

Sweat, Strain & Sirens: Extreme heat, humidity and emergency department demand in the NT

Collaborations & Funding

NT Health

Chief Minister and Cabinet

University of Tasmania – Menzies & Centre for Safe Air

Menzies School of Health Research

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Aboriginal Medical Service Alliance of the NT, AMSANT

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Presented from the traditional lands of the Larrakia people

Background

- Extreme heat pose a growing threat to human health. This relationship is not well understood in NT.
- One study to date exploring mortality data in NT, which demonstrated an elevated risk of mortality in hot temperatures. Limited knowledge on the impact humidity.
- Humidity could potentially amplify heat-related health effects.
- Australia's current heatwave warning system uses a heatwave definition that does not incorporate the influence of humidity.

Heatwave intensity

Low-intensity heatwaves are frequent during summer.

- Most people can cope.

Severe heatwaves are less frequent.

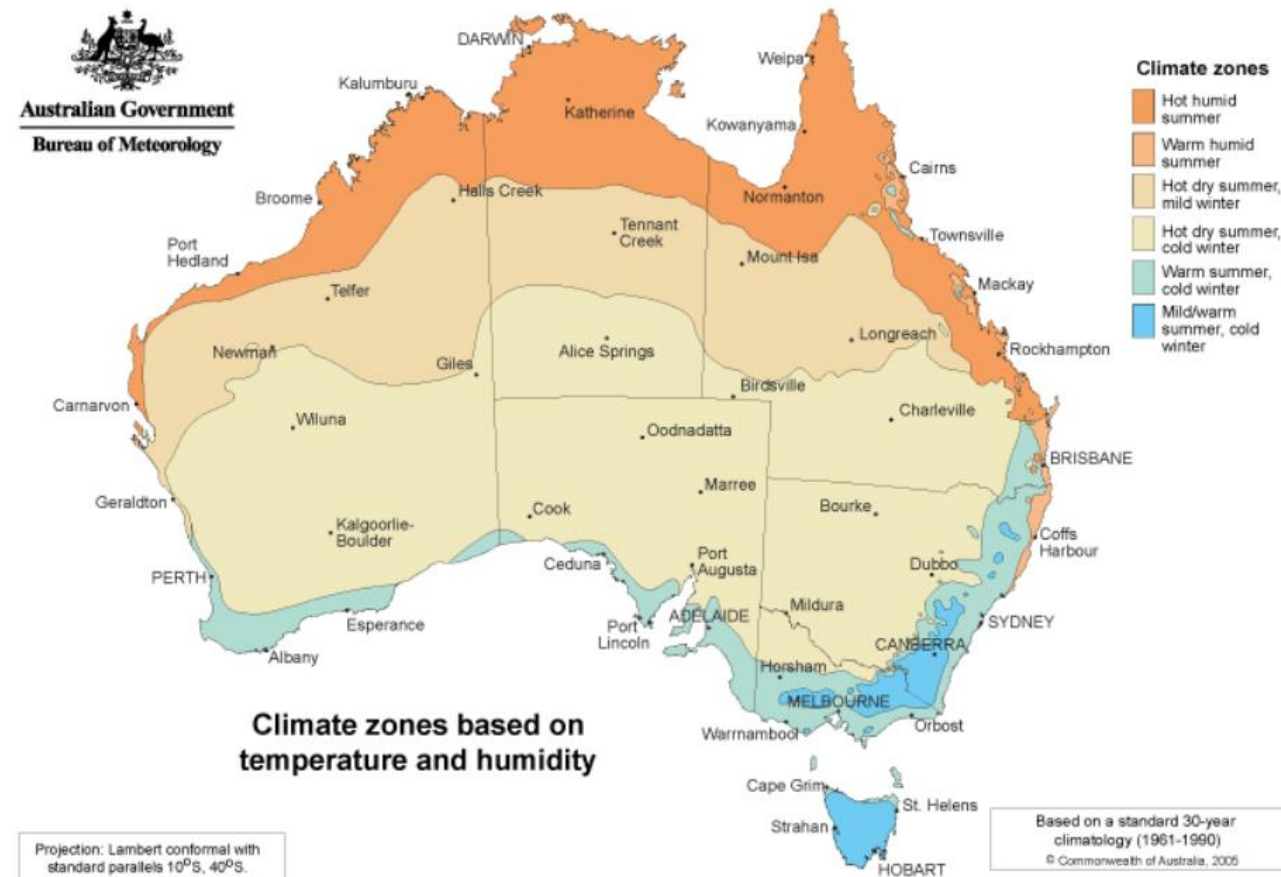
- Can impact vulnerable people such as elderly, people with chronic health conditions

Extreme heatwaves are rare.

