report Report: "Hazelwood Health Study Annual Report 3" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/1636419/hazelwood-health-study-3rd-annual-report_v1.2.pdf
15. Community Wellbeing	Dec 2017	Paper on the politics of loss and hope in the Latrobe Valley, drawing on information from the Community Wellbeing interviews and focus groups. Academic paper: https://www.anzrsai.org/assets/Uploads/PublicationChapter/AJRS-23.3-pages-421-to-446.pdf
16. Community Wellbeing	Dec 2017	Video summary on the major role that social media played during the Hazelwood mine fire. Video link: http://hazelwoodhealthstudy.org.au/research-areas/community-wellbeing/ and https://youtu.be/LVwQBvaNgtM
17. Early Life Follow-up	Jan 2018	Volume 1 technical report on ELF survey data completed by parents of 548 children sampled across the Valley and born between 2012 and 2015. Report: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/1636452/elf-vol-1_-cohortdesciption_parentreportedoutcomes-v1.2.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1766085/20180201-HHS-ELF-Volume-1-Research-Summary.pdf
18. Hazelinks	March 2018	Hazelinks technical report describing the association between $PM_{2.5}$ and data from the Medicare Benefits Schedule (MBS; health service use) and Pharmaceutical Benefits Scheme (PBS; pharmaceutical dispensation). Report: https://www.hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0010/2324908/Hazelinks-MBS-PBS-Technical-Report-Version-2.0.pdf. Research Summary: https://www.hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2324907/Hazelinks-MBS-and-PBS-Time-Series-Research-Summary-v2.0.pdf
19. Hazelinks	May 2018	Abstract on deidentified hospital emergency presentations and admissions presented at the American Thoracic Society (ATS) 2018 International Conference Conference Proceeding Abramson et al (2018). "Emergency Presentations and Hospital Admissions Following Exposure to Smoke from a Coal Mine Fire". Available at: https://www.abstractsonline.com/pp8/#!/4499/presentation/14343

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
20. Adult Survey	May 2018	Abstract on Adult Survey self-reported asthma and respiratory symptoms presented at ATS 2018. Conference Proceeding: Abramson et al (2018). "Adults Exposed to Coal Mine Fire Smoke Report More Asthma and Respiratory Symptoms than Those Not Exposed". Available at: https://www.abstractsonline.com/pp8/#!/4499/presentation/19606 (To be listed in a new section of the HHS website)
21. Hazelinks	July 2018 & March 2020	Paper describing the association between mine fire $PM_{2.5}$ and deidentified hospital emergency presentations and admissions (based on findings previously presented in the technical report (row 8 above). Academic paper: Guo et al (2020) The association of coal mine fire smoke with hospital emergency presentations and admissions: Time series analysis of Hazelwood Health Study" in Chemosphere, available at https://www.sciencedirect.com/science/article/pii/S0045653520308602. Citation also shown at https://hazelwoodhealthstudy.org.au/study-findings/publications. No Research Summary for this publication as a previous Research Summary was produced for the preceding technical report (see row 8 above)
22. Early Life Follow-up	July 2018	Abstract on children's lung health submitted to the Australia & New Zealand Society of Respiratory Science and the Thoracic Society of Australia and New Zealand (ANZSRS/TSANZ) Annual Scientific Meeting, July 2018. Conference Proceeding: Shao J et al. (2018). An assessment of early life exposure to coalmine fire smoke and children's lung health (abstract TOL 003). Available at https://doi.org/10.1111/resp.13267 and cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations
23. Community Wellbeing	Nov 2017 May 2018	A travelling photographic exhibition featuring images generated by local community groups and residents symbolising their hopes for the future of Morwell. Exhibition photos: https://hazelwoodhealthstudy.org.au/media/our-hopes Exhibition catalogue: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0005/2073362/Updated-Catalogue-Final.pdf
24. Early Life Follow-up	August 2018	Abstract describing the association between smoking during pregnancy and early development atherosclerosis, presented to the European Cardiology Congress 2018. Conference proceeding: Zhao et al (2018) Smoking during pregnancy significantly increases the risk of early atherosclerosis: a study from coalmine smoke exposure [abstract] available at https://esc365.escardio.org/Congress/ESC-Congress-2018/Best-Posters-6-Best-Posters-in-preventive-cardiology/176295-smoking-during-pregnancy-significantly-increases-the-risk-of-early-atherosclerosis-a-study-from-coalmine-smoke-exposure#abstract also cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations
25. Early Life Follow-up	August 2018	Abstract on smoke exposure during infancy and lung function submitted to the International Society for Environmental Epidemiology (ISEE) 2018. Conference proceeding: Shao et al (2018) Exposure to Smoke from a Coal Mine Fire during Infancy and Lung Function Three Years after the Event. Available at https://ehp.niehs.nih.gov/doi/10.1289/isesisee.2018.P02.1800

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		and cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations
26. Psychological Impacts (Adult)	August 2018	Paper summarising the findings from qualitative interviews with adult Morwell residents on the social and psychological impacts of the event. Academic paper: Jones et al 2018 "Experiences of a prolonged coal-mine fire. In Disaster Prevention and Management. Available by subscription https://doi.org/10.1108/DPM-05-2018-0145. Pre-print version freely available at https://research.monash.edu/files/252507394/252145312_oa.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/1766079/20180605-adults-Psych-stream-research-summary-4.pdf
27. Hazelinks	August 2018	Abstract on $PM_{2.5}$ and PBS data submitted to ISEE 2018 Conference Proceeding: Johnson et al (2018) Fine particulate matter and medications dispensed during and after a brown coal mine fire: a time series analysis. Presented at the International Society of Exposure Science and International Society for Environmental Epidemiology 2018 Joint Annual Meeting. 26–30 August 2018, Ottawa, Canada. Available at https://ehp.niehs.nih.gov/doi/10.1289/isesisee.2018.P02.1550
28. Hazelinks	August 2018	Abstract on $PM_{2.5}$ and Medicare health service data submitted to ISEE 2018. Conference Proceeding: Johnson et al (2018) Brown coal mine fire-related fine particulate matter and medical service utilisation in Australia: a time series analysis. Presented at the International Society of Exposure Science and International Society for Environmental Epidemiology 2018 Joint Annual Meeting, Ottawa, Canada, 26–30 August 2018. Available at https://ehp.niehs.nih.gov/doi/10.1289/isesisee.2018.O02.04.19
29. Psychological Impacts (Schools)	Sept 2018	Paper on the perception of staff from a specialist school on the impacts of the smoke and relocation on students and staff at the school. Academic paper: Berger et al (2018) "Disaster Impacts on Students and Staff from a Specialist, Trauma-Informed Australian School" in Journ Child Adol Trauma. Available by subscription at https://doi.org/10.1007/s40653-018-0228-6. Full text freely avail on pre-print server at: https://doi.org/10.31234/osf.io/agdb5 Link also provided at https://hazelwoodhealthstudy.org.au/study-findings/publications Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0010/1766080/20180910-Psychological-Impacts-Stream-Specialist-School-Interviews-Research-Summary.pdf
30. Psychological Impacts (Schools)	Sept 2018	Analysis of round 1 Schools Study interviews on the impacts of the mine fire on students. Academic publication: Berger et al (2020) "Children's Perspectives on the Impact of the Hazelwood Mine Fire and Subsequent Smoke Event". Child & Youth Care Forum. Available by subscription from: https://doi.org/10.1007/s10566-020-09551-8. Pre-print version available at https://doi.org/10.31234/osf.io/8mhxf (also https://psyarxiv.com/8mhxf/) Link also provided at https://hazelwoodhealthstudy.org.au/study-findings/publications Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/1766083/20180906-Psychological-Impacts-Stream-Childrens-perspectives.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
31. Early Life Follow-up	Oct 2018	ELF Technical Report Volume 2 reporting on the clinical assessments looking at the relationship between smoke exposure and respiratory functioning. Technical Report: Link provided at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/2052516/ELFVol-2-Lung-Function-Testing-v1.1.pdf Research summary: One Research Summary which combines the findings from ELF Volumes 2 and 3 is available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0005/1766102/ELF-vols-2_3-Research-Summary.pdf
32. Early Life Follow-up	Oct 2018	ELF Technical Report Volume 3, reporting on the clinical assessments looking at the relationship between smoke exposure and cardiovascular functioning. Technical Report: Zhao et al (2018) "The Latrobe Early Life Follow-up (ELF) Cohort Study Volume 3 Investigation of possible associations between coal mine fire emissions and vascular outcomes in the ELF cohort three years after the fire" Link provided at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/2150547/ELF-Cohort-Study_Volume-3-CV-Report_v1.1.pdf Research summary: One Research Summary which combines the findings from ELF Volumes 2 and 3 is available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0005/1766102/ELF-vols-2_3-Research-Summary.pdf
33. Early Life Follow-up	Nov 2018	Abstract presented to the American Heart Association Scientific Sessions 2018 on normal ranges of intima-media thickness in young children. Followed by a paper on this same subject, submitted to Paediatric Cardiology. Conference Proceeding: Zhao et al, (2018) Feasibility and Normal Ranges of Arterial Intima-Media Thickness and Stiffness in 2-Year-Old Children. Available at https://www.ahajournals.org/doi/10.1161/circ.138.suppl_1.13237 and cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations Academic paper: Zhao et al (2019). "Feasibility and Normal Ranges of Arterial Intima-Media Thickness and Stiffness in 2-Year-Old Children: A Pilot Study" in Paediatric Cardiology. Available by subscription at https://link-springer-com.ezproxy.lib.monash.edu.au/content/pdf/10.1007/s00246-019-02088-1.pdf. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications.
34. Psychological Impacts (Adult)	Nov 2018	Paper on adult psychological outcomes which combined analysis of Adult Survey findings with follow up face to face interviews. Academic paper: Maybery et al (2020) "A mixed-methods study of psychological distress following an environmental catastrophe: the case of the Hazelwood open-cut coalmine fire in Australia" in Anxiety, Stress, & Coping. Available by paid subscription at https://www.tandfonline.com/doi/abs/10.1080/10615806.2019.1695523 Full text also available on a preprint server at: https://psyarxiv.com/euj96/ Citation also shown at https://hazelwoodhealthstudy.org.au/study-findings/publications Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/1766101/Psych-stream-mixed-methods-research-summary-V2.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
35. All	Nov 2018	4th Annual Report Report: "Hazelwood Health Study Annual Report 4" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1636251/hhs-4th-annual-report-v1.0.pdf
36. Hazelinks	Dec 2018	Report on risk of ambulance attendances during the Hazelwood mine fire compared with before and after the event (1st extraction, deidentified data). Report version 1.0 placed on https://hazelwoodhealthstudy.org.au/study-findings/study-reports in Dec 2018 but removed in Feb 2020 for revisions to be made. Report version 1.1 listed on https://hazelwoodhealthstudy.org.au/study-findings/study-reports in March 2020 as being available upon request by calling 1800 985 899 or emailing contact@hazelwoodhealthstudy.org.au Research summary: available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/1766100/Ambulance-attendances-during-the-Hazelwood-mine-fire.pdf Refer row 63 for the academic paper based on these findings.
37. Early Life Follow-up	Dec 2018	Paper on birth outcomes in the Latrobe Valley following the mine fire based on analysis of anonymous Victorian Perinatal Data Collection records. Academic paper: Melody et al (2019) Maternal exposure to fine particulate matter from a coal mine fire and birth outcomes in Victoria, Australia. Published in Environment International .Full text available at https://doi.org/10.1016/j.envint.2019.03.028 and citation shown at https://hazelwoodhealthstudy.org.au/study-findings/publications Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/1766097/Birth-outcomes-using-anonymous-Victorian-Perinatal-Data-Collection-Records.pdf
38. Adult Survey	Jan 2019	Analysis on the Adult Survey looking at the relationship between level of smoke exposure and health outcomes. Report: Ikin et al (2019) Hazelwood Health Study Adult Survey Volume 2: The relationship between Hazelwood mine fire smoke exposure and health outcomes. Available on the HHS website at: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/1636460/hazelwoodhealthstudy-adult-survey-volume-2-report-v1.1.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1766094/20190123-Adult-Survey-Volume-2-Research-Summary.pdf
39. Psychological Impacts (Schools)	March 2019	Report on the second round of face to face interviews with students participating in the Schools Study tracking ongoing impacts. Report: Allen et al (2019) Hazelwood Health Study Schools Study: Report of Round 2 Qualitative Findings available on the HHS website at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/1766135/Schools-Study-Round2-Interviews.pdf Research summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0007/1766104/Research-Summary-Schools-Study-Round-2-Interviews.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
40. Hazelinks	March 2019	Paper based on revised analysis of PBS data (see row 18 above) assessing the relationship between smoke exposure and medication dispensing. Academic paper: Johnson et al (2019) "Fine particulate matter exposure and medication dispensing during and after a coal mine fire: A time series analysis from the Hazelwood Health Study". Available by subscription at https://doi.org/10.1016/j.envpol.2018.12.085. Citation also shown at https://hazelwoodhealthstudy.org.au/study-findings/publications with readers advised to email contact@hazelwoodhealthstudy.org.au to request a full copy of the paper. No Research Summary for this publication as a previous Research Summary was produced for the preceding technical report (see row 18 above)
41. Psychological Impacts (Schools)	March 2019	Paper on the first round of the Schools Study combining analysis of survey and interview findings. Academic paper: Maybery et al (2019) The psychological impact and experiences of children following the Hazelwood mine fire and subsequent smoke event. Preprint version available at https://psyarxiv.com/rw657 Cited on the HHS website at: https://hazelwoodhealthstudy.org.au/study-findings/publications. Subsequently, this paper has been extensively revised and re-titled "Posttraumatic stress among school-aged students following a mine fire." The revised manuscript has been published by the *Journal of Aggression, Maltreatment and Trauma* and is available at www.tandfonline.com/doi/abs/10.1080/10926771.2023.2228240. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0007/1766104/Research-Summary-Schools-Study-Round-2-Interviews.pdf
42. Community Wellbeing	May 2019	Community Wellbeing Stream Technical Report Volume 1 (Version 1.0 of this report replaced with version 2.0 in October 2019) Report: Yell et al (2019) Community Wellbeing Stream Report Volume 1: Community perceptions of the impact of the smoke event on community wellbeing and of the effectiveness of communication during and after the smoke event. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0018/2052540/CW-Report-Volume-1_v2.0.pdf Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1766103/community-perceptions-of-the-impact.pdf
43. Early Life Follow-up	May 2019	Paper on the relationship between mine fire smoke and risk of pregnancy-related health outcomes incl gestational diabetes. Academic paper: Melody et al (2019) "Maternal exposure to fine particulate matter from a large coal mine fire is associated with gestational diabetes mellitus: A prospective cohort study" published in *Environmental Research* and available by subscription at https://doi.org/10.1016/j.envres.2019.108956 Full citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications; website viewers invited to request a copy of the paper by emailing contact@hazelwoodhealthstudy.org.au Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/1795830/Re

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		search-Summary-ELF-Exposure-to-mine-fire-smoke-and-the-risk-of-pregnancy-related-health-problems.pdf Abstract submitted to the World Congress of Epidemiology 2020 (which was cancelled)
44. Early Life Follow-up	May 2019	ELF Technical Report Volume 4 on updated analysis of birth outcomes using additional information provided by parents and maternal health data. Report: Melody et al (2019) https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/2052517/Latrobe-ELF-tech-report-volume-4_v1.0.pdf Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/2052562/Research-Summary-ELF-Repeat-analysis-of-birth-outcomes.pdf Abstract submitted to the World Congress of Epidemiology 2020.
45. Early Life Follow-up	May 2019	Abstract on nitrogen dioxide and lung function, submitted to the American Thoracic Society Scientific Meeting, Conference Proceeding: Shao et al (2019) " Ambient Nitrogen Dioxide Exposure During Infancy Influences Respiratory Mechanics in Preschool Years [Abstract]" published in the American Journal of Respiratory and Critical Care Medicine available by paid subscription at https://doi.org/10.1164/ajrccm-conference.2019.199.1_MeetingAbstracts.A7058. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations
46. Respiratory	July 2019	Paper examining whether exposure to smoke from the mine fire is associated with respiratory symptoms, asthma control and decline in lung function. Academic paper: Taylor et al (2019) "Is asthma associated with exposure to smoke from a coal mine fire?" Pre-print available at: https://www.biorxiv.org/content/10.1101/631317v1 Pre-print citation and link provided on HHS website shown at https://hazelwoodhealthstudy.org.au/study-findings/publications Nb. as of 17/3/20, this paper was yet to be published in a scientific journal. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0019/1840024/Research-Summary-Respiratory-Stream-Lung-Function-and-Asthma-Impacts.pdf
47. Hazelinks	Oct 2019	Paper describing revised analysis (see row 18 above) of the association between $PM_{2.5}$ and Medicare health service use. Academic paper: Johnson et al. (2020) "Coal-mine fire-related fine particulate matter and medical-service utilization in Australia: a time-series analysis from the Hazelwood Health Study" in the International Journal of Epidemiology. Full text available by subscription at https://doi.org/10.1093/ije/dyz219. Citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications and readers may request a full copy by emailing contact@hazelwoodhealthstudy.org.au No Research Summary for this publication as a previous Research Summary was produced for the preceding technical report (see row 18 above)
48. Cardiovascular	Oct 2019	Paper aiming to estimate the prevalence of hypertension in the cohort and identify predictors of hypertension management (does not address any research question about the impact of the mine fire)

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		Academic paper: Betts et al (2020) "Factors associated with hypertension and its management among older rural Australians" published in the Australian Journal of Rural Health (May 2020) 28(4), 399-407. Full text available by subscription at https://doi.org/10.1111/ajr.12634. Citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications and readers may request a full copy by emailing contact@hazelwoodhealthstudy.org.au Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0016/2011831/CVD-Hypertension-Research-Summary.pdf The Research Summary invites readers to request the full copy of the paper by calling 1800 985 899 or emailing contact@hazelwoodhealthstudy.org.au
49. Cardiovascular	Oct 2019	Paper aiming to measure any association between mine fire $PM_{2.5}$ and cardiovascular disease (CVD) risk factors. Academic paper: Betts et al (2021) "Markers of cardiovascular disease among adults exposed to smoke from the Hazelwood coal mine fire" published in the International Journal of Environmental Research and Public Health, 18(4), 1587. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications and freely available at https://doi.org/10.3390/ijerph18041587. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0015/2011830/CVD-Blood-Vessel-Health-Research-Summary-1.pdf
50. Adult Survey	Oct 2019	Abstract submitted to the European Respiratory Society International Congress on $PM_{2.5}$ and chronic cough. Conference Paper: Abramson et al (2019) "Chronic cough is related to cumulative $PM_{2.5}$ and exposure from a coal mine fire [abstract]" available at https://erj.ersjournals.com/content/54/suppl_63/PA4455 and cited on the HHS website https://hazelwoodhealthstudy.org.au/study-findings/presentations
51. Respiratory	Nov 2019	Abstract describing the association between $PM_{2.5}$ and chronic obstructive pulmonary disease (COPD) based on adult Respiratory Stream clinic data. Submitted to the ATS 2020. Conference Proceeding: Prasad SR, Borg B, Gao CX et al (2020) Chronic Obstructive Pulmonary Disease Is Associated with Exposure to Fine Particles from a Coal Mine Fire [abstract]. Accepted as an e-poster for inclusion in the American Thoracic Society 2020 Virtual meeting. Also published in the American Journal of Respiratory and Critical Care Medicine; 201:A7835. https://www.atsjournals.org/doi/abs/10.1164/ajrccm-conference.2020.201.1_MeetingAbstracts.A7835
52. Exposure Assessment	Nov 2019	Paper written by CSIRO describing the modelling of $PM_{2.5}$ data. Academic paper: Luhar et al (2020) Modelling smoke distribution in the vicinity of a large and prolonged fire from an open-cut coal mine. Atmospheric Environment, 117471. Available from http://www.sciencedirect.com/science/article/pii/S1352231020302089. Citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications No Research Summary for this paper as it replicates CSIRO's modelling report and Research Summary described in Row 4 above.

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
53. All	Nov 2019	5th Annual Report Report: "Hazelwood Health Study Annual Report 5" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2052828/HHS-5th-Annual-Report-v-1.0-with-Appendices.pdf
54. Adult Survey/ Psychological Impacts	Dec 2019	Paper describing the association between $PM_{2.5}$ and symptoms of distress and contributing factors Academic paper: Broder et al (2020) "The factors associated with distress following exposure to smoke from an extended coal mine fire" published in *Environmental Pollution 266*, 115131. Available by paid subscription at https://doi.org/10.1016/j.envpol.2020.115131 or http://www.sciencedirect.com/science/article/pii/S0269749119373907. To request a free copy of the paper call 1800 985 899 or email contact@hazelwoodhealthstudy.org.au. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2052585/Long-term-psychological-health-following-the-Hazelwood-mine-fire.pdf
55. Community Wellbeing	Dec 2019	Community Wellbeing Stream Technical Report Volume 2 on the community perceptions of effectiveness of community rebuilding activities. Report: Yell et al (2019) Community Wellbeing Stream Report Volume 2: Community perceptions of the effectiveness of community rebuilding activities https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2059236/CW-Report-Volume-2_version-1.0.pdf Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0003/2058960/Research-Summary-Community-perceptions-of-the-effectiveness-of-community-rebuilding-activities.pdf
56. Early Life Follow-up	Nov 2019	Paper describing association between smoke and health service and medication usage in children. Academic paper: Shao et al (2020) "Exposure to air pollution during the first 1000 days of life and subsequent health service and medication usage in children" published by Environmental Pollution. Available by subscription at https://doi.org/10.1016/j.envpol.2019.113340. Full citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications; website viewers invited to request a copy of the paper by emailing contact@hazelwoodhealthstudy.org.au Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0010/2052568/ELF-Research-Summary-GP-visits-and-medication-use.pdf
57. Early Life Follow-up	Dec 2019	Paper describing the association between exposure to coal mine fire and tobacco smoke, and subclinical vascular function in young children. Academic paper: Zhao et al 2019 "Early life exposure to coal mine fire and tobacco smoke affect subclinical vascular function" published in Archives of Disease in Childhood. Available by subscription at https://adc.bmj.com/content/early/2019/12/20/archdischild-2019-317528. Full citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications; website viewers invited to request a copy of the paper by emailing contact@hazelwoodhealthstudy.org.au

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
58. Early Life Follow-up	Dec 2019	Technical Report, Research Summary and paper describing the association between $PM_{2.5}$ and common illnesses like coughs, colds and asthma based on parent-reported monthly diaries. Report: Willis et al (2019) Latrobe Early Life Follow-up (ELF) Cohort Study Volume 6. The impact of exposure to coal mine fire smoke in early life on parent-reported indicators of childhood atopic and respiratory illness. Version 1.0. Available upon request by calling 1800 985 899 or emailing contact@hazelwoodhealthstudy.org.au Academic paper: Willis et al (2020) "Respiratory and atopic conditions in children two to four years after the 2014 Hazelwood coalmine fire" in the Medical Journal of Australia, 2020, vol 213(6), pp 269-275. Freely available at https://doi.org/10.5694/mja2.50719. Link also shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications Research Summary: available on the HHS website at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/2052569/2019.09-Monthly-diary-summary-for-participants-.pdf The Research Summary invites readers to request the full copy of the technical report by calling 1800 985 899 or emailing contact@hazelwoodhealthstudy.org.au
59. Adult Survey	Dec 2019	Paper based upon the Adult Survey, respiratory symptoms, building materials and $PM_{2.5}$ Academic paper: Johnson et al (2019) Associations between Respiratory Health Outcomes and Coal Mine Fire $PM_{2.5}$ Smoke Exposure: A Cross-Sectional Study. In the International Journal of Environmental Research and Public Health. Available at https://www.mdpi.com/1660-4601/16/21/4262 Also cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications
60. Hazelinks	Jan 2020	Technical report describing the association between mortality, the mine fire period and $PM_{2.5.}$ Report: v1.0 submitted to DHHS in November 2019 and resubmitted as v1.1 in February 2020. Report and accompanying Q and A document freely available on the Hazelwood Health Study website at https://hazelwoodhealthstudy.org.au/study-findings/study-reports Research Summary: https://hazelwoodhealthstudy.org.au/study-findings/fact-sheets-and-summaries
61. Early Life Follow-up	Feb 2020	Paper describing association between smoke and lung function in young children. Academic paper: Shao et al (2020) "Early life exposure to coal mine fire smoke emissions and altered lung function in young children" in *Respirology*. Available by subscription at https://doi.org/10.1111/resp.13617. Full citation shown on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications; website viewers invited to request a copy of the paper by emailing contact@hazelwoodhealthstudy.org.au
62. Cardiovascular	March 2020	Paper describing the relationship between diet quality scores and cardiometabolic risk factors in regionally-dwelling older Australian adults with increased cardiovascular risk. Academic paper: Owen et al (2020) Recommended Intake of Key Food Groups and Cardiovascular Risk Factors in Australian Older, Rural-Dwelling Adults. Published in *Nutrients*. Freely available at https://www.mdpi.com/2072-

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		6643/12/3/860/htm and on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications As this publication does not address a Hazelwood Health Study research question, a HHS Research Summary has not been prepared.
63. Hazelinks	April 2020	Paper describing the association between $PM_{2.5}$ and deidentified ambulance data (based on analysis previously presented in the technical report (see row 36 above). Academic paper: Gao Et Al "Impact of acute exposure to mine fire emitted $PM_{2.5}$ on ambulance attendances: a time series analysis from the Hazelwood Health Study" in *Environmental Research*, 110402. Available by subscription at https://doi.org/10.1016/j.envres.2020.110402. For a free copy of this article, please email contact@hazelwoodhealthstudy.org. No Research Summary as findings were previously presented (see row 36)
64. Adult Survey	April 2020	Paper describing the establishment, recruitment and followup of the HHS adult cohort. Academic paper: Ikin et al "Cohort Profile: The Hazelwood Health Study adult cohort" in the *International Journal of Epidemiology*. Available by subscription at https://doi.org/10.1093/ije/dyaa083. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. A free copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au No Research Summary released with this publication as it does not present new findings.
65. Psychological Impacts (Schools)	April 2020	Paper describing Schools Study participants, linked NAPLAN data and CRIES measures. Academic paper: Berger at al "The Impact of a Mine Fire and Smoke Event on Academic Outcomes for Primary and Secondary School Students" in *Psychological Trauma: Theory, Research, Practice, and Policy*. Available by subscription at www.doi.org/10.1037/tra0001179. Pre-print freely available at https://psyarxiv.com/unms5/. Pre-print link provided on the HHS website at www.hazelwoodhealthstudy.org.au/study-findings/publications. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0018/2232054/20201606-NAPLAN-The-Impact-of-a-Mine-Fire-and-Smoke-Event-on-Academic-Outcomes-for-Primary-and-Secondary-School-Students.pdf
66. Respiratory Stream	May 2020	Abstract describing the association between $PM_{2.5}$ and COPD submitted to the American Thoracic Society Annual Meeting 2020. Nb. the Meeting was replaced with ATS Virtual. The abstract has been accepted and published. Conference Proceeding: Prasad et al (2020) Chronic Obstructive Pulmonary Disease Is Associated with Exposure to Fine Particles from a Coal Mine Fire [abstract]. *American Journal of Respiratory and Critical Care Medicine*; 201:A7835. Available at https://www.atsjournals.org/doi/abs/10.1164/ajrccm-conference.2020.201.1_MeetingAbstracts.A7835. Also cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations.
67. Early Life Follow-up	June 2020	Paper describing the establishment, recruitment and follow-up of the HHS Early Life Follow-up cohort. Academic paper: Melody et al. "Cohort Profile: The Hazelwood Health Study Latrobe Early Life Follow-Up (ELF) Study" in the *International Journal of*

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		Epidemiology 2020. Available by subscription https://doi.org/10.1093/ije/dyaa136. Cited on the website at https://hazelwoodhealthstudy.org.au/study-findings/publications. A free copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au. No Research Summary released with this publication as it does not present new findings.
68. Respiratory Stream	July 2020	Paper and conference abstract describing the association between $PM_{2.5}$ and lung mechanics using the forced oscillation technique (FOT) in the adult Respiratory Stream. Academic paper: Holt et al. (2021) "Long term impact of coal mine fire smoke on lung mechanics in exposed adults" in *Respirology*. Available by subscription at https://onlinelibrary.wiley.com/doi/10.1111/resp.14102. Pre-print version freely available at https://doi.org/10.1101/2020.10.14.20213009. Pre-print link also cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. Conference Proceeding: Holt et al Altered lung mechanics after coal mine fire smoke exposure in adults. Abstract accepted by ERS International Virtual Congress 2020. In European Respiratory Journal, 56(suppl 64), 3146. https://doi.org/10.1183/13993003.congress-2020.3146 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/2351096/Research-Summary_RespStream_FOT-paper.pdf
69. Hazelinks	August 2020	Paper describing the describing the association between $PM_{2.5}$ and linked ambulance attendance data in consented Adult Survey participants. Academic paper: Broder et al. Long-term impact of exposure to coalmine fire emitted PM2·5 on emergency ambulance attendances: Hazelwood Health Study. (2021) Published by *Chemosphere*. Available by subscription at doi.org/10.1016/j.chemosphere.2021.132339. Cited on the HHS website and a free copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0012/2351100/Hazelinks-Research-summary_linked-ambulance-paper.pdf
70. Respiratory Stream	August 2020	Paper describing the association between $PM_{2.5}$ and COPD, $T_L$co and symptoms in adult Resp Stream participants. Same findings as those presented in the abstract at row 66 above. Academic paper: Prasad et al. "Chronic Obstructive Pulmonary Disease is associated with exposure to fine particles from a coal mine fire" published by the journal *Annals of the American Thoracic Society*. Available by subscription at www.atsjournals.org/doi/10.1513/AnnalsATS.202012-1544OC. Pre-print version freely available at https://doi.org/10.1101/2020.10.14.20213009. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0007/2351095/Research-Summary_RespStream_COPD-paper.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
71. Adult Survey/ Psych Impacts	Oct 2020	Paper describing the association between psychological distress and respiratory symptoms in the context of the mine fire. Not a Hazelwood Health Study research question. Academic paper: Samuel et al "Associations between self-reported respiratory symptoms and psychological distress following exposure to a landscape fire" 2021 published in *Stress and Health*. Available by subscription at https://doi.org/10.1097/EE9.0000000000000042. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. A free copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au Conference proceeding: Poster accepted for TSANZ Vic 2020. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/presentations. No Research Summary released with this publication as it does not address a HHS research question.
72. Adult Psych Impacts	Nov 2020	Paper and abstract describing psychological distress in young adults. Academic paper: O'Donohue et al (2022) "The psychological impacts of a smoke event on young adults compared to other aged adults in Victoria, Australia". Published in the *Int Jnl Risk Reduction*. Freely available at www.doi.org/10.1016/j.ijdrr.2021.102727 Conference Proceeding: abstract accepted for presentation at the 4th International Childhood Trauma Conference held in Melbourne, Australia in August 2022. No Research Summary released with this publication.
73. Adult Psych Impacts	Nov 2020	Technical report describing the initial analysis of data from the 2019-2020 Mental Health and Wellbeing Follow-up Survey. Report: Carroll M. et al (2020). Hazelwood Health Study Technical Report. 2019-2020 Mental Health and Wellbeing Follow-up Survey: A follow-up to the 2016-2017 Adult Survey investigating the ongoing psychological health of adults who lived in Morwell during the 2014 Hazelwood mine fire. Freely available on the Hazelwood Health Study website at https://hazelwoodhealthstudy.org.au/study-findings/study-reports Research Summary: Reseach-summary-Mental-Health-Follow-up-Report-07122020.pdf (hazelwoodhealthstudy.org.au)
74. Early Life Follow-up	Nov 2020	Technical report describing the sources of air pollution to which ELF families were exposed. Report: Chappell K et al (2020) The Latrobe Early Life Follow-up (ELF) Cohort Study Volume 5. A description of sources of air pollution inside and outside the home environments of children in the Latrobe ELF Cohort. Available on the Hazelwood Health Study website at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0010/2424871/ELF-Report-Vol-5_Version1.0.pdf No Research Summary released with this publication as it does not address a HHS research question.

