MJA
The Medical Journal of Australia

Supporting Information

Supplementary methods and results

**This appendix was part of the submitted manuscript and has been peer reviewed.
It is posted as supplied by the authors.**

Appendix to: Thomson TN, Szanyi J, Mulvenna V. Heat health alerts and emergency department presentations by people aged 65 years or older, Victoria, 2010–22: a case–crossover analysis. *Med J Aust* 2024; doi: 10.5694/mja2.52364.

1. Victorian heat health alert system

From 1 December 2010 to 1 March 2022, the Victorian Department of Health operated a heat health alert system during the summer season (typically 1 November – 31 March). Temperature thresholds were set for each of the nine weather forecast districts (Table 1), based on the lower temperature limits above which mortality of people aged 65 years and over increases substantially.

During the operational period of the heat health alert system, the Victorian Department of Health monitored the Bureau of Meteorology forecasts of daily minimum and maximum temperatures and calculated the daily mean temperature for each weather forecast district. The mean temperature for any given day was calculated as the mean of the forecast daily maximum temperature and the forecast overnight temperature (using the forecast daily minimum for the following day). When this mean met or exceeded the temperature threshold for any of the included weather stations in a weather forecast district, an alert was issued (Figure 1).

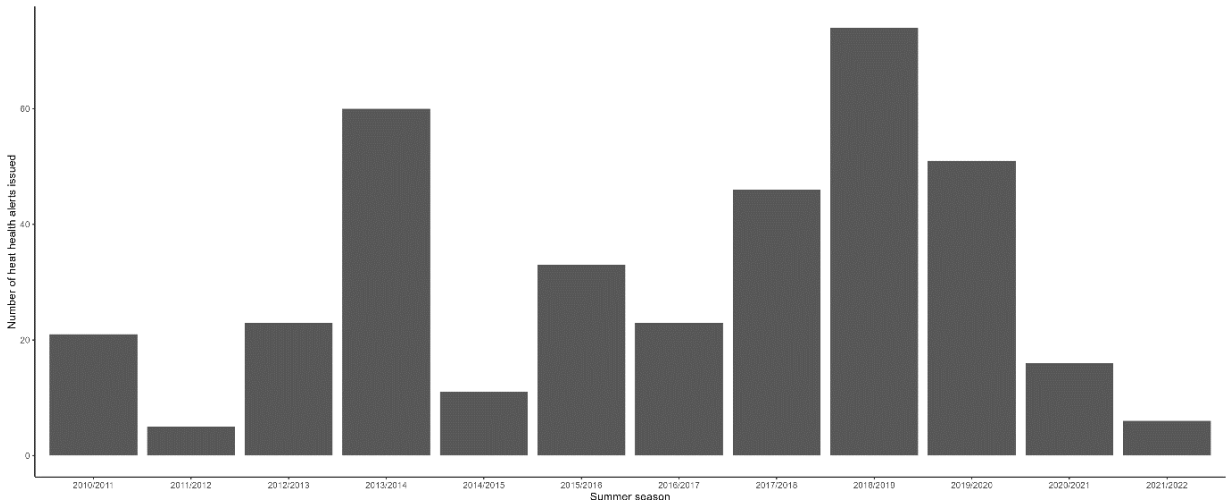
From the 2022/23 summer season, the Victorian Department of Health aligned heat health alerts with the Australian Bureau of Meteorology heatwave warning system. Heatwave warnings are now issued when 10% or more of a weather forecast district is in a severe or extreme heatwave, calculated using forecast minimum and maximum temperatures for the next three days, compared with what is considered hot for that location and the observed temperatures from the previous 30 days. This new data is not included in the current analysis.

Table 1: Heat health temperature thresholds for Victorian weather forecast districts used to issue heat health alerts

Weather forecast district	Heat health temperature threshold	Weather station sites
Mallee	34°C	Mildura
Wimmera	32°C	Horsham
South West	30°C	Hamilton
Northern Country	32°C	Bendigo Shepparton
North Central	30°C	Seymour
North East	32°C	Wodonga
East Gippsland	30°C	Bairnsdale
West & South Gippsland	30°C	Sale
Central	30°C	Melbourne Ballarat Geelong

The full dataset of the Victorian heat health alerts issued is available online.[1]

Figure 1: Number of heat health alerts issued in Victoria, by summer season, 1 December 2010 to 31 March 2022



2. Supplementary methods

A space-time-stratified case-crossover design[2] was used, with case and control days defined for each weather forecast district. Case days were the day of an alert and the day after. Controls days were selected use a time-stratified selection strategy, including all days with the same day of the week, month, and year as case days (if these days were not already included as case days). Events were analysed within strata that were defined by the weather forecast district, year, month, and day of the week.

Public hospital Emergency Department (ED) presentations were obtained from the Victorian Emergency Minimum Dataset (VEMD)[3]. Presentations were assigned to weather forecast districts based on postcode of residence, with presentations for patients with unknown or non-Victorian postcodes excluded. Presentations were included if any of the (maximum three) International Classification of Diseases 10th Revision (ICD-10) codes listed for that presentation indicated a disease group of interest (Table 2).