- Can cause problems for people who don't take precautions to keep cool – even for healthy people.
- Can impact infrastructure – power and transport

Study: Impact of heatwaves on emergency department presentations, 2001 to 2023

- Do more people present to the emergency department when there's a heatwave?
- What are the key characteristics of these people?
- What about humidity - impacts on health?
 - Tropical Top End
 - Arid Central Australia



Heatwaves - Excess heat factor

Heatwave definition

A heatwave is when the maximum and minimum temperatures are unusually hot over 3 days.

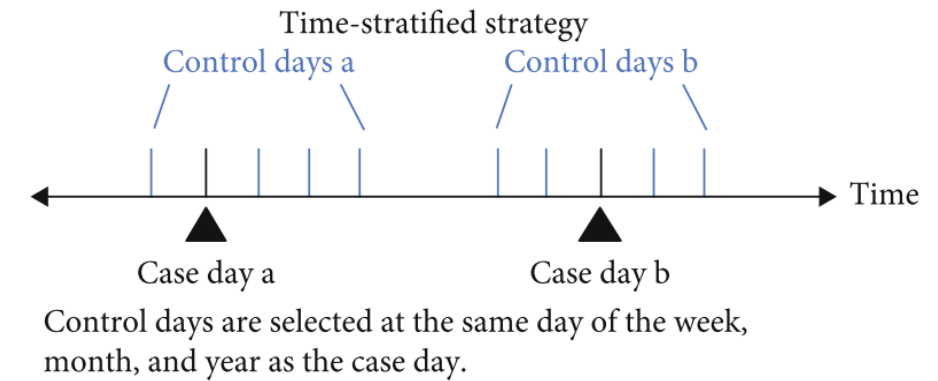
Heatwave definition - Excess heat factor ($\text{EHF}_{(T)}$) which combines

- average temperatures for a 3-day period with what would be considered hot at that location
- observed temperatures at that location over the past 30 days.

**** Uses temperature only *****

Methods:

Study design: space-time stratified case-crossover design (Wu & Guo, 2021)



Outcome: daily counts of emergency department (ED) presentations, between 1 Jan 2001 and 31 December 2023, for all 6 public hospitals in the NT