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
75. Early Life Follow-up	Nov 2020	Paper describing the association between respiratory and cardiovascular function in young children. Academic paper: Hemstock E et al (2021). Associations between respiratory and cardiovascular function in early childhood. Published by the journal *Respirology* and cited on the HHS website at www.hazelwoodhealthstudy.org.au/study-findings/publications. Available by subscription at https://doi.org/10.1111/resp.14117 or a free copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au. No Research Summary released with this publication as it does not address a HHS research question.
76. All	Nov 2020	6th Annual Report Report: "Hazelwood Health Study Annual Report 6" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/2452866/HHS-6th-Annual-Report-v1.0.pdf
77. Respiratory Stream	Dec 2020	Paper describing the characteristics of e-cigarette users. Academic paper: Lee WK et al (2021) Are E-cigarette use and vaping associated with increased respiratory symptoms and poorer lung function in a population exposed to smoke from a coal mine fire? Published in *Respirology* and cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. Available by subscription at https://doi.org/10.1111/resp.14113 or a copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au. No Research Summary released with this publication as it does not address a HHS research question.
78. Psych Impacts Schools	Feb 2021	Paper describing analysis of deidentified NAPLAN data Academic paper: Gao CX et al (2023). Evaluating the impact of Hazelwood mine fire event on students' educational development with Bayesian interrupted time-series hierarchical meta-regression. Published in March 2023 by the journal *PLoS ONE* and freely available at https://doi.org/10.1371/journal.pone.0281655. A preprint version is also available at https://doi.org/10.1101/2021.03.28.21254516. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0004/2560378/Deidentified-NAPLAN_Research-Summary.pdf
79. Hazelinks	March 2021	Paper describing hospital admission data linked to Adult Survey participants. Academic paper: Xu R et al (2021) Long-term impacts of coal mine fire emitted $PM_{2.5}$ on hospitalization: a longitudinal analyses of the Hazelwood Health Study. Published by the *International Journal of Epidemiology* and available at https://doi.org/10.1093/ije/dyab249. Cited on the website at https://hazelwoodhealthstudy.org.au/study-findings/publications. A copy of the paper can be requested by emailing contact@hazelwoodhealthstudy.org.au. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0007/2552263/Linked-Hospital-Paper-Research-Summary.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
80. Cardiovascular	April 2021	Paper describing the flow mediated dilatation results from CVD Stream round 1 clinical testing. Academic paper: Mundisugih et al (2021) "Vascular responses among adults exposed to smoke from the Hazelwood coal mine fire". Published in *Vascular Health and Risk Management* and freely available at www.doi.org/10.2147/VHRM.S339439. Cited on the website at https://hazelwoodhealthstudy.org.au/study-findings/publications. No Research Summary released with this publication because the findings are very similar to those previously reported (refer row 49 above).
81. Adult Psych Impacts	May 2021	Literature review exploring the psychological outcomes for young adults after disaster events Academic paper: O'Donohue et al (2021) "Psychological outcomes for young adults after disastrous events: A mixed-methods scoping review". Published by Social Science & Medicine. Available by subscription https://doi.org/10.1016/j.socscimed.2021.113851. No Research Summary released with this publication as it does not address a HHS research question.
82. Hazelinks	June 2021	Paper describing the results from the previously release mortality report (refer row 60 above). Academic paper: Dimitriadis et al (2021) "Exposure to mine fire related particulate matter and mortality: A time series analysis from the Hazelwood Health Study" published in *Chemosphere.* Available by subscription at https://doi.org/10.1016/j.chemosphere.2021.131351. The more detailed report (refer row 60 above) and a FAQ document is freely available on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/study-reports. Research Summary: the Research Summary for the previously released report (refer row 60 above) is available on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/fact-sheets-and-summaries.
83. Adult Psych Impacts	July 2021	Paper based on mental health related ambulance, emergency department presentations & hospital admissions. Academic paper: Carroll et al (2022) "Impacts of coal mine fire-related $PM_{2.5}$ on the utilisation of ambulance and hospital services for mental health conditions" published in *Atmospheric Pollution Research.* Available by subscription at: https://doi.org/10.1016/j.apr.2022.101415. A free pre-print version of this paper (not externally peer reviewed) is available at https://psyarxiv.com/hgv7t/ Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2745873/Research-Summary_AdultPsych_HospitalAmbulance.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
84. Hazelinks	July 2021	A short paper regarding the incidence of cancer in the 5 years after the Hazelwood mine fire. Academic paper: Yu et al (2021) "Impacts of high concentration, medium duration coal mine fire related $PM_{2.5}$ on cancer incidence: 5-year follow-up of the Hazelwood Health Study". Published by *Environmental Health Insights*. Freely available at https://journals.sagepub.com/doi/10.1177/11786302211059722. Cited on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/publications. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/2718962/Research-Summary_linked-cancer-5years-v1.0-1.pdf
85. Adult Psych Impacts	July 2021	Paper exploring the ongoing psychological distress associated with exposure to smoke during the 2014 Hazelwood coal mine fire. This is based on the previously released Technical report describing the initial analysis of data from the 2019-2020 Mental Health and Wellbeing Follow-up Survey (refer row 73). Academic paper: Carroll et al (2022) "An exploration of the trajectory of psychological distress associated with exposure to smoke during the 2014 Hazelwood coal mine fire". Published by the *International Journal of Hygiene and Environmental Health*. Freely available until 16 April 2022 at https://authors.elsevier.com/c/1eel8574Px5z6b. Available by subscription at https://doi.org/10.1016/j.ijheh.2022.113946. Cited on the website at https://hazelwoodhealthstudy.org.au/study-findings/publications. A pre-print version of this paper (not externally peer reviewed) is available at https://doi.org/10.31234/osf.io/tz5c4 Research Summary: the Research Summary for the previously released report (refer row 73 above) is available on the HHS website at https://hazelwoodhealthstudy.org.au/study-findings/fact-sheets-and-summaries
86. All	Nov 2021	7th Annual Report Report: "Hazelwood Health Study Annual Report 7" available at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/2834399/HHS-7th-Annual-Report-v1.0.pdf
87. Hazelinks	Dec 2021	A short commentary describing findings in regard to the association between $PM_{2.5}$ exposure and Emergency Department presentations linked to Adult Survey participants. Academic paper: Smith et al "Long-term impact of exposure to the 2014 Hazelwood coal mine fire on emergency department presentations in Australia". Published by *Environmental Research*. Freely available at https://doi.org/10.1016/j.envres.2023.115440 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2881458/Linked-emergency-dept-presentations.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
88. Early Life Follow-up	March 2022	Based on the ELF Study's round 2 clinical data, this abstract describes the association between in-utero $PM_{2.5}$ exposure and lung mechanics 7 years later. Conference proceeding: Hemstock et al "Prenatal exposure to emissions from a coalmine fire and childhood lung function." Accepted for presentation at three conferences; the Centre for Air Pollution, Energy and Health Research Symposium in May 2022 (oral presentation); the International Society for Environmental Epidemiology Asia and Western Pacific Chapter & International Society for Exposure Science in Asia Chapter in June 2022 (poster); the 34th Annual Conference of the International Society for Environmental Epidemiology in September 2022 (poster). The abstract is available at https://ehp.niehs.nih.gov/doi/abs/10.1289/isee.2022.P-0422. Formal citations not yet available. The poster is available on the HHS website at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0005/3078446/Poster_HemstockEtAl_2022_ELF-PrenatalPM-exposure_lung-function.pdf. Research Summary: NA
89. Early Life Follow-up	March 2022	An abstract describing the association between in-utero and infant $PM_{2.5}$ exposure and subsequent hospital emergency department presentations and admissions. Conference proceeding: Ziou et al "Early life exposure to coal smoke and hospital visitation: findings from a data linkage cohort study". Accepted and presented as a poster at the 2022 Annual conferences of the International Society for Environmental Epidemiology. The abstract is available at https://ehp.niehs.nih.gov/doi/abs/10.1289/isee.2022.P-0441 The poster is available on the HHS website at https://www.monash.edu/hazelwood-health-study/study-findings/presentations?a=3076583 Research Summary: NA
90. Early Life Follow-up	March 2022	An abstract describing the association between in-utero and infant $PM_{2.5}$ exposure, and subsequent primary care medical service use and prescribed medications. Conference proceeding: Ziou et al "Prenatal and early postnatal exposure to air pollution associations with primary care and prescription usage". Accepted and presented as a poster at the 2022 Annual conferences of the International Society for Environmental Epidemiology. Available at https://doi.org/10.1289/isee.2022.P-0442. The poster is available on the HHS website at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/3076589/Poster_ZiouEtAl_ISEE2022_544_PM-exposure_Primary-care_prescriptions.pdf Research Summary: NA
91. Adult Psychological Impacts	April 2022	A paper describing explore the role of Hazelwood mine fire-related posttraumatic stress, and general psychological distress, in the presentation of physical symptoms such as pain, fatigue, shortness of breath and gastrointestinal problems experienced during the 2019-2020 Black Summer bushfires. Academic paper: Gao et al "Somatic symptoms, psychological distress and trauma in response to climate disasters: lessons from the 2014 Hazelwood mine fire and 2019-20 Black Summer bushfires." Published by *BMC Public Health* in August 2023 and freely available at

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
		https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-16501-1. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/2997033/May-2022-Physical-symptoms.pdf
92. Early Life Follow-up	July 2022	A paper based on the ELF Study round 2 clinical assessments, describing the lack of an association between in utero exposure to mine fire smoke and lung function 7 years later. Academic paper: Hemstock et al (2023) "No association between in utero exposure to emissions from a coalmine fire and post-natal lung function." Published in April 2023 by *BMC Pulmonary Medicine* and freely available at www.bmcpulmmed.biomedcentral.com/articles/10.1186/s12890-023-02414-7 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/2999232/July-2022-Childhood-lung-function.pdf
93. Early Life Follow-up	Sept 2022	Abstract describing longitudinal analysis of ELF Study round 1 and 2 FOT and intima-media thickness data. Conference proceeding: Hemstock et al (2023). "The Health Impacts of Exposure to Air Pollution in Early Childhood. TO 004". Presented to the Annual Scientific Meeting for Leaders in Lung Health & Respiratory Science scheduled for 25-28th March 2023. Proceedings published by *Respirology*, 28: 28-109. www.doi.org/10.1111/resp.14459. The abstract can be viewed at https://hazelwoodhealthstudy.org.au/__data/assets/image/0017/3252113/Abstract_HemstockEtAl2023_-lung-function_TSANZ.png Research Summary: NA
94. Early Life Follow-up	Sept 2022	Manuscript describing early life exposure to mine fire smoke and associated emergency department presentations and hospital admissions. Academic paper: Ziou et al (2023). "Contrasting health outcomes following a severe smoke episode and ambient air pollution in early life: Findings from an Australian data linkage cohort study of hospital utilisation." Published in *Environmental Health Perspectives* in November 2023 and available at https://ehp.niehs.nih.gov/doi/full/10.1289/EHP12238 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0020/3110843/November-2022-Emergency-department-visits-and-hospital-admissions-among-exposed-infants.pdf
95. Respiratory Stream	Oct 2022	Abstract describing adult Respiratory Stream round 1 clinic multi breath washout results. Conference proceeding: McCrabb et al (2023) "Increased conductive ventilation heterogeneity following exposure to coal-mine fire smoke. TO 035" Presented to the *Annual Scientific Meeting for Leaders in Lung Health & Respiratory Science* scheduled for 25-28th March 2023. Proceedings published by *Respirology*, 28: 28-109. www.doi.org/10.1111/resp.14459 Research Summary: NA

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
96. Respiratory Stream	Nov 2022	Abstract describing longitudinal change in lung function based on adult Respiratory Stream round 1 and round 2 clinics. Conference proceeding: Holt et al (2023). "Change in Lung Function After Exposure to Smoke from a Mine Fire: A Clinical Follow-up" presented as a poster at the 2023 *Annual Conference of the American Thoracic Society.* Freely available at https://www.atsjournals.org/doi/abs/10.1164/ajrccm-conference.2023.207.1_MeetingAbstracts.A4366. The poster presented can be viewed at https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/3635462/Hazelwood-ATS-conference-poster-2023_v1.0-1.pdf Research Summary: NA
97. All	Nov 2022	8th Annual Report Report: "Hazelwood Health Study Annual Report 8" available at https://hazelwoodhealthstudy.org.au/study-findings/study-reports
98. Early Life Follow-up	Nov 2022	Manuscript describing results from deidentified extracts of MBS and PBS data for babies. Academic paper: Ziou et al (2023) "Primary and pharmaceutical care usage concurrent associations with a severe smoke episode and low ambient air pollution in early life". Published by *Science of the Total Environment* and freely available at https://doi.org/10.1016/j.scitotenv.2023.163580. Research Summary: https://hazelwoodhealthstudy.org.au/study-findings/fact-sheets-and-summaries
99. Adult Survey	Feb 2023	Abstract describing the association between mine fire PM and risk of COVID-19. Conference proceeding: Lane et al (2023) "Long-term risk of COVID-19 after extreme smoke exposure" presented at the European Respiratory Society (ERS) 2023 International Congress and the Australasian Epidemiological Association (AEA) 2023 Annual Scientific Meeting. Available at https://erj.ersjournals.com/content/62/suppl_67/PA3810 Research Summary: refer row 100
100. Adult Survey	March 2023	Paper describing the association between mine fire smoke exposure and vulnerability to COVID-19 infection, severity and mortality. Academic paper: Lane et al (2023) "Long term effects of extreme smoke exposure on COVID-19: A cohort study" published by *Respirology* and available at https://onlinelibrary.wiley.com/doi/abs/10.1111/resp.14591. A preprint version is also available at https://www.medrxiv.org/content/10.1101/2023.04.12.23288500v1 Research Summary: www.hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0010/3268549/2023-May-Long-Term-effect-of-smoke-on-Covid-19-Vulnerability.pdf

Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
101. Early Life Follow-up	March 2023	Paper describing the trajectory of FOT results between rounds 1 and 2 clinical data collection Academic paper: Hemstock et al (2023) "Lung function changes in children exposed to mine fire smoke in infancy" published in April 2024 by *Respirology* and available at https://doi.org/10.1111/resp.14657. Research Summary: www.hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/3268487/May-2023-Lung-function-changes-in-children-exposed-to-mine-fire-smoke-in-infancy.pdf
102. Adult Psychological Impacts	April 2023	Paper describing the trajectory of IES-R scores from round 1 (Adult Survey) to round 2 (Adult Psychological Stream Followup Survey) Academic paper: Smith et al (2023) "Sociodemographic circumstances, health, and life experience shape posttraumatic distress trajectories among individuals exposed to smoke during a large-scale coal mine fire." Published in April 2023 by the *J Traumatic Stress*. Freely available at https://doi.org/10.1002/jts.22923 Research Summary: www.hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0005/3053876/August-2022-Distress-Trajectories.pdf
103. Respiratory Stream	April 2023	Paper describing a systematic review of the literature on PM exposure and COVID-19 infections, severity and death. Academic paper: Sheppard et al (2023) "Particulate matter air pollution and COVID-19 infection, severity, and mortality: A systematic review and meta-analysis" published by *Science of The Total Environment*. Freely available at https://onlinelibrary.wiley.com/doi/10.1002/jts.22923 and https://doi.org/10.1016/j.scitotenv.2023.163272 No Research Summary released with this publication as it does not address an HHS research question.
104. Early Life Follow-up	April 2023	Abstract and paper describing allergic sensitisation in smoke exposed children. Academic paper: Ziou et al (2023) "Exposure to air pollution concentrations of various intensities in early life and allergic sensitisation later in childhood" published by *BMC Pulmonary Medicine*. Freely available at https://doi.org/10.1186/s12890-023-02815-8 Conference Proceeding: Ziou et al (2023) "Allergic sensitisation following early life exposure to the Hazelwood mine fire" presented to the Australian Public Health Conference 2023 (26-28 September 2023). Research Summary: www.hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0007/3344911/June-2023-Allergies-in-children-seven-years-after-the-mine-fire.pdf
105. Adult Respiratory Stream	May 2023	Manuscript describing ventilation heterogeneity using multibreath nitrogen washout in adults. Manuscript: McCrabb et al (2023) "Ventilation heterogeneity is increased in adults exposed to coal mine fire-related $PM_{2.5}$." Accepted by *Respirology*. Freely available at https://onlinelibrary.wiley.com/doi/full/10.1111/resp.14817. Also available on the preprint server medRXiv at www.doi.org/10.1101/2023.06.08.23291105. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0009/3452841/202

Stream		Release Date	Details of study outputs and link (if applicable) to publicly available documents
			3-MBW-The-impact-of-coal-mine-fire-smoke-on-lung-ventilation-in-adults-Results-from-the-Respiratory-Stream..pdf
106.	Adult Survey	June 2023	Abstract and paper describing longitudinal self-reported respiratory symptoms in adults, collected in 2017 and 2022, and their interaction with COVID-19. Abstract: Lane et al (2023) "Respiratory symptoms after coalmine fire and pandemic: a longitudinal analysis of the Hazelwood Health Study adult cohort" accepted for presentation at AEA 2023 and APSR 2023. AEA Abstract Book number 166 available at https://www.aea2023.com/_files/ugd/a52314_2af2498077ba4a8e8ad639a3f027ecf2.pdf Manuscript: Lane et al (2023) "Respiratory symptoms after coalmine fire and pandemic: a longitudinal analysis of the Hazelwood Health Study adult cohort". Under review with *PLOS Global Public Health* and a preprint version is freely available on medRxiv at www.medrxiv.org/content/10.1101/2023.08.23.23294510v1. Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/3403955/2023-Self-reported-respiratory-health.pdf
107.	Respiratory Stream	August 2023	Paper describing FeNo (airway inflammation) results from Round 2 of the adult Respiratory Stream. Manuscript: Kress et al (2023) "$PM_{2.5}$ from a coal mine fire has little to no long-term impact on eosinophilic airway inflammation" published by BMC Pulmonary Medicine and is freely available at https://bmcpulmmed.biomedcentral.com/articles/10.1186/s12890-024-03075-w Research Summary: one combined Research Summary for rows 107 and 108. https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/3542507/2024-February-Lung-function-in-adults-7.5-years-later-after-the-mine-fire.pdf
108.	Respiratory Stream	August 2023	Paper describing paper lung function at R2 and change in lung function since R1. Manuscript: Holt et al (2023). "Lung function may recover after exposure to smoke from a coal mine fire: cohort study" submitted in May 2024 to *BMJ Open Respiratory Research*. 17 September update: under review. A preprint is freely available on medRxiv at http://medrxiv.org/content/early/2024/07/30/2024.07.29.24311157.abstract Research Summary: one combined Research Summary for rows 107 and 108. https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/3542507/2024-February-Lung-function-in-adults-7.5-years-later-after-the-mine-fire.pdf
109.	Early Life Follow-up	Sept 2023	Paper describing vascular health in smoke-exposed young children and 3- and 7-year follow-up. Manuscript: Hemstock et al (2024). "Increased vascular stiffness in children exposed *in utero* but not children exposed postnatally to emissions from a coalmine fire" published by *Environmental Epidemiology.* Freely available at http://dx.doi.org/10.1097/EE9.0000000000000309. Research Summary: https://hazelwoodhealthstudy.org.au/study-findings/fact-sheets-and-summaries

	Stream	Release Date	Details of study outputs and link (if applicable) to publicly available documents
110.	Community Wellbeing	Nov 2023	Paper exploring the unequal mobilities of smoke and people, drawing on concepts of mobility justice and emergency mobilities to reflect on the political dimensions of uneven mobility in times of crisis. Manuscript: Duffy et al (2023). "The social justice issues of smoke im/mobilities." Published in November 2023 by the *Australian Geographer* and available at https://doi.org/10.1080/00049182.2023.2256595. Research Summary: N/A
111.	Adult Psychological Impacts and Community Wellbeing	Nov 2023	Paper investigating associations between smoke exposure, psychological distress, sociodemographic circumstances and perceptions of community wellbeing using the Community Wellbeing Index. Manuscript: Carroll et al (2024). "Predictors of residents' perspectives on the wellbeing of their community in the aftermath of a prolonged coalmine fire" Under review with *BMC Public Health*. A preprint version is freely available on PsyArXiv Preprints at https://osf.io/preprints/psyarxiv/vt56g Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/3523790/Longer-term-community-wellbeing-after-the-Hazelwood-mine-fire.pdf
112.	Community Wellbeing	Nov 2023	Paper investigating optimal communication during complex disasters with health impacts. Manuscript: Yell S et al (2023) "Learning lessons in disaster communication: From the Hazelwood mine fire to the COVID-19 pandemic." To be submitted to *Communication Research and Practice*.
113.	Cancer	Nov 2023	Paper investigating cancer incidence in the 7 years after the fire. Manuscript: Yu P et al (2023) "Is there a difference in cancer incidence after a coalmine fire?" Published by *Cancer Epidemiology* and freely available at https://doi.org/10.1016/j.canep.2024.102651 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0006/3648732/2024-Did-mine-fire-smoke-exposure-increase-rates-of-cancer-in-exposed-communities.pdf
114.	Cancer	Dec 2023	Paper investigating cancer survival to end 2019 using deidentified Victoria-wide data (excluding Melbourne). Manuscript: Lane T et al (2023) "Survival among cancer patients after coalmine fire: Analysis of registry data in regional Victoria, Australia." Under review with *Cancer Causes and Control*. A preprint version (not peer reviewed) is freely available at: https://www.medrxiv.org/content/10.1101/2024.05.19.24307600v2 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0005/3678503/2024-Research-Summary-Cancer-Survival-Time-.pdf
115.	Adult Survey	Dec 2023	Paper investigating whether diet quality moderates the adverse effects of smoke exposure on respiratory symptoms. Manuscript: Govindaraju T et al (2023) "Does diet quality moderate the long-term effects of discrete but extreme $PM_{2.5}$ exposure on respiratory symptoms? A study of the Hazelwood coalmine fire" published by *Environmental*

Stream		Release Date	Details of study outputs and link (if applicable) to publicly available documents
			Research in April 2024 and available at https://doi.org/10.1016/j.envres.2024.119014 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0008/3648707/2024-Diet-quality-and-smoke-effects-on-chronic-cough-and-phlegm-.pdf
116.	All	Nov 2023	9th Annual Report Report: "Hazelwood Health Study Annual Report 9" available at https://hazelwoodhealthstudy.org.au/study-findings/study-reports
117.	Hazelinks	Feb 2024	Paper investigating the long-term effects of the mine fire smoke on hospital and ambulance use – deidentified data extractions. Manuscript: Lane T et al (2024) "Long-term effects of a coalmine fire on hospital and ambulance use: an interrupted time series study" published by *Environmental Research*. Freely available at www.sciencedirect.com/science/article/pii/S0013935124015986. A preprint version (not peer reviewed) also available at: https://www.medrxiv.org/content/10.1101/2024.05.09.24307097v1 Research Summary: https://hazelwoodhealthstudy.org.au/__data/assets/pdf_file/0011/3648728/2024-AV-callouts-and-ED-presentations-8-years-post-mine-fire.pdf
118.	Early Life Follow-up	June 2024	Paper describing anonymous hospital emergency department presentations and hospital admissions in the 5 years post-fire, amongst young children aged up to 2 years at time of fire. Manuscript: Ziou M et al (2024) "Long-term hospital utilisation in children exposed to a severe air pollution episode in their first two years of life." Submitted to *Environmental Research*. Research Summary: https://hazelwoodhealthstudy.org.au/study-findings/fact-sheets-and-summaries
119.	Respiratory Stream	July 2024	Paper and conference abstract describing change over 3 clinical rounds in adult lung function Conference proceeding: O'Sullivan CF et al (2024) "Understanding Potential Lung Recovery from Coal Mine Fire Smoke exposure". Poster presented to the 2024 European Respiratory Society Congress. Vienna, Austria 7-11 September 2024. The poster can be viewed at www.hazelwoodhealthstudy.org.au/study-findings/presentations Manuscript: O'Sullivan et al (2024) Understanding Potential Lung Function Recovery from Coal Mine Fire Smoke - A Cohort Study. To be submitted to the European Respiratory Journal Research Summary: in preparation
120.	Psychological Impacts	August 2024	Technical report describing longitudinal psychological outcomes over three survey rounds. Technical Report: Carroll et al (2024) "Hazelwood Health Study Technical Report: 2022 Mental Health and Wellbeing Follow-up Survey. A longitudinal study of psychological health and wellbeing among adults who were living in Morwell during the 2014 Hazelwood mine fire." Awaiting DH review. Research Summary: in preparation

Appendix 4: Lay language Research Summaries

	Research Stream	Date	Topic
1	Air Quality Assessment	May 2015	Preliminary estimates of how far the mine fire smoke travelled during the mine fire event
2	Hazelinks	Sept 2016	Initial findings from the analysis of ambulance call outs during the event
3	Psychological Impacts	Nov 2016	Initial findings from the first year of data collection from the Schools Study
4	Air Quality Assessment	Feb 2017	Summary Report - Air quality modelling of smoke exposure from the Hazelwood mine fire
5	Older People	Feb 2017	Policy Brief - Policy review of the impact of the Hazelwood mine fire on older people
6	Psychological Impacts	June 2017	Schools Study - Summary of key year 1 findings
7	Hazelinks	Sept 2017	Emergency Presentations and Hospital Admissions
8	Adult Survey	Sept 2017	Comparison of Morwell to Sale
9	Hazelinks	Sept 2017	Baseline cancer incidence analysis
10	Community Wellbeing	Dec 2017	Video Summary - Social Media Analysis (link to online video)
11	Latrobe ELF Study	Jan 2018	Latrobe ELF Cohort Study Volume 1
12	Psychological Impacts	Aug 2018	Interviews with Morwell residents about their experiences of the Hazelwood coal mine fire
13	Psychological Impacts	Sept 2018	Schools Study - Impacts of the Hazelwood mine fire on students and staff from a specialist school which relocated during the smoke event
14	Psychological Impacts	Sept 2018	Schools Study - Children's perspectives on the impact of the Hazelwood mine fire and subsequent smoke event
15	Latrobe ELF Study	Oct 2018	Indicators of lung and blood vessel function three years after the fire
16	Psychological Impacts	Nov 2018	Adult psychological outcomes following the Hazelwood mine fire: A mixed methods study
17	Hazelinks	Dec 2018	Ambulance attendances during the Hazelwood mine fire

18	Latrobe ELF Study	Dec 2018	Birth outcomes using anonymous Victorian Perinatal Data Collection Records
19	Adult Survey	Jan 2019	Adult Survey: Mine fire exposure and health
20	Psychological Impacts	March 2019	Schools Study - The ongoing experiences of students following the Hazelwood mine fire
21	Latrobe ELF Study	May 2019	Exposure to mine fire smoke and the risk of pregnancy-related symptoms
22	Community Wellbeing	May 2019	Community perceptions of the impact of the Hazelwood mine fire on community wellbeing, and of the effectiveness of communication during and after the fire
23	Latrobe ELF Study	May 2019	Updated analysis of birth outcomes in the Latrobe ELF Cohort
24	Respiratory	July 2019	Lung Function and Asthma Impacts
25	Adult Survey	July 2018	Adult Survey, mine fire exposure, housing materials and self-reported respiratory health
26	Cardiovascular	Oct 2019	Factors associated with high blood pressure and its management among older Gippslanders
27	Cardiovascular	Oct 2019	Heart and blood vessel health in older adults exposed to smoke from the Hazelwood mine fire
28	Psychological Impacts	Dec 2019	Long term psychological health following the Hazelwood mine fire
29	Latrobe ELF Study	Dec 2019	Monthly diary summaries
30	Latrobe ELF Study	Dec 2019	General practitioner visits and medication use amongst young children exposed to the mine fire smoke
31	Community Wellbeing	Dec 2019	Community perceptions of the effectiveness of community rebuilding activities
32	Psychological Impacts	June 2020	The impact of a mine fire and smoke event on academic outcomes for Primary and Secondary School students
33	Hazelinks	Sept 2020	MBS and PBS Time Series - Use of health services and medications
34	Respiratory	Sept 2020	Coal mine fire smoke exposure and chronic obstruction of lung airflow in adults
35	Respiratory	Sept 2020	The impact of coal mine fire smoke on lung health in adults

36	Hazelinks	Sept 2020	Hazelwood mine fire smoke exposure and ambulance attendances in the following years
37	Hazelinks	Oct 2020	Risk of death in Morwell, the broader Latrobe Valley and surrounding smoke impacted areas during and after the Hazelwood mine fire Mortality Report Questions and Answers available here
38	Psychological Impacts	Dec 2020	The ongoing psychological health in adults six years after 2014 Hazelwood mine fire
39	Hazelinks	April 2021	Hazelwood mine fire smoke exposure and hospital admissions in the following years
40	Psychological Impacts	April 2021	Evaluating the impact of the Hazelwood mine fire event on students' educational development
41	Hazelinks	Oct 2021	Research on cancer, five years after the mine fire
42	Psychological Impacts/Hazelinks	Nov 2021	Impacts of the Hazelwood mine fire on ambulance attendances, emergency department presentations and hospital patient admissions for mental health conditions
43	Hazelinks	Feb 2022	Hazelwood mine fire smoke exposure and hospital emergency department presentations in the following years
44	Psychological Impact	May 2022	Physical symptoms, psychological distress and trauma in response to climate disasters
45	Latrobe ELF Study	July 2022	Lung function in children whose mothers were exposed to mine fire smoke during pregnancy
46	Psychological Impacts	Aug 2022	Factors shaping the pattern of distress after the 2014 Hazelwood mine fire
47	Latrobe ELF Study	Nov 2022	Emergency department visits and hospital admissions among infants following exposure to smoke from the mine fire
48	Latrobe ELF Study	Jan 2023	General practitioner visits and medications prescribed for infants following their exposure to mine fire smoke
49	Respiratory	May 2023	Long-term effects of extreme smoke exposure on vulnerability to COVID-19
50	Latrobe ELF Study	May 2023	Lung function changes in children exposed to mine fire smoke in infancy
51	Latrobe ELF Study	June 2023	Allergies in children seven years after the mine fire
52	Adult Survey	Aug 2023	Self-reported respiratory health and the COVID-19 pandemic

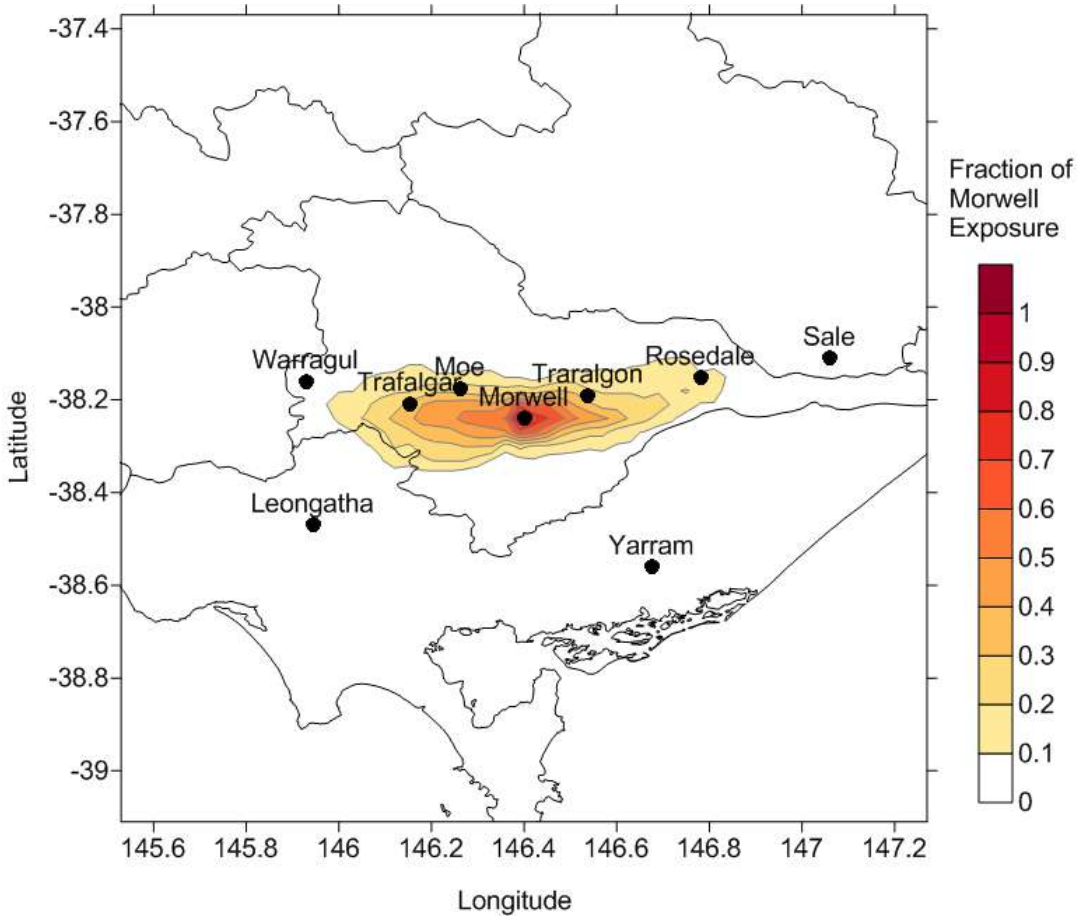
53	Latrobe ELF Study	Oct 2023	Blood vessel health in young children 7 years after the fire
54	Adult Survey	Jan 2024	Longer-term community wellbeing after the Hazelwood mine fire
55	Respiratory	Feb 2024	The impact of coal mine fire smoke on lung function in adults 7.5 years later
56	Adult Survey	April 2024	Diet quality & smoke effects on chronic cough & phlegm
57	Cancer	April 2024	Did mine fire smoke exposure increase rates of cancer in exposed communities?
58	Hazelinks	April 2024	Ambulance callouts & ED presentations 8 years post mine fire

Estimation of smoke exposure from the Hazelwood mine fire

On 9 February 2014 the Hazelwood open cut brown coal mine in the Latrobe Valley, Victoria, caught fire. This resulted in the nearby town of Morwell being covered in plumes of smoke and ash over a period of six weeks. The Latrobe Valley was exposed to the most smoke from the fire, and the smoke could be smelled for hundreds of kilometers.

Researchers from Monash University are studying the health of people living in the Latrobe Valley town of Morwell, which was closest to the fire. The study will span 10 years to see if the smoke has caused health problems. The research also needs to study people in a town nearby that only experienced a low level of smoke exposure, in order to look at the differences in health compared to Morwell.

The air quality team at CSIRO has made preliminary estimates of how the smoke travelled in the air using weather data such as wind direction, speed and temperature, and computer models. The team investigated how far the smoke travelled and how often the smoke passed over different towns in the Latrobe Valley and the broader Gippsland region for the duration of the fire.



Caption: The variation in smoke exposure (relative to the exposure experienced across Morwell) in the Latrobe Valley and beyond, as estimated by the CSIRO model.

Smoke is measured as the weight of particles smaller than 2.5 thousandths of a millimetre in size (referred to as $PM_{2.5}$). There is an advisory quality standard for these particles which is 25 micrograms (millionths of a gram) per cubic metre as a 24 hour average. Observations showed that Morwell and Traralgon experienced the highest levels of smoke. Towns such as Rosedale, Warragul, and Sale received lower levels of smoke.

Hazelwood Health Study Fact Sheet 1

Smoke exposure during the Hazelwood mine fire was associated with increased ambulance call out for respiratory and cardiac events

The Hazelwood Health Study researchers have completed some preliminary data analysis which suggests an association between Hazelwood mine fire smoke exposure and an increase in ambulance attendance for cardiac and respiratory conditions in the Latrobe Valley.

This research uses smoke exposure levels estimated by the CSIRO along with Ambulance Victoria attendance data for medical conditions which were assessed, by the paramedics, as being cardiac or respiratory-related.

The findings show that ambulance call outs for cough, asthma, heart attack and heart failure, during February and March 2014, were elevated in the areas of the Latrobe Valley with higher levels of smoke exposure.

The researchers took in to consideration ambulance attendance data from January 2011 to December 2014 to ensure that seasonal and temperature changes were not an alternative explanation for the increase in ambulance attendance during the mine fire period. Because of heightened health sensitivities during the period of the fire, the researchers concede that some people may have been more likely to call an ambulance when they might not have otherwise; however this is unlikely to explain all of the increase in ambulance attendance.

The findings, which are considered preliminary while the researchers further refine the smoke exposure models, will be presented as a poster at the International Society for Environmental Epidemiology conference in Rome, Italy on 3 September 2016. The purpose of the presentation to international experts is to facilitate early discussion and feedback about the analytical approaches employed by the researchers. Meanwhile the Study will continue to collect health information from the community.

Hazelwood Health Study Fact Sheet 2

The Hazelwood mine fire was associated with increased stress and concern in children in the Latrobe Valley

The Hazelwood Schools Study was established to explore the psychological impacts of the Hazelwood mine fire on school age children. Children in years 3, 5, 7 and 9 in all Morwell schools, and in the majority of schools across the wider Latrobe Valley, were invited to participate. Preliminary findings suggest a possible association between Hazelwood mine fire smoke exposure and an increase in stress and concern in children in the Latrobe Valley.

The findings draw on information from questionnaires and interviews completed by children from 20 schools both in Morwell and across the Latrobe Valley. Further information collected from parents, teachers and education departments is still being examined.

We interviewed 69 children and they told us how the smoke affected their health and wellbeing at the time of the event. Some children spoke about how they had breathing difficulties, were frustrated and worried, and did not sleep very well during the event. Some children were also worried about the health of other family members. They also said that finding out information about what was happening, distracting themselves and thinking in a positive way helped them to cope better.

The questionnaire assessed the longer term psychological impact of the mine fire event on the children. Questions included:

- how often the children still think about the event;
- how often they avoid reminders of the event; and
- how often are they more alert or watchful to warning signs of a similar event occurring.

On average, the 323 children in the study scored at a moderate level on these questions. Children generally answered the questions by saying that they 'rarely to sometimes' think about, avoid or are more alert or watchful about the event. The findings showed that young children (Year 3 and 5) scored significantly higher than older children (Year 7 and 9). Children from Morwell schools also showed higher scores than those from schools outside of Morwell; however, this was mostly explained by a greater number of younger children being recruited in Morwell.