This list of ICD-10 codes was developed following a review of the published literature analysing associations between heat and health outcomes. This body of literature reports associations between heat and, for example,

- Cardiovascular morbidity, including coronary heart disease, acute coronary syndrome, arrhythmias and cardiac arrest (but a protective effect against morbidity due to hypertension as replicated in the current study – this may be due to peripheral vasodilation and a subsequent reduction in systolic blood pressure in response to heat),[4]
- Respiratory morbidity, possibly due to increased ventilatory requirements and the exacerbation of pre-existing chronic obstructive pulmonary disease,[5]
- Diabetes-related morbidity, likely related to the relationship between physiological and metabolic dysfunction seen in diabetes and the response to heat stress,[5]
- Renal morbidity, due to diversion of blood from the renal vasculature to the periphery in response to heat.[5]

Conditional logistic regression models were created using the clogit() function from the *survival* package in R version 4.1.2. All models are adjusted for public holidays, obtained from the holiday_aus() function from the *tsibble* package in R, with Victorian Grand Final Public Holiday dates added for each year.

3. Supplementary results

VEMD data was extracted for all relevant days over the study period (any date that was included in the study as a case and control days for any weather forecast district), and 81,337 records were excluded due to unknown (14,180 records) or non-Victorian residential postcodes (other Australian states and territories, or overseas, 67,157 records).

Table 2: Emergency department presentations during the case and control periods for each disease group (by people aged 65 years and over), and ICD-10 codes used to identify presentations

Disease group (ICD-10 codes)	Case period	Control period
Diseases of the circulatory system (I00 – I99)	8,819	25,837
Hypertensive diseases (I10 – I15)	386	1,530
Ischaemic heart disease (I20 – I25)	1,639	4,770
Acute coronary syndrome (I21 – I22)	924	2,611
Cardiac arrest (I46)	92	272
Arrhythmia (I47 – I49)	2,148	6,262
Heart failure (I50)	1,404	4,120
Cerebrovascular disease (I60 – I69)	1,453	4,232
Diseases of the respiratory system (J00 – J99)	5,852	16,305
Chronic obstructive pulmonary disease (J41 – J44)	1,514	3,914
Asthma (J45 – J46)	235	680
Diabetes mellitus (E10 – E14)	193	546
Mental and behavioural disorders (F00 – F99)	1,504	3,946
Organic mental disorders (F00 – F09)	787	1,947
Mental and behavioural disorders due to psychoactive substance use (F10 – F19)	194	527
Schizophrenia (F20 – F29)	61	188
Mood disorders (F30 – F39)	152	407
Neurotic, stress-related and somatoform disorders (F40 – F48)	297	825
Kidney disease (N00 – N39)	3,636	9,951
Acute renal failure (N17)	653	1,437
Urolithiasis (N20 – N23)	472	1,413
Urinary tract infection (N10 – N12, N30, N39.0)	2,037	5,794
Volume depletion (E86)	808	1,083
Heatstroke and sunstroke (T67)	437	182

References

1 Victorian Government. Victorian Department of Health Historic Heat Health Alerts (December 2010 – March 2022). 27 August 2023. https://discover.data.vic.gov.au/dataset/victorian-department-of-health-historic-heat-health-alerts-december-2010-march-2022 (viewed June 2023).

2. Lewer D, Petersen I, Maclure M. The case-crossover design for studying sudden events. *BMJ Med* 2022; **1**: e000214.

3. Victorian Department of Health. Victorian Emergency Minimum Dataset (VEMD). 2023. https://www.health.vic.gov.au/data-reporting/victorian-emergency-minimum-dataset-vemd (viewed Dec 2023).

4. Liu J, Varghese BM, Hansen A, et al. Heat exposure and cardiovascular health outcomes: a systematic review and meta-analysis. *Lancet Planet Health* 2022; **6**: e484-e495.

5. Bunker A, Wildenhain J, Vandenbergh A, et al. Effects of air temperature on climate-sensitive mortality and morbidity outcomes in the elderly; a systematic review and meta-analysis of epidemiological evidence. *EBioMedicine* 2016; **6**: 258-268.

STROBE Statement—Checklist of items that should be included in reports of *case-control studies*

	Item No	Recommendation	Included
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	X
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	X
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	X
Objectives	3	State specific objectives, including any prespecified hypotheses	X
Methods			
Study design	4	Present key elements of study design early in the paper	X
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	X
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	X
		(*b*) For matched studies, give matching criteria and the number of controls per case	X
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	X
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	X
Bias	9	Describe any efforts to address potential sources of bias	X
Study size	10	Explain how the study size was arrived at	X
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	X
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	X
		(*b*) Describe any methods used to examine subgroups and interactions	X
		(*c*) Explain how missing data were addressed	X
		(*d*) If applicable, explain how matching of cases and controls was addressed	X
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	n/a
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	X
		(b) Indicate number of participants with missing data for each variable of interest	X
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	X
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	X
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	X
Discussion			
Key results	18	Summarise key results with reference to study objectives	X
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	X
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	X
Generalisability	21	Discuss the generalisability (external validity) of the study results	X
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	X

*Give information separately for cases and controls.