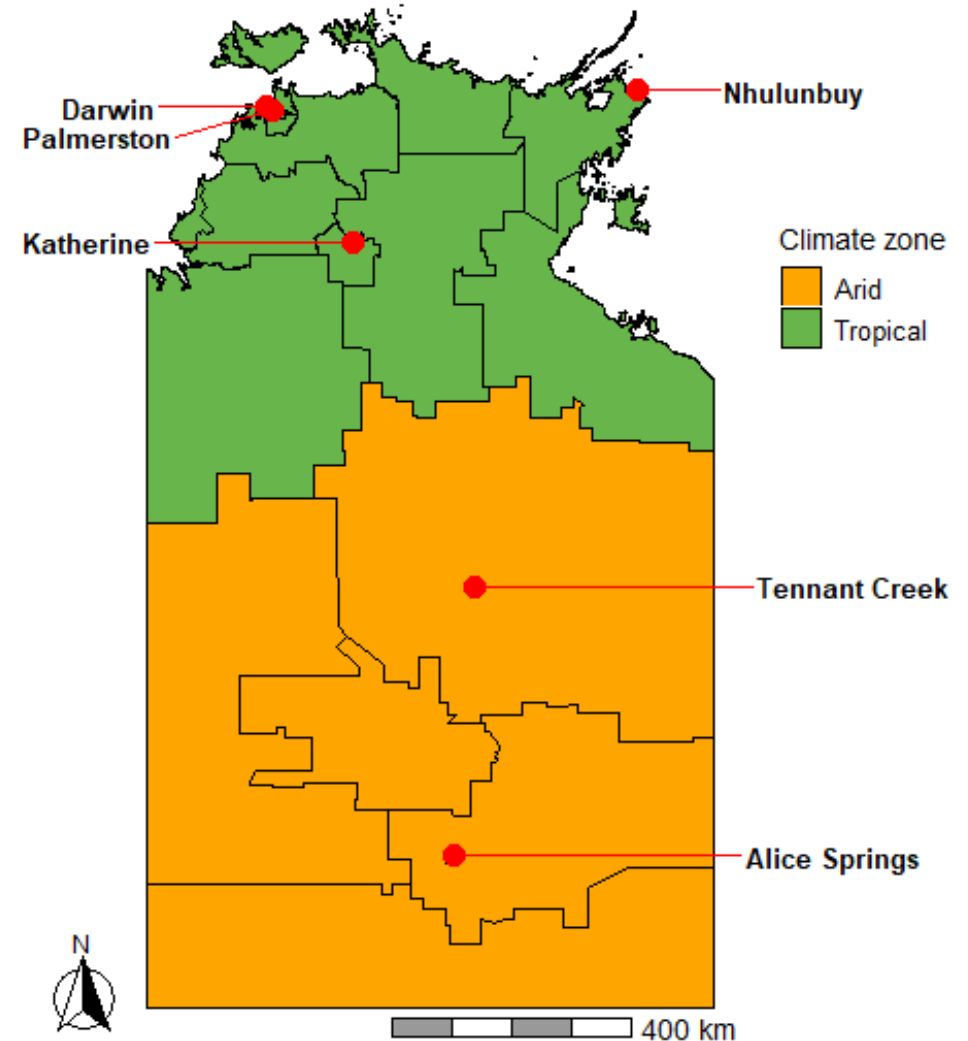
Exposure:

- Temperature only: excess heat factor (EHF - T) (Nairn and Fawcett, 2015)
- Temperature and humidity: heat index (EHF - HI) (Nairn et al., 2022)
- 3 levels of intensity: Low, severe, extreme

Heatwaves were mapped to ABS Statistical Area 2 (SA2) regions.

A case was a resident in SA2 at the time of the heatwave and presented to ED on the same day as heatwave.

We also analysed the heatwave trends by the two climatic zones.



Methods (cont.):