The findings suggest that, whilst many children were stressed by the mine fire event at the time, most are not experiencing ongoing anxiety. However, parents who are concerned that their children might be experiencing ongoing stress or trauma should contact their General Practitioner for further assessment or support. Guidelines about how to identify stress or trauma in children are attached to this Fact Sheet.

The findings are considered preliminary while the researchers further collate information from parents, teachers and education departments. Further results will be released as they come available.

Trauma

About trauma

A traumatic event is something that threatens your life or safety, or the lives of people around you. It is an experience that is stressful and has a significant impact on your emotional state.

A traumatic event might be a natural disaster, such as a bushfire, flood or earthquake, or it might be as a result of a serious accident, a physical or sexual assault, losing someone close to you, or something else. Trauma can also be experienced across many repeated traumatic events (such as ongoing abuse, neglect or violence).

65% of Australians have experienced a traumatic event

Experiencing some trauma is common, with up to 65% of Australians experiencing a traumatic event at some stage in their lives[1]. Trauma can be especially challenging for young people as they are still learning about themselves, establishing their identity and gaining independence. Young people respond to traumatic events in many different ways and this depends on their past experiences, personality, levels of support, level of exposure to trauma and the nature of the event. Most young people will make a good recovery but a few will have longer-term problems.

Getting support soon after the traumatic experience can make a big difference to a person's recovery.

Effects of trauma

After a traumatic event it is normal for a young person to experience strong emotions and feelings. These can include:

Emotional numbness and detachment – feeling cut-off from what happened, other people, and themselves

Shock and disbelief – that the event has happened

Fear – of death or injury, being alone, not being able to cope, or the event happening again

Helplessness – feeling that they have no control

Guilt or shame – for not having stopped the event, being better off than others, not reacting in the best way or not coping well enough

Sadness – for things that have gone or been lost

Isolation – feeling that no-one understands or can help

Euphoria – joy at being alive and safe

Anger and frustration – about the event or the unfairness of the situation

Re-experiencing the event – through dreams, flashbacks or thoughts

Changes in relationships – some people may seem unsupportive or unavailable while others might seem closer than before.

Some young people may experience other physical and behavioural reactions, including:

- Headaches
- Changes in appetite and weight
- Racing heart
- Shaking or sweating
- Trouble sleeping
- Trouble concentrating
- Emotional distress, including mood swings, anxiety or a quick temper
- Difficulty with school or work
- Withdrawal from friends and family
- Difficulties with normal daily activities
- Increased risk-taking behaviour
- Increased use of alcohol and other drugs
- Avoiding situations that remind them of the traumatic experience
- Increased alertness or watchfulness.

These reactions are normal and usually begin to lessen in the days and weeks after a traumatic event.

headspace National Youth Mental Health Foundation is funded by the Australian Government Department of Health under the Youth Mental Health Initiative.

Trauma

How can family and friends provide support?

Support from the family is extremely important for young people following a traumatic experience. Most young people will recover well with the support of family, friends and their community. Being with familiar and caring people helps them to regain a sense of safety and re-establish normal routines.

To help young people through the process of recovery, there are some things that you can do:

- **Acknowledge the trauma** that they have experienced – let them know that you are there for them and are ready to listen and support them
- **Provide information** about common reactions to traumatic experiences and normalise their physical and emotional responses
- **Encourage them to spend time with family**, friends and other trusted people
- **Limit their access to media coverage of the traumatic event** – information is important, but too much can reinforce distress
- **Encourage them to re-establish their normal routines** such as meal times, sleep, work, study and relaxation
- **Join them in doing enjoyable activities**
- **Let them talk about their experience when they feel ready.** This can help them to begin to make sense of what has happened and to try to understand what it means for them and their life.

What are post-traumatic mental health problems?

Although most young people begin to recover from a traumatic experience over the weeks following the experience some will have persisting or worsening symptoms. This can increase their risk of developing mental health problems such as depression, anxiety, post-traumatic stress disorder (PTSD), or problems with substance use.

Possible signs of a mental health problem include changes in behaviour or mood, and any of the effects of trauma that:

- Persist for more than two weeks
- Worsen over time
- Affect their school, work, relationships or activities they enjoy
- Are distressing
- Lead to thoughts of harming themselves or someone else.

It has been estimated that 2-8% of adolescents will develop PTSD at some point in their lifetime[2]. If symptoms of trauma are left untreated they can have a significant effect on a young person's social, emotional, behavioural and physical development. Getting help early can reduce the likely effect of mental health problems on their life and improve the chances of a full recovery.

Supporting young people to seek help

Supporting a young person to find a health professional such as a general practitioner (GP) or counsellor who they trust and feel comfortable with is important. If they've had a positive experience with a family GP or another health professional in the past it might be helpful to encourage them to contact them again. You could also support them to contact your local community health centre or **headspace** centre. Psychological treatments, such as cognitive-behavioural therapy (CBT), can help young people who have symptoms of PTSD.

Supporting someone who has been through trauma can be a very difficult experience so be sure to get the support you need as well.

headspace
National Youth Mental Health Foundation

For more information, to find your nearest headspace centre or for online and telephone support, visit headspace.org.au

References: [1]Creamer et al. (2001), Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being, Psychological Medicine, 2001; 31 (7):1237-1247. https://digital.library.adelaide.edu.au/dspace/bitstream/2440/6593/1/hdl6593.pdf. [2] Merikangas et al. (2010), Lifetime Prevalence of Mental Disorders in US Adolescents: Results from the National Comorbidity Study-Adolescent Supplement (NCS-A), J Am Acad Child Adolesc Psychiatry. 2010 Oct; 49(10): 980–989. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2946114/

Summary Report - Air quality modelling of smoke exposure from the Hazelwood mine fire

On 9 February 2014, a disused section of the Hazelwood open-cut brown coal mine in the Latrobe Valley caught fire resulting in the nearby town of Morwell being covered in plumes of smoke and ash over a period of six weeks. Although the plumes travelled large distances, the Latrobe Valley experienced the largest smoke levels due to the fire.

To complement air quality measures that were made during the mine fire, but were not made in Morwell when the fire first started, the air quality team at CSIRO has conducted an air quality modelling study of the mine fire. To assess the air quality impacts on nearby communities, concentrations of two major pollutants from the fire were estimated, namely particles smaller than 2.5 thousandths of a millimetre ($PM_{2.5}$) and carbon monoxide (CO). The team used weather information such as wind direction, wind speed and temperature, combined with an estimate of how much coal was burned each day during the fire using fire activity maps provided by the Country Fire Authority. Air quality measurements made by the Environmental Protection Authority (EPA) Victoria near the fire location were used to calculate the amount of $PM_{2.5}$ and CO released per unit mass of burning coal. All this information was put into computer models to predict the levels of $PM_{2.5}$ and CO in the Latrobe Valley for the duration of the fire.

Two types of air quality models were used: The first model used a very high area resolution (100 to 300 m, which is about street level size) to estimate the air quality impacts in the vicinity of the fire, such as within the towns of Morwell and Traralgon. The second, larger-scale model used a much lower area resolution (3 km, which is about small town sized) and covered the whole of eastern Victoria, estimating air quality impacts for towns located hundreds of kilometers from the mine fire.

The high-resolution modelling showed that the hourly averaged concentration of $PM_{2.5}$ in southern Morwell reached as high as 3700 micrograms (millionths of a gram) per cubic metre of air during the early period of the fire (see Figure 1). The concentrations of $PM_{2.5}$ returned to usual levels of about 6 micrograms per cubic metre in the Latrobe Valley by March 12th. Modelled peak hourly concentrations of CO reached 60 parts in one million, with usual levels being about 0.07 parts in one million. The modelled concentrations were compared with measured data and found to be similar (Figure 1). Note that no measurements were made during the first few days of the fire, when some of the largest concentrations were predicted by the model.

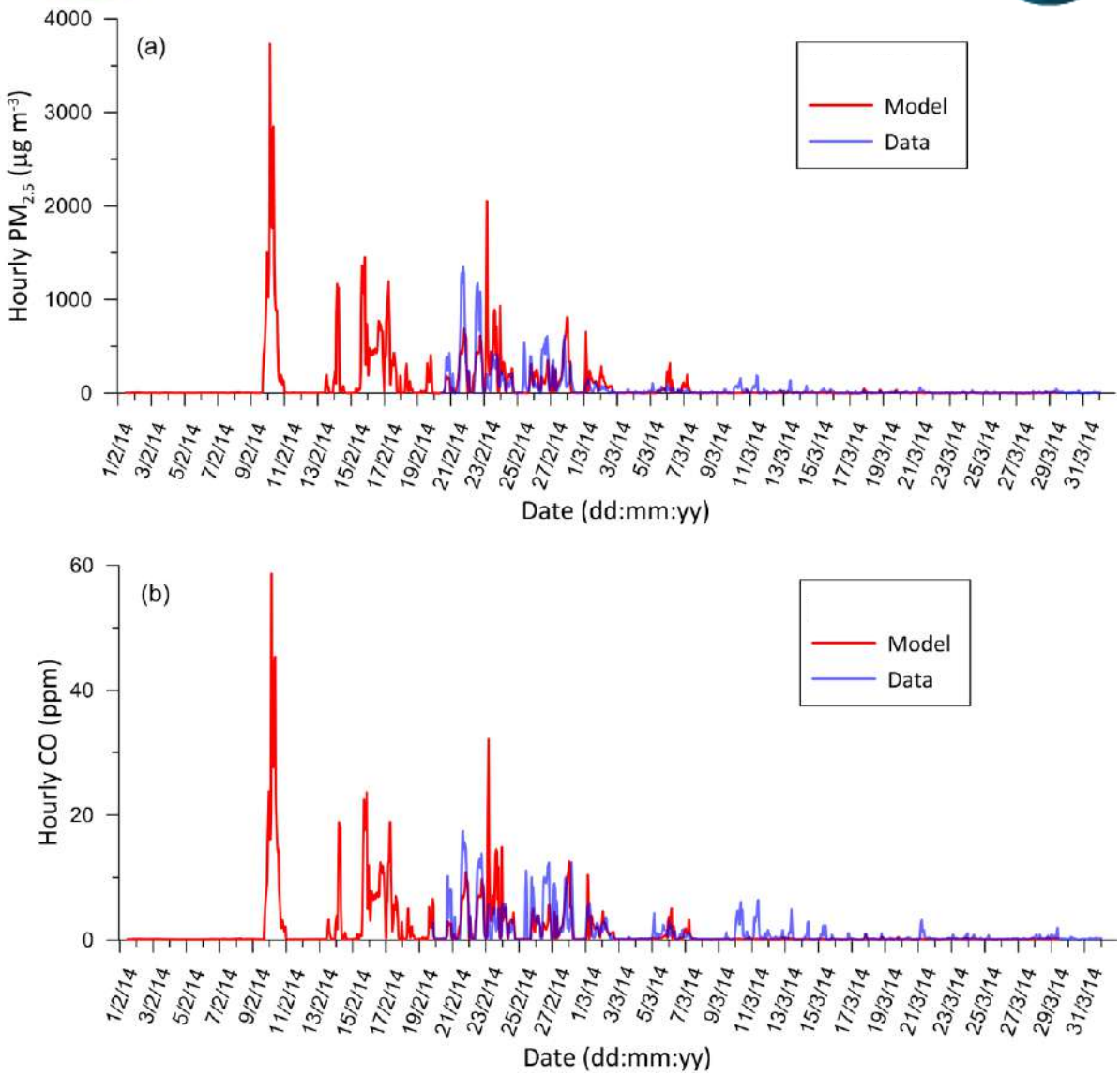


Figure 1 Hourly-averaged observed and modelled concentrations of (a) $PM_{2.5}$ and (b) CO at southern Morwell. Output from the fine-scale modelling used. No observations (or data) were available for the early period of the fire.

In Australia, the outdoor air quality standards (National Environment Protection Measures) for $PM_{2.5}$ particles are 25 micrograms per cubic metre as a 24-hour average and, for CO, nine parts in one million as an eight hour average. The modelling showed that Morwell residents were exposed to the greatest number of exceedances of the $PM_{2.5}$ standard, with 23 days at southern Morwell and 12 days at eastern Morwell when $PM_{2.5}$ was above the standard during the 45 days the fire burned. There were five days above the $PM_{2.5}$ standard at Traralgon. The standard for CO was exceeded seven times at southern Morwell.

Elsewhere in the Latrobe Valley, $PM_{2.5}$ concentrations decreased rapidly as the smoke plumes dispersed in the atmosphere. The large-scale modelling showed that there were three days above the 24 hour $PM_{2.5}$ air quality standard at Churchill and two days above the standard at Moe (Figure 2 shows a distribution of the modelled number of exceedances). There were no exceedances of the CO outdoor air quality standard outside of Morwell.

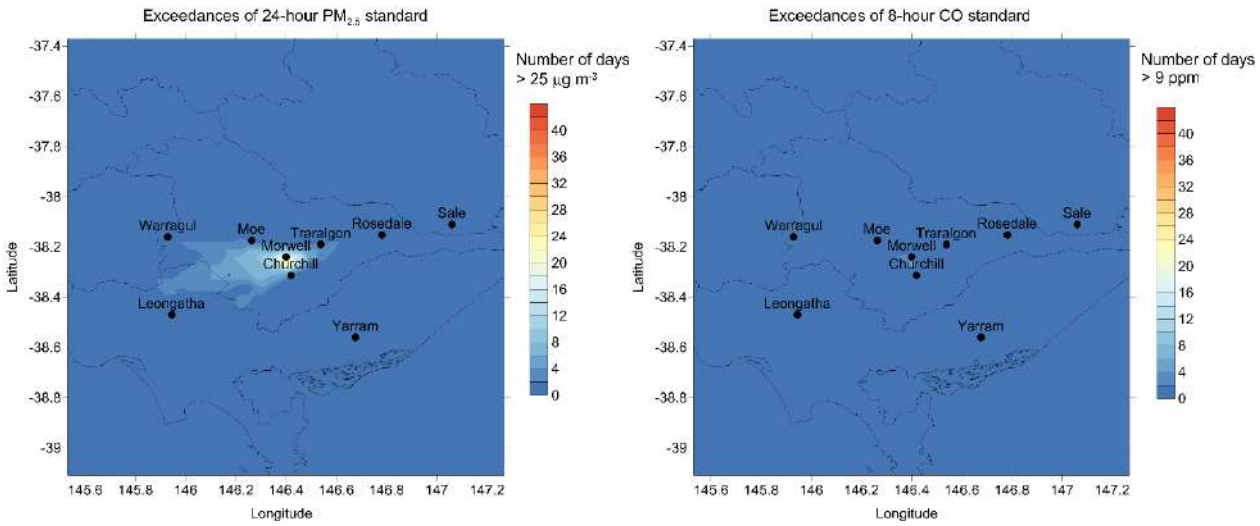


Figure 2 Distribution of the number of days (out of a possible 45) when the outdoor air quality standards (National Environment Protection Measures) for $PM_{2.5}$ (left) and CO (right) were exceeded, based on the larger-scale modelling.

The lower resolution Victoria wide model predicted low concentrations of $PM_{2.5}$ and CO for the population at Sale. Residents in Sale have been chosen as the control population for the Hazelwood Health Study Adult Survey. The peak hourly averaged $PM_{2.5}$ concentration predicted at Sale was 17 micrograms per cubic metre on 10th February, whilst peak CO was 0.46 parts in one million on 22nd February. No exceedances of either air quality standard were predicted by the model for Sale during the mine fire.

Policy Brief

Hazelwood Health Study 27/02/2017

Policy review of the impact of the Hazelwood mine fire on older people: Final Report

Judi Walker, Matthew Carroll, Marita Chisholm

The review explored the impact of the 45-day Hazelwood mine fire event in 2014 on older people living in the Morwell community in the context of policy-driven decisions made at the time.

It was apparent from the research that the voices of older people, especially those usually robust older people living independently in the community, were paid little attention during the event. While service providers, with the support of the Victorian Department of Health and other agencies, worked hard to ensure that older clients were well supported, there was little support for older people who were not receiving health and community services.

While there are numerous publications which identify older people as being beyond a certain age cut-off, there is no universally accepted definition with age limits primarily used for the purposes of statistical reporting and service eligibility. Given that this research is assessing the experiences of older people, we thought it inappropriate to invoke an arbitrary age limit, and instead involved people who identified themselves as being older.

Engagement with the community and with sections like the older cohort, focused on providing information through data sheets and alerts rather than two-way engagement. This led to confusion and mixed messaging. It also undermined the trust placed on the government by older residents and the broader community, making it hard for them to see how much good work was being done on their behalf. The apparent mismatch between existing policies and the extended and dynamic nature of the Hazelwood smoke event prompted the development of policy on the run. This was a matter of considerable concern and further eroded the trust of the community in the Department of Health and other agencies.

WHAT DID WE DO?

We were able to gain an understanding of older residents' experiences of the smoke event and the efforts put in place to support them using a mix of research methodologies. We combined the findings from focus groups held with over 90 local older people and community members and interviews with 17 local decision-makers and representatives of services which supported older people during the smoke event, with reviews of relevant literature and various government policies.

This brought together a considerable body of knowledge from data gathered over 13 months with conclusions drawn verified in a workshop with key respondents.

This review has important implications for stakeholders, best practice policy development and program planning to improve preparations for and responding to a future disaster event.

Key considerations for policy development and program planning

The recurring issue arising throughout the research process, culminating in the verification workshop with key community and organizational participants, was the requirement to listen to and include the voices of older people.

The criticality of who is delivering the message

- Guarantee consistency among spokespersons - respondents felt that there were too many voices, and that the various spokespersons were rostered on a rotating basis and so had no chance to build local knowledge and engagement.
- Appoint spokespersons who are seen to be part of the event – so either use a local person (much preferred) or if an external person then they need to be seen as staying in/with the community.
- Respond to the clear preference for local government to take the communications lead – the older community looks to their local council.
- Provide age-relevant spokespersons – a 20 year old carries little weight with the older cohort; include older people or known senior health professionals as support speakers.
- Make use of existing community groups involving older people to seek advice from and to disseminate information.

The criticality of how the message is delivered

- Ensure that roles and responsibilities amongst and between agencies involved are known and understood in order to reduce anxiety and confusion among the elderly.
- Avoid presenting the elderly in an unfairly negative light.
- Engage with the older community – two way conversations showing empathy and understanding rather than talking to a leaflet and citing previous reports.
- Provide information that is comprehensible and do-able.
- Avoid conflicting communications and mis-information.
- Provide simple and helpful emergency information via social media from a clearly-identified trusted source.
- Avoid leaving an emergency information vacuum which may be filled by less-informed respondents.

The criticality of who is being targeted

- Demonstrate awareness of all the vulnerabilities of older people and how they play out together - e.g. focus on people with chronic conditions, mobility limitations and limited social networks rather than targeting older people as a group.
- Demonstrate awareness of the needs of the 'robust elderly' who do not receive health and community services and so may be in greater need during an emergency event where normal routines and services are disrupted.

The criticality of communication with older people to build and maintain confidence and trust

- Actively communicate what has changed, the protocols in place, changes in agency structure, relevant new policies and procedures, mitigation and prevention strategies.
- Make use of existing community groups involving older people to disseminate information.
- Make use of disaster management exercises to involve agency personnel and community volunteers and engage with local media.

These policy considerations are based on the conclusions drawn from the review. A summary is provided below. A full copy of the Report can be downloaded from the study website http://hazelwoodhealthstudy.org.au/

Summary of the Review's key conclusions

The impact of the Hazelwood mine fire event on older people

Our discussions with older residents showed that there was **considerable diversity in terms of the impacts of the smoke event**, with many older residents reporting a wide array of physical and psychological symptoms at the time, and some reporting ongoing symptoms as well as concerns about long-term health impacts. Conversely, other older residents reported being minimally impacted by the smoke event and that it was no worse than previous smoke exposures. The diverse range of responses may be because we talked with an array of groups and included older people who were not receiving health and social services and who received little or no support during the smoke event. Discussions with service providers tended to reinforce the stoic and robust nature of older residents. It may be that these observations were because service providers were largely consulting with those receiving their services, who would have felt confident that help was available should the need arise.

The impact of policy-driven decisions made at the time on older people

There was almost universal agreement that the Hazelwood smoke event was **a unique occurrence** which was beyond the scope of existing policies that had been developed for bushfires and other emergencies. One of the challenges faced by the Department of Health and other agencies during the smoke event was the **lack of a strong evidence base regarding the impacts of coalmine fire smoke events**, including impacts on sub-groups such as older people. The lack of evidence on the short and long-term impacts of exposure to coal mine fire smoke hampered the public health response to the mine fire event.

A number of respondents from the general community and from service provider representatives felt that the community should have been evacuated early into the event, However, our review of the literature made it clear that the decision to evacuate or temporarily relocate a community or sub-sets of that community is incredibly challenging, especially for frail older people with chronic health conditions. So the Department of Health faced a difficult situation, having to weigh the concerns of the community against the risks of a major community relocation effort in the absence of clear evidence.

There was a clear thread through the community, service provider and decision maker discussions regarding the mismatch between existing emergency policies and the extended, dynamic and uncertain nature of the Hazelwood mine fire event. The development of **policy on the run** and the resultant **change in health advice** to older people and other at-risk groups to temporarily relocate, coming as late as it did in the event period, was a source of annoyance for some older residents.

In addition to developing new policies and protocols, there were issues in the way in which existing policies interacted, such as the Municipal Emergency Management Plans (MEMPlans). In the case of a major event such as the Hazelwood mine fire, these MEMPlans are overridden by the state level plan, relegating local council to a minimal but supportive role. This approach may be suitable when responding to short sharp disaster events such as bushfire, allowing councils to take a more active role once the emergency has passed. However, in the current example of an extended duration event which was impacting a community this approach resulted in clear issues.

The impact of the jumbled roles of emergency personnel and agencies on older people

One of the 'unique' challenges of the Hazelwood event was the extended duration. The emergency response continued over a 45-day period, with the public focus shifting from the response to a complex of fires which initially directly threatened the Morwell community to an ongoing fire largely restricted to the mine site and threatening state electricity supplies, and to a long term emerging smoke health threat. These shifts, coupled with the fact that multiple agencies were involved (including emergency, environmental, health, local and state government) and that **their roles changed** in line with the changes in the response focus, clearly created issues with the response and the engagement of the local community and the subsequent impact on older people.

The increasing focus on the impacts of the smoke event on the health of the community saw the event change from being a fire event under the control of the Country Fire Authority to a public health event under the control of the Department of Health. The command structures of these two bodies vary considerably. These differences, combined with the fact that the fire event continued at the same time as the smoke event, led to some **role confusion and mixed messaging**. Roles were blurred rather than distinct. One of the most obvious manifestations of this role confusion was the breakdown in communication which occurred during the smoke event, and lead to older residents reporting having less trust in the emergency response and in the people and organizations at the centre of that response.

The impact of communications during the event on older people

It was clear from the findings of the Hazelwood Mine Fire Inquiry (convened in 2014 and again in 2015-2016) and from the feedback of older residents that there were **challenges engaging with older people and the broader community**. Communication was not well coordinated, at points it appeared contradictory. Older community members in particular found it hard to comprehend, and many older people not in residential care or not receiving services, felt disengaged and ignored.

One policy issue which became apparent in the response to the Hazelwood mine fire was **when and how to target older people in the response, including which groups to target**. The focus during the event on older people appeared to be targeted on those people in residential care settings and on those in receipt of services – those perceived as most vulnerable. This was entirely appropriate. Our review of the literature made it clear that it is important to consider the needs of other older people living in the community who may be more at risk than more frail older people who receive regular support and therefore are being monitored. This was backed up in discussions with older residents, who reported suffering from physical health symptoms or being unable to access supports to get respite from the smoke or to clean their properties. How to access the broader group of older people living in the community was highlighted in the literature as being very challenging. Instead of trying to identify lists of people to be individually targeted, a more successful approach could be to increase engagement activities with the different sectors of the community, including older residents.

In addition to engaging the community in a two-way conversation the **messages being shared with older people and the broader community should be appropriate and do-able**. While the Department of Health was advising residents to seek respite away from the smoke, including the later message for 'at risk' groups to temporarily relocate, it was apparent from our discussions that the capacity to relocate was closely associated with a number of other factors including access to alternative accommodation, social networks, transport, and sufficient funds.

A full copy of the Report can be downloaded from the study website http://hazelwoodhealthstudy.org.au/

Schools Study: Summary of key year 1 findings

Hazelwood Health Study 27/06/2017

Professor Darryl Maybery, Dr Matthew Carroll, Dr Emily Berger, Sarah Lee and Professor Alexander McFarlane

Background: Bushfires which threatened the town of Morwell resulted in the Hazelwood mine fire which blanketed Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. This was one of the most significant air pollution incidents in Victoria's history, with the concentrations of smoke contaminants reaching high levels.

The Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire in response to community concerns. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups. This summary report is from the Psychological Impacts research stream and focuses on work examining the impact of the mine fire on the wellbeing of primary and secondary school-aged children (known as the Schools Study). This summary provides key findings from the analysis of survey data, interviews with children and NAPLAN results.

Key findings from the student surveys:

The survey identified a range of symptoms of distress associated with the mine fire. Whilst the majority of students reported little or no symptoms, approximately one quarter reported increased levels of distress. It is important to note that factors other than the mine fire could have contributed to this distress.

Across all grade levels, Morwell children tended to have higher distress scores than those from outside Morwell, but this was affected by age, with primary students scoring more highly than secondary students.

A review of previous studies revealed that the level of impact on Morwell children was similar to that seen in other events, especially non-lethal events near communities not directly affected by a major disaster.

Key findings from the interviews with children:

The discussions with the children focused on their experiences at the time of the fire and whether they were experiencing any ongoing concerns. In line with the survey results, there was a range in the reported impacts of the smoke. Many reported few, if any, impacts and some reported positive outcomes, including more school excursions and opportunities to connect with children from other schools.

There were however, a considerable number of children reporting negative outcomes. With regards to their experiences at the time, they indicated that they:

- had a very negative experience of the smoke;
- made attempts to avoid the smoke, including some families & entire schools relocating during the event;
- experienced increased stress and worry about family and friends;
- felt an impact on their physical health/illness (e.g. asthma, colds and chest pain);
- highlighted the importance of support that they received;
- were influenced by the way adults (i.e. parents and teachers) responded to and coped with the event; and
- provided suggestions on what could be done if there was a future event.

With regards to ongoing impacts, some children reported disturbing recall of the fire and smoke 18 months after the event, along with experiencing higher stress and worry with these memories. In addition, some children reported trying to avoid thinking about the smoke.

Key findings on NAPLAN data comparing Morwell to non-Morwell students

As a group, Morwell children's NAPLAN scores increased following the smoke event (i.e. between the 2013 and 2015 NAPLAN rounds) significantly more than scores for non-Morwell children. This effect was likely to be due to Morwell students working up from lower scores in 2013, as well as other factors. When age, gender, and school type (i.e. government versus non-government) were considered, the differences between Morwell and non-Morwell students largely disappeared. The take-home message here is that Morwell students did not show any decline in NAPLAN scores from 2013 to 2015 as a result of the mine fire.

What we did: We recruited 20 local schools, including 8 in Morwell and another 12 elsewhere in Latrobe City. Students were recruited from Grades 5, 7, and 9, in line with the Grades who completed NAPLAN in 2015. There were 323 children in the first year of the study (126 from Morwell and 197 non-Morwell). The children ranged from 8 to 16 years of age, with 167 (52%) girls. Participation was higher in the younger children, with 113 in Grade 3, 90 in Grade 5, 84 in Grade 7 and 36 from Grade 9. In order to better understand the short and long term impacts of the smoke on a subgroup of children, 69 students were interviewed.

Schools Study Aims

1. Was exposure to the smoke associated with greater distress among children in Morwell compared to those in schools elsewhere in Latrobe City?
2. Were there other factors which may have altered the impact of the smoke on children?
3. What were the impacts of the smoke on children's educational outcomes including NAPLAN scores?

Other considerations / need for further research

The local context needs to be taken into consideration when interpreting these findings. The 2014 Hazelwood Mine Fire Inquiry report noted that the mine fire impacted on an already disadvantaged community. The power industry has played a pivotal role in the community, leading up to the Hazelwood mine fire, and more recently, the closure of the power station and mine.

These findings represent the start of an ongoing research program, with further research needed to explore the current findings and to provide ongoing tracking of the wellbeing of these children and the broader community over time.

Further information

A more detailed report is being prepared and will be made available on the study website at http://hazelwoodhealthstudy.org.au/study-reports/

Hazelwood HEALTH STUDY

Emergency Presentations and Hospital Admissions **Research Summary**

September 2017

Meet the team

Martine Dennekamp
Lahn Straney
Christina Dimitriadis
Caroline Gao
Yuming Guo
Michael Abramson

Analysis aims

The aim of this analysis was to examine whether coal mine fire-related pollutants were associated with increased risks of emergency presentations or hospital admissions for cardiovascular and respiratory diseases.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

This analysis examined the impacts of the 2014 Hazelwood mine fire on emergency presentations and hospital admission in the Latrobe Valley and surrounding areas. We found that most fire-impacted areas had higher rates of emergency presentations and hospital admissions during the coal mine fire period (9 February 2014 to 10 March 2014) compared with the broader period from January 2009 to June 2015.

We found that the rates of emergency presentations and hospital admissions for asthma and Chronic Obstructive Pulmonary Disease (COPD) and all respiratory diseases were higher during the Hazelwood mine fire period, in comparison with the non-fire periods (30 days before and 30 days after the fire). However, there was no evidence of increased rates for cardiovascular disease. Coal mine fire-related pollutants were associated with emergency presentations for asthma and COPD after 6 days' exposure and for all respiratory diseases after 5 days' exposure.

Attributable to the coal mine fire-related pollutants, there were estimated to be 14 emergency presentations for asthma and COPD, 22 emergency presentations for 'all' respiratory diseases and 132 for 'all' conditions included in the analysis. Of this number, Morwell residents counted for 9 emergency presentations for asthma and COPD, 14 for respiratory diseases and 83 for all conditions.

A full report describing the findings from this analysis can be found at hazelwoodhealthstudy.org.au/study-findings/study-reports

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Emergency Presentations and Hospital Admissions **Research Summary**

August 2017

What we did

Researchers first collected emergency presentations, hospital admissions, air pollution and temperature data to be used in the analysis.

Data relating to hospital emergency presentations and hospital admissions were both obtained from the Department of Health and Human Services. Daily data were obtained for the period 1 January 2009 to 30 June 2015. These data were de-identified so that it was not possible to recognise which person the information was connected with.

Air pollution estimates were based on level of particulate matter in the air measuring less than 2.5 thousandths of a millimetre in diameter ($PM_{2.5}$). These were modelled by the Commonwealth Scientific and Industrial Research Organisation for the areas impacted by the mine fire smoke. Daily maximum temperatures were collected from the Australian Bureau of Meteorology.

A statistical method called *time series analysis* was used to measure the association between daily air pollution levels and emergency presentations and hospital admissions, while taking into account the influences of other contributing factors such as season and temperature.

Considerations

This analysis only investigated the impact of coal mine fire-related $PM_{2.5}$ and did not include other criteria pollutants (e.g. carbon monoxide, ozone, nitrogen dioxide, sulphur dioxide). Future work will assess the impacts of other air pollutants.

While the findings suggest an increase in hospital presentations or admissions associated with the mine fire smoke, the data is not sufficient to link any individual case to the mine fire.

Where to from here

Further analysis will be conducted later this year to examine the effects of coal mine fire-related $PM_{2.5}$ on ambulance call-outs, medical services and dispensing of medications, and to assess the effects of other air pollutants, particularly carbon monoxide on health outcomes.

HHS results will be shared with relevant organisations to ensure that findings are used to shape services for the future health of the Latrobe Valley.

This research was funded by the Victorian Department of Health and Human Services.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Adult Survey Comparison of Morwell to Sale
Research Summary

September 2017

Meet the team

Professor Michael Abramson
Dr Jillian Blackman
Dr Matthew Carroll
Ms Christina Dimitriadis
Mr Anthony Del Monaco
Dr Martine Dennekamp
Ms Susan Denny
Dr Caroline Gao
Professor Darryl Maybery
Professor Judi Walker

Analysis aims

The analysis aimed to assess whether Morwell adults, who were heavily exposed to smoke from the Hazelwood mine fire, report more adverse cardiovascular, respiratory or psychological symptoms compared to Sale adults, who were minimally exposed.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we did

To be included in the Adult Survey, people had to be aged 18 or older at the time of the mine fire, and lived in Morwell or in one of 16 selected areas in Sale.

Contact details were drawn from the Victorian electoral roll. The roll identified 9448 residents of Morwell and 4444 from Sale. Residents were offered the option of completing the survey in one of three ways: by telephone interview, online or paper questionnaire. Recruitment began in May 2016 and concluded in February 2017.

Many methods were used in an attempt to contact and recruit eligible residents from Morwell and Sale, including mailed-out invitation packs, phone, media engagement, public events, and road-side banners.

Community Champions were also enlisted to help promote the Adult Survey to residents using their established networks.

In total, 3096 (33%) Morwell residents and 960 (23%) Sale residents participated in the survey. To assess whether the Adult Survey participants were representative of the wider populations from which they were drawn, we compared them with population data available from the Australian Bureau of Statistics.

This research was funded by the Victorian Department of Health and Human Services.

Hazelwood HEALTH STUDY

What we found

The occurrence of most self-reported, doctor diagnosed medical conditions was similar in Morwell and Sale prior to the Hazelwood mine fire. Exceptions were high cholesterol and angina, which were slightly higher in Morwell, and arrhythmia (irregular heart rhythm) which was slightly lower.

Self-reported doctor diagnosed asthma, since the mine fire, and current respiratory symptoms were all more common among Morwell participants compared with Sale. Among asthmatics, symptoms were reported to be more severe in Morwell compared to Sale. Chest and nose irritation, consistent with chronic bronchitis and rhinitis, was also more commonly reported by Morwell participants.

Morwell participants were one and a half times more likely than Sale participants, to report that a doctor had diagnosed them with high blood pressure since the mine fire (6.6% in Morwell compared to 4.5% in Sale). Morwell participants were also seven times more likely to report that a doctor had diagnosed them with a heart attack since the mine fire. However, heart attack was reported by 1% of Morwell participants and only 0.1% of Sale participants, and findings based upon such small numbers should be interpreted with caution.

While there were no significant differences, prior to the mine fire, in self-reported history of stressful life events and mental health diagnoses, Morwell participants were more likely to report symptoms of distress following the event. They were also four times more likely to report that a doctor had diagnosed them with Post Traumatic Stress Disorder (PTSD). As with heart attack, however, the increased risk in PTSD was based on small numbers (1.4% in Morwell) and should also be interpreted with caution.

Considerations

An important strength of the Adult Survey was the inclusion of a comparison group of adults, from selected areas of Sale, who provided an important benchmark against which the health of the Morwell participants could be compared.

However, because a relatively large proportion of adults from Morwell and Sale did not participate, it is possible that the findings do not truly reflect the two communities. The reliance on self-reported health data only, also limits interpretation of these findings.

Where to from here

These findings represent just the first step in the analysis of the Adult Survey data, providing only broad group differences between Morwell and Sale based on self-reported data.

A second volume of Adult Survey findings, analysing the association between mine fire smoke exposure and health outcomes in Morwell residents will be released in late 2017.

The clinic-based Cardiovascular and Respiratory streams of the HHS, and also linkage to health datasets such as those maintained by ambulance and hospital services, will complement the self-reported Adult Survey data by adding objectively collected health information.

HHS results will be shared with relevant organisations to ensure that findings are used to shape services for the future health of the Latrobe Valley.

A detailed report on this research can be found at
www.hazelwoodhealthstudy.org.au/study-findings/study-reports/

Hazelwood HEALTH STUDY

Baseline Cancer Incidence Analysis **Research Summary**

September 2017

Meet the team

Professor Malcolm Sim
Christina Dimitriadis
Dr Caroline Gao
Anthony Del Monaco

The analysis aims

The aim of this analysis was to provide information on cancer patterns in Latrobe City and surrounding areas prior to the Hazelwood Mine fire in 2014.

Understanding the baseline, or pre-mine fire, rates of cancers in these areas will be important when interpreting the rates of cancer that occur after the mine fire.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

Results showed the overall numbers of baseline, pre-mine fire, cancers in Latrobe City and combined surrounding areas (Baw Baw, Gippsland-South West, and Wellington) to be similar to the expected number of overall cancers in the rural and regional Victorian population.

A higher rate of mesothelioma was observed in males in Latrobe City when compared to the expected rate in the rural and regional Victorian population. The excess of mesothelioma is most likely due to past asbestos exposure, as this is the only known cause of mesothelioma found in Australia. This may relate to past asbestos exposure in the power industry or other worksites in the region or domestic exposure due to asbestos-containing building materials.

For males, the observed number of bladder cancers was also higher than expected in Latrobe City.

For females in Latrobe City, an excess of liver, lung and overall blood cancers was observed. The number of cancers in the surrounding areas were similar to those expected in the rural and regional Victorian population for the main cancer groups.

Given the many analyses done for this report some results may be a chance finding. However future analyses of linked cancer data will assist in determining the validity of the current findings.

A full report describing the findings from this analysis can be found at hazelwoodhealthstudy.org.au/study-findings/study-reports

What we did

A data extract from the Victorian Cancer Registry for the period 1 January 2009 to 31 December 2013 was analysed. Analysis included Latrobe City (main exposure area), as well as the surrounding areas of Baw Baw, Gippsland-South West and Wellington combined. The three areas surrounding Latrobe City have been shown to include areas which had some exposure during the fire and therefore were included in analysis (combined). The date range and geographical boundaries of the analysis were selected to capture cancer rates in Latrobe City and surrounding areas before the fire period.

The analysis compared the number of recorded cancers (for the main types of cancers) in Latrobe City and combined surrounding areas with the number of cancers that would be expected in the Victorian rural and regional population (based on rural and regional counts by age group and sex).

This research was funded by the Victorian Department of Health and Human Services.

Considerations

As cancer reporting in Victoria became mandatory in 1982, the Victorian Cancer Registry data used in the analysis are very complete for the relevant years, which is a strength of this analysis.

One limitation is that risk factor information was not available to further investigate possible causes of the excess cancers observed. A further limitation is that only Victorian cancer data were included in this analysis, so that cancers occurring in Latrobe City residents who later moved interstate and had their cancer diagnosed there would not be identified.

Where to from here

This first analysis of Victorian Cancer Registry data provides an overview of cancer rates in Latrobe City and surrounding areas prior to the Hazelwood Mine fire in 2014. Because many cancers are slow to develop, it is anticipated that analyses of post mine-fire cancer rates, in the Latrobe City and surrounding areas, will take place in 2018 and again in 2023. Undertaking those analysis at earlier dates is unlikely to yield meaningful findings.

HHS results will be shared with relevant organisations to ensure that findings are used to shape services for the future health of the Latrobe Valley.

Hazelwood HEALTH STUDY

The Latrobe Early Life Follow-up Cohort Study Vol 1 **Research Summary**

February 2018

Analysis aims

We aimed to find out if some pregnancy or birth outcomes in children from the Latrobe Valley were affected by exposure to smoke from the mine fire.

Meet the team

Fay Johnston
Shannon Melody
Marita Dalton
Amanda Wheeler
Tierney O'Sullivan
Grant Williamson
Martine Dennekamp
Shyamali Dharmage
Karen Wills
Melanie Reeves
Jane Ford
Alison Venn
Christine Roberts

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, The University of Adelaide and the CSIRO.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

Of the 548 children included in the study, 199 were born to mothers who were pregnant at the time of the fire and 190 were aged less than 2 years at the time of the fire. The remainder were not exposed to fire-smoke either before or after their birth. Most parents (74% of mothers and 59% of fathers) reported that their stress increased in response to the mine fire, especially those living closest to the fire. We did not find an association between mothers' exposure to smoke from the mine fire and birth before full term (37 weeks), birth weight at term, or weight for stage of pregnancy. The analysis took into account the possible influence of risk factors like age of mothers, and smoking during pregnancy.

A full report describing the findings from this analysis can be found at hazelwoodhealthstudy.org.au/study-findings/study-reports

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

We surveyed the parents of a sample children from the Latrobe Valley who were born between 1 March 2012 and 31 December 2015. This period included the coal mine fire in February 2014. We estimated how much smoke each child may have been exposed to by matching their home address with the daily estimated amount of air pollution in that area. We asked the parents to tell us about their own age, education, smoking status and other things that can affect birth outcomes. We also asked the parents to tell us at how many weeks their child was born and their child's weight at birth. We used standard statistical tests to look for possible associations between smoke exposure and birth outcomes.

This research was led by the Menzies Institute for Medical Research at the University of Tasmania and funded by the Victorian Department of Health and Human Services.

Considerations

These initial results are reassuring. If there was an impact on birth outcomes, the size of that impact was not big enough to be detected in this study. However, this study was relatively small. Small studies cannot always identify very small associations that might be present.

Where to from here

The next step is to do a larger study of hospital records for babies born in the Latrobe Valley. This will cover the same time-period as our survey. Looking at hospital records will enable us to research a wider range of birth related outcomes, and include a larger number of births.

HHS results will be shared with relevant organisations to ensure that findings are used to shape services for the future health of the Latrobe Valley.

Hazelwood HEALTH STUDY

Interviews with Morwell residents about their experiences of the Hazelwood coal mine fire

Research Summary

August 2018

Analysis aims

This study examines the perspectives of Morwell residents regarding the impact of the fire. Of particular interest were the social and psychological impacts of the event which was of both long duration and of anthropogenic (man-made) origin.

Meet the team

Dr Rebecca Jones

Ms Sarah Lee

Prof Darryl Maybery

Prof Alexander McFarlane

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

There were a range of reactions to the fire from those without a great deal of concern to those who were very preoccupied in an ongoing manner about what happened. The Morwell residents with greatest distress focused their concerns upon fear and confusion during the event, the perceived health effects of the smoke, anger towards authorities and loss of a sense of community and security. One of the significant ways in which people managed these responses was to normalise the event. The long duration and man-made origin of the event created deep uncertainty which exaggerated the impact of the fire. The Morwell interviewees indicated the importance of providing clear and understandable quality information to residents during and after such disasters.

Hazelwood HEALTH STUDY

What we did

Interviewees were selected from Morwell residents who were 18 years and older at the time of the mine fire and who had participated in the HHS Adult Survey. An initial subgroup of 70 people was randomly selected in a way which ensured that both men and women of different ages were invited. Methods used to recruit participants included mail, follow up emails and phone calls. Twenty-six people who could be contacted and consented were interviewed. Most (82%) were aged between 40 and 69 years, with only a few aged 20-39 or 70+. Interviews followed a semi-structured, face to face format. The first part of the interview was designed to prompt recall of the event and of its impacts and the second part focussed on coping both at the time and since the event. Questions included, “What effects did the mine fire have on you at the time?”, “Does what happened still affect you?” and “What, if anything, helped you handle the effects of the fire?”. Interviews varied in length from 15 minutes to one hour 20 minutes with the majority of interviews being between 30 minutes and one hour.

Photo Credit: Keith Pakenham, Country Fire Authority

Considerations

Key strengths of the study include the relatively large qualitative sample and the recruitment of men and women of different ages. However, those who could be contacted and who agreed to participate may have been biased towards residents who were more opinionated about the event. Further, the views of people younger than 40 were not well represented. The interviews were conducted with participants almost three years after the event. While this may have adversely impacted recall of the event it also was able to elicit longer term impacts. Finally, the health impact of the fires need to be considered in the context of the background mental and physical health of the community.

Where to from here

This research comprises just one part of the HHS Psychological Impacts Stream. Future activities for this stream include the resurveying of Adult Survey participants and analysis of data recently collected from Latrobe Valley school children. Integration of this work with that of the HHS Community Wellbeing Stream will facilitate knowledge about how best to support recovery in the community.

This research was funded by the Victorian Department of Health and Human Services.

Hazelwood HEALTH STUDY

Impacts of the Hazelwood mine fire for students and staff from a specialist school which relocated during the smoke event

Research Summary

September 2018

Analysis aims

The primary aim of this study was to examine the impact of the smoke event on wellbeing, educational outcomes and teaching practices for students and staff at a specialist school which relocated during the smoke event. A secondary aim was to explore whether the trauma-informed model of practice already in use at the school provided a framework which assisted students and staff during the event.

Meet the team

Dr Emily Berger

Dr Matthew Carroll

Prof Darryl Maybery

Mr Dylan Harrison

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

Impacts on student wellbeing included increased anxiety and frustration, difficulty adjusting to the relocation environment, reduced sense of safety and a drop in both attendance and schoolwork completion. Increased stress at home was also reported. Staff reported their own frustration and anxiety around the event including difficulty obtaining information. Staff noted that the event created challenges on both a personal and professional level, with some reporting concerns for themselves and their families at the same time as working hard to look after the students. The relocation of the school imposed extra duties upon staff, reduced their access to teaching resources and increased the time spent dealing with behavioural issues.

On a positive note, the school relocation reduced exposure to the smoke and permitted the school to do more outdoor activities with the students. In addition, the school's use of a trauma-informed approach to teaching provided considerable insights into how best to support students during this period.

This report is being published in the Journal of Child and Adolescent Trauma.
A copy of the pre-print version of this article is available at www.hazelwoodhealthstudy.org.au/publications

Hazelwood HEALTH STUDY

What we did

Eight school staff were interviewed, including administrative, teaching and support personnel. The school caters for students aged 12 to 18 years who have stopped attending, or been excluded, from mainstream education because of traumatic, behavioural, emotional, learning and/or family and relationship challenges. The school uses an evidence informed, three-tiered, trauma-based model of care. Interviews followed a semi-structured, face to face format. The first part of the interview included open-ended questions about the effect of the event on student and staff wellbeing, learning and teaching. The second part focused on coping both at the time and since the event. The interviews were recorded, transcribed, returned to participants for review and then analysed to identify recurring themes.

Where to from here

This research comprises just one part of the HHS Psychological Impacts Stream. Future activities for this stream include the resurveying of Adult Survey participants and the analysis of data recently collected from Latrobe Valley school children. Integration of this work with that of the HHS Community Wellbeing Stream will facilitate knowledge about how best to support recovery in the community.

Considerations

The findings are from one specialist school and are not necessarily reflective of the experiences of all school staff following traumatic experiences. In addition, the unique nature of this prolonged community-wide pollution event means that the issue of relocation may not be applicable to all disaster events in which schools are required to respond. An improvement in the design of the study would be to explore the experiences of the entire school community, including students and families, and to further explore the contribution of parent distress on child outcomes.

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

This research was funded by the Victorian Department of Health and Human Services.

Hazelwood HEALTH STUDY

Children's perspectives on the impact of the Hazelwood mine fire and subsequent smoke event
Research Summary

September 2018

Analysis aims

The primary aim of this study was to understand the immediate and ongoing impacts of the mine fire event on the social, emotional and academic well-being of young people. The study also investigated the coping strategies used by young people and their suggestions about what would be helpful in future events.

Meet the team

Dr Emily Berger

Dr Matthew Carroll

Professor Darryl Maybery

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

The interviews revealed that the fire and subsequent smoke left a strong impression on most of the participants, with students talking about the unpleasant smell, how the ash felt in their throat and got into their home and school. In addition to being an unpleasant event, the interviews revealed that the event impacted on some children's social, emotional and academic wellbeing, while other children appeared to have experienced little impact from the event. While a number of students talked about difficulties coping at the time, including anger, stress and anxiety, most indicated that these effects had abated. Some, however, reported still being more alert to cues for fire events. In addition, some students remarked on the educational impacts including change to school routines, absences from school, and the impact of relocation (either at the family or school level).

Looking beyond themselves, some reported on the emotional and physical impact of the event on their parents, family and community, including short and long-term health outcomes, impacts on friendships and increased family conflict. Students also talked about how they attempted to minimise these impacts through helping to protect the family home or keeping family members safe at the time of the fire and smoke.

A more detailed paper describing the findings from this analysis can be found at
www.hazelwoodhealthstudy.org.au/study-findings/publications

Hazelwood HEALTH STUDY

What we did

Sixty-nine children and adolescents from seven schools in Morwell and one school in Traralgon were interviewed approximately 1 ½ years after the mine fire. The majority of students were in grade 3, followed by grade 5, year 7 and then year 9. The interviews lasted approximately 30-40 minutes and were conducted face to face with a researcher at the child's school. A semi-structured interview was used to allow for both the researcher and the children to direct the conversation. The interview asked children about the perceived impact of the fire and smoke on them and others, their views on management of the fire and how they coped at the time, as well as whether they experienced any changes at home or school during or following the fire.

Where to from here

This research comprises one aspect of the HHS Psychological Impacts stream. Future activities for this stream include analysis of a second round of surveys and interviews with students conducted almost four years after the mine fire, and reporting on the impacts for other vulnerable groups including older adults.

Considerations

Although a close to representative sample of male and female students from government and independent schools were involved in the interviews, less than one third of parents consented for their child to participate. Therefore the results may not necessarily reflect the experiences of all children and adolescents following the 2014 Hazelwood mine fire.

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

This research was funded by the Victorian Department of Health and Human Services.

Hazelwood HEALTH STUDY

Research Summary | The Latrobe ELF Study: Indicators of lung and blood vessel function three years after the fire

October 2018

Analysis aims

Three years after the mine fire event, we aimed to find out if smoke from that fire affected the health of the lungs and blood vessels in very young children from the Latrobe Valley including children whose mothers were pregnant with them at the time.

Meet the team

Fay Johnston
Graeme Zosky
Graham Hall
Kazuaki Negishi
Alison Venn
Shyamali Dharmage
Marita Dalton
Rachel Foong
Amanda Wheeler
Shannon Melody
Grant Williamson
Tierney O'Sullivan
Jingyi Shao
Bing Zhao
Melanie Reeves
Katherine Chappell

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire happened. This includes children whose mothers were pregnant with them at the time.

What we found

Blood vessel health

In children who were aged up to two years at the time of the fire, we found weak evidence for a link between higher mine fire smoke exposure and very small increases in blood vessel stiffness, and no evidence for a link with blood vessel thickness. We did not find any links between smoke exposure and blood vessel health in children whose mothers were pregnant with them at the time of the fire.
We also found that smoking during pregnancy was linked with thicker blood vessels in children.

Lung health

In children who were aged up to two years at the time of the mine fire, we found weak evidence for a link between higher mine fire smoke exposure and slightly increased lung stiffness, but not with other lung function measures.
We also found that lung function was reduced in children whose mothers smoked during pregnancy.

Two detailed reports describing these findings can be found at
www.hazelwoodhealthstudy.org.au/study-reports

Hazelwood HEALTH STUDY

What we did

We tested the blood vessel thickness and stiffness of 248 children using ultrasound. Increases in the thickness or stiffness of blood vessels indicate poorer blood vessel health.

We did a simple lung test on 105 children, known as the forced oscillation technique. It uses small vibrations to see how easily air goes in and out while children are breathing through a tube. We measured the resistance to air flow, the stiffness of the lungs, and if lung function changed after using an asthma puffer containing salbutamol. Fewer children had lung checks than blood vessel checks because many ELF participants were too young for the lung test.

We worked out how much smoke each child had been exposed to by looking at where the child was each day during the fire and how polluted the air was in the area.

When we analysed the data we took into account other factors that can affect blood vessel and lung function such as age, sex, height, weight and exposure to tobacco smoke.

Where to from here?

Further studies are needed to confirm these results. ELF participants born during 2015 were not included in the lung health testing because they were mostly too young to participate. They are an important group because they were never exposed to the mine fire smoke. Their inclusion in the testing planned for 2020 will improve the ability of the ELF study to identify, with more certainty, possible lung health impacts linked with exposure to the mine fire smoke.

HHS results will be shared with relevant organisations to ensure they are used to shape services for the future health of the Latrobe Valley

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborators from Melbourne University and the Telethon Kids Institute.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

Considerations

The evidence for a link between mine fire smoke exposure and the stiffness of blood vessel or lungs was present but not strong. We cannot rule out the possibility that the results occurred by chance, or were due to other unmeasured factors that can affect blood vessel or lung health.

Blood vessel stiffness and thickness varies among healthy children. Greater stiffness does not automatically mean that children will later develop blood vessel or heart problems. Stiffer or thicker blood vessels are two of many things, including genetic make-up, smoking tobacco, stress, diet and physical activity that can influence the risk of heart disease in later life.

Lung function varies a lot between children and from day to day. Lower than expected results on the day of testing do not automatically mean that there are lung problems. However, children with symptoms like shortness of breath, wheezing, or frequent coughing should always have these checked by a doctor.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Research Summary

Adult psychological outcomes following the Hazelwood mine fire: A mixed methods study

November 2018

Analysis aims

This study assessed the psychological impacts of six weeks of exposure to smoke and ash from the Hazelwood mine fire. The study compared residents from the most exposed community (Morwell) with those from a similar, but minimally-exposed, control community (Sale).

Meet the team

Professor Darryl Maybery
Rebecca Jones
Matthew Carroll
Joanna F Dipnall
Emily Berger
Alexander McFarlane

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we did

This analysis combined two different sets of findings. Firstly, outcomes from the Adult Survey of 3091 participants in Morwell and 960 in Sale completed more than two years after the event. Secondly, information from face-to-face interviews with 26 of the Morwell Adult Survey participants. The survey included a measure of posttraumatic stress symptoms associated with the mine fire, a measure of general distress and information on mental health diagnoses. The interviews explored the psychological impacts more deeply, particularly the posttraumatic stress symptoms.

Hazelwood HEALTH STUDY

What we found

In a self-report survey, Morwell residents scored higher than Sale residents on a measure of symptoms of posttraumatic stress associated with the mine fire event. Morwell residents also scored higher on a measure of general distress. Results indicated that, on average, the Hazelwood mine fire continued to generate moderate levels of distress in the local community more than two years after the event. However, there was considerable diversity in the response, from no impact to severe distress. These findings were supported by qualitative interviews. Half of the interview participants reported no psychological impact at the time of the mine fire event, nine reported impacts at the time which had dissipated by the time of the interviews, and the remaining four reported still being psychologically impacted three years post-event. Intrusive thoughts were the most frequently reported symptom of posttraumatic stress. The interviews highlighted the increased vulnerability of people with pre-existing mental health concerns. It appears that diagnosis of PTSD has been more common in Morwell since the mine fire; however, total numbers are too small to be certain.

To request a copy of the full report, please call 1800 985 899 or email contact@hazelwoodhealthstudy.org.au

Considerations

While all attempts were made to ensure that the Adult Survey participants were representative of their communities, participants tended to be older and more advantaged than non-participants. In addition, the self-report nature of the survey may have reduced the reliability of the responses. Finally, the small sample used for the interviews may have restricted the range of possible responses. Therefore, the results may not necessarily reflect the experiences of all adults following the 2014 Hazelwood mine fire.

Where to from here

This research comprises one aspect of the HHS Psychological Impacts stream. Future activities for this stream include follow up surveys and interviews with adults and with school-aged children, and targeted analysis of the existing data to look at specific factors such as age, prior mental health history, and prior exposure to traumatic events.

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventative Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

This research was funded by the Victorian Department of Health and Human Services.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Ambulance attendances during the Hazelwood mine fire
Research Summary

December 2018

Analysis aims

This study aimed to investigate whether there were increased ambulance attendances during the mine fire period, compared to other times before and after the mine fire. The study also aimed to determine whether those attendances were associated with changes in mine fire-related air pollution levels.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history.

It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

Photo Credit: Keith Pakenham, Country Fire Authority

Meet the team

Associate Professor Yuming Guo

Dr Caroline Gao

Dr Joanna Dipnall

Professor Rory Wolfe

Dr Jillian Blackman

Christina Dimitriadis

Professor Malcolm Sim

Professor Karen Smith

Professor Michael Abramson

What we found

When the mine fire period was compared to other times before and after the mine fire, the analysis showed an overall 15% increase in ambulance attendances. This corresponded to approximately 225 additional ambulance attendances during the mine fire period for all conditions. When ambulance attendances for respiratory conditions were investigated separately, there was a 47% increase during the mine fire period compared to other times. This corresponded to approximately 37 additional ambulance attendances for respiratory conditions during the mine-fire period.

When we looked at changes in the levels of mine fire-related air pollution, we could see that increases in pollution levels were followed by increases in ambulance attendances for respiratory conditions for about 5 days.

A full report describing the findings from this analysis can be found at hazelwoodhealthstudy.org.au/study-findings/study-reports

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

Daily ambulance attendances data for the period July 2010 to March 2015 were obtained from Ambulance Victoria for Morwell and surroundings towns.

Air pollution estimates were based on fine air particles measuring less than 2.5 thousandths of a millimetre in diameter ($PM_{2.5}$). These were modelled by the Commonwealth Scientific and Industrial Research Organisation for the areas impacted by the mine fire smoke. Daily maximum temperatures were collected from the Australian Bureau of Meteorology.

A statistical method called time series analysis was used to examine whether ambulance attendances increased during the mine fire period and to measure the association between ambulance attendances and daily average $PM_{2.5}$ levels. The analysis took into account the influences of other contributing factors such as season and temperature.

Photo Credit: Monash Rural Health Latrobe Valley & West Gippsland

Considerations

Within each affected town, ambulance counts were too small to allow for comparisons between areas with higher and lower air pollution levels. Therefore we may have under estimated the impact in the most highly exposed areas. It is important to note that the data was not sufficient to link any individual person's ambulance call out to mine fire smoke exposure and that ambulance data were collected for administrative purposes and, therefore, may not provide accurate diagnostic information.

Where to from here

Researchers will be conducting further analyses using ambulance attendance, hospital admission, emergency presentation and cancer datasets.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health and Human Services.

Birth outcomes using anonymous Victorian Perinatal Data Collection Records

Research Summary

December 2018

Analysis aims

We aimed to find out whether babies born to pregnant mothers exposed to mine fire smoke were born earlier or smaller compared to those born to mothers who were not exposed during pregnancy.

Meet the team

Fay Johnston
Shannon Melody
Alison Venn
Karen Wills
Jane Ford
Marita Dalton
Grant Williamson

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire happened. This includes children who were in the womb and had not been born yet.

What we found

In general, we found that babies born to mothers who were exposed to the coal mine fire smoke during pregnancy, compared to mothers who were not exposed, were no different in their birthweight, were not more likely to be born small nor to be born too early. This supports findings that we have previously reported, where we collected birth details through a survey of families enrolled in the Latrobe ELF Study.

However, we did find that smoke exposure was linked to birthweight in some babies, but only if the mother had a diagnosis of gestational diabetes. These babies were more likely to be heavier at birth by approximately 100 grams, compared to babies born to exposed mothers without gestational diabetes. This effect was in addition to the higher birthweight that you would expect from gestational diabetes alone.

To view a copy of the full report go to https://hazelwoodhealthstudy.org.au/study-findings/publications **or** https://doi.org/10.1016/j.envint.2019.03.028

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

What we did

- After obtaining ethical approval for this research, we obtained anonymous birth records held by the Victorian Perinatal Data Collection for all babies born in the Latrobe Valley before, during and after the fire (born 1st March 2012 to 31st December 2015).
- To estimate how much mine fire smoke pregnant women had been exposed to during the fire, we used air pollution data provided by CSIRO and the recorded home address at the time the baby was born.
- We looked to see if different amounts of mine fire smoke exposure were associated with birthweight and when babies were born. When we analysed the data, we took into account other factors that can affect birthweight and maturity, including infant sex, the mother's age, health and smoking status during pregnancy.

Considerations

We calculated exposure based on the mother's address at delivery. This means we may not have captured changes in smoke exposure that resulted from movement within and outside of the Latrobe Valley during the fire.

Where to from here?

These findings will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley. Additionally, findings will help guide responses to severe smoke events in the future. We will also be investigating whether exposure to smoke from the coal mine fire was linked to onset of pregnancy complications, including gestational diabetes mellitus.

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborators from Melbourne University and the Telethon Kids Institute.

We are grateful to CCOPMM for providing access to the de-identified data used for this project and for the assistance of the staff at the Consultative Councils Unit, Safer Care Victoria. The views expressed in this paper do not necessarily reflect those of CCOPMM

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health and Human Services.

Hazelwood HEALTH STUDY

Adult Survey: Mine fire smoke exposure and health
Research Summary

January 2019

Analysis aims
This research aimed to assess whether adults who were heavily exposed to air pollution from the mine fire, had poorer psychological, respiratory or cardiovascular health, compared with adults who were less or minimally exposed.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

Almost all Morwell participants, and some Sale participants, were exposed to mine fire-related air pollution. For some participants, their average daily exposure level exceeded World Health Organization guidelines. Compared to participants with no fire-related air pollution exposure, participants with medium or high exposure were more likely to report only fair or poor health than to report excellent or very good health. Participants with low, medium or high exposure were also more likely to report respiratory symptoms (wheeze, night-time and resting shortness of breath, chronic cough and phlegm, chest tightness and nasal symptoms). The increases in respiratory symptoms ranged from 15% to 110%. Cough, in particular, appeared to increase with each increase in air pollution exposure level. Asthma symptom severity was also slightly higher in asthmatics who had low or high air pollution exposure compared to asthmatics with no exposure.

Compared to participants with no exposure, participants with low, medium or high exposure also reported more symptoms of psychological distress that they associated with the mine fire that occurred 2.5 years earlier. These included symptoms like intrusive thoughts about the fire, avoidance behaviours (such as trying not to think about it) and being jumpy or easily startled. Intrusive thoughts, in particular, appeared to increase with each increase in air pollution exposure level.

We did not find a relationships between mine fire-related air pollution exposure and risk of having high blood pressure, high cholesterol, any cardiovascular condition, diabetes or cancer which had been diagnosed by a doctor in 2014 or later.

A detailed report on this research can be found at
http://hazelwoodhealthstudy.org.au/study-findings/study-reports/

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

We surveyed 3,096 adults from Morwell and 960 from Sale approximately 2.5 years after the mine fire event. Participants answered questions about their locations (e.g. home and work) during the mine fire and their recent general, psychological, respiratory and cardiovascular health. Using air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure during the fire, to fine air particles < 2.5 thousandths of a mm in diameter ($PM_{2.5}$). We then compared the self-reported health of people with high, medium, low or no $PM_{2.5}$ exposure. This analysis took into consideration other factors that can influence health, such as participant's jobs that involved exposure to dusts or fumes, their education level and cigarette smoking.

Considerations

Only 34% of Morwell adults, and 23% of Sale adults participated. Whilst this is comparable to participation rates in other Australian research studies, there is the possibility that participants were not representative of their towns. The researchers used a number of statistical methods to correct for known differences between participants and non-participants, and between Morwell and Sale. However, there remains the possibility that factors other than the mine fire air pollution were responsible for some of the differences in health reported by exposed and not exposed participants.

The HHS is led by Professors Michael Abramson and Judi Walker at Monash University with collaborators from the Menzies Institute, Federation University, University of Adelaide and CSIRO.
The research was funded by the Department of Health and Human Services.

Where to from here?

Some Adult Survey participants have gone on to have lung function tests, cardiovascular health tests or psychological health interviews. Many have also agreed to the researchers accessing their ambulance, hospital and cancer data. Future research will combine these data sources in order to provide a fuller description of participants' health.

Hazelwood HEALTH STUDY

Research Summary

The ongoing experiences of students following the Hazelwood mine fire

March 2019

Analysis aims

This study assessed the psychological impacts of six weeks of exposure to smoke and ash from the Hazelwood mine fire on school-aged children. The study compared students from schools in the most exposed community (Morwell) with those from schools elsewhere in the Latrobe Valley which were less exposed to the smoke event.

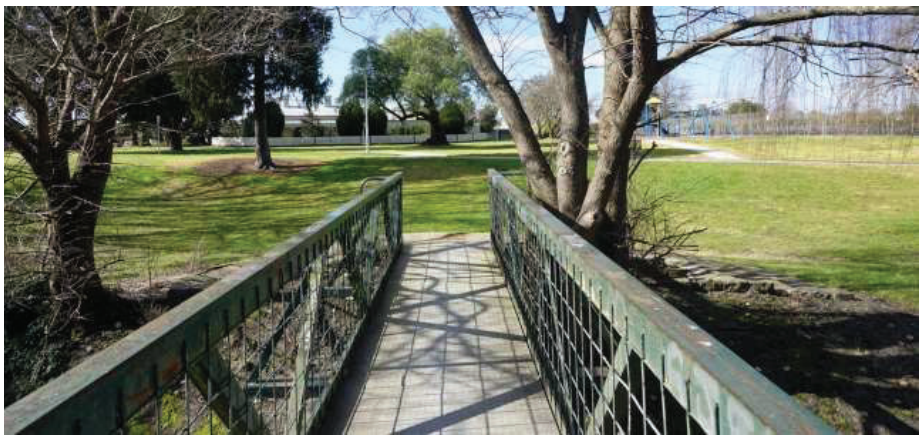
Meet the team

Sonia Allen
Matthew Carroll
Emily Berger
Darryl Maybery
Tim Campbell

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.



What we found

The interviews revealed that for most students, their recall of the event was vivid, with students recalling feeling anxious or sick at the time; disruption of routines and relocation of home or school; some relief from sharing the experience with friends or family; and being confined to indoors or trips away from the smoke. While the majority of the participants reported little to no ongoing concerns, some did express current concerns. The need to move on from the event was clearly expressed, however, for some students this was challenging, with thoughts of the event rekindled by anniversaries, media reports, and smoke in the air. In particular, some students reported experiencing key symptoms of distress associated with the event such as dreaming about the event, feeling more restless, or trying to avoid thinking about it by distracting themselves with other activities. Students remarked on a number of things that helped them at the time, highlighting the important role that family, friends, and school personnel played in supporting them. With regards to preparing for and responding to future events, students remarked on the need for clearer communication with them on the nature of the event and potential impacts, and what they can do to look after themselves and their families.

A more detailed report describing the findings from this analysis can be found at
http://hazelwoodhealthstudy.org.au/study-findings/study-reports/

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

This analysis is focused on the second round of face to face interviews completed in 2017 by 46 students in grades 5, 7, and 9. The students were primarily from Morwell schools and had completed a similar interview in 2015. This allowed us to explore the impacts of the event more deeply.

Where to from here

This research comprises one aspect of the HHS Psychological Impacts stream. Future activities for this stream include follow up surveys and interviews with school-aged children and adults.

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventative Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

This research was funded by the Victorian Department of Health and Human Services.

Considerations

While all attempts were made to recruit as many students as possible into the Schools Study, the majority of eligible families did not respond to the invitation to participate. Older students were also less likely to participate than their younger counterparts, due in part to there being only one secondary school in Morwell. Finally, the random sample used for the interviews may have restricted the range of possible responses. This raises the possibility that the participant samples for the survey and interviews may not represent the full student population at the time.

Hazelwood HEALTH STUDY

Research Summary

The Latrobe ELF Study | Exposure to mine fire smoke and the risk of pregnancy-related health problems

May 2019

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire happened. This includes children whose mothers were pregnant with them at the time.

Analysis aims

We aimed to find out whether pregnant mothers exposed to mine fire smoke were more likely to experience complications in pregnancy, including gestational diabetes, high blood pressure, or placental problems, compared to mothers who were not exposed in their pregnancy.

What we found

We found that pregnant women exposed to smoke from the coal mine fire were more likely to be diagnosed with gestational diabetes compared to pregnant women who were not exposed to coal mine fire smoke. Exposure in the second trimester of pregnancy was associated with the greatest risk of gestational diabetes. The number of extra cases of gestational diabetes that were likely to be connected to smoke exposure from the fire was 16. We found no evidence that exposure to smoke was associated with other complications in pregnancy, including high blood pressure conditions or problems with the position or attachment of the placenta.

Meet the team

Fay Johnston
Shannon Melody
Alison Venn
Karen Wills
Jane Ford

To request a copy of the full technical report, please call 1800 985 899 or email contact@hazelwoodhealthstudy.org.au

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

- After obtaining ethical approval for this research, we obtained anonymous Victorian Perinatal Data Collection records for pregnant women in the Latrobe Valley who gave birth at 20 or more weeks gestation between 1st March 2012 to 31st December 2015.
- We used the recorded home address at the time the baby was born to estimate how much smoke pregnant women had been exposed to during the fire.
- We looked to see if the amount of smoke exposure during the fire was associated with whether the mother had gestational diabetes, high blood pressure in pregnancy or an abnormally positioned or implanted placenta. When we analysed the data, we took into account other factors that can affect pregnancy complications, including whether the mother smoked in pregnancy, the mother's age and year of conception.

Where to from here?

These findings will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley. Additionally, findings will help guide responses to severe smoke events in the future, by supporting the need for pregnant women to be provided with targeted advice to reduce their exposure during the event.

Considerations

We calculated exposure based on the mother's address at delivery. This means we may not have captured changes in smoke exposure that resulted from movement within and outside of the Latrobe Valley during the fire.

The Latrobe ELF Cohort Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborators from Melbourne University and the Telethon Kids Institute.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood Health Study | Exposure to mine fire smoke and the risk of pregnancy-related health problems

Hazelwood HEALTH STUDY

Community perceptions of the impact of the Hazelwood mine fire on community wellbeing, and of the effectiveness of communication during and after the fire

Research Summary

May 2019

Analysis aims

This analysis presents community perceptions of the impact of the smoke event on community wellbeing, and the elements that are important for effective communication during and after the smoke event.