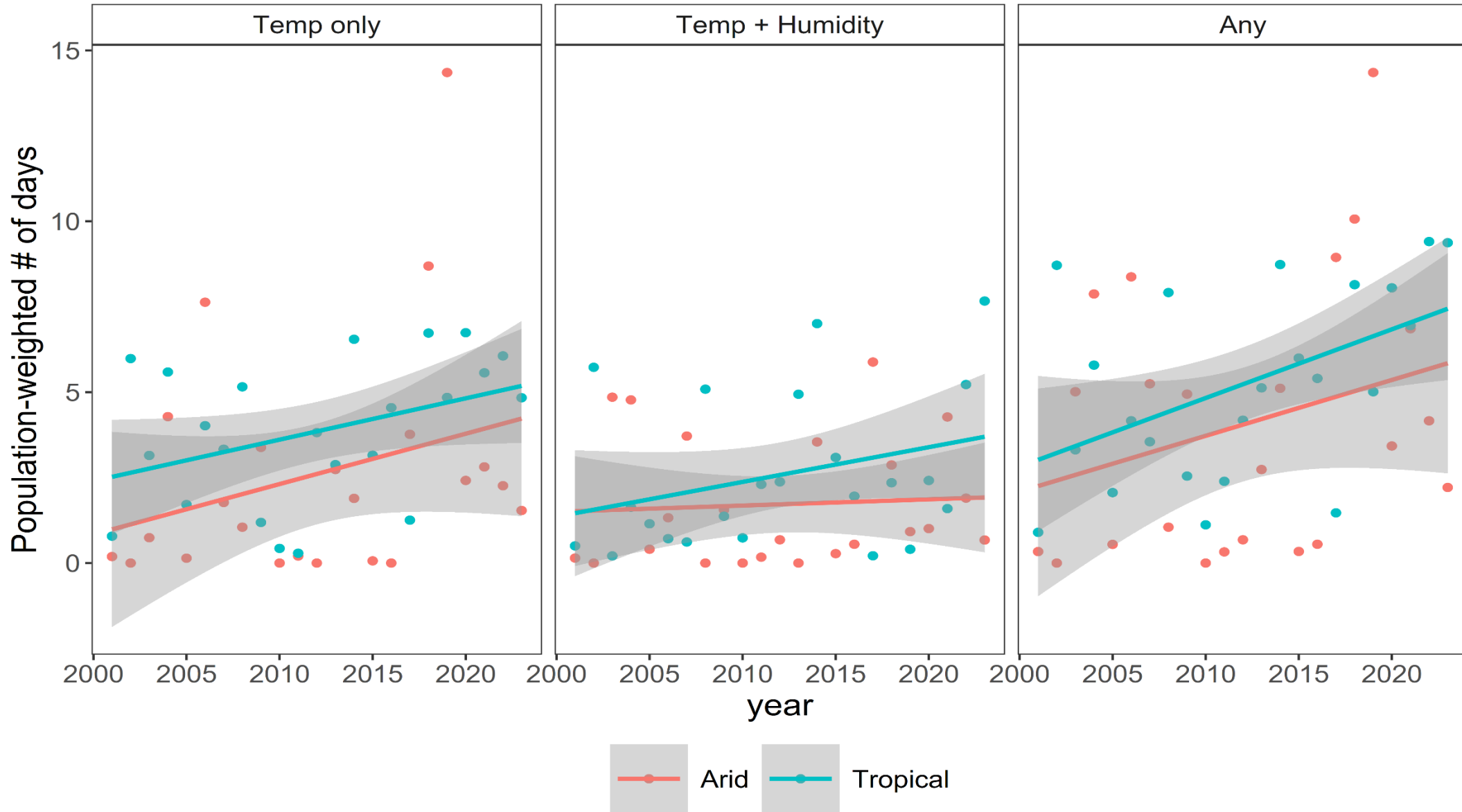
Covariates: fine particulate matter (PM_{2.5}) and public holidays

Analysis: We used conditional Poisson regression models:

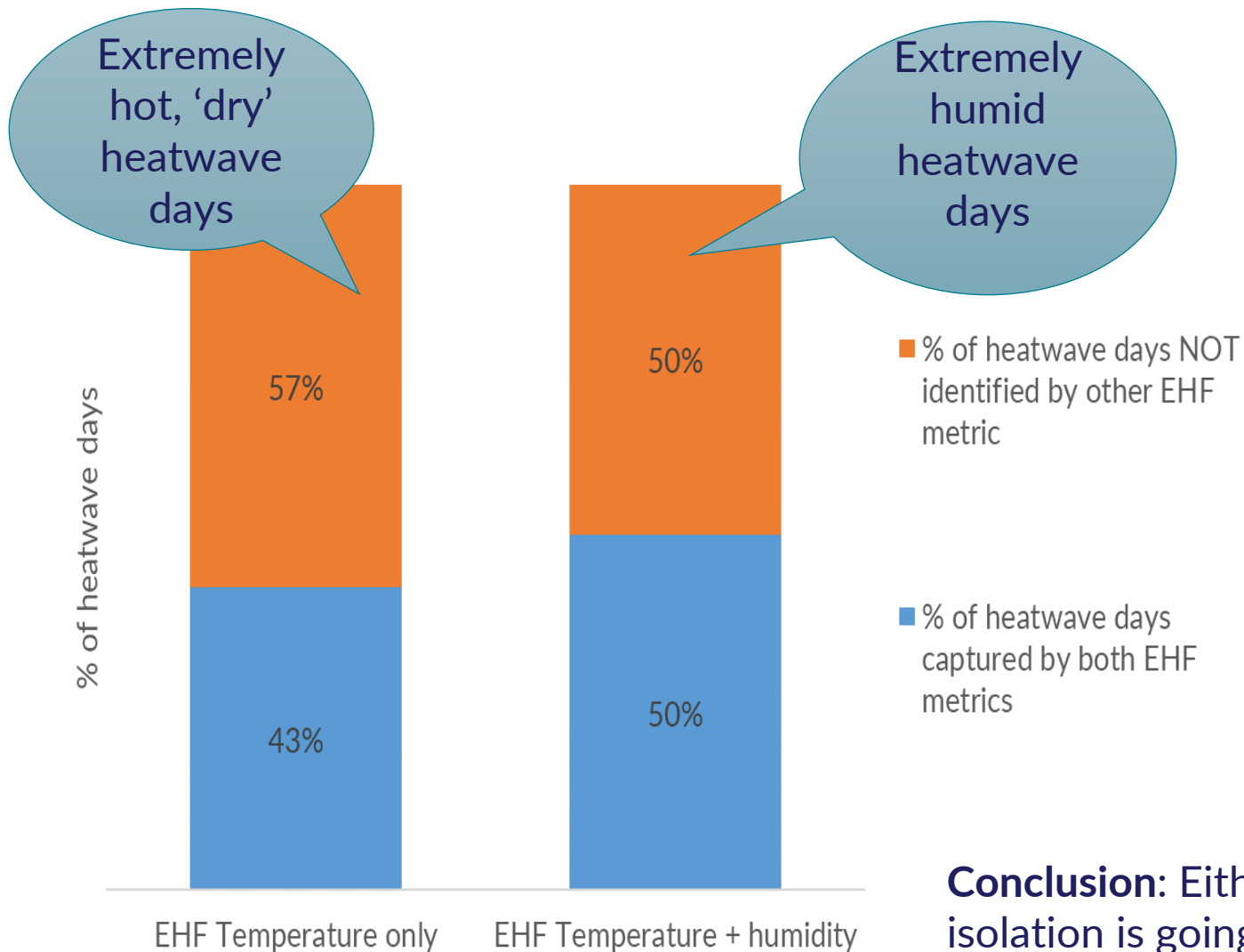
- the entire population, inclusive of all-cause ED presentations,
- demographic characteristics including Indigenous status, residential status, sex, age group and IRSD,
- climatic zone inclusive of tropical or arid climate, and
- the most common diagnostic reasons for ED presentations, diabetes and the effects of heat and light.