Meet the Team

Dr Susan Yell
Assoc Prof Michelle Duffy
Dr Sue Whyte
Dr Larissa Walker
Dr Matthew Carroll
Prof Judi Walker

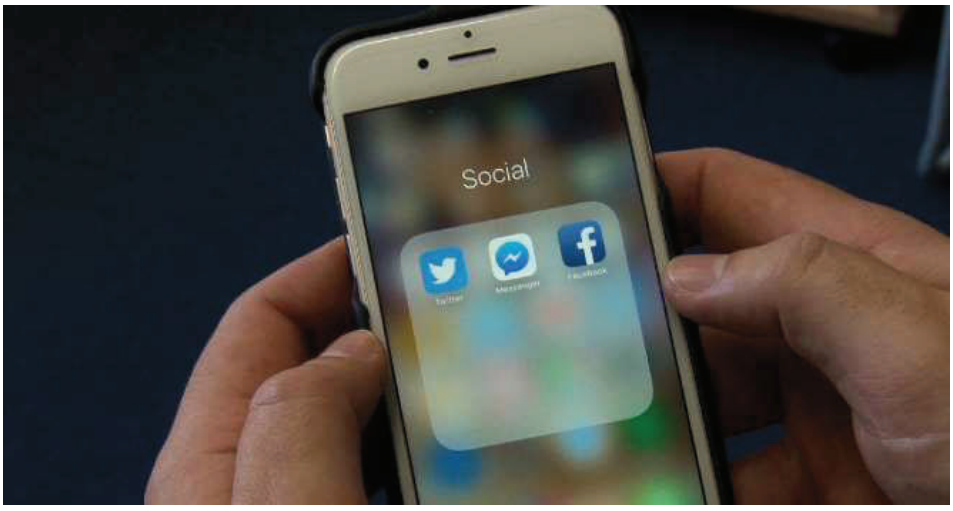
The Community Wellbeing Stream is led by Federation University. The HHS is led by Monash University with collaborators from Federation University, the University of Tasmania, the University of Adelaide and CSIRO.

The research was funded by the Department of Health and Human Services.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Community Wellbeing Stream** is the part of the Hazelwood Health Study that looks at the impact of the smoke event on the community wellbeing of those living in Morwell and the Latrobe Valley. This includes looking at the communication during and after the mine fire, and at the community rebuilding efforts that have taken place since the fire.



What we did

We held group discussions with community members and interviewed people from community organisations and agencies involved in the emergency response and recovery, local journalists and social media users. We also collected media articles about the mine fire, along with social media posts by community members on three local Facebook groups. We interviewed a total of 85 people, and analysed 1,096 media reports and 1,709 social media posts.

Hazelwood HEALTH STUDY

What we found

We found that the event had a substantial impact on community wellbeing, most notably a loss of trust in the authorities dealing with the crisis. The main factors leading to this loss of trust were the problems with communication and information, the lack of an emergency plan and a sense on the part of some in the community that the government, authorities and GDF Suez (the owners of the mine and power station) had not accepted responsibility for what happened and were not held accountable.

This loss of trust also led some community members and groups to take matters into their own hands, finding ways to support one another, meet the needs of those impacted by the fire, and lobby for government to address their concerns. Social media had an important function in enabling community groups to organise and express themselves.

These initiatives were important to addressing the concerns of the community and determining ways forward. However, many questioned the motives of those who took on this work, while others were concerned about the repercussions on the reputation of the community.

Problems with official communication during the smoke event played a prominent part in the community's distress. Local media and social media were important in filling information gaps and representing the concerns of the wider community, while at the same time reflecting some of the divisions and conflicts in this diverse community. In reflecting on what could have been done better in communicating with the community, our interviewees mentioned a number of elements important for effective communication. These were:

- media and social media as a sounding board and a strategic resource;
- fast, accurate and honest communication;
- a broad range of channels;
- face-to-face communication is important;
- a trusted spokesperson, preferably someone local;
- empathic communication;
- continuity of spokespeople;
- a local communications team.

A copy of the full report describing the findings from the analysis can be found at
http://hazelwoodhealthstudy.org.au/publications

Where to from here?

A further report is being prepared which presents our findings on community perceptions of the effectiveness of community rebuilding activities. Additional data collection is planned to track the ongoing wellbeing of the community.

Considerations

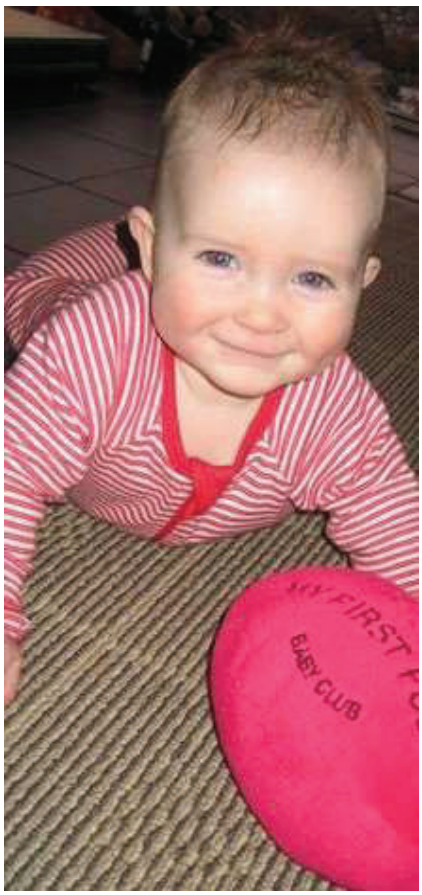
The findings of this study would be useful for policy and planning for future disasters. They show that there is a requirement to listen to the community, address their concerns and communicate with them honestly, accurately and empathically, using appropriate channels and trusted spokespersons. To do so promotes a relationship of trust between community members and agencies involved in disaster, so necessary for effective disaster response and management. In addition, we argue for the development of a comprehensive disaster management plan which recognises the specific needs and risks for this community, and which includes a communications and community engagement strategy.
While every attempt was made to speak to a broad array of individuals and organisations, it is possible that the participant sample may not represent the full range of viewpoints.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Updated analysis of birth outcomes in the Latrobe ELF cohort
Research Summary

May 2019



Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the HHS that follows the health and growth of children who were younger than two years old when the fire happened. This includes children who were in the womb and had not been born yet.

Analysis aims

We aimed to repeat our first analysis of birth outcomes using improved estimates of smoke exposure and health data to find out whether babies born to pregnant mothers exposed to mine fire smoke were born earlier or smaller compared to those born to mothers who were not exposed.

Meet the team

Fay Johnston, Shannon Melody, Alison Venn, Karen Wills, Jane Ford, Marita Dalton, Grant Williamson, Tierney O'Sullivan.

What we found

We found that babies born to mothers exposed to the coal mine fire smoke during pregnancy were no different in their birthweight and were not more likely to be born too early. This supports our findings reported previously.

As with our first analysis we found that smoking during pregnancy was associated with lower birthweights in babies.

A detailed report describing the findings from this analysis can be found at
http://hazelwoodhealthstudy.org.au/study-findings/study-reports/

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

- After obtaining ethical approval for this research, we enrolled children born between 1st March 2012 and 31st December 2015 who lived in the Latrobe Valley. We then asked families to complete a detailed survey about the study child, their family, their health and the pregnant mother's whereabouts during the fire.
- We looked to see if the amount of smoke exposure during the fire was associated with whether babies were born early and how much they weighed. When we analysed the data, we took into account other factors that can affect birthweight and maturity, including infant sex, the mother's age, health and smoking status during pregnancy.
- In this updated analysis, we used information collected in the survey about the mother's whereabouts during the fire to calculate a more detailed estimate of smoke exposure. We also did additional analyses using the birth data recorded by midwives or doctors at the time of the birth in addition to the parent-reported birth outcomes used in the first analysis.

Where to from here

These findings will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley. Additionally, findings will help guide responses to severe smoke events in the future.

Considerations

There were some factors that might affect birthweight, such as pregnancy complications and how many pregnancies a mother has had, which we were unable to account for in this analysis. We are investigating some of these separately.

The Latrobe ELF Cohort Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborators from Melbourne University and the Telethon Kids Institute. The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health and Human Services.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

The impact of coal mine fire smoke on asthma
Research Summary

May 2019

Analysis aims
Three and a half years after the mine fire, this research aimed to discover whether adults with asthma who were exposed to the smoke had more severe symptoms, worse lung function or poorer asthma control, compared to adults with asthma who were not exposed.

Meet the Team

Dr Sasha Taylor
Brigitte Borg
Dr Caroline Gao
David Brown
Dr Ryan Hoy
Annie Makar
Tom McCrabb
Dr Jillian Ikin
Professor Bruce Thompson
Professor Michael Abramson

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO. The research was funded by the Department of Health and Human Services.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Respiratory Stream** is the part of the HHS that examines whether exposure to smoke from the mine fire is associated with respiratory symptoms, asthma control and decline in lung function.

What we found

In adults with asthma from Morwell who were exposed to the smoke, compared to adults with asthma from Sale who were unexposed, we found no differences in asthma-related symptoms or severity, lung function or airway inflammation. However, there was some evidence that adults with asthma from Morwell had poorer asthma control.

A copy of the pre-print version of this article is available at
http://hazelwoodhealthstudy.org.au/publications/

Hazelwood HEALTH STUDY

What we did

We tested 165 adults with asthma from Morwell who were exposed to the smoke, and 64 adults with asthma from Sale who were not exposed. Participants underwent a number of tests of lung health, including a measure of inflammation in the lungs, how hard and fast participants could blow air out of their lungs and whether that changed after using an asthma puffer containing salbutamol (Ventolin). Participants also answered questions about respiratory symptoms such as cough and wheeze, medication use and their asthma control. We took into consideration other factors that could influence lung health, such as age, height, weight, cigarette smoking and participant's jobs that may have involved exposure to dusts or fumes.

Where to from here?

Further analysis of the Respiratory Stream data will explore the health effects of the mine fire smoke on the small airways of the lungs, on adults with chronic obstruction pulmonary disease and on adults without asthma. Follow up testing of the Respiratory Stream participants is planned so that longer term health effects of the mine fire smoke can be investigated.

Considerations

We cannot be certain that the mine fire smoke had a causal role in the reduction of asthma control in Morwell because additional factors could be influential, such as income, access to health services and adherence to medication instructions. Our asthma control measure also relied on self-reported data which could limit interpretation. Further, because a large proportion of adults from Morwell and Sale did not participate in the baseline Adult Survey from which the Respiratory Stream participants were drawn, it is possible that the findings do not truly reflect the two communities.

Hazelwood HEALTH STUDY

Further results from the Adult Survey. The relationship between Hazelwood mine fire smoke exposure, housing materials and self-reported respiratory health.

Research Summary

July 2019

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The Hazelwood Health Study involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

To assess whether there was an association between mine fire smoke exposure, housing and roofing materials, and respiratory health in adults residing in the Latrobe Valley.

Meet the Team

Sasha Taylor
Brigitte Borg
Caroline Gao
David Brown
Ryan Hoy
Annie Makar
Tom McCrabb
Jillian Ikin
Bruce Thompson
Michael Abramson

What we did

We surveyed 3,096 adults from Morwell approximately 2.5 years after the mine fire event. Participants answered questions about their locations during the mine fire (e.g., home, work or leave). Based on those locations, air pollution data modelled by CSIRO was used to estimate each participant's level of exposure during the fire to fine particles less than 2.5 thousandths of a mm in diameter ($PM^{2.5}$). Participants also answered questions about their home's main building materials and type of roof. We then looked to see if increasing level of $PM^{2.5}$ exposure was associated with increasing likelihood of self-reported respiratory symptoms 2.5 years after the mine fire, and whether building or roofing type made any difference. This analysis took into consideration other factors that could influence health, such as participant's jobs that involved exposure to dusts or fumes, their education level and cigarette smoking.

What we found

In adults who lived in Morwell during the mine fire, we found evidence of an association between higher mine fire smoke exposure and increased likelihood of cough, wheeze and phlegm 2.5 years later. The link was stronger in those adults whose houses were built from weatherboard with tin or metal roofs. In contrast, brick or cement houses with tiled roofs showed a lower risk. The link between increasing air pollution and respiratory symptoms was also stronger in men, and in all adults of working age. One explanation for this could be that these groups spent more time outdoors during the mine fire, whereas some women and adults of retirement age could have spent more time indoors.

A detailed paper describing these findings can be found at www.hazelwoodhealthstudy.org.au/publications

Considerations

Only 34% of Morwell adults participated. Whilst this is comparable to participation rates in other Australian research studies, there is the possibility that participants were not completely representative of their town. The researchers used a number of statistical methods to correct for known differences between participants and non-participants, however there remains the possibility that factors other than the mine fire air pollution were responsible for some of the differences in health reported by highly exposed and less exposed participants. Also, housing material and roofing type were only collected for each participant's primary residence, but the proportion of time spent at that home would have varied between participants.

Where to from here?

Further analysis of the Respiratory Stream data will explore the health effects of the mine fire smoke on the small airways of the lungs, on adults with chronic obstruction pulmonary disease and on adults without asthma. Follow up testing of the Respiratory Stream participants is planned so that longer term health effects of the mine fire smoke can be investigated.

The Hazelwood Health Study is led by Monash University with collaborators from the Menzies Institute, Federation University, The University of Adelaide and CSIRO. The research was funded by the Department of Health and Human Services.

Hazelwood HEALTH STUDY

Factors associated with high blood pressure and its management among older Gippslanders

Research Summary

October 2019

Analysis aims
This research aimed to measure how common high blood pressure (hypertension) was in Gippsland and the Latrobe Valley and how well it was managed.

The **Cardiovascular Stream** is the part of the Hazelwood Health Study that has measured markers of heart and blood vessel health, including blood pressure, in older adults.

Meet the Team
Dr Sasha Taylor
Dr Juliana Betts
Dr Caroline Gao
Mr David Brown
Dr Jillian Ikin
Ms Andrea Taggert
A/Prof Dion Stub
Prof Michael Abramson
Prof Danny Liew

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we found

We found no evidence that the mine fire smoke led to higher blood pressure in adults from Morwell who were exposed to the smoke, compared to adults from Sale who were unexposed. When we combined the Morwell and Sale participants, we found that approximately 80% of participants were found to have high blood pressure. Among those with high blood pressure, 37% were determined to be 'undermanaged'. That meant they had been diagnosed with hypertension by a doctor, or were taking antihypertensive medications, but their blood pressure was still too high. A further 8% of participants with high blood pressure were determined to be 'unmanaged', meaning that their high blood pressure had not yet been diagnosed or treated by a doctor. Compared to participants without high blood pressure, those with high blood pressure were more likely to have signs of kidney damage and thickening of the heart muscle. After taking into consideration a number of factors that can influence blood pressure, being employed and being single were both independently associated with higher blood pressure.

To request a copy of the full technical report, please call 1800 985 899 or email contact@hazelwoodhealthstudy.org.au

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

We tested 498 adults who lived in or near the Gippsland towns of Morwell and Sale. Participants were aged between 55 and 89 years. Participants were considered to have high blood pressure if they had blood pressure readings of ≥140/90 mmHg (millimetres of mercury), or a self-reported doctor-diagnosis of high blood pressure, or if they took medication for high blood pressure. Electrocardiography (ECG) was used to measure any thickening of the main pumping chamber of the heart (left ventricle), which can result from prolonged high blood pressure. Kidney damage can also result from prolonged high blood pressure, and this was investigated by taking a blood sample to measure kidney function. We took into consideration other factors that could influence blood pressure, such as history of heart disease or diabetes, age, sex, body mass index, cigarette smoking, alcohol consumption, physical activity and socioeconomic status.

Where to from here?

Further investigation of heart and blood vessel health in Gippsland will be undertaken with the use of Medicare, medication, ambulance and hospital data sets.

Considerations

Cardiovascular Stream participants were drawn from the HHS Adult Survey which had recruited adults who had lived in the towns of Morwell and Sale during the 2014 Hazelwood mine fire. Therefore, the findings may not accurately represent the broader Gippsland area.

The HHS is led by Monash University with collaborators from Menzies, Federation University, the University of Adelaide, the Alfred and CSIRO.

The research was funded by the Department of Health and Human Services.

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Heart and blood vessel health in older adults exposed to smoke from the Hazelwood mine fire

Research Summary

October 2019

Analysis aims

Three and a half years after the mine fire, this research aimed to discover whether adults who were exposed to the smoke had poorer heart or blood vessel health, compared to adults who were not exposed.

Meet the Team

Dr Juliana Betts
Dr Caroline Gao
Ms Elizabeth Dewar
Ms Karen Kilpatrick
Dr Sinjini Biswas
Dr Berihun Zeleke
A/Prof Dion Stub
Dr Jillian Ikin
Ms Andrea Taggert
Mr David Brown
Prof Michael Abramson
Prof Danny Liew

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and vulnerable groups.

The **Cardiovascular Stream** is the part of the Hazelwood Health Study that has measured markers of heart and blood vessel health in older adults who were exposed to the mine fire smoke.

What we did

We tested 365 adults from Morwell who were exposed to the smoke, and 162 adults from Sale who were not exposed. Participants were aged between 55 and 89 years. They underwent a number of tests including Flow Mediated Dilatation (FMD) with ultrasound to measure blood vessel health and electrocardiography (ECG) to measure electrical activity of the heart. Blood samples were tested for markers of elevated risk of heart disease. In particular, blood was tested for high sensitivity (hs) C-reactive protein (CRP) which can detect inflammation, N-terminal pro B-type natriuretic peptide (NT-proBNP) which can indicate heart failure, Troponin which is released into the blood when there is heart damage and cholesterol which is a measure of heart disease risk. We took into consideration other factors that could influence heart or blood vessel health, such as age, sex, cigarette smoking, alcohol consumption and physical activity.

A more detailed paper describing the findings from this analysis can be found at https://hazelwoodhealthstudy.org.au/study-findings/publications

Hazelwood HEALTH STUDY

What we found

In adults from Morwell who were exposed to the smoke, compared to adults from Sale who were unexposed, we found no differences in FMD measures of blood vessel health, nor in electrical activity of the heart measured by ECG. There were also no differences between the Morwell and Sale participants in their blood pressure or in their blood markers for inflammation (hsCRP), heart failure (NT-proBNP) or heart damage (Troponin). However, cholesterol levels were slightly higher in Sale participants, indicating slightly increased risk of heart disease. Overall, this study found no association between Hazelwood mine fire smoke exposure and cardiovascular disease evident four years after the fire. However, there were associations between both cigarette smoking and obesity, and inflammation increasing the risk of heart attack.

Considerations

The researchers used a number of statistical methods to correct for known differences between Morwell and Sale participants which might influence health. However, there remains the possibility that such factors other than the mine fire air pollution influenced the findings. Further, because a large proportion of adults from Morwell and Sale did not participate in the baseline Adult Survey from which the Cardiovascular Stream participants were drawn, it is possible that the findings do not truly reflect the two communities. Because these tests were undertaken four years after the fire, it is also possible that shorter-term associations between smoke exposure and markers of cardiovascular disease were missed.

Where to from here

Future research planned by the Hazelwood Health Study includes investigation of lung, heart and blood vessel health in young children; lung health and psychological health in adults; and psychological wellbeing of school aged children who were exposed to the Hazelwood mine fire smoke.

The HHS is led by Monash University with collaborators from Menzies, Federation University, the University of Adelaide, the Alfred and CSIRO.

The research was funded by the Victorian Department of Health and Human Services

Hazelwood HEALTH STUDY

Research Summary

Long term psychological health following the Hazelwood mine fire

December 2019

Analysis aims

This research aimed to assess whether adults who were heavily exposed to air pollution from the mine fire had more symptoms of long-term posttraumatic distress than adults who were less or minimally exposed.

Meet the team

Jonathan Broder
Caroline Gao
Tim Campbell
Emily Berger
Darryl Maybery
Alexander McFarlane
Jessica Tsoutsoulis
Jillian Ikin
Michael Abramson
Malcolm Sim
Judi Walker
Ashok Luhar
Matthew Carroll

Considerations

The experiences of the participants may not necessarily reflect the experiences of all adults following the mine fire. The researchers used a number of statistical methods to correct for known differences between participants and non-participants, and between Morwell and Sale. However, there remains the possibility that factors other than the mine fire air pollution were responsible for some of the differences in posttraumatic distress reported by highly exposed and less exposed participants.

This research was funded by the Victorian Department of Health and Human Services.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

What we did

We surveyed 3,096 adults from Morwell and 960 from Sale approximately 2.5 years after the mine fire. Using air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure to fine air particles less than 2.5 thousandths of a millimetre in diameter ($PM_{2.5}$) during the mine fire. We then compared symptoms of posttraumatic distress in people with different levels of exposure. We also examined the contribution of other factors that can influence psychological health such as age, prior mental health, prior traumatic exposures, and chronic respiratory and cardiovascular conditions.

What we found

Increases in exposure to air pollution during the mine fire were shown to be related to increases in symptoms of posttraumatic stress reported by adults two and a half years later. The link between air pollution and post-traumatic distress was strongest in the youngest adult participants. Other factors, such as prior mental health, were also associated with distress related to the Hazelwood mine fire.

Where to from here?

A follow-up survey of some participants is planned, as is new data collection about the psychological health of young children and their families.

To request a copy of the full technical report, please call 1800 985 899 or email contact@hazelwoodhealthstudy.org.au

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Research Summary | The Latrobe ELF Study:

Were children exposed to mine fire smoke more likely to have minor illnesses a few years later?

December 2019

Aims of the study

We wanted to find out if children who were exposed to more smoke from the coal mine fire during their mother's pregnancy or in their first two years of life were more likely to have common illnesses like coughs and colds, asthma, and skin rashes in the two to four years after the fire.

Our study team is

Fay Johnston
Gabriela Willis
Kate Chappell
Shannon Melody
Amanda Wheeler
Marita Dalton
Grant Williamson
Tierney O'Sullivan
Shyamali Dharmage
Graeme Zosky

Background

In February and March 2014, the Hazelwood coal mine caught fire and burned for about six weeks. The air in the nearby town of Morwell was full of smoke and ash for most of this time, affecting the people who lived there and causing a lot of concern in the community.

The Hazelwood Health Study was set up to find out the impact of the fire on the health of the people in Morwell, particularly children and older people.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health of children who were younger than two years old when the fire happened. This includes children whose mothers were pregnant with them at the time of the fire.

What we found

For unborn babies exposed to the fire, we found that the more smoke they were exposed to during their mother's pregnancy, the more likely parents were to report coughs, runny noses, wheeze, visiting a health care professional, and having a cold, in the two to four years after the fire. For example, children unexposed to the fire reported coughs or colds in 13% of their monthly diaries, while children exposed to the fire during their mother's pregnancy reported coughs or colds in 17% of diaries (once we accounted for other factors which might affect this).

For children exposed in early life the results were not as clear.

Smoke exposure was not linked with reports of rashes, fever, use of antibiotics or steroid skin creams.

We found that cough and cold symptoms were much more common in younger children and during winter. Reports of rashes and prescribed skin creams were more evenly spread across the age-groups and seasons.

To request a copy of the full technical report,
please call 1800 985 899 or email contact@hazelwoodhealthstudy.org.au

Hazelwood HEALTH STUDY

What we did

We enrolled children living in the Latrobe Valley into the study in late 2016. This included children aged two years and under at the time of the fire, children whose mothers were pregnant with them at the time of the fire, and a comparison group of children who were born after the fire.

Between June 2016 and October 2018, each month we asked parents in the study to complete a short online questionnaire. We asked whether, in the previous month, their child had any symptoms such as cough, runny nose, wheeze, or rash; whether they had been to a doctor or another health care professional; whether they had used any antibiotics, asthma inhalers, or skin steroid cream; and whether a doctor had diagnosed any coughs/colds or other lung infections, asthma, or eczema/dermatitis.

We worked out how much smoke each child had been exposed to by looking at where the child was (or mother for children in the womb) during each day of the fire and how smoky the air was in that place.

Then we looked to see if the things we asked about in the monthly diaries were reported the same, more, or less in children exposed to different amounts of smoke during their mother's pregnancy or their first two years of life.

We also looked at other factors that can affect how commonly these illnesses occur, including the age of the child, the season, if they lived with a smoker, and how much air pollution from traffic or other sources they were exposed to.

Considerations

It was not possible to know whether the differences we saw were completely due to the coal mine fire smoke. It might be that parents of young children or those who were pregnant at the time of the fire may have been more concerned about their child's health and reported more symptoms or been quicker to take their child to the doctor.

The differences we found were small and it is difficult to know what they mean for the risk to an individual child. We need to do more studies to understand this better.

Where to from here?

We will share these findings with the community and local organisations to make sure that they are used to improve the health of people in the Latrobe Valley.

What we find in the Latrobe ELF Study also helps us understand more about the effects of smoke on children's health in general. This is important to know as other children may be exposed to smoke from bushfires or other sorts of fires in the future.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania, with help from Melbourne University and the Telethon Kids Institute.

The Hazelwood Health Study is led by Monash University with help from Menzies, Federation University, the University of Adelaide, and CSIRO.

General practitioner visits and medication use amongst young children exposed to the mine fire smoke

Research Summary

December 2019

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study(HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow-up (ELF) Study** is the part of the HHS that follows the health and growth of children who were younger than two years old when the fire happened. This includes children who were in the womb and had not been born yet.

Analysis aims

We aimed to find out if exposure to smoke from the mine fire either during pregnancy, or during the first two years of life, was associated with visits to a General medical Practitioner (GP) or the prescription of asthma puffers, steroid skin creams and antibiotics over a one-year period following the fire.

Meet the team

Fay Johnston
Jingyi Shao
Graeme Zosky
Amanda Wheeler
Shyamali Dharmage
Marita Dalton
Grant Williamson
Tierney O'Sullivan
Katherine Chappell

What we found

We found that children exposed to the mine fire smoke during their first two years of life were more likely to have antibiotics dispensed in the year after the fire, compared with those not exposed. For those exposed children, there were no other associations between mine fire smoke and visits to GPs or the dispensing of other medications.
In the group of children whose mothers were exposed to the mine fire smoke during pregnancy there were no associations between mine fire smoke and visits to GPs or dispensing of medications in their first year of life.

A detailed paper describing the findings from this analysis can be requested from contact@hazelwoodhealthstudy.org.au

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we did

- With the permission of the parents of 286 children in the ELF Study, we obtained Medicare Benefits Schedule (MBS) data on the number of GP visits, and Pharmaceutical Benefits Scheme (PBS) data on the numbers of prescribed asthma puffers, steroid containing skin creams, and antibiotics dispensed from pharmacies during the period 2014-2016.
- We used each child's home address and locations during the fire period to estimate how much smoke had been experienced by each child, or mother if pregnant. The analysis included children who had a range of exposure to the smoke, including some who had no exposure in pregnancy or infancy.
- For children whose mother were exposed to smoke during pregnancy we evaluated these outcomes for their first year of life. For children who were exposed to smoke during their infancy we evaluated outcomes for the year following the fire.
- When we analysed the data, we took into account other factors that can affect health outcomes such as age, second hand smoke exposure, the mothers' level of stress during pregnancy, socioeconomic status and the background air quality in this area.

Considerations

PBS data only captures prescribed and subsidised medications, so some asthma puffers and steroid skin creams bought without a medical prescription are not included. This study could not determine reasons for the observed increases in antibiotic prescribing. This might have reflected an increased tendency to prescribe antibiotics because of heightened health concerns following the fire, or it might have reflected an increase in the diagnosis of infections requiring antibiotics.
These results were based on a relatively small number of children. Further analysis of anonymous health data from the entire Latrobe Valley will include many more children.

Where to from here
The results will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley.

The Latrobe ELF Cohort Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborators from Melbourne University and the Telethon Kids Institute. The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood Health Study | GP visits and medication use amongst young children exposed to mine fire smoke

Community perceptions of the effectiveness of community rebuilding activities
Research Summary

December 2019

Analysis aims
The purpose of this analysis is to explore community perceptions of the effectiveness of community rebuilding activities.
This work extends the previous analysis released in May this year looking at the community perceptions of the impacts of the event and the effectiveness of communication during and after the event.

Meet the Team
Dr Susan Yell
Assoc Prof Michelle Duffy
Dr Sue Whyte
Dr Larissa Walker
Dr Matthew Carroll
Prof Judi Walker

The Community Wellbeing Stream is led by Federation University. The HHS is led by Monash University with collaborators from Federation University, the University of Tasmania, the University of Adelaide, the University of Newcastle and CSIRO.

The research was funded by the Department of Health and Human Services.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Community Wellbeing Stream** is the part of the Hazelwood Health Study that looks at the impact of the smoke event on the community wellbeing of those living in Morwell and the Latrobe Valley. This includes looking at the communication during and after the mine fire, and at the community rebuilding efforts that have taken place since the fire.

What we did

We held group discussions with community members and interviewed people from community organisations and agencies involved in the emergency response and recovery, local journalists and social media users. We also collected media articles about the mine fire, along with social media posts by community members on three local Facebook groups. We interviewed a total of 85 people, and analysed 1,096 media reports and 1,709 social media posts. We partnered with community members to produce a photographic exhibition which expressed their aspirations for the future.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

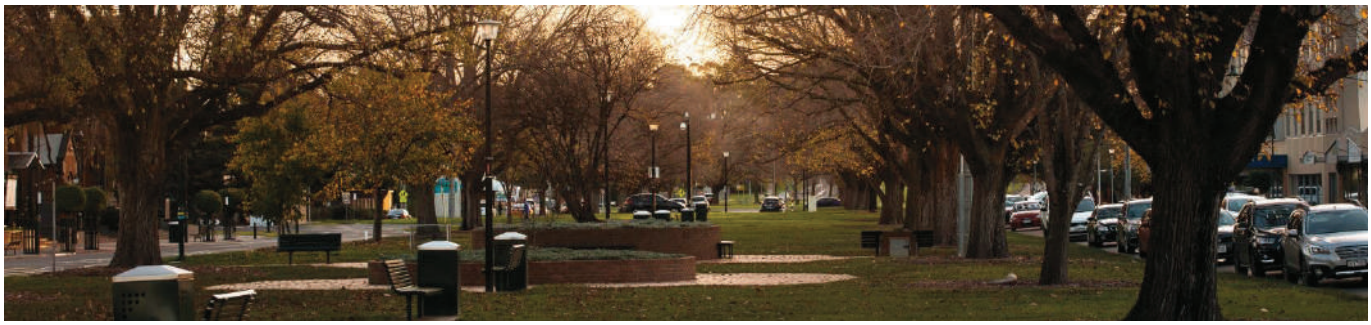
What we found

A range of recovery initiatives were undertaken by various agencies, but not all the work that was done was recognised or valued by the community. Effective recovery initiatives involved a partnership between agency and community, and open dialogic communication. The distinctive characteristics of this community require a place-based approach to the recovery process.

Three years after the mine fire and smoke event, there were still community concerns regarding the apparent lack of planning for a similar future emergency. Stakeholders identified a need for clear and distinct strategies for managing the recovery phase, and for transitioning from the emergency phase to the recovery phase.

The question of 'recovery to what' was very important to this community, as was the development of a long-term vision. The community's focus on recovery shifted over the 3-year period (2014-2017) from a primary concern with physical health, to include a range of concerns: broader wellbeing, job creation and sustainability, and the implications of a transition from coal.

This volume of work is intended to be read in conjunction with the earlier work on the impacts of the event released in May 2019.
Copies of both reports describing the full findings from these analyses can be found at
www.hazelwoodhealthstudy.org.au/study-reports



Considerations

The findings of this study would be useful for policy and planning for future disasters. Stakeholders noted the challenges needed in developing an appropriate emergency plan, and that it would require significant resources and financial support.

The community used different communication spaces to communicate and receive information at different times during the recovery period, and this knowledge can be used to inform future emergency planning. Effective rebuilding and recovery should involve collaborative community-led approaches and partnerships.

While every attempt was made to speak to a broad array of individuals and organisations, it is possible that the participant sample may not represent the full range of viewpoints. However, the analysis of media and social media broadened the range of potential viewpoints.

Where to from here?
Additional data collection is planned to track the ongoing wellbeing of the community.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Research Summary

The Impact of a Mine Fire and Smoke Event on Academic Outcomes for Primary and Secondary School Students

June 2020

Analysis aims

This study aimed to determine whether students in years 3, 5, 7 and 9 who were from schools highly exposed to the Hazelwood mine fire, or who reported higher levels of ongoing distress associated with the event, had different academic outcomes from students who were less exposed or who reported less distress associated with the event.

Meet the team

Dr Emily Berger
Dr Caroline Gao
Mr Jonathan Broder
Mr Tim Campbell
Prof Darryl Maybery
Dr Matthew Carroll

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we did

This analysis compared students from schools in Morwell, which were highly exposed to the smoke event, with those from lesser exposed schools located elsewhere in the Latrobe Valley. 303 students aged 7 to 16 years completed a survey more than one year after the event, which included the Children's Revised Impact of Events Scale (CRIES-13); a measure of distress associated with the mine fire. This survey information was coupled with students' NAPLAN scores (obtained from the Australian Curriculum, Assessment and Reporting Authority) from the years before and the year after the Hazelwood event. When we analysed the data, we took into account other known factors that can affect academic performance, including age, sex and school sector.

A more detailed paper describing the findings from this analysis can be found at
https://hazelwoodhealthstudy.org.au/study-findings/publications

What we found

The longitudinal analysis found that secondary school students from schools most exposed to the smoke had delayed academic development (as measured by NAPLAN scores) after the event compared to students from lesser exposed schools. Primary school students from Morwell did not show the same delay in academic development. Having a higher level of distress was not associated with delayed academic outcomes.

Considerations

The number of participating students was relatively low. We cannot rule out the possibility that the results occurred by chance, or were due to other unmeasured factors that can affect academic performance such as another distressing event.

The finding that primary school students from Morwell did not have the same delay in academic development as older secondary students could be because more supports may have been targeted at primary schools following the event.

Where to from here

Future research will aim to analyse NAPLAN data for all students across the Latrobe Valley, and not just those who completed our survey. HHS results will be shared with relevant organisations to ensure they are used to shape services for the future wellbeing of the Latrobe Valley.

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

This research was funded by the Victorian Department of Health and Human Services.

Hazelwood HEALTH STUDY

Use of health services and medications **Research Summary**

September 2020

Analysis aims

The aims of these analyses were to examine whether coal mine fire-related air pollutants were associated with increased use of health services, and increased dispensing of prescription medications, for cardiovascular, respiratory and mental health conditions.

Meet the team

Michael Abramson

Yuming Guo

Amanda Johnson

Joanna Dipnall

Jillian Ikin

Caroline Gao

Christina Dimitriadis

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research the University of Tasmania, The University of Adelaide and the CSIRO.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

What we did

Data on health service use in the Latrobe Valley area were obtained from the Medicare Benefits Schedule (MBS) database for the period 1 July 2012 to 30 June 2016. Data on prescription medications dispensed by pharmacists were obtained from the Pharmaceutical Benefits Scheme (PBS) database for the period 1 January 2013 to 31 December 2016. MBS and PBS data were provided by the Commonwealth Department of Human Services. The Commonwealth Scientific and Industrial Research Organisation Oceans and Atmosphere modelled hourly levels of mine fire-related air pollutants based on concentrations of fine air particulate matter with a diameter of 2.5 thousandths of a millimetre or less ($PM_{2.5}$). Daily maximum temperatures were collected from the Australian Bureau of Meteorology. A statistical method called time series analysis was used to measure the associations between daily average $PM_{2.5}$, use of health services and dispensing of medications in the Latrobe Valley. These models took into account the influences of other contributing factors such as season, temperature and public holidays.

Hazelwood HEALTH STUDY

What we found

The analyses found that levels of mine fire-related $PM_{2.5}$ were associated with increased health service use and increased rates of dispensing prescription medications in the Latrobe Valley area. During the 30 day period from 9 February to 10 March 2014, it was estimated that there were an additional 3,274 General Practitioner consultations and 159 respiratory health service visits attributed to coal mine-fire related $PM_{2.5}$. Increased General Practitioner consultations occurred after about 4-5 days of smoke exposure. Increased respiratory health service visits occurred after about 7 days of smoke exposure. There was also a small increase in mental health consultations after about 15 days of exposure.

Furthermore, it was estimated that an additional 2,093 cardiovascular medications, 890 respiratory medications and 1,053 mental health related medications were dispensed as a result of coal mine-fire related $PM_{2.5}$.

A full report describing the findings from this analysis can be found at hazelwoodhealthstudy.org.au/study-findings/study-reports

Considerations

While the findings suggest there was an increase in the use of medical services and dispensing of medications in the Latrobe Valley associated with the coal mine fire smoke, the data are not sufficient to link any individual's case to the mine fire.

There are some limitations to interpretation of these data. Numbers of medications dispensed may not equal numbers of medications taken by recipients. Medications provided over the counter at pharmacies (without a prescription) are not included in the PBS dataset and medical services that do not qualify for Medicare benefits are not included in the MBS dataset.

Finally, in this instance measurement of air pollution was limited to $PM_{2.5}$ and did not include other possible pollutants such as carbon monoxide.

Where to from here

To complement these findings based on MBS and PBS data, the HHS is also evaluating data from clinical examinations and interviews to further assess cardiovascular, respiratory and mental health in smoke effected communities.

The HHS results will be shared with relevant organisations to ensure that findings are used to shape services for the future health of the Latrobe Valley.

This research was funded by the Victorian Department of Health and Human Services.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Research Summary

Results from the Respiratory Stream. Coal mine fire smoke exposure and chronic obstruction of lung airflow in adults

September 2020

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.
The **Respiratory Stream** is the part of the HHS that examines whether exposure to smoke from the mine fire is associated with respiratory symptoms, asthma control and decline in lung function.

Meet the team

Shivonne Prasad
Caroline Gao
Brigitte Borg
Jonathan Broder
David Brown
Jillian Ikin
Annie Maker
Tom McCrabb
Ryan Hoy
Bruce Thompson
Michael Abramson

What we did

Chronic Obstructive Pulmonary Disease (COPD) is characterised by persistent obstruction of lung airflow that interferes with normal breathing and is not fully reversible. In the past COPD has been called 'chronic bronchitis' and 'emphysema'. We measured COPD in 346 adults from Morwell and 173 from Sale, using a breathing test called spirometry. Spirometry measures how much air you inhale and exhale, and how fast you exhale. The test was performed ten minutes after using an asthma puffer containing salbutamol (Ventolin). We also conducted a test called 'transfer factor for carbon monoxide' ($T_L$co) which measures the ability of the lung to transport gas into and out of blood. Participants also answered questions about respiratory symptoms such as cough and chest tightness and medication use.
We worked with CSIRO to estimate the levels of fine particles in the mine fire smoke smaller than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Particles this fine can travel deep into people's lungs. Morwell participants were grouped into three levels of mine fire $PM_{2.5}$ exposure (*low*: daily average of 6 micrograms per cubic metre of air (µg/m^3); *medium*: average of 12 µg/m^3; and *high*: average of 28 µg/m^3). Sale participants were categorised as having little or no exposure. We took into consideration other factors that could influence lung health, such as age, height, weight, cigarette smoking and participant's jobs that may have involved exposure to gases, dusts or fumes.

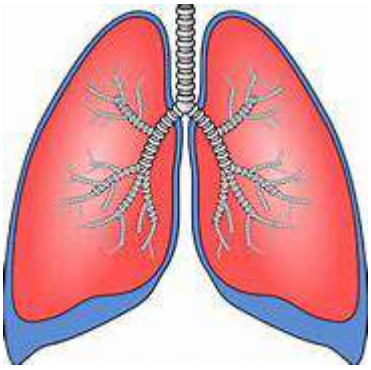
Analysis aims

Three and a half years after the mine fire, this research aimed to discover whether adults who were more highly exposed to the mine fire smoke had more Chronic Obstructive Pulmonary Disease than adults who had less exposure.

A detailed paper describing the findings from this analysis can be requested from the Hazelwood Health Study researchers by email contact@hazelwoodhealthstudy.org.au or phone 1800 985 899

What we found

We found that as the level of mine fire $PM_{2.5}$ exposure increased evidence of chest tightness and chronic cough was increased more than three years later. When we investigated COPD, the results differed depending on whether participants were cigarette smokers or non-smokers. Amongst non-smokers, there was strong evidence of increasing levels of $PM_{2.5}$ exposure being associated with increased levels of COPD. We did not see this dose response relationship between $PM_{2.5}$ exposure and COPD amongst smokers. However, amongst smokers we did see that increased $PM_{2.5}$ exposure was particularly associated with increased evidence of chronic cough. We did not find any evidence of an association between mine fire $PM_{2.5}$ exposure and the ability of the lung to transport gas into and out of blood.



Considerations

We cannot be absolutely certain that the mine fire smoke caused the changes that we observed in lung airflow obstruction, chronic cough and chest tightness. This is because additional factors can affect lung health, such as genes, previous exposure to other sources of smoke, infections or access to health services. Regardless of the cause, people with symptoms like shortness of breath, chest tightness or frequent coughing should always have these checked by a doctor.

Where to from here

Follow up testing of the Respiratory Stream participants is important so that longer term health effects of the mine fire smoke can be investigated and we can see if the changes in lung health resolve, persist or worsen.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.
The research was funded by the Department of Health and Human Services.

Research Summary

Results from the Respiratory Stream. The impact of coal mine fire smoke on lung health in adults

September 2020

Analysis aims

Three and a half years after the mine fire, this research aimed to discover whether adults who were more highly exposed to the mine fire smoke had poorer lung function than adults who had less exposure.

Meet the team

Nicolette Holt
Caroline Gao
Brigitte Borg
David Brown
Jonathan Broder
Jillian Ikin
Annie Maker
Tom McCrabb
Kris Nilsen
Bruce Thompson
Michael Abramson

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups. The **Respiratory Stream** is the part of the HHS that examines whether exposure to smoke from the mine fire is associated with respiratory symptoms, asthma control and decline in lung function.

What we did

We worked with CSIRO to estimate the levels of fine particles in the smoke smaller than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Particles this fine can travel deep into people's lungs. We tested 346 adults from Morwell who were grouped into three levels of mine fire $PM_{2.5}$ exposure (*low*: daily average of 6 micrograms per cubic metre of air (µg/m^3); *medium*: average of 12 µg/m^3; and *high*: average of 28 µg/m^3) and 173 adults from Sale who had little or no exposure. Participants underwent a test of lung health using the forced oscillation technique (FOT). FOT involves normal breathing on a machine while sound waves are used to measure how easily air can move through the lungs and the stretchiness of the lungs. The test was conducted both before and after using an asthma puffer containing salbutamol (Ventolin). Participants also answered questions about respiratory symptoms such as cough and wheeze and medication use. We took into consideration other factors that could influence lung health, such as age, height, weight, cigarette smoking and participants' jobs that may have involved exposure to dusts, smoke or fumes.

A detailed paper describing the findings from this analysis can be requested from the Hazelwood Health Study researchers by email contact@hazelwoodhealthstudy.org.au **or phone 1800 985 899**

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy @HazelwoodHS

What we found

We found that as the level of mine fire $PM_{2.5}$ exposure increased, lung stretchiness decreased. That is, three and a half years after the mine fire, higher levels of smoke exposure were associated with poorer lung function in adults. It is normal for the lungs to become less stretchy as we age. However, our findings indicated that each 10 $\mu g/m^3$ increment in smoke exposure was associated with reduced stretchiness that you would normally observe after approximately four years of aging. This finding was independent of participants' actual age.

Hazelwood Health Study Respiratory Scientists above from left to right: Brigitte Borg, Tom McCrabb, Annie Makar.

Considerations

We cannot be absolutely certain that the mine fire smoke caused the change in lung stretchiness because additional factors can affect lung health, such as genes, previous exposure to other sources of smoke, infections or access to health services. The small decreases in lung stretchiness that we measured may not mean that the affected adults will experience any noticeable lung problems now or in the future. However, people with symptoms like shortness of breath, wheezing, or frequent coughing should always have these checked by a doctor. Further, because a large proportion of adults from Morwell and Sale did not participate in the baseline Adult Survey from which the Respiratory Stream participants were drawn, it is possible that the findings do not truly represent lung health in the two communities.

Where to from here

Follow up testing of the Respiratory Stream participants is important so that longer term health effects of the mine fire smoke can be investigated and we can see if changes in lung stretchiness resolve, persist or worsen.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health and Human Services.

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy @HazelwoodHS

Hazelwood mine fire smoke exposure and ambulance attendances in the following years

Research Summary

September 2020

Meet the team

Jonathan Broder
Caroline Gao
Michael Abramson
Rory Wolfe
Christina Dimitriadis
Jillian Ikin
Malcolm Sim
Anthony Del Monaco
Fay Johnston
Matthew Carroll
David Brown
Karen Smith
Yuming Guo

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups. The **Hazelinks Stream** of the HHS investigates the long-term health of the smoke-exposed communities by using administrative health datasets, such as ambulance, hospital, Medicare, pharmaceutical, cancer and death records.

Analysis aims

This analysis aimed to see whether people who were most exposed to smoke from the Hazelwood mine fire were more likely to have needed an ambulance in the years following the event, compared with people who were less exposed or not exposed.

What we did

Approximately 2.5 years after the Hazelwood mine fire, 3096 Morwell residents participated in the HHS Adult Survey. Each participant filled in a time-location diary to show where they were on each day and night of the mine fire period. This was important because the smoke levels varied quite a bit from day to day. Using the diaries and air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure during the fire, to fine air particles in the smoke of less than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Consent was given by 2223 of the Adult Survey participants for the researchers to access their Ambulance Victoria attendance records. For this analysis we looked at ambulance attendances from just after the fire, 1 April 2014 to 31 December 2017.

A detailed report describing the findings from this analysis can be found at
hazelwoodhealthstudy.org.au/study-findings/study-reports

What we found

We found that as the levels of exposure to smoke-related $PM_{2.5}$ increased, the likelihood that a participant required an ambulance attendance in the following years also increased. This is evidence for a dose-response relationship. In particular we observed that increases in smoke exposure during the fire, were associated with increases in ambulance attendances for respiratory (lung) conditions and for cardiovascular (heart) conditions in the years after the fire. These findings could mean that the mine fire smoke impacted the lung- and heart-health of people for a prolonged period after the fire was put out.

Considerations

The analysis used a number of statistical methods to account for other factors that might have influenced ambulance attendances, such as previous health, age, gender, marital status, smoking history and employment in jobs that involved exposure to dust, fumes, smoke, mist or gas. However, there remains a possibility that factors other than the mine fire smoke influenced the ambulance attendances. Further, because a proportion of adults from Morwell did not participate in the Adult Survey, it is possible that the findings do not truly reflect that community.

Where to from here

These findings which used ambulance attendance data, will be looked at along-side other findings which used hospital, Medicare, pharmaceutical, cancer and death records, self-reported symptoms and clinical examinations of participants, to get a comprehensive overview of the long-term effects of the Hazelwood coalmine smoke on the health of adults in the Latrobe Valley.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health and Human Services.

Hazelwood HEALTH STUDY

Risk of death in Morwell, the broader Latrobe Valley and surrounding smoke impacted areas during and after the Hazelwood mine fire

Research Summary

October 2020

Analysis aims

This research aimed to determine whether death rates increased during or after the mine fire and whether these rates were affected by changes in the levels of mine fire smoke pollution.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The Study involves multiple research streams targeting different health outcomes and different vulnerable groups.

Meet the team

Associate Professor Yuming Guo
Ms Christina Dimitriadis
Dr Caroline Gao
Professor Rory Wolfe
Dr Jillian Ikin
Professor Michael Abramson
Professor Malcolm Sim

What we did

For this research we defined the 'mine fire period' as the 30 days from 9 February to 10 March 2014. After these dates the smoke levels dropped quickly. We used national death records to calculate the rates of death during the mine fire period, and during the six months after the mine fire, in Morwell, in the broader Latrobe Valley, and in surrounding smoke impacted areas. We also calculated the rates of death after daily changes in smoke levels. The national death records provided information about the cause of death which was defined as the disease or injury that led to the death (for example asthma, heart disease or an accident). The term *cause of death* did not relate to whether the mine fire smoke pollution contributed to the death, but assisted us to investigate whether certain types of deaths were more common during or after the mine fire. We took in to consideration other factors that could influence death rates such as season, temperature and the age of the population.

A detailed report describing the findings from this analysis can be found at
hazelwoodhealthstudy.org.au/study-findings/study-reports

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we found

When all deaths were counted (regardless of cause of death), the overall risk of death in Morwell and in other smoke impacted areas was similar to what would usually be expected during the 30 day mine fire period. However, in the six months after the mine fire, the overall risk of death in Morwell (but not in other smoke impacted areas) was slightly higher than what would usually be expected.

When specific causes of death were investigated, the following results were found.

During the 30 day mine fire period, in the Latrobe Valley:

- there was an increase in the risk of death from injury. The greatest increases in risk of death from injury during the mine fire period were observed in men and in residents aged 80 years and older. Across all smoke-impacted communities, there were approximately 11 extra deaths from injury during the mine fire period.

In the six months after the mine fire, in the Latrobe Valley and particularly Morwell:

- there was an increased risk of death from cardiovascular conditions, particularly ischaemic (coronary) heart disease. Greatest risks were observed in men and residents aged 80 years and older. There were approximately 26 extra deaths in Morwell from cardiovascular conditions in the six months after the mine fire.

There was no association between mine fire smoke and an increased risk of death from respiratory conditions.

Where to from here

These findings will be shared with relevant health and emergency services to help inform future responses to air pollution events. The Hazelwood Health Study will continue to monitor the long-term health of communities impacted by the mine fire.

The Hazelwood Health Study is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide and CSIRO. The research was funded by the Department of Health and Human Services.

Considerations

Some of the findings from this research were based on quite small numbers of deaths. When numbers are small, it is possible that the increases in risk of death have occurred by chance. It is not possible from these records to tell what activity or behavior led to the injury related deaths that were observed in this research.

The finding of no association between mine fire smoke and respiratory-related deaths does not mean that the smoke was safe for people with respiratory illnesses. Instead it is possible that some people with chronic respiratory illnesses took precautionary action during the mine fire, such as leaving the smoky areas, staying indoors and/or taking additional medication. These actions may have prevented some potential respiratory-related deaths and contributed to the lack of an association between the mine fire and respiratory deaths. Other Hazelwood Health Study research has shown that the mine fire smoke contributed to a worsening of respiratory symptoms.

Even though the researchers were able to investigate changes in the rates of death across the community that might have been associated with the mine fire smoke, the data did not allow the researchers to answer questions about whether any individual person's death was caused by the fire.

Website: www.hazelwoodhealthstudy.org.au/study-reports @hazelwoodhealthstudy @HazelwoodHS

Hazelinks Mortality Report: Time series analyses of anonymous mortality data for the period July 2009 to June 2015

For a glossary of important terms used in the report, click here.

Your questions and answers

What is Hazelinks?

Hazelinks is a research stream of the Hazelwood Health Study that uses population health datasets to investigate changes in the health of the community during and after the Hazelwood mine fire.

What is the Hazelinks Mortality Report?

The Hazelinks Mortality Report describes analysis of data obtained from the National Mortality Database (NMD) which is a register of every death in Australia. Using NMD data from 1 July 2009 (approximately 4 ½ years before the mine fire) to 30 June 2015 (almost 1 ½ years after the mine fire), the analysis aimed to answer three research questions:

1. In mine-fire affected communities, did death rates increase during the mine fire compared to similar time periods before and after the fire?
2. In mine-fire affected communities, did death rates increase after the mine fire compared to before the fire?
3. In mine-fire affected communities, were changes in the daily levels of mine fire smoke associated with changes in death rates?

What are the main findings in the Hazelinks Mortality Report?

The patterns of deaths observed in the Latrobe Valley over the period 1 July 2009 to 8 February 2014 were used to estimate what the *expected* risk of death was for the 30-day *mine fire period* when smoke levels were most intense and for the *six months after the mine fire*.

During the 30 day mine fire period

When all deaths were considered (irrespective of the cause of death), the overall risks of death in Morwell and in other fire impacted areas during the 30 day *mine fire period*, were similar to expected.

However, when cause of death categories were looked at separately, it was observed that there was a three-fold increase in risk of injury-related deaths in Morwell during the 30 day *mine fire period*. There was also a small increase in injury-related deaths in the rest of the Latrobe Valley and surrounding smoke-impacted areas during the 30 day *mine fire period.*

It was estimated that there was a total of 11 injury-related deaths during the 30 day *mine fire period* across all of the smoke impacted areas (including three in Morwell) that were "attributable to the mine fire event"; meaning that they were additional deaths to those expected.

The excess injury-related deaths were predominantly categorised as unintentional, as opposed to cases of intentional self-harm. In the Latrobe Valley, men and residents aged 80 years or older were at greatest increased risk of death from injury during the mine fire period.

Increases in daily mine fire-related $PM_{2.5}$ pollution levels were found to be associated with increases in risk of injury-related death, suggesting a dose-response relationship.

Key findings

During the 30 day period 9 February to 10 March 2014, when smoke levels were the most intense:

- there was an increased risk of injury-related deaths in the smoke impacted areas, particularly in Morwell;
- there were 11 more injury-related deaths in the smoke impacted areas during this period than would have been expected;
- these injury-related deaths were predominantly unintentional;
- men and residents aged 80 years or older were at greatest increased risk of injury-related death.

During the six months after the mine fire

When all deaths were considered (irrespective of the cause of death), the overall risk of death in Morwell during the *six months after the mine fire* was 29% higher than expected. In smoke impacted areas outside of Morwell, the overall risk of death during the *six months after the mine fire* was similar to expected

When cause of death categories were looked at separately, it was observed that there was a 27% increase in risk of death from cardiovascular (heart and circulation) conditions in the Latrobe Valley as a whole and, more specifically, a 62% increase in Morwell during the *six months after the mine fire*. In particular, risk of death from Ischaemic Heart Disease (IHD, also known as coronary artery disease) was increased. In total there were an extra 26 cardiovascular deaths in Morwell attributed to this six-month period, including 17 with IHD. Those 26 cardiovascular deaths represented 38% of all cardiovascular deaths in Morwell during this six-month period. Men and residents aged 80 and above in the Latrobe Valley were at an increased risk of death from IHD in the six months after the fire.

Key findings

During the 6 months after the mine fire period, from 11 March to 11 September 2014:

- there was an increased risk of death from cardiovascular diseases in the Latrobe Valley, particularly in Morwell;
- there were 26 cardiovascular-related deaths in Morwell, including 17 with Ischaemic Heart Disease, that were additional deaths to those expected;
- men and residents aged 80 years or older were at greatest increased risk of death from cardiovascular diseases.

Was there an increase in deaths from respiratory conditions related to the mine fire during the mine fire period and in the following six months?

There were no associations observed between the mine fire and respiratory-related deaths. This is unlikely to mean that the smoke posed no threat to people with respiratory illnesses. Instead it is likely that vulnerable people with chronic respiratory illnesses took preventive action including leaving the smoke impacted areas, wearing protective masks and/or increasing their use of preventive medications or oxygen therapy. Other Hazelwood Health Study research streams have shown an association between the mine fire smoke and respiratory symptoms in smoke affected communities.

Why did injury-related deaths increase during the 30-day mine fire period?

The numbers of excess injury-related deaths (11 during the mine fire period) were too small to subcategorise into more detailed injury-types. Also, the National Mortality Database data did not allow us to infer what activities or behaviours led to the injury-related deaths. Therefore, we don't know exactly what people were doing, or what types of injuries they sustained. However, there are studies showing that exposure to environmental pollutants can have adverse neurological and behavioural effects, such as reducing cognitive judgment and increasing anxiety, depression and self-harm behaviours. Anecdotal evidence suggests that some people in smoke affected areas may have undertaken risky activities, such as climbing ladders to remove ash or flammable debris from roofing, however the National Mortality Database did not contain this information.

Who were the 11 people with injury-related deaths, and 26 people with cardiovascular-related deaths attributed to the mine fire?

The National Mortality Database data were anonymous and only allowed the researchers to look at changes in the patterns of deaths across the population as a whole. The data did not allow the researchers to identify which 11 from all injury-related deaths, or which 26 from all cardiovascular-related deaths, were additional to those expected. The researchers also couldn't answer questions about whether any individual person's death was caused by the mine fire.

GLOSSARY OF IMPORTANT TERMS USED IN THE HAZELINKS MORTALITY REPORT

$PM_{2.5}$: Very small particles usually found in smoke that have a diameter of 2.5 thousandths of a millimetre or less. When breathed in, $PM_{2.5}$ particles are small enough to travel deeply into the lungs and some can even enter the bloodstream. The Hazelwood Health Study uses $PM_{2.5}$ levels as the main measure of smoke pollution during the mine fire.

Fire impacted areas: These are the towns/localities where the ground level $PM_{2.5}$ concentrations were higher than usual for at least one day during the *mine fire period*. See Figure 1.

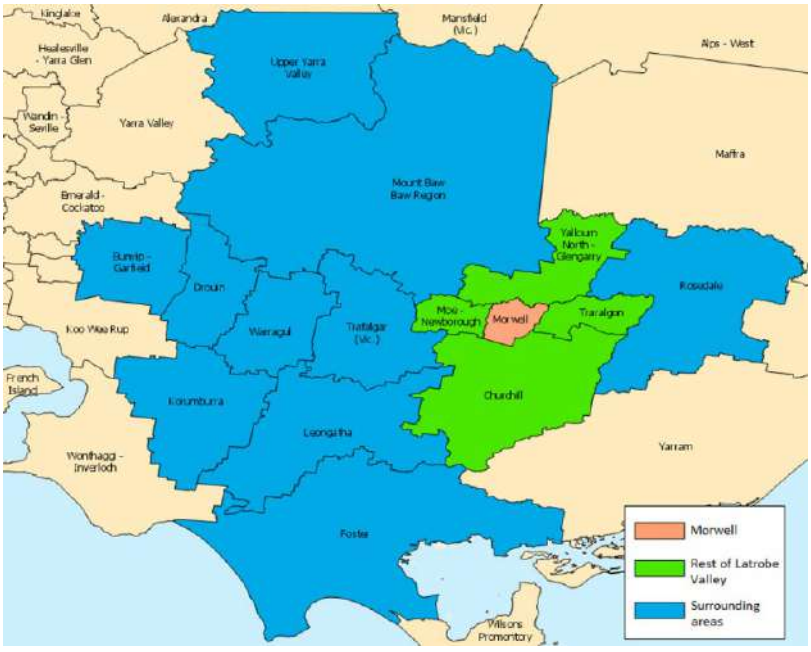


Figure 1. Geographical location of the fire impacted areas

Mine fire period: The Hazelwood mine fire burned for approximately six weeks from 9 February 2014. However, in the Hazelinks Mortality Report, the term *mine fire period* is defined as the 30-day period from 9 February to 10 March 2014. That was the period of the most intense smoke exposure. Figure 2 shows the estimated smoke $PM_{2.5}$ concentrations from 1 February to 31 March 2014 in the southern part of Morwell. The shaded section of Figure 2 shows the first 30-day period of the mine fire, when ground level $PM_{2.5}$ concentrations were markedly higher than usual. From 11 March 2014 onwards, $PM_{2.5}$ concentrations returned to very close to usual levels.

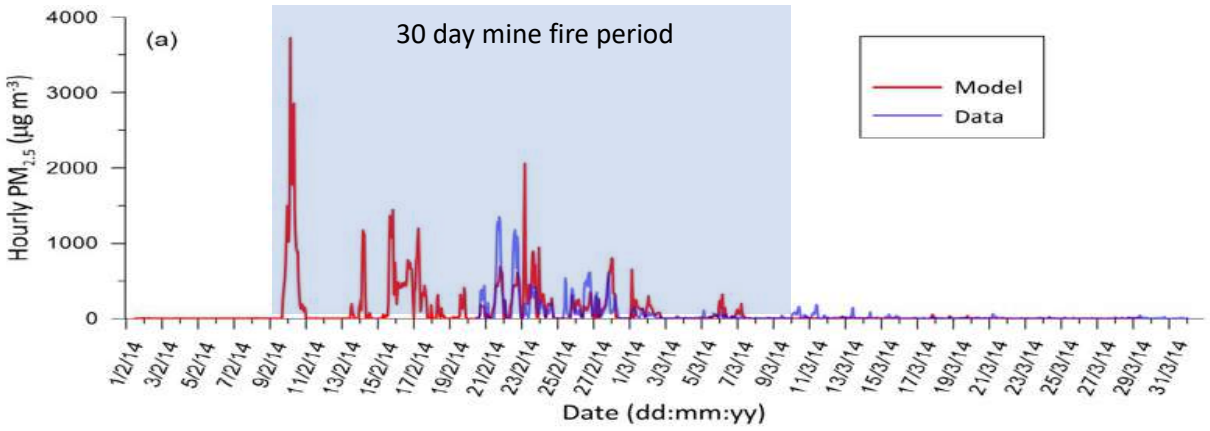


Figure 2. Hourly-averaged observed and modelled concentrations of $PM_{2.5}$ at southern Morwell.
Source: Emmerson K, Reisen F, Luhar A, Williamson G, Cope M. Air quality modelling of smoke exposure from the Hazelwood mine fire Australia: CSIRO; 2016. Available from: https://hazelwoodhealthstudy.org.au/study-findings/study-reports.

Six months after the mine fire period: The period from 11 March to 11 September 2014.

Entire analysis period: The period from 1 July 2009 to 30 June 2015 for which we had death data.

All deaths or **all-cause mortality:** These are counts of all deaths no matter what was the cause of death.

Cardiovascular-related death: These deaths were the result of diseases of the heart and circulatory system. Examples include hypertensive diseases, pulmonary heart disease, ischemic heart disease and diseases of the arteries.

Injury-related death: These deaths were the result of an injury. Examples include injuries due to accidents (such as transport accidents, falls, accidental contact with force, heat or poison), intentional self-harm, assault and medication or drug overdoses.

Dose-response relationship: A dose-response relationship occurs when changes to the level/dose of something (like a medication or exposure to pollution) are associated with changes to a health outcome. In this report we investigated whether there was a dose-response relationship between changes in daily levels of mine fire smoke $PM_{2.5}$ exposure and risk of death.

Research Summary

The ongoing psychological health in adults six years after the 2014 Hazelwood mine fire

December 2020

Analysis aims

This analysis aimed to investigate whether levels of psychological distress in adult Morwell residents have changed in the three years since the 2016-2017 Adult Survey. The analysis also investigated whether changes in psychological distress were associated with smoke exposure during the event, and examined the role of other risk factors.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

Meet the team

Dr Matthew Carroll
Mr Tim Campbell
Dr Caroline Gao
Ms Catherine Smith
Prof Darryl Maybery
Dr Emily Berger
Mr David Brown
Ms Shantelle Allgood
Dr Jillian Ikin
Prof Rory Wolfe
Prof Judi Walker
Dr Susan Yell
Prof Malcolm Sim
Prof Michael Abramson

What we did

We invited a sample of Morwell residents who participated in the 2016-2017 Adult Survey to complete a Mental Health and Wellbeing Follow-up Survey. In both survey rounds, we measured psychological distress experienced specifically in relation to the 2014 Hazelwood mine fire (Impact of Events Scale-Revised: IES-R), and psychological distress experienced more generally (Kessler-10 Scale: K10). We estimated smoke exposure levels for each participant using CSIRO data on the density of fine airborne particles ($PM_{2.5}$) in the smoke plumes. In total, 713 people participated in the follow-up survey.

A more detailed paper describing the findings from this analysis can be found at
https://hazelwoodhealthstudy.org.au/study-findings/publications

What we found

The main finding was that, 6 years after the Hazelwood event, there was a continuing relationship between participants' level of exposure to $PM_{2.5}$ during the 2014 mine fire and the level of ongoing psychological distress they associated with the event, with the most exposed people reporting higher distress levels on the IES-R. In addition, participants' psychological distress (scoring on both the IES-R and K10) increased in the three years between the two survey rounds. Consistent with the earlier Adult Survey analysis, the impact of $PM_{2.5}$ exposure on event-related psychological distress was most severe for younger adults. Furthermore, higher psychological distress remained associated with several other key risk factors, including asthma, chronic obstructive pulmonary disease (COPD), having experienced multiple prior traumatic events, and being unemployed or unable to work.

Considerations

The data collection period for the follow-up survey (December 2019 to March 2020) coincided with the catastrophic bushfire and smoke events that impacted south-eastern Australia during the 2019-2020 summer. These background circumstances likely had an influence on some participants' survey responses, and may be one of the reasons for the increasing distress levels between the two rounds.

Where to from here

This is the first of several analyses planned for the data collected in the follow-up survey. Analyses in 2021 will explore the role of additional factors important to understanding mental health outcomes, including social support, loneliness, resilience, and community wellbeing. A third survey round to further explore long-term mental health outcomes in the Morwell community is planned for 2022.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, and CSIRO.

This research was funded by the Victorian Department of Health and Human Services.

Hazelwood HEALTH STUDY

Hazelwood mine fire smoke exposure and hospital admissions in the following years

Research Summary

April 2021

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history.

It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The Hazelinks Stream of the HHS investigates the long-term health of the smoke-exposed communities by using administrative health datasets, such as ambulance, hospital, Medicare, pharmaceutical, cancer and death records.

Analysis aims

This analysis aimed to see whether people who were most exposed to smoke from the Hazelwood mine fire were more likely to have been admitted to hospital in the years following the event, compared with people who were less exposed or not exposed.

Meet the team

Mr Rongbin Xu
Dr Caroline Gao
Ms Christina Dimitriadis
Ms Catherine Smith
Dr Matthew Carroll
Dr Jillian Ikin
Prof Fay Johnston
Prof Malcolm Sim
Prof Michael Abramson
Prof Yuming Guo

What we did

Approximately 2.5 years after the Hazelwood mine fire, 4,056 residents from Morwell (exposed to the mine fire smoke) and Sale (unexposed) participated in the HHS Adult Survey. Each participant filled in a time-location diary to show where they were on each day and night of the mine fire period. This was important because the smoke levels varied quite a bit from day to day. Using the diaries and air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure during the fire, to fine air particles in the smoke of less than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Consent was given by 2,725 of the Adult Survey participants for the researchers to access their hospital admissions data held by the Department of Health. For this analysis we looked at hospital admissions from January 2009 to February 2019.

A more detailed paper describing the findings from this analysis can be found at
hazelwoodhealthstudy.org.au/study-findings/publications

Website: http://www.hazelwoodhealthstudy.org.au/ @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

What we found

Amongst women, we found that as the levels of exposure to smoke-related $PM_{2.5}$ increased, the likelihood of being admitted to hospital in the following 5 years for a respiratory-related condition, also increased. This relationship was not observed for men. There was no evidence that mine-fire $PM_{2.5}$ exposure was associated with increased hospitalizations for cardiovascular diseases, mental illness, injuries, type 2 diabetes, renal diseases or neoplasms during the 5 years after the fire. These findings could mean that the mine fire smoke impacted the lung health of women for a prolonged period after the fire was put out.

Considerations

The analysis used a number of statistical methods to account for other factors that might have influenced hospital admissions, such as previous health, age, gender, marital status, smoking history and employment in jobs that involved exposure to dust, fumes, smoke, mist or gas. However, there remains a possibility that factors other than the mine fire smoke influenced the hospital admissions. Further, because a proportion of adults from Morwell did not participate in the Adult Survey, it is possible that the findings do not truly reflect that community.

Where to from here

These findings which used hospital admissions data, will be looked at alongside other findings which used ambulance, Medicare, pharmaceutical, cancer and death records, self-reported symptoms and clinical examinations of participants, to get a comprehensive overview of the long-term effects of the Hazelwood coalmine smoke on the health of adults in the Latrobe Valley.

The Hazelwood Health Study is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide and CSIRO.
The research was funded by the Department of Health.

Website: http://www.hazelwoodhealthstudy.org.au/ @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Research Summary

Evaluating the impact of the Hazelwood mine fire event on students' educational development

April 2021

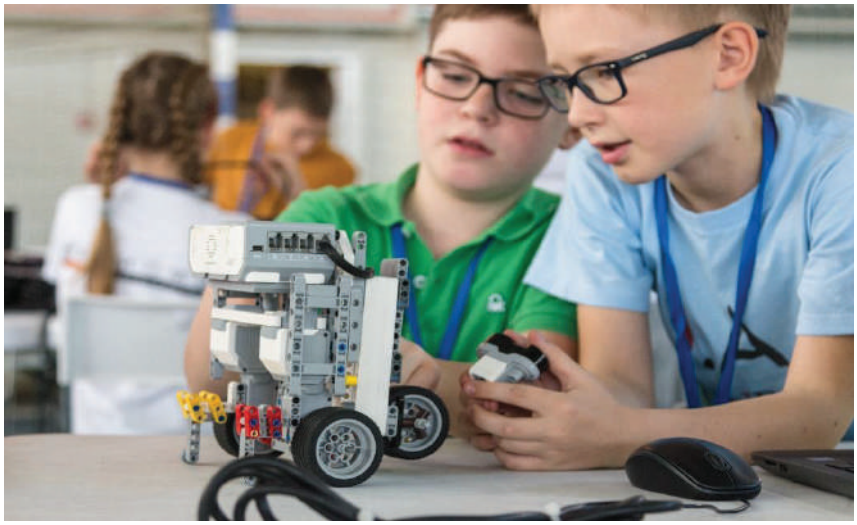
Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

This study aimed to determine whether students in years 3, 5, 7 and 9 from schools in Morwell which were highly exposed to the Hazelwood mine fire, had different academic outcomes to students from schools which were moderately exposed, or from schools with little or no exposure.



What we did

A new statistical approach was used to analyse NAPLAN and school administrative data from 2008 to 2018 to analyse change in educational outcomes as a result of exposure to the 2014 mine fire. School-level data from 69 primary and secondary schools, including average scores in each NAPLAN domain for years 3, 5, 7 and 9, were used rather than individual student-level data. The analysis compared academic progress in students from highly exposed schools in Morwell, to those from moderately exposed schools in the rest of the Latrobe Valley, and students from schools in Wellington Shire which had little or no exposure to the smoke event. The analysis took into consideration differences in school profile, including socioeconomic status, school size, gender ratio, and school sector (government vs non-government), as well as grade level and longer term trends in NAPLAN.