NT weather trends – heatwave increasing

of severe or extreme heatwave days per year



Comparison EHF's – days recognised as heatwave

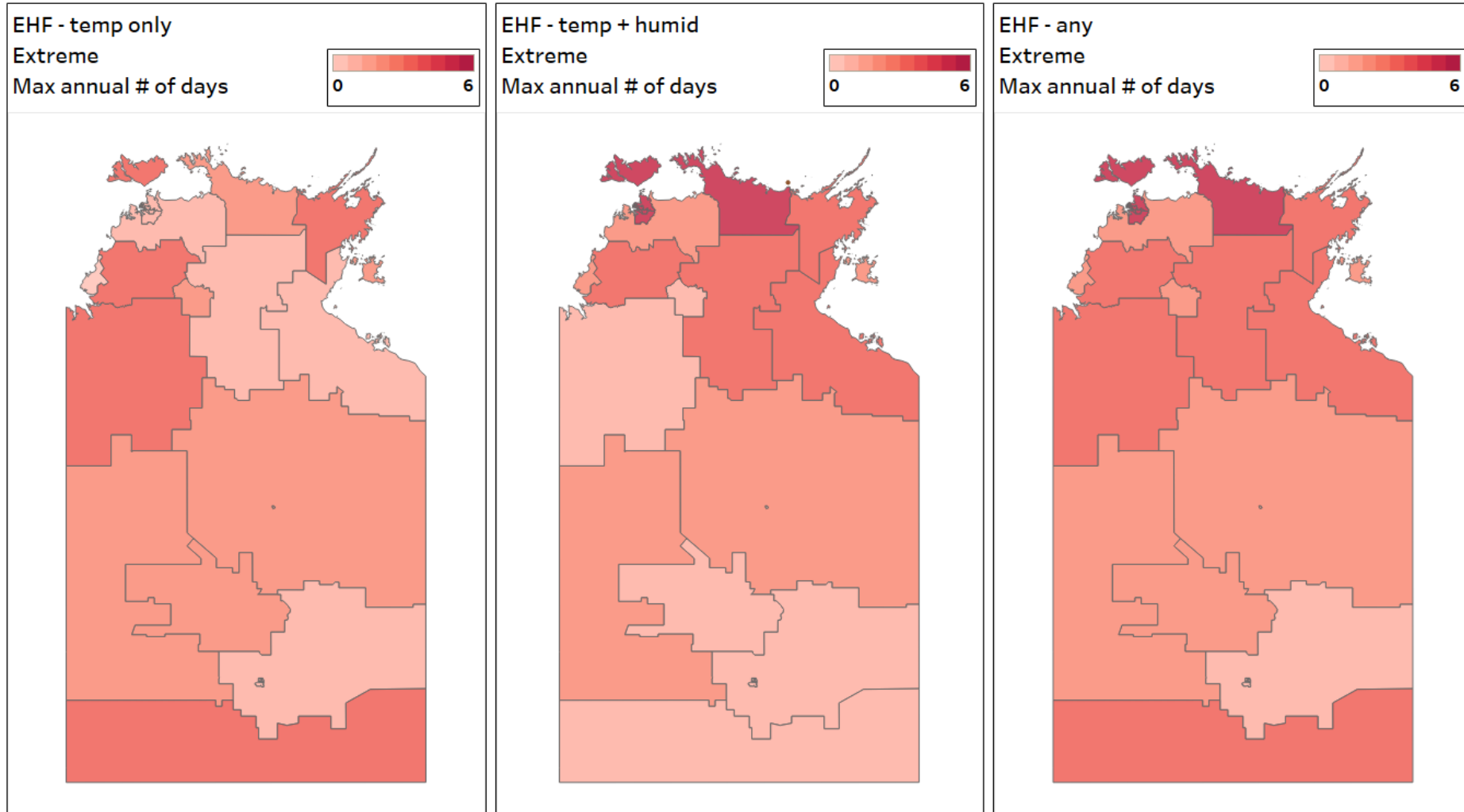


Maximum number of extreme heatwave days per year by statistical areas 2 (SA2)

Max # days	# of SA2s		
	Temp only	Temp + Humidity	Any
0	1	0	0
1	54	12	7
2	7	5	8
3	5	4	6
4	1	4	4
5	0	42	42
6	0	1	1

Conclusion: Either metric in isolation is going to miss $\geq 50\%$ of heatwave days

Max number of heatwaves per year by SA2 regions



Heatwave days per NT population by EHF metric

Max # days	Population		
	Temp only	Temp + Humidity	Any
0	2,446	0	0
1	194,637	55,062	33,366
2	31,280	15,882	32,327
3	18,214	17,681	22,932
4	3,642	10,899	10,899
5	0	147,053	147,053
6	0	3,642	3,642

Emergency department presentations

	Heatwave – temperature only		Heatwave – temperature + humidity	
	Low intensity	Severe/extreme intensity	Low intensity	Severe/extreme intensity
Increased risk of ED presentation (95% CIs)	1.6%↑ (0.2% -3.0%)	4.4%↑ (1.8% - 7.1%)	0.9%↑ (.05% -2.4%)	6.1%↑ (2.5% - 9.8%)



Emergency department presentations

	Heatwave – temperature only		Heatwave – temperature + humidity	
	Low intensity	Severe/extreme intensity	Low intensity	Severe/extreme intensity
Whole population	1.6%↑	4.4%↑	0.9%↑	6.1%↑
Additional ED presentations	8 people	22 people	1 person	31 people

How many people does this % increase translate to?

In 2024, in the NT an average of 505 people present to ED each day



Small contribution to the health burden

Australian studies*

Deaths 0% to 92%

Hospital admissions 7% to 58%

ED presentations 2% to 14%

Ambulance 2% to 21%

PHC unknown

Symptomatic - unknown

Deaths

Hospital
admissions

ED presentations

Ambulance dispatches

Primary health care visits

People with symptoms

NT studies

Deaths** 14%

?

1% - 6%

?

?

?