A more detailed paper describing the findings from this analysis can be found at
www.hazelwoodhealthstudy.org.au/study-findings/publications

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy @HazelwoodHS

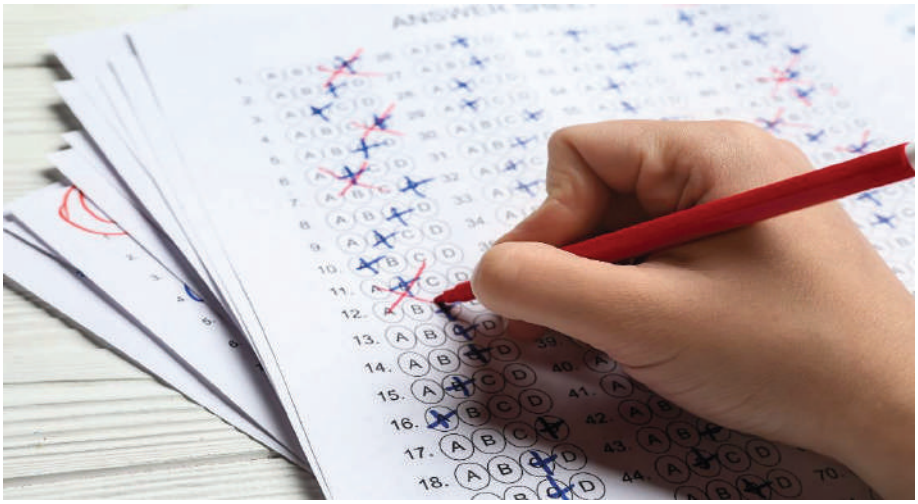
Hazelwood HEALTH STUDY

What we found

In the year following the mine fire, major academic interruptions across all NAPLAN domains were evident in the highly exposed Morwell schools. Compared to the Victorian regional average, this interruption equated to a three to four-month delay in educational attainment which had not fully recovered several years later. This evidence of considerable and enduring delays highlights the need to provide educational and community-based supports in response to future events. Importantly, this work introduces a new statistical method to use readily available school-level data to assess educational impacts resulting from other disasters.

Considerations

Due to the low number of secondary schools in the region, we were unable to evaluate which year levels were most impacted by the mine fire event. The aggregated nature of the school-level data meant that we were unable to consider individual-level factors that influence academic outcomes, such as each student's physical, psychological or social health. More detailed region-specific data on unemployment, service availability and other factors which might influence academic performance were not available for this analysis.



Meet the team

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Dr Sam Brilleman
Dr Emily Berger
Dr Jillian Ikin
Ms Catherine Smith
Mr Tim Campbell
Prof Rory Wolfe
Prof Fay Johnston
Prof Yuming Guo
Dr Matthew Carroll

Where to from here

HHS results will be shared with relevant organisations to ensure they are used to shape services for the future wellbeing of the Latrobe Valley.

The HHS is led by Monash University with collaborators from the Menzies Institute for Medical Research at the University of Tasmania, Federation University, The University of Adelaide and CSIRO.

The research was funded by the Victorian Department of Health.

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy @HazelwoodHS

Hazelwood HEALTH STUDY

Research on cancer, five years after the mine fire
Research Summary

October 2021

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.
The Hazelinks Stream of the HHS investigates the long-term health of the smoke-exposed communities by using administrative health datasets, such as ambulance, hospital, Medicare, pharmaceutical, cancer and death records.

Meet the team

Pei Yu
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Jillian Ikin
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David Brown
Malcolm Sim
Michael Abramson

Analysis aims

This analysis aimed to see whether people who were most exposed to smoke from the Hazelwood mine fire were more likely to have a diagnosis of cancer during the five years following the event, compared with people who were less exposed or not exposed.

What we did

We searched the Victorian Cancer Registry (VCR) for any records matching 2208 Morwell residents who were exposed to the Hazelwood mine fire smoke, and 646 Sale residents who were much less exposed or not exposed, who had previously participated in the Hazelwood Health Study Adult Survey and agreed to VCR linkage. Each participant had filled in a time-location diary to show where they were on each day and night of the mine fire period. This was important because the smoke levels varied quite a bit from day to day. Using the diaries and air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure during the fire, to fine particles in the smoke of less than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). For this analysis we looked at new cancers diagnosed between 9 August 2014 and 31 December 2019. Cancers usually take a long time to develop. For this reason, cancers diagnosed within 6 months after the mine fire were not included as these were extremely unlikely to have been caused by the smoke.

A detailed paper describing the findings from this analysis can be requested from the Hazelwood Health Study researchers by email contact@hazelwoodhealthstudy.org.au or phone 1800 985 899

Hazelwood HEALTH STUDY

What we found

We found that overall cancer incidence was higher in Morwell than in Sale during the 5 years after the mine fire. However, within exposed Morwell participants, we did not observe a difference in cancer incidence between highly exposed and less exposed participants. That is, we observed a difference in overall cancer incidence between the two towns, but no strong evidence that cancer incidence was associated with smoke exposure. This suggests the possibility that the difference in cancer incidence between the two towns *may* not have been caused by the mine fire. When we looked at specific cancer sites such as lung, colorectal and urinary cancers, numbers were too small to show any definite evidence of a difference between the two towns or between higher and lesser $PM_{2.5}$ exposed participants.

Considerations

The analysis used a number of statistical methods to account for other factors that might have influenced cancer incidence, such as age, sex, education, smoking history and employment in jobs that involved exposure to dust, fumes, smoke, mist or gas. We did not find that these factors explained the difference in cancer between the two towns. However, there remains the possibility that factors other than the mine fire smoke influenced the difference in cancer between Morwell and Sale, such as differences in job types or diet. Further, because proportions of adults from Morwell and Sale did not participate in the Adult Survey, it is possible that the findings do not truly reflect those communities. Finally, a five year follow up period may be too brief to detect some cancers which can be very slow to develop.

Where to from here

These findings which used cancer registry data will be looked at alongside other findings which used ambulance, hospital, Medicare, pharmaceutical and death records, self-reported symptoms and clinical examinations of participants, to obtain a comprehensive overview of the long-term effects of the Hazelwood coalmine smoke on the health of adults in the Latrobe Valley. A further linkage with the VCR is planned for 2023 in order to obtain approximately 9 years of cancer data.

The Hazelwood Health Study is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide and CSIRO.
The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Impacts of the Hazelwood mine fire on ambulance attendances, emergency department presentations and hospital patient admissions for mental health conditions

October 2021

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels.

The smoke event caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

Meet the team

Matthew Carroll
Caroline X Gao
Tim Campbell
Catherine Smith
Emily Berger
Darryl Maybery
Jillian Ikin
Michael Abramson
Malcolm Sim
Alexander McFarlane
Christina Dimitriadis
Karen Smith
Yuming Guo

Analysis aims

The aim of this analysis was to examine whether coal mine fire-related air pollutants were associated with increased rates of ambulance attendances, emergency department presentations and hospital patient admissions for mental health conditions.

What we did

Latrobe Valley ambulance and hospital services data were obtained from Ambulance Victoria and the Victorian Department of Health for the period 1 July 2010 to 31 March 2015. Air pollution modelling by the CSIRO estimated hourly levels of fine air particles in the smoke with a diameter of 2.5 thousandths of a millimetre or less ($PM_{2.5}$). A statistical method called time series analysis was used to measure the associations between daily average $PM_{2.5}$, and daily rates of ambulance attendances, emergency department presentations and hospital admissions for mental health conditions in the Latrobe Valley. We looked at the use of these health services during the first 30-days of the fire when smoke concentrations were highest, from 9 February to 10 March 2014, and compared that with health service use before and after the Hazelwood event. We also took into account the influences of other factors, such as season, temperature, and public holidays.

A more detailed paper describing the findings from this analysis can be found at
https://hazelwoodhealthstudy.org.au/study-findings/publications

Hazelwood HEALTH STUDY

What we found

The analyses found that levels of mine fire-related $PM_{2.5}$ during the first 30 days of the fire, were associated with short-term increases in ambulance attendances and emergency department presentations, but not hospital patient admissions, for mental health conditions in the Latrobe Valley area.

The most prominent effects were observed after about 5 days of smoke exposure, where for each 10 $\mu g/m^3$ increase in mine fire-related $PM_{2.5}$, the estimated risk of an ambulance attendance for anxiety increased by 38% and the risk of an emergency department presentation for depression increased by 36%.

Considerations

While the findings suggest there was an increase in the rates of ambulance attendances and emergency department presentations for mental health conditions in the Latrobe Valley associated with the coal mine fire smoke, the data are not sufficient to link any individual's case to the mine fire.

An important limitation to interpretation of these data relates to the challenge of making rapid clinical judgements in relation to mental health status during an emergency situation such as an ambulance attendance. There is potential for misdiagnosis in these circumstances.

Where to from here

The HHS has a continuing program of research, which includes clinical respiratory examinations and periodic surveys of mental health and wellbeing, to better understand health impacts of the mine fire in affected communities.

These HHS results will be shared with relevant organisations to ensure they are used to shape services for the future health and wellbeing of the Latrobe Valley

The Hazelwood Health Study is a collaborative program of research led by the Monash University Schools of Public Health and Preventive Medicine and Rural Health in partnership with Federation University, the Menzies Institute for Medical Research at the University of Tasmania, the University of Adelaide and the CSIRO.

This research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Hazelwood mine fire smoke exposure and hospital emergency department presentations in the following years **Research Summary**

February 2022

Analysis aims

This analysis aimed to see whether people who were most exposed to smoke from the Hazelwood mine fire were more likely to have presented to a hospital emergency department in the years following the event, compared with people who were less exposed or not exposed.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups. The Hazelinks Stream of the HHS investigates the long-term health of the smoke-exposed communities by using administrative health datasets, such as ambulance, hospital, Medicare, pharmaceutical, cancer and death records.

Meet the team

Catherine Smith
Caroline Gao
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Christina Dimitriadis
Matthew Carroll
Malcolm Sim
Dion Stub
Michael Abramson
Yuming Guo

What we did

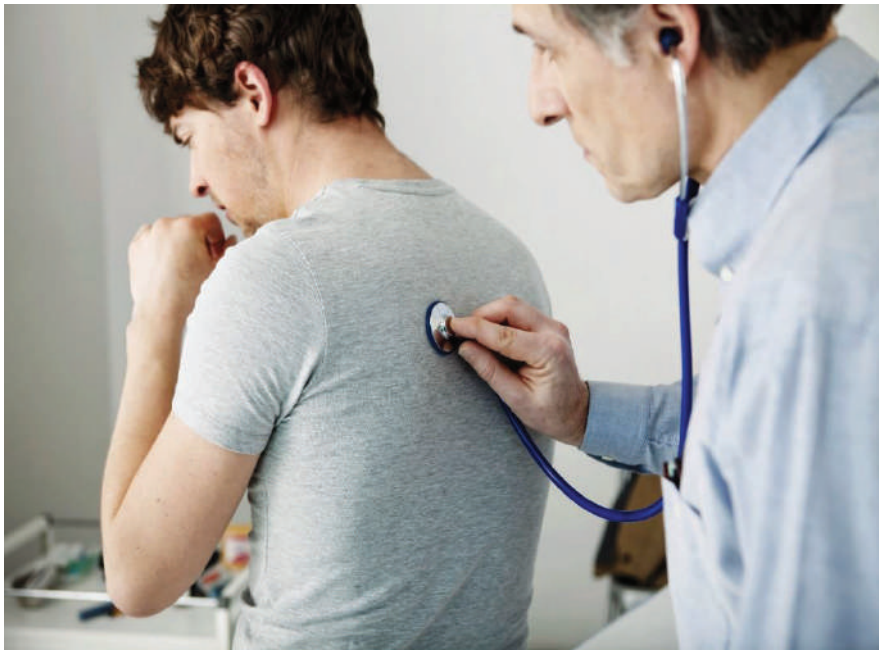
Approximately 2.5 years after the Hazelwood mine fire, 4,056 residents from Morwell (exposed to the mine fire smoke) and Sale (unexposed) participated in the HHS Adult Survey. Each participant filled in a time-location diary to show where they were on each day and night of the mine fire period. This was important because the smoke levels varied quite a bit from day to day. Using the diaries and air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure during the fire, to fine air particles in the smoke of less than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Consent was given by 2,725 of the Adult Survey participants for the researchers to access their hospital emergency department (ED) presentations data held by the Department of Health. For this analysis we looked at ED presentations from January 2009 to February 2019.

A detailed paper describing the findings from this analysis can be found at https://hazelwoodhealthstudy.org.au/study-findings/publications

Hazelwood HEALTH STUDY

Considerations

The analysis used a number of statistical methods to account for other factors that might have influenced ED presentations, such as previous health, age, gender, marital status, smoking history and employment in jobs that involved exposure to dust, fumes, smoke, mist or gas. However, there remains a possibility that factors other than the mine fire smoke influenced the ED presentations. Further, because a proportion of adults from Morwell did not participate in the Adult Survey, it is possible that the findings do not truly reflect that community.



What we found

We found that as the levels of exposure to smoke-related $PM_{2.5}$ increased, the likelihood of presenting to the ED with a respiratory-related (lung) condition increased during the following 5 years. The likelihood of presenting to the ED with a cardiovascular-related (heart) condition also increased during the first 2.5 years after the mine fire, particularly for ischaemic heart disease and atherothrombotic disease.

These findings could mean that the mine fire smoke impacted the lung- and heart-health of people for a prolonged period after the fire was put out.

Where to from here

These findings which used ED presentations data, will be looked at along side other findings which used hospital admission, ambulance, Medicare, pharmaceutical, cancer and death records, self-reported symptoms and clinical examinations of participants, to obtain a comprehensive overview of the long-term effects of the Hazelwood coalmine smoke on the health of adults in the Latrobe Valley.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide, the University of Newcastle and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Physical symptoms, psychological distress and trauma in response to climate disasters

May 2022

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

The aim of this analysis was to explore the role of Hazelwood mine fire-related posttraumatic stress, and general psychological distress, in the presentation of physical symptoms such as pain, fatigue, shortness of breath and gastrointestinal problems experienced during the 2019-2020 Black Summer bushfires.

Considerations

Evaluation of the mental and physical health of a community that has been impacted by a previous traumatic event, at the time of experiencing a new and similar event, is somewhat novel in disaster research. This study contributes to a better understanding of the mental health implications of repeated exposures to disasters, which is particularly important given extreme weather events, including bushfires, are likely to become more common due to climate change.

There were some limitations to this research, including the use of self-reported health information which is not always accurate. Specifically, the somatic symptoms that were more commonly reported by survey respondents are largely non-specific, and can be experienced by the wider population. Also, the experiences of the 709 participants may not reflect the experiences of the rest of the community, and without a control group the strength of the link between the prevalence of self-reported symptoms and the subsequent event may not be an accurate representation.

What we did

Between December 2019 and early March 2020, 709 Morwell residents, who had previously participated in the 2016-2017 Adult Survey, completed a Mental Health and Wellbeing Follow-up Survey.

The follow-up survey coincided with the Black Summer bushfires which impacted south-eastern Australia. In both survey rounds, we measured posttraumatic stress currently experienced specifically in relation to the 2014 Hazelwood mine fire, and psychological distress experienced more generally. Then we looked at the association between posttraumatic stress, general distress, and self-reported physical symptoms (also known as somatic symptoms in the clinical literature) measured during the follow-up survey.

Hazelwood HEALTH STUDY

What we found

Just over one third (36%) of survey respondents reported a medium or high level of physical symptoms. The most frequently reported symptoms included fatigue, limb pain, trouble sleeping, back pain, headaches and shortness of breath. We found that higher levels of posttraumatic stress and general distress were each associated with the presence of most of the measured physical symptoms. That is, people who reported higher levels of mine fire-related posttraumatic stress, or higher levels of general distress, also reported more physical symptoms, or more severe physical symptoms, than people reporting lower levels of stress. These associations were independent of other risk factors that could also have influenced physical symptoms, such as age, smoking history and diagnosed medical conditions.

Healthcare providers and public health authorities should be aware of this high prevalence of physical symptoms observed in a climate disaster-exposed community during a later event, which is suggestive of a possible link between physical symptoms, trauma-related stress and general distress. The findings of this study highlight the importance of screening and monitoring for posttraumatic stress symptoms in communities impacted by climate disasters to ensure unmet care needs are identified and addressed. As pain was among the most frequently reported symptoms, this study has also highlighted the need for better funding and referral pathways to multidisciplinary pain management and care in fire impacted communities.

A detailed paper describing the findings from this analysis can be found at
www.hazelwoodhealthstudy.org.au/study-findings/publications

Meet the team

Caroline Gao
Jana Menssink
Timothy Campbell
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Matthew Carroll

Where to from here

The Hazelwood Health Study will conduct a future follow-up with the cohort to understand whether physical symptoms and posttraumatic stress persist. In addition, a collaboration between the HHS Psychological Impacts and Early Life Follow-up streams will explore parental mental health and family functioning following the mine fire.

The HHS is led by Monash University with collaborators from Menzies, Federation University, The University of Adelaide and CSIRO. The research was funded by the Victorian Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Lung function in children whose mothers were exposed to mine fire smoke during pregnancy

July 2022

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The Latrobe Early Life Follow up (ELF) Study is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire occurred. This includes children whose mothers were pregnant with them at the time.

Analysis aims

Seven years after the mine fire, this research aimed to discover whether there were differences in the lung function of children whose mothers were exposed to mine fire smoke during pregnancy compared to unexposed children.

What we did

We invited children from the Early Life Follow-up stream who were exposed to mine fire smoke during pregnancy and children that were not exposed ('unexposed') to attend clinical testing. We did a simple lung function test on 79 children, known as the forced oscillation technique. It uses small vibrations to measure how easily air moves in and out of the lungs while the children were breathing through a tube. We measured resistance to air flow, and the stiffness of the lungs. We worked out how much smoke each child had been exposed to by looking at where the child's mother was each day during the fire and how polluted the air was in that area. When we analysed the data, we considered other factors that can affect lung function such as age, sex, height, and exposure to tobacco smoke.

Meet the team

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Amanda Wheeler
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Marita Dalton
Grant Williamson
Caroline Gao
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Fay Johnston
Graeme Zosky

Hazelwood HEALTH STUDY

What we found

We didn't find any difference in the lung function of children exposed to smoke during pregnancy compared to unexposed children. We also didn't find any differences in the lung function of children whose mothers were exposed to high levels of smoke during pregnancy compared to those whose mothers were exposed to lower levels of smoke.

A detailed paper describing the findings from this analysis can be requested from the study team by emailing contact@hazelwoodhealthstudy.org.au

Considerations

Lung function varies a lot between days and between children of different ages and genders. Although we did not find any evidence of changes to lung function resulting from the coal mine fire there are two plausible explanations. Firstly, the six-week extreme smoke exposure event may have been too short for any substantial changes to lung function to occur in children who were exposed during pregnancy. Secondly, there may have been short term changes in lung function that did occur, which disappeared before the seven-year follow-up test. It is also important to mention that the small number of participants may have limited our ability to see any differences if they did exist.

Where to from here?

Further studies are needed to confirm these results. Childhood is a rapid period of lung development and growth. Therefore, lung function should be evaluated at various time points to fully understand the health implications of mine fire smoke exposure during pregnancy.

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborations from Melbourne University and the Telethon Kids Institute.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Factors shaping the pattern of distress after the 2014 Hazelwood mine fires

August 2022

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

The aims of this analysis were to assess the level of posttraumatic distress in the community after the Hazelwood mine fire, how distress levels have changed over time, and what factors might have influenced those changes.

What we did

Between December 2019 and early March 2020, 709 Morwell residents, who had previously participated in the 2016-2017 Adult Survey, completed a Mental Health and Wellbeing Follow-up Survey. In both survey rounds, we used a questionnaire called the Impact of Events Scale-Revised (IES-R) to measure the level of posttraumatic distress being experienced, at that time, in direct relation to the 2014 Hazelwood mine fire. We looked to see whether participants' distress had remained the same, become worse or improved over time; we called that the posttraumatic distress trajectory. Participants were then grouped into one of four posttraumatic distress trajectory categories:

- Resilience – a low level of distress at the time of both surveys
- In-recovery - distress that progressed from a high to low level across surveys
- Delayed-onset - distress that progressed from a low to high level across surveys
- Chronic – a high level of distress at the time of both surveys

We explored how each of these distress trajectories were related to participants' levels of smoke exposure during the mine fire, and to a variety of important personal and social circumstances such as medical history, social support, education, employment and experiences of other stressful life events.

Meet the team

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Hazelwood HEALTH STUDY

What we found

The most common distress trajectory was resilience (77% of participants), which was associated with higher levels of social support, paid employment, and education. Loneliness and low levels of social support were associated with chronic and delayed-onset distress trajectories. Adversities such as prior trauma, recent stressful life-events, and diagnosed physical or mental health conditions were also associated with chronic and delayed-onset distress trajectories. The amount of smoke that participants were exposed to during the mine fire was not a strong determinant of which distress trajectory they were on. These findings indicate that socioeconomic circumstances, connections with others, health, and life experiences were the most important factors shaping peoples' posttraumatic distress trajectories during the six years after the mine fire.

A detailed paper describing the findings from this analysis can be found at
hazelwoodhealthstudy.org.au

Considerations

There were some limitations to this research. Health information which is self-reported in surveys is not always accurate and the experiences of the 709 participants may not necessarily reflect the experiences of the rest of the community. Additionally, the second survey coincided with the 2019-20 Black Summer bushfires which caused smoky conditions in the Latrobe Valley. We were not able to directly assess what effects that event may have had on participants' distress trajectories related to the earlier mine fire.

Where to from here?

The Hazelwood Health Study will conduct a future follow-up survey to further monitor long-term posttraumatic distress outcomes after the mine fire, including how the Black Summer bushfires and ongoing COVID-19 pandemic may have impacted these outcomes.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Emergency department visits and hospital admissions among infants following exposure to smoke from the mine fire

November 2022

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire occurred. This includes children whose mothers were pregnant with them at the time.

Analysis aims

We aimed to find out if exposure to smoke from the mine fire either during pregnancy, or during the first year of childhood, was associated with increased hospital presentations and admissions over a one-year period following the fire.

What we did

After getting ethical approval for this research, we obtained anonymous birth records for all babies born in the Latrobe Valley before, during and after the fire (born 1st March 2012 to 31st December 2015), who had been linked with records of presentations to the emergency department or admissions to hospital by the Victorian Data Linkage Unit. We used air pollution data provided by CSIRO and the residential address at the time of birth to estimate how much mine fire smoke the child or their pregnant mother was exposed to during the fire period.

We looked to see if different amounts of mine fire smoke exposure were associated with higher risks of emergency department visits or hospital admissions, for either any reason or for causes related to infections, allergies or respiratory conditions. For children whose mothers were exposed to smoke during pregnancy, we evaluated these outcomes in their first year of life. For children who were exposed to smoke during infancy, we evaluated them in the year following the fire. In our analysis we considered other factors that can affect health of children, such as infant sex, the mother's smoking status during pregnancy, and usual background levels of air pollution, to distinguish the specific influence of the smoke from the mine fire.

Meet the team

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Hazelwood HEALTH STUDY

What we found

We found that children whose mothers were exposed to higher levels of mine fire smoke during pregnancy were more likely to present to the emergency department for allergies or skin rash than children whose mothers were exposed to lower levels or no smoke at all during pregnancy.

We also found that children exposed to the mine fire smoke during their first year of life were more likely to present to the emergency department for respiratory conditions and infections, compared to those not exposed. There were no other associations between exposure to smoke, by pregnant mothers or by children in their first year of life, and emergency department presentations. Also, no association was found between exposure to smoke and hospital admissions in any group of children.

A detailed paper describing the findings from this analysis can be requested from the study team by emailing contact@hazelwoodhealthstudy.org.au

Considerations

We calculated exposure based on the mother's home address. This means we may not have captured changes in smoke exposure that resulted from each family's movements within and outside of the Latrobe Valley during the fire. Also, this study could not determine contributing reasons for increases in emergency department visits following the fire. For example, an increase in presentations to an emergency department might reflect an increase in some health conditions following the fire, or it might reflect a heightened level of worry among parents in the year after the fire, leading them to be more likely to seek care for their children at an emergency department.

Where to from here?

These findings will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley. Additionally, findings will help guide responses to severe smoke events in the future. We will also assess if exposure to smoke from the coal mine fire was associated with increases in other indicators of health care utilisation among this group of children in the year following the fire. These will include evaluation of attendances to general practitioners, and dispensations of prescriptions for medications that treat infections, allergies and asthma.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Victorian Department of Health.

Hazelwood HEALTH STUDY

Research Summary

General practitioner visits and medications prescribed for infants following their exposure to mine fire smoke

January 2023

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire occurred. This includes children whose mothers were pregnant with them at the time.

Analysis aims

We aimed to find out if exposure to smoke from the mine fire, either during pregnancy or during the first two years of childhood, was associated with increased general practitioner (GP) visits and dispensing of prescribed medications over a two-year period following the fire

What we did

After getting ethical approval for this research, we obtained anonymous birth records for all babies born in the Latrobe Valley before, during and after the fire (born 1st March 2012 to 31st December 2014), who had been linked by the Centre for Victorian Data Linkage with Medicare Benefits Schedule (MBS) data on visits to GPs and Pharmaceutical Benefits Scheme (PBS) data on dispensed prescription medications. We used air pollution data provided by CSIRO and the residential address at the time of birth to estimate how much mine fire smoke the child or their pregnant mother was exposed to during the fire period.

We looked to see if different amounts of mine fire smoke exposure were associated with higher numbers of GP visits for any cause, or filling of prescriptions for medicines used to treat infections, eczema or respiratory symptoms.
For children whose mothers were exposed to smoke during pregnancy, we evaluated these outcomes in their first two years of life. For children who were exposed to smoke during infancy, we evaluated them in the two-year period following the fire.

In our analysis we considered other factors that can affect health of children, such as infant sex, the mother's smoking status during pregnancy, and usual background levels of air pollution, to distinguish the specific influence of the smoke from the mine fire.

Hazelwood HEALTH STUDY

What we found

We found that children whose mothers were exposed to higher levels of mine fire smoke during pregnancy were more likely to have prednisolone, or similar steroid medications, dispensed in the first two years of life. These medications are mainly used to treat croup and asthma symptoms.

We found that children exposed to the mine fire smoke during their first two years of life were more likely to have prescriptions for antibiotics dispensed in the two years following the fire, and prescriptions for skin creams for eczema in the second year after the fire. They were also more likely to visit a GP, particularly in the first year after the fire.

A detailed paper describing the findings from this analysis can be requested from the study team by emailing contact@hazelwoodhealthstudy.org.au

Considerations

We calculated exposure based on the mother's home address. This means we may not have captured changes in smoke exposure that resulted from each family's movements within and outside of the Latrobe Valley during the fire. Also, this study could not determine contributing reasons for increases in GP visits and prescriptions dispensed following the fire. For example, the findings could reflect a heightened level of worry among parents in the two years after the fire leading them to seek care more frequently for their children for minor symptoms, or there could randomly have been more influenza or gastroenteritis viruses circulating in childcare centres around the areas where there was the most smoke. Finally, only prescribed and subsidised medications were included in the PBS data, so we could not account for some asthma puffers and weak steroid skin creams bought over-the-counter.

Meet the team

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Alison Venn

Where to from here?

These findings will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley. Additionally, findings will help guide responses to severe smoke events in the future. We will also assess if exposure to smoke from the coal mine fire was associated with increases in use of health services among these children later in childhood, to see if the associations persist.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Victorian Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Long-term effects of extreme smoke exposure on vulnerability to COVID-19

May 2023

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognized as one of the most significant air quality incidents in Victoria's history, with the concentration of smoke contaminants reaching high levels. The smoke event caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire.

More recently, the COVID-19 pandemic has impacted the Latrobe City region with more than 32,000 confirmed cases. International researchers have shown a link between exposure to air pollution, such as smoke and traffic exhaust, and the risk of being infected with COVID-19. One theory is that air pollution increases the number of receptors in the body that the COVID-19 virus uses to bind to and infect cells.

Meet the team

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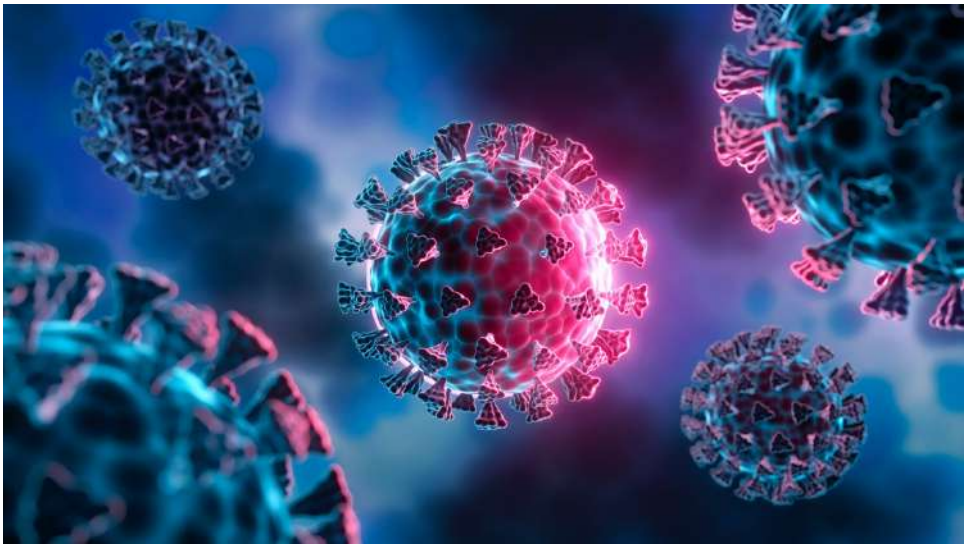

What we did

We surveyed 408 adults from Morwell and 204 from Sale approximately eight years after the mine fire. Using air pollution modelling conducted by CSIRO, we calculated each participant's level of exposure to smoke-related fine air particles < 2.5 micrometres in diameter ($PM_{2.5}$) during the mine fire. We then compared rates of COVID-19 infection in people with different levels of exposure. When we analysed the data we took into account other factors that influence lung health such as age, body mass, socioeconomic status, prior chronic respiratory conditions and tobacco smoking.

Analysis aims

Our research aimed to investigate whether adults who had been heavily exposed to air pollution from the 2014 mine fire were more likely to become infected with COVID-19 than adults who were less or minimally exposed.

Hazelwood HEALTH STUDY

What we found

From the 612 participants, 271 (44%) reported either that they had been diagnosed with COVID-19 or had symptoms consistent with COVID-19. We found that people who were most highly exposed to the mine fire smoke in 2014 were slightly more likely to have had COVID-19 than people who were less exposed. However, the finding of a link between smoke exposure and COVID-19 infection was quite weak and may have been a chance finding.

A detailed paper describing the findings from this analysis is freely available at
www.medrxiv.org/content/10.1101/2023.04.12.23288500v1

Considerations

The self-report of COVID-19 diagnoses or COVID-19 like symptoms may not have always been accurate. Further, there was the possibility that factors other than the mine fire air pollution were responsible for the small observed difference in COVID-19 infections reported by highly exposed compared with less exposed participants. However, it was also possible that previous smoke exposure did in fact increase vulnerability to COVID-19 and that measures to protect people from future air pollution events are important.

Where to from here?

The finding will be shared with relevant health and emergency services to ensure they are used to guide current health service provision and future responses to smoke events. The HHS is continuing to investigate the long term effects of smoke from the mine fire through health surveys and clinical testing.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Lung function changes in children exposed to mine fire smoke in infancy

May 2023

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire occurred. This includes children whose mothers were pregnant with them at the time.

Analysis aims

Seven years after the mine fire, this research aimed to discover whether there were changes in the lung function of children who were exposed to mine fire smoke during infancy and if the changes previously observed persisted over time.

What we did

We invited children from the ELF Study who were exposed to mine fire smoke during infancy to attend clinical testing 7 years after the fire. We did a simple lung function test known as the forced oscillation technique on 115 children. It uses small vibrations to measure how easily air moves in and out of the lungs while the children breathe through a tube. We measured resistance to air flow and the stiffness of the lungs. By looking at where each child was on each day during the fire and how polluted the air was in that area, we were able to work out how much smoke they had been exposed to. When we analysed the data, we considered other factors that can affect lung function such as age, sex, height, and exposure to tobacco smoke.

Meet the team

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Marita Dalton
Grant Williamson
Caroline Gao
Michael Abramson
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Graeme Zosky

What we found

During testing previously undertaken 3 years after the fire, we found a link between mine fire smoke exposure and slightly increased lung stiffness. Further testing undertaken 7 years after the fire didn't find any link between mine fire smoke exposure and increased lung stiffness. Instead, there were moderate improvements in lung stiffness between the 3 and 7 year follow-up, of children exposed to smoke during infancy. This suggested that reductions in lung function observed at the 3-year follow-up had improved over time.

A detailed paper describing the findings from this analysis can be requested from the study team by emailing contact@hazelwoodhealthstudy.org.au

Considerations

Childhood is a period of rapid lung growth and varies considerably between children of different ages. Those variations, plus other factors that influence lung health, such as genetic makeup and exposure to tobacco smoke, may have impacted on our measurements.

Where to from here?

Further studies are needed to confirm these results. Childhood is a rapid period of lung development and growth. Therefore, lung function should be evaluated at further timepoints to fully understand the health implications of mine fire smoke exposure during infancy.

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborations from Melbourne University and the Telethon Kids Institute.

The HHS is led by Monash University in collaboration with Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Victorian Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Allergies in children seven years after the mine fire

June 2023

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire occurred. This includes children whose mothers were pregnant with them at the time.

Analysis aims

We aimed to find out if exposure to smoke from the mine fire, either during pregnancy or during the first two years of childhood, was associated with increased likelihood of possible allergies seven years after the fire.

What we did

We invited children from the Early Life Follow-up Study who were exposed to mine fire smoke during pregnancy or the first two years of life, and children who were not exposed ('unexposed') to attend clinical testing. We collected blood samples in 103 children and tested them for specific allergic sensitisation to dust, fungi, cats, and grass pollen, as well as for an overall measure of allergy called total Immunoglobulin E (IgE). Allergic sensitisation occurs when the body's immune system mistakenly identifies an otherwise harmless substance as a threat and produces IgE antibodies in reaction.

We used air pollution data provided by CSIRO and movements of the pregnant mother and/or the child during the fire period to estimate how much mine fire smoke they were exposed to. We looked to see if higher amounts of mine fire smoke exposure were associated with a higher chance of having IgE antibodies (being overall allergic) or being allergic to dust, fungi, cats or grass pollen. In our analysis we considered other factors that could affect health of children, such as the child's age, social factors and usual background levels of air pollution, to distinguish the specific influence of the smoke from the mine fire.

Hazelwood HEALTH STUDY

What we found

Compared to babies with low mine fire smoke exposure, we found that the babies of mothers who were exposed to higher levels of mine fire smoke during pregnancy or those who directly breathed the smoke in their first two years of life, were at no higher risk of a positive blood test indicating overall allergy or specific allergies to dust, cats, fungi, or grass pollen seven years after the fire.

A detailed paper describing the findings from this analysis can be requested from the study team by emailing contact@hazelwoodhealthstudy.org.au

Where to from here?

These findings will be shared with relevant organisations and the scientific community to ensure they are used to shape services for the future health of the Latrobe Valley. Additionally, findings will help guide responses to severe smoke events in the future.

Considerations

Although we did not find a link at this stage between exposure to the fire and the risk of common allergies, this risk generally continues to increase until children reach adolescence, so there is a possibility that these results could change in the next few years. Additionally, having a positive result to an allergy test does not mean that the child will necessarily have clinical symptoms. It is also important to mention that the number of participants in our study was small, and that may have limited our ability to detect a subtle difference between exposed and unexposed children if it was present. Finally, this study did not test for a range of possible allergies (e.g., food, dogs, tree pollen), thus our results cannot tell us anything about if there was a link between the smoke and those allergies.