*Mason H, C King J, E Peden A, C Franklin R. Systematic review of the impact of heatwaves on health service demand in Australia. BMC health services research. 2022 Jul 28;22(1):960.

**Quilty S, Jupurrurla NF, Lal A, Matthews V, Gasparrini A, Hope P, Brearley M, Ebi KL. The relative value of sociocultural and infrastructural adaptations to heat in a very hot climate in northern Australia: a case time series of heat-associated mortality. The Lancet Planetary Health. 2023 Aug 1;7(8):e684-93.

Demographic sub-groups (severe/extreme)

	Heatwave - Temperature only		Heatwave - Temperature + humidity	
	Significant % increase	Risk ratio (95% CI)	Significant % increase	Risk ratio (95% CI)
Indigenous status				
Aboriginal		1.022 (0.987 - 1.059)	5.9%	1.059 (1.006 - 1.114)*
Non-Aboriginal	3.7%	1.037 (1.004 - 1.072)*	4.6%	1.046 (1.003 - 1.091)*
Residential status				
NT resident	3.1%	1.031 (1.005 - 1.058)*	5.3%	1.053 (1.017 - 1.090)*
Visitor	16.2%	1.162 (1.038 - 1.301)*		1.111 (0.957 - 1.290)
Age group				
Age < 5 years		0.977 (0.914 - 1.043)		1.009 (0.919 - 1.107)
5 to 18 years		0.990 (0.935 - 1.049)		0.972 (0.898 - 1.052)
19 to 49 years	5.2%	1.052 (1.018 - 1.087)*		1.041 (0.997 - 1.087)
50 to 64 years		1.028 (0.975 - 1.085)	14.1%	1.141 (1.059 - 1.230)*

Presenting diagnosis (severe/extreme)

	Heatwave - Temperature only		Heatwave - Temperature + humidity	
	Significant % increase	Risk ratio (95% CI)	Significant % increase	Risk ratio (95% CI)
Effects of light and heat	571.7%	6.717 (6.150 - 7.337)*	354.7%	4.547 (4.088 - 5.058)*

Heat stress accounts for < 0.1% of ED presentations on heatwave days – these small numbers won't accurately assess heat impacts on health



Presenting diagnosis

Heatwave - Temperature only

	Significant % increase	Risk ratio (95% CI)
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Skin	11.6%	1.116 (1.048 - 1.189)*
Respiratory		1.013 (0.954 - 1.076)
Cardiovascular		0.988 (0.924 - 1.056)
Urinary		0.969 (0.899 - 1.045)
Injury		1.003 (0.955 - 1.053)
Mental/behavioural		0.926 (0.865 - 0.991)

Heatwave - Temperature + humidity

	Significant % increase	Risk ratio (95% CI)
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		1.005 (0.923 - 1.094)
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		1.029 (0.947 - 1.118)
--	--	-----------------------

	11.1%	1.111 (1.015 - 1.216)*
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		1.012 (0.917 - 1.118)
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		0.977 (0.915 - 1.043)
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		0.943 (0.860 - 1.035)
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Summary

Health impacts increase with heatwave severity.

Humidity matters – in tropical & arid regions of the NT.

Study validates heatwave public messaging for severe & extreme heatwaves.

Different vulnerabilities/ high-risk populations for extremely hot 'dry' heatwaves & extreme humidity days.

Complexities in measuring heat

“As climate change accelerates the frequency, duration, and severity of extreme heat events, the need for coherent, risk-informed, and cross-sectoral warning systems becomes increasingly urgent”.