Meet the team

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Shyamali Dharmage
Luke Knibbs
Grant Williamson
Marita Dalton

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborations from Melbourne University and the Telethon Kids Institute.

The HHS is led by Monash University in collaboration with Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Victorian Department of Health.

Website: www.hazelwoodhealthstudy.org.au @hazelwoodhealthstudy

Hazelwood HEALTH STUDY

Research Summary

Self-reported respiratory health after the Hazelwood coalmine fire and the COVID-19 pandemic

August 2023

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The Hazelwood Health Study involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

8.5 years after the mine fire, this research aimed to investigate whether adults who had been heavily exposed to smoke from the fire were more likely to report respiratory symptoms than adults who were less or minimally exposed. The analysis also aimed to investigate whether the relationship between mine fire smoke exposure and respiratory symptoms was made worse by COVID-19 infection.

What we did

In 2016/2017, approximately 2.5 years after the mine fire event, 3,096 Morwell and 960 Sale residents completed the Hazelwood Health Study Adult Survey. Participants answered questions about their locations on different days during the mine fire (e.g. home, work or leave). Based on those locations, air pollution data modelled by CSIRO was used to estimate each participant's level of exposure during the fire to fine airborne smoke particles less than 2.5 thousandths of a mm in diameter ($PM^{2.5}$). Participants also reported whether they had experienced any of seven respiratory symptoms in the year prior to the survey; those being current wheeze, chest tightness, shortness of breath at night, shortness of breath at rest, nasal symptoms, chronic cough and phlegm. At that time, we found that people who had been exposed to higher levels of $PM^{2.5}$ (that is, higher levels of mine fire smoke) were more likely to report chronic cough and current wheeze than people who had been exposed to less smoke.

In 2022, approximately 8.5 years after the fire, 612 participants were resurveyed. We looked to see whether their previously reported respiratory symptoms had improved, stayed the same or worsened. We also investigated whether contracting COVID-19 had made any difference to the association between mine fire smoke exposure and respiratory symptoms. This analysis took into consideration other factors that could influence health such as age, socioeconomic status and cigarette smoking.

Hazelwood HEALTH STUDY

What we found

Compared with the symptoms reported 2.5 years after the event, mine fire smoke-exposed participants reported a sustained and worsening increase in chronic cough and possibly a worsening increase in current wheeze, 8.5 years after the event. That is, the effect of mine fire smoke exposure on cough and wheeze seemed to have increased over time.

Mine fire smoke-exposed people who had contracted COVID-19, compared to mine fire smoke-exposed people who had not contracted COVID-19, were more likely to report shortness of breath at night, chronic phlegm and possibly chest tightness. That is, mine fire smoke exposure and COVID-19 combined, resulted in more respiratory symptoms than mine fire smoke exposure alone.

A detailed paper describing the findings from this analysis is freely available at
www.medrxiv.org/content/10.1101/2023.04.12.23288500v1

Meet the team

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Considerations

Only 34% of Morwell adults participated in the original 2016/2017 Adult Survey and, of those, 26% participated in the 2022 Survey. Whilst this was comparable to participation rates in other Australian research studies, there is the possibility that participants were not completely representative of their town.

Where to from here?

The finding will be shared with relevant health and emergency services to ensure they are used to guide current health service provision and future responses to smoke events. The HHS is continuing to investigate the long term effects of smoke from the mine fire through health surveys and clinical testing.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Blood vessel health in young children 7 years after the coalmine fire

October 2023

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The **Latrobe Early Life Follow up (ELF) Study** is the part of the Hazelwood Health Study that follows the health and growth of children who were younger than two years old when the fire occurred. This includes children whose mothers were pregnant with them at the time.

Analysis aims

Seven years after the mine fire event, this research aimed to discover whether smoke from the fire affected the health of blood vessels in very young children from the Latrobe Valley, including children whose mothers were pregnant with them at the time. The study also aimed to determine if usual levels of background air pollution were associated with blood vessel health in early childhood.

What we did

We invited children from the ELF Study who were exposed to mine fire smoke during infancy or in the womb to attend clinical testing in 2017 (3-year follow-up) and/or 2021 (7-year follow-up). We measured blood vessel thickness and stiffness using ultrasound, in 248 children at the 3-year follow-up and 163 children at the 7-year follow-up.

We worked out how much smoke each child had been exposed to by looking at where the child was each day during the fire and how polluted the air was in that area. When we analysed the data, we considered other factors that can affect lung function such as age, sex, height, and exposure to tobacco smoke.

Hazelwood HEALTH STUDY

What we found

In children who were up to 2 years of age at the time of the fire, the 2017 clinical testing showed weak evidence that higher smoke exposure was linked to very small increases in blood vessel stiffness, indicating poorer blood vessel health 3 years after the event. However, the 2021 clinical testing showed a modest improvement in blood vessel stiffness, indicating possible recovery 7 years after the event.

In children whose mothers were pregnant with them at the time of the fire, the 2017 testing showed no link between higher smoke exposure and poorer blood vessel health. However, the 2021 testing did show a link between higher smoke exposure and a mild increase in vessel stiffness, indicating poorer blood vessel health 7 years after the event. This group of children also had increased vessel stiffness linked to exposure to background air pollution.

A detailed paper describing the findings from this analysis can be requested from the study team by emailing contact@hazelwoodhealthstudy.org.au

Considerations

We cannot rule out the possibility that the results occurred by chance, or were due to other unmeasured factors that can affect blood vessel health. Vessel growth varies a lot between children of different ages and genders. Vessel stiffness does not automatically mean that children will later develop blood vessel or heart problems. Stiffer blood vessels are one of many things, including genetic make-up, smoking tobacco, stress, diet and physical activity that can influence the risk of heart disease in later life.

Where to from here?

Further studies are needed to confirm these results. Childhood is a rapid period of lung development and growth. Therefore, lung function should be evaluated at further timepoints to fully understand the health implications of mine fire smoke exposure during infancy. A 3rd round of clinical testing is scheduled for 9 years after the fire.

Meet the team

Emily Hemstock
Ashley Bigaran
Shantelle Allgood
Amanda Wheeler
Shyamali Dharmage
Marita Dalton
Grant Williamson
Caroline Gao
Michael Abramson
Kazuaki Negishi
Fay Johnston
Graeme Zosky

The Latrobe ELF Study is led by the Menzies Institute for Medical Research at the University of Tasmania with collaborations from Melbourne University and the Telethon Kids Institute.

The HHS is led by Monash University in collaboration with Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Victorian Department of Health.

Hazelwood HEALTH STUDY

Research Summary

Longer-term community wellbeing after the Hazelwood mine fire

January 2024

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The Hazelwood Health Study involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

The aims of this analysis were to assess longer-term community wellbeing in Morwell and how it has changed since the 2014 Hazelwood mine fire, from the perspectives of community members exposed to the event. The analysis also explored what influences demographic, social, and health factors, as well as smoke exposure during the mine fire, variously had on perceptions of community wellbeing.

What we did

Between December 2019 and early March 2020, 585 Morwell residents, who had previously participated in the 2016-2017 Adult Survey, completed a Mental Health and Wellbeing Follow-up Survey. As part of the survey, we measured people's current sense of community wellbeing and how it had changed in Morwell since the 2014 Hazelwood mine fire. We examined how participants' responses regarding community wellbeing were associated with levels of smoke exposure during the mine fire, and with a variety of important personal circumstances such as age, health history, social support, education, employment, and experiences of other trauma and stressful life events.

Meet the team

Matthew Carroll
Timothy Campbell
Catherine Smith
Caroline Gao
Tyler Lane
Darryl Maybery
Emily Berger
David Brown
Michael Abramson
Michelle Duffy
Damian Morgan
Larissa Walker
Susan Yell

Hazelwood HEALTH STUDY

What we found

Overall, participants reported being somewhat dissatisfied with community in Morwell at the time of the 2019-2020 follow-up survey and that community wellbeing was perceived to have declined since the mine fire. The community's social, economic, and environmental conditions were particular points of dissatisfaction, whilst feeling a sense of connection to place was the most positively regarded aspect of community life. Appraisals of community wellbeing were typically lower among participants who were younger, had experienced recent stressful events, or who were more bothered by health complaints. Participants' perceptions of community wellbeing and its direction since the mine fire were not dependent on how much smoke they had been exposed to during the event.

A detailed paper describing the findings from this analysis can be found at
https://hazelwoodhealthstudy.org.au/study-findings/publications

Considerations

There were some limitations to this research. Health information which is self-reported in surveys is not always accurate and the experiences and perspectives of the participants may not necessarily reflect those of the rest of the community. The retrospective measure of change in community wellbeing since the mine fire was devised for the study and was not robustly tested; so may be susceptible to biases.

Where to from here?

The Hazelwood Health Study has conducted a further, more recent follow-up survey to monitor long-term health and wellbeing outcomes after the mine fire. The measure of current community wellbeing was repeated in this survey, which also included assessments of the impacts of the 2020 Black Summer bushfires and the COVID-19 pandemic. Analyses of this additional data will enable us to further understand the progression of community wellbeing in Morwell after the mine fire within the context of other significant events.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

The impact of coal mine fire smoke on lung function in adults 7.5 years later

February 2024

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The Hazelwood Health Study involves multiple research streams targeting different health outcomes and different vulnerable groups.

The Respiratory Stream is the part of the HHS that examines whether exposure to smoke from the mine fire is associated with respiratory symptoms, asthma control or decline in lung function.

Analysis aims

Seven and a half years after the mine fire, this research aimed to discover whether adults who were more highly exposed to the mine fire smoke had poorer lung function than adults who had less exposure.

What we did

We worked with CSIRO to estimate the levels of fine particles in the smoke smaller than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Particles this fine can travel deep into people's lungs. In 2017-2018, Round 1 of the Respiratory Stream testing, we tested 346 adults from Morwell who were grouped into three levels of mine fire $PM_{2.5}$ exposure (low: daily average of 6 micrograms per cubic metre of air ($\mu g/m^3$); medium: average of 12 $\mu g/m^3$; and high: average of 28 $\mu g/m^3$) and 173 adults from Sale who had little or no exposure.

In 2021, Round 2, we retested 217 adults from Morwell and 112 from Sale. In both rounds, participants underwent spirometry which measured how much air they inhaled and exhaled, and how fast they exhaled, in order to detect any evidence of Chronic Obstructive Pulmonary Disease (COPD). COPD is characterised by persistent obstruction of lung airflow. Participants also underwent a test of lung health using the forced oscillation technique (FOT) which measured how easily air moved through the lungs and the stretchiness of the lungs. In round 2, all participants also underwent a breath test of airway inflammation called fractional exhaled nitric oxide (FeNO). We took into consideration other factors that could influence lung health, such as age, height, weight, cigarette smoking and participant's jobs that may have involved exposure to dusts or fumes.

Hazelwood HEALTH STUDY

What we found

In Round 1 we found that, as the level of mine fire $PM_{2.5}$ exposure increased, lung stretchiness decreased and evidence of COPD in non-smokers increased. That is, 3.5 years after the mine fire, higher levels of smoke exposure were associated with poorer lung function in adults. It is normal for the lungs to become less stretchy as people age. However, our findings indicated that each 10 $\mu g/m^3$ increment in smoke exposure was associated with reduced stretchiness that you would normally observe after approximately four years of aging. This finding was independent of participants' actual age.

In Round 2, the previously observed airflow obstruction and reduced stretchiness in the lungs showed signs of recovery. Also, there was no evidence of airway inflammation. That is, 7.5 years after the mine fire, higher levels of smoke exposure were not associated with poorer lung function in adults

A detailed paper describing the findings from this analysis can be requested from the Hazelwood Health Study researchers by email. contact@hazelwoodhealthstudy.org.au or phone 1800 985 899

Meet the team

Nicolette Holt
Sara Kress
Catherine Smith
Caroline Gao
Brigitte Borg
Tyler Lane
David Brown
Jillian Ikin
Annie Makar
Tom McCrabb
Mikayla Thomas
Kris Nilsen
Bruce Thompson
Michael Abramson

Considerations

We could not be absolutely certain that the mine fire smoke caused the features of COPD or reduction in lung stretchiness observed at Round 1. Other factors could have affected lung health, such as genes, previous exposure to other sources of smoke, respiratory infections or access to health services.

The improvement that we observed at Round 2 may have reflected a true recovery in lung health after 7.5 years. However, 190 participants from Round 1 did not take part at Round 2, which meant that we couldn't know whether their lung health also improved or not. Anybody with symptoms like shortness of breath, wheezing, or frequent coughing should always have these checked by a doctor.

Where to from here?

All Respiratory Stream participants from Rounds 1 and 2 were invited to participate in Round 3. These assessments were completed last year and we are now analysing the data.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood HEALTH STUDY

Research Summary

A good diet quality reduces the effects of mine fire-related smoke on chronic cough and phlegm

April 2024

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study was established to examine the impacts of the mine fire. The Hazelwood Health Study involves multiple research streams targeting different health outcomes and different vulnerable groups.

Analysis aims

Mine fire smoke exposure is known to increase respiratory symptoms whereas diet quality, specifically, fruit and vegetable quality, is thought to protect against respiratory symptoms. We aimed to investigate whether good diet quality weakened the effects of mine fire smoke on respiratory health.

What we did

We surveyed 282 residents of Morwell and 166 residents of Sale, 8.5 years after the mine fire. We asked about respiratory symptoms including chronic cough and phlegm, along with diet quality using the Australian Eating Survey. We worked with CSIRO to estimate the levels of fine particles in the mine fire smoke smaller than 2.5 thousandths of a mm in diameter ($PM_{2.5}$). Particles this fine can travel deep into people's lungs. We investigated whether higher $PM_{2.5}$ exposure was associated with increased respiratory symptoms and whether a better diet quality weakened the adverse impact of smoke exposure on those symptoms.

Hazelwood Health Study website: www.hazelwoodhealthstudy.org.au

Hazelwood HEALTH STUDY

What we found

Fire-related $PM_{2.5}$ was associated with self-reported chronic cough, current wheeze and chronic phlegm. But when we looked at this association together with diet quality, we found that overall diet quality and specifically fruit and vegetable quality diminished the effect of fire-related $PM_{2.5}$ on chronic cough and chronic phlegm. It's possible that antioxidants found in fruits and vegetables, especially vitamin C, carotenoids and flavonoids, may reduce respiratory damage caused by $PM_{2.5}$.

A more detailed paper describing these findings can be found at
www.hazelwoodhealthstudy.org.au/study-findings/publications

Meet the team

Thara Govindaraju
Martin Man
Alice Owen
Matthew Carroll
Brigitte Borg
Catherine Smith
Caroline Gao
David Brown
David Poland
Shantelle Allgood
Jillian Ikin
Michael Abramson
Tracey McCaffrey
Tyler Lane

Considerations

Both diet quality and respiratory symptoms were self-reported and may not have been accurate. Considering diet quality was measured 8.5 years after mine fire, it might not reflect the diet that participants had at the time of the event.

Where to from here?

The finding will be published in a peer reviewed journal and shared with relevant health and community services to ensure they are used to guide current health service provision and continuous improvement of lifestyle behaviours including healthy eating in the community.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, and CSIRO.

The research was funded by the Department of Health.

Hazelwood Health Study website: www.hazelwoodhealthstudy.org.au

Hazelwood HEALTH STUDY

Research Summary

Did mine fire smoke exposure increase rates of cancer in exposed communities?

April 2024

Analysis aims

There are studies which show that air pollution can increase rates of cancer in exposed communities. Our study investigated whether exposure to smoke from the Hazelwood mine increased yearly rates of cancer in Morwell or the rest of Latrobe Valley during the 7 years after the fire, taking into consideration trends in cancer rates in the rest of regional Victoria.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The Cancer Stream of the HHS investigates the long-term health of the smoke-exposed communities by using records from the Victorian Cancer Registry (VCR).

Meet the team

Pei Yu
Caroline Gao
Catherine Smith
Sherene Loi
Natasha Kinsman
Jillian Ikin
Yuming Guo
Malcolm Sim
Michael Abramson
Tyler Lane

What we did

We searched the VCR for all new cancers diagnosed between 2009 and 2021. We then limited the analysis to cancers in people aged 40+ due to very small numbers in younger people. We compared the yearly trend in new cancers diagnosed before the 2014 mine fire, with the yearly trend after. The theory was that, if there was a change in the yearly trend of new cancers diagnosed in smoke effected areas after the fire compared with before, that was not seen in other parts of regional Victoria, then a likely cause was the mine fire.

Hazelwood Health Study website: http://www.hazelwoodhealthstudy.org.au/

Hazelwood HEALTH STUDY

What we found

We identified 851 new cancers in Morwell after 2014, and 2,460 in the rest of the Latrobe Valley. When we combined all cancer types together and compared the years before the mine fire with the years after in both areas, we found no difference in the yearly trend of new cancer cases. That is, after the mine fire we could see no increase in the overall rates of cancer.

When we looked at people of different ages, we saw a small increase after the mine fire in cancers diagnosed among people aged 60-69 years in 'the rest of the Latrobe Valley'. However, the evidence for this was weak and this was not likely to be an effect of mine fire smoke because the same trend was not observed in Morwell where smoke exposure levels were higher.

When we divided cancers into different subtypes, we found a decrease (improvement) after the mine fire in the yearly rate of newly diagnosed blood-related cancers in Morwell; those include leukaemia, lymphoma and myeloma. There are a number of chemicals including solvents, pesticides and herbicides, and jobs such as farming, painting and construction, that have been linked to blood cancer. Possible explanations, for this decrease in the rate of new blood cancers, could be closure of industries in or around Morwell that had exposed workers to those sorts of chemicals, or relocation of previously exposed workers out of Morwell. Alternatively, this may have been a chance finding

A detailed paper describing the findings from this analysis is available by contacting us at contact@hazelwoodhealthstudy.org.au

Where to from here

Further VCR data are being collected to detect any new cancers diagnosed in the 2200+ members of the Hazelwood Health Study Adult Cohort. For those people we have detailed mine fire smoke exposure data and also comprehensive information about other factors which could contribute to health such as family medical history, cigarette smoking and alcohol use, marital status and socioeconomic status. Those data will provide further information about whether the mine fire contributed to new cancer cases in the years after exposure.

Considerations

There is currently no conclusive evidence that air pollution from the mine fire increased cancer rates in the Latrobe Valley. However, it can take many years for some new cancers to appear after a toxic exposure. Therefore, future research will provide more accurate information.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, the University of Newcastle and CSIRO.

The research was funded by the Department of Health.

Hazelwood Health Study website: http://www.hazelwoodhealthstudy.org.au/

Hazelwood HEALTH STUDY

Research Summary

Ambulance callouts, Emergency Department presentations and hospital admissions 8 years after the fire

April 2024

Analysis aims

This study aimed to investigate whether smoke from the mine fire resulted in increased ambulance attendances, hospital Emergency Department (ED) presentations or hospital admissions during the 8 years after the event.

Background

The fire in the Morwell open cut brown coal mine adjacent to the Hazelwood Power Station blanketed the town of Morwell and the surrounding area in smoke and ash for six weeks in February and March 2014. The smoke event was recognised as one of the most significant air quality incidents in Victoria's history. It caused considerable community concern within Morwell and the broader community. In response to these concerns, and following extensive community consultation, the Hazelwood Health Study (HHS) was established to examine the impacts of the mine fire. The HHS involves multiple research streams targeting different health outcomes and different vulnerable groups.

The Hazelinks Stream of the HHS investigates the long-term health of the smoke-exposed communities by using administrative health datasets, such as ambulance, hospital, Medicare, pharmaceutical, cancer and death records.

Meet the team

Tyler Lane
Catherine Smith
Caroline Gao
Jillian Ikin
Rongbin Xu
Emily Nehme
Michael Abramson
Yuming Guo

What we did

We obtained daily ambulance attendances data for the period January 2013 to December 2021 and daily ED presentations and hospital admissions data for the period January 2009 to June 2022. We used air pollution data modelled by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to estimate smoke levels across Morwell (highest smoke exposure), compared with the wider Latrobe Valley (lower smoke exposure) and the rest of regional Victoria (no smoke exposure) during the mine fire. A statistical method called time series analysis was used to examine whether ambulance attendances, ED presentations or hospital admissions increased during the 8 years after the mine, and whether any increases were associated with mine fire smoke levels. We combined all types of medical conditions together but also looked at heart, lung and mental health-related conditions separately. The analysis took into account the influences of other contributing factors such as season and temperature.

Hazelwood Health Study website: http://www.hazelwoodhealthstudy.org.au/

Hazelwood HEALTH STUDY

What we found

Compared with before the fire, and compared also with service use trends in the rest of regional Victoria, hospital ED presentations increased by 15% in Morwell and 9% in the wider Latrobe Valley, and hospital admissions increased by 9% in Morwell and 8% in the wider Latrobe Valley during the 8 years after the mine fire for all medical conditions combined. There was no clear change in the rate of ambulance attendances.

When we looked at heart, lung and mental health-related conditions separately, once again compared with before the fire, and with service use trends in the rest of regional Victoria, we found that heart-related ED presentations increased by 9% in Morwell but remained unchanged in the wider Latrobe Valley, and heart-related hospital admissions increased by 13% in Morwell and 6% in the wider Latrobe Valley.

Lung-related ED presentations and hospital admissions remained unchanged in Morwell. However, lung-related ED presentations in the wider Latrobe Valley slightly increased by 3% and lung-related hospital admissions in the wider Latrobe Valley increased by 5%.

The largest increases were for mental-health-related conditions. Mental health-related ED presentations increased by 10% in Morwell but remained unchanged in the wider Latrobe Valley. Whereas mental health-related hospital admissions substantially increased by 46% in Morwell and 42% in the wider Latrobe Valley during the 8 years after the mine fire.

A detailed paper describing the findings from this analysis can be found at https://hazelwoodhealthstudy.org.au/study-findings/publications

Considerations

It is possible that long-term health effects of smoke from the mine fire contributed to increased hospital ED presentations and/or hospital admissions in the 8 years after the event. It is also possible that the mine fire event, and consequent establishment of health-related entities such as the Hazelwood Health Study and the Latrobe Health Assembly have led to behavioural change in the community. For example, people in the region may be more likely to seek medical care regardless of whether their health condition was a result of the fire or not. Such a change in health seeking behaviour could explain the increases in hospital ED presentations and/or hospital admissions in Morwell and the wider Latrobe Valley.

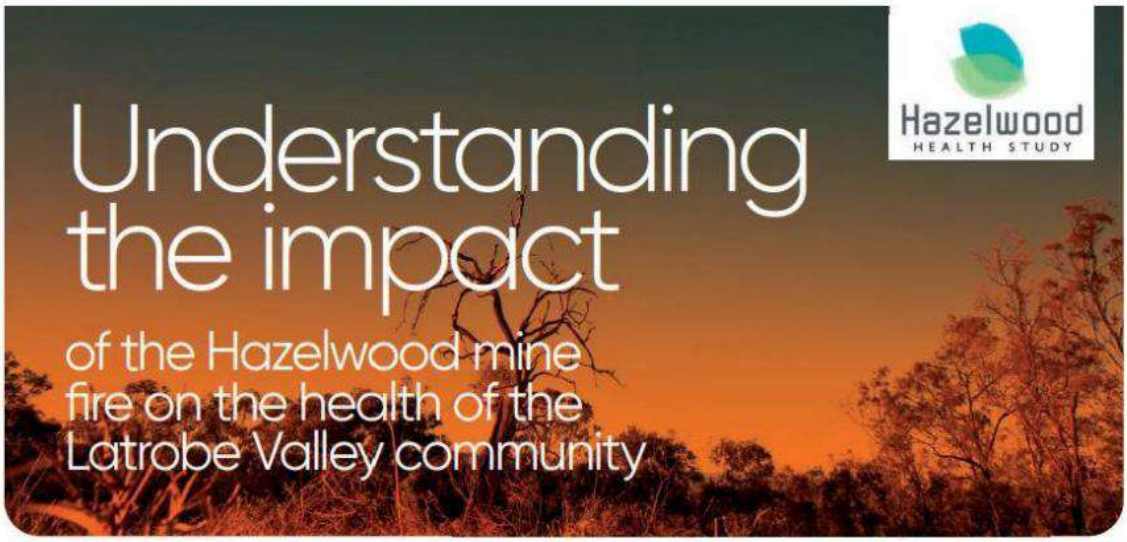
Where to from here

To complement these findings, the study continues to investigate a range of health outcomes including lung function, cardiovascular health, child development, community wellbeing, educational outcomes and cancer.

The HHS is led by Monash University with collaborators from Menzies Institute for Medical Research, Federation University, The University of Adelaide, the University of Newcastle and CSIRO.
The research was funded by the Department of Health.

Hazelwood Health Study website: http://www.hazelwoodhealthstudy.org.au/

Appendix 5: 2023 Community Flyer



The Hazelwood mine fire had a major impact on the Latrobe Valley community. As well as being an incredibly stressful time for locals living in the area, it understandably caused many people to have concerns about the length of time they were exposed to smoke from the fire and its possible health effects. In 2014, the Hazelwood Health Study was set up to monitor the long-term health of community members. This leaflet provides a snapshot of the Study's findings to date.

Health information has now been collected from more than 70,000 people

The Hazelwood Health Study, now in its 9th year, is led by Monash University, the University of Tasmania and Federation University. Data collected includes:

70,000
Health service information from more than 70,000 people across the Latrobe Valley and wider Gippsland

10,000
The educational results of more than 10,000 school children

4,500
Cancer information from more than 4,500 people

4,000
Physical symptoms, mental health and smoke exposure information from more than 4,000 adults

3,500
Pregnancy and birth information from more than 3,500 women

1,000 + 500
Heart and lung information from more than 1,000 adults and 500 young children

300
Mental health information from more than 300 school children.

INTERESTING

While the Study shows that the fire has contributed to ongoing health problems in Morwell and surrounding areas, it has also shown that some of those problems are improving.

The heart and lung health of adults was affected but there are signs of improvement

at the time of fire

6 months later

CARDIOVASCULAR HEALTH (heart and blood vessels)

- Medications dispensed
- Risk of death from cardiovascular conditions

RESPIRATORY HEALTH (lungs and breathing)

- Medications dispensed
- Ambulance call-outs
- Emergency department attendances
- Hospital admissions
- Specialist visits (among men)

NO CHANGE in risk of death from respiratory conditions

Fire-related distress persists in some adults

AT TIME OF FIRE

- Mental health-related consultations, prescriptions, ambulance call-outs and hospital admissions

2.5 YEARS LATER

14% of adults reported symptoms consistent with post-traumatic stress disorder (PTSD)

Moderate levels of distress reported by adults in Morwell, with higher levels of distress among people who were exposed to more smoke

Distress was most common among younger adults and those who already had respiratory or mental health conditions

5.5 YEARS LATER

- Fire-related distress (especially among younger adults) compared to the levels reported 2.5 years after the fire – this may have been partly due to additional smoke exposure during the 2019 Black Summer fires

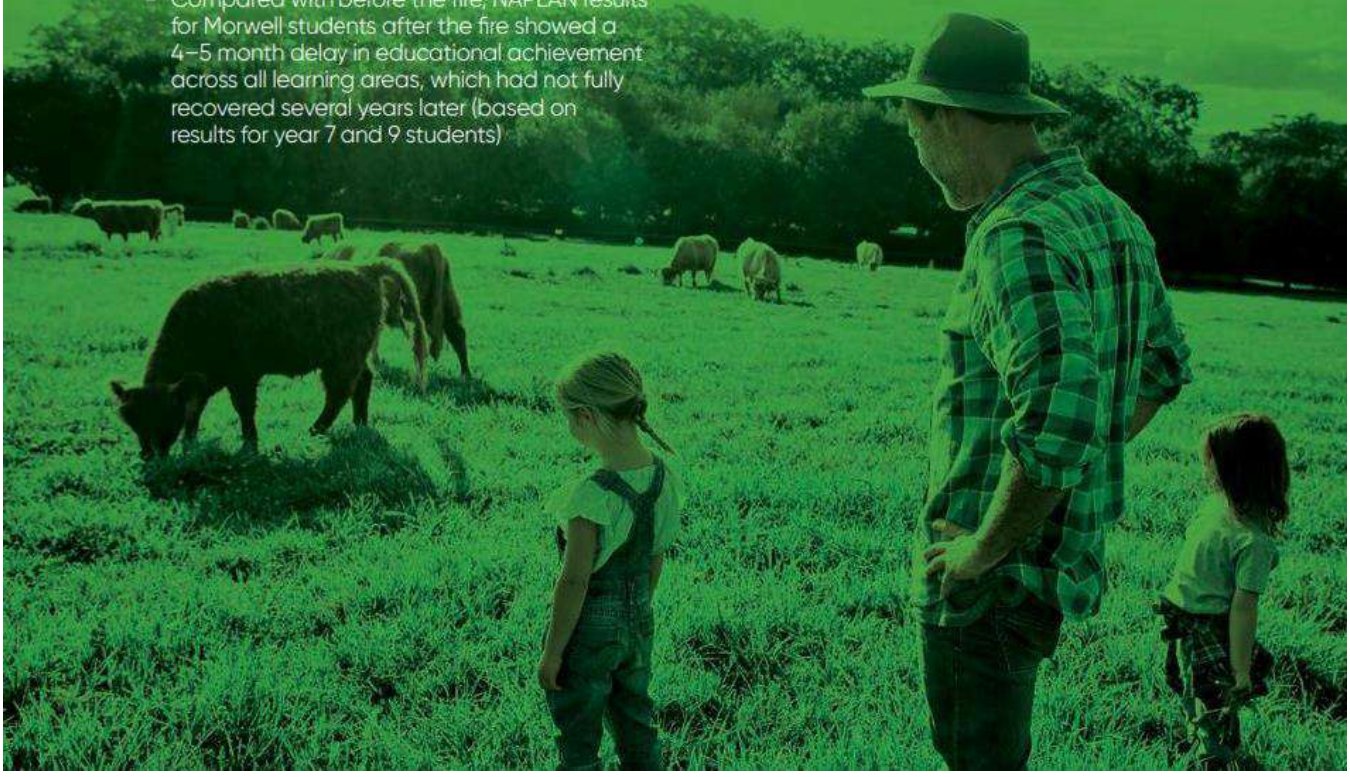

2.5 to 3 years later
3.5 to 4 years later
Self-reported heart attacks and high blood pressure (but reported by very small numbers of people)
NO DIFFERENCES in cardiovascular disease, reduced heart function, heart muscle damage, abnormal heart rhythm or abnormal blood vessel health
Respiratory symptoms, e.g. cough, shortness of breath
Chest tightness
Chronic (long-term) cough
Lung stiffness
Chronic obstructive pulmonary disease (COPD) among non-smokers
Chronic cough among smokers
Control of asthma
Pregnant women exposed to mine fire smoke
Risk of gestational diabetes
Babies who were in the womb at the time of the fire
After birth:
Symptoms such as runny nose, cough and wheeze
Healthcare visits
Upper respiratory infections (colds)
Very young children
Use of antibiotics, steroid creams and asthma medications
Visits to GPs and emergency departments
Children who were tested several years later
3 years after the fire
Stiffness of lungs and blood vessels
6 years after the fire
NO stiffness of lungs detected, meaning this may have resolved
Health issues in babies and young children continue to be monitored

Tracking educational and mental health outcomes in school children

- **Specialist school students had particular difficulties at the time of the fire**
- **1.5 years after the fire:**
  - Most mainstream school students did not have ongoing problems, but about 1 in 5 students (22%) reported post-traumatic stress symptoms
  - Morwell students exposed to smoke reported more distress than non-Morwell students, with primary school students reporting more symptoms than secondary students
- **NAPLAN (National Assessment Program – Literacy and Numeracy) results:**
  - Compared with before the fire, NAPLAN results for Morwell students after the fire showed a 4–5 month delay in educational achievement across all learning areas, which had not fully recovered several years later (based on results for year 7 and 9 students)

DID YOU KNOW?

No differences in cardiovascular health several years after the fire suggests that earlier problems may now have resolved. However, the data suggests ongoing impacts on lung health.



Findings related to older people, communication, community wellbeing and recovery

In addition to the specific health and education impacts described in this leaflet, the Hazelwood Health Study has also found that:

- Voices of older people were paid little attention during the event and there was little support for them, especially those living independently
- The public health response at the time was limited by a lack of evidence about the likely health impacts of the mine fire
- There were problems with official communication about the mine fire, which led to confusion, mixed messaging, and a loss of trust in the authorities who were dealing with the crisis
- Because of this, local media outlets and social media groups were important in filling communication gaps and representing community concerns
- As well as health considerations, community recovery includes broader wellbeing, job creation and sustainability, along with careful consideration of the implications of an energy transition away from coal

Study findings drive positive change for Latrobe Valley and beyond

Although the Study can't change what happened in the past, it is providing important learnings. The research findings are regularly shared with local and Statewide organisations such as the Latrobe City Council, the Gippsland Primary Health Network, the Latrobe Health Advocate, the Latrobe Health Assembly and the Department of Health.

Here are some examples of how the Study has helped shape services for the ongoing health of the Latrobe Valley or changed the way authorities now respond to bushfire and other smoke-related events to protect the health of the community:

Contributing to decisions made during the Black Summer bushfires

During the 2019 Black Summer bushfires across eastern Australia and Tasmania, study findings were used in making decisions to evacuate smoke-affected communities and supply air purifiers in evacuation shelters.

Informing national guidelines for smoke events

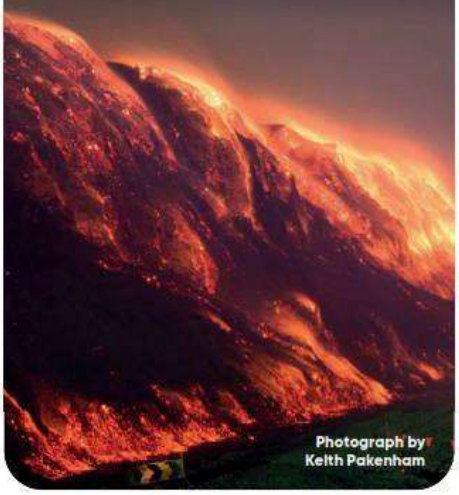
The Study's findings have also helped inform national guidelines for prolonged smoke events, showing the importance of minimising pregnant women's exposure to air pollution.

Prompting extra mental health services for school-aged children

In response to the Study, the Department of Health recognised the increased levels of distress in school-aged children, which led to the establishment of a clinical pathway and the increased provision of mental health services in the region.

CONSEQUENCES FOR COAL MINE OPERATORS

Study findings were included in the 2019 Supreme Court trial that found the Hazelwood coal mine operators guilty of 10 Worksafe breaches, as well as an earlier trial that found them guilty of three Environment Protection Act breaches. The mine operators were found guilty of polluting the atmosphere so as to make it harmful to health.



Photograph by Keith Pakenham

Ongoing research

The Hazelwood Health Study is continuing, which may reveal further evidence of health improvements and lessons for the future. We will share the latest findings with the community as they become available. If you were in the Latrobe Valley at the time of the fire and have concerns about your health or that of your family members, please see your GP.

Hazelwood HEALTH STUDY

For more information about the Hazelwood Health Study, go to **https://hazelwoodhealthstudy.org.au/**

We would like to express our sincere thanks to everyone who has participated in the Hazelwood Health Study.