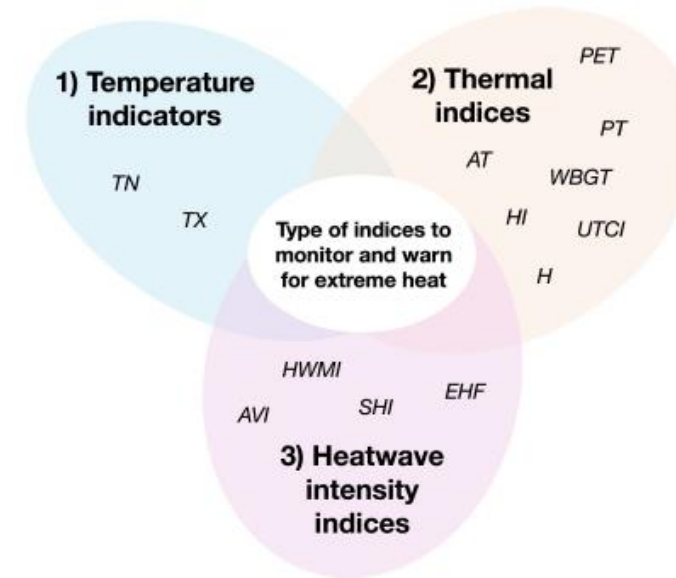


Figure 1. Typology for standardized and complementary extreme heat services and warnings. Indicators are grouped into three broad categories: (1) Temperature-based indicators (e.g., TX = daily maximum temperature, TN = daily minimum temperature), (2) Thermal stress indices (e.g., AT = apparent temperature, PET = physiologically equivalent temperature, PT = perceived temperature, WBGT = wet-bulb globe temperature, HI = heat index, H = humidex, UTCI = universal thermal climate index), and (3) Heatwave intensity metrics (e.g., HWMI = heat wave magnitude index, AVI = heatwave average intensity, SHI = standardised heat index, EHF = excess heat factor). *Note: The indicators listed here are illustrative and not exhaustive within each category.*

What's next

- We can't ignore increasing extreme very hot, very dry days in NT
- Public Health also needs valid measures of thermal comfort to warn public of risks of extreme heat associated humidity.
- Further research
 - NT – Wet Globe Bulb Temp (WGBT) or Universal Climate Index
 - Interstate studies, varied by the type of measures

Public health response – target responses to

- Severe & extreme heatwaves
- High risk populations



Contact details

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Additional slides to answer any Q's

Space-time-stratified case crossover

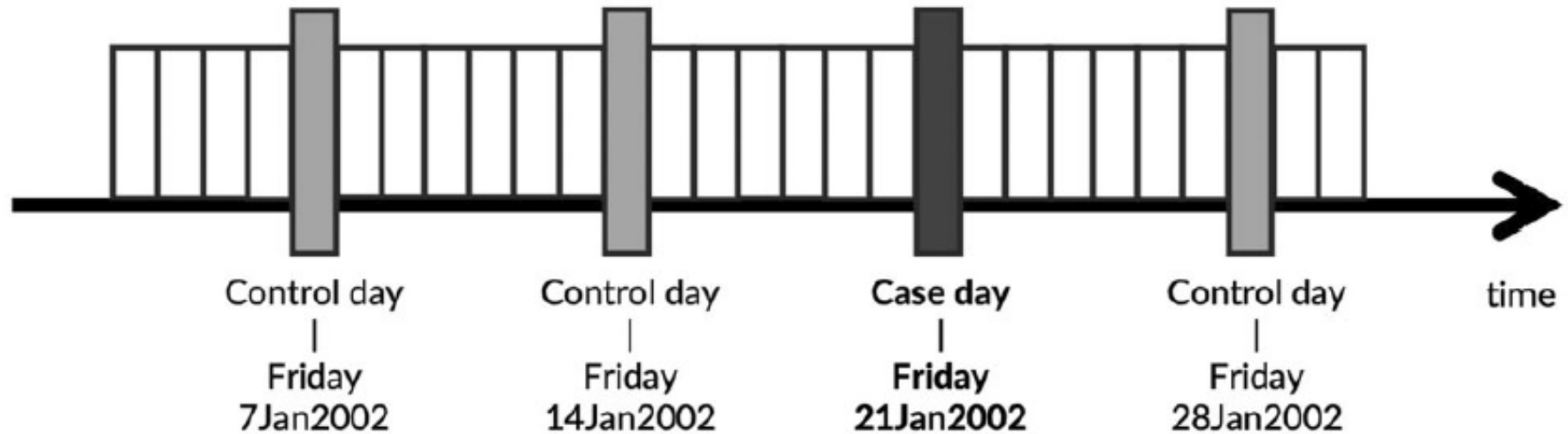


Figure 1. Illustrative example of time-stratified control day selection

Tobias et. Al . Time-stratified case-crossover studies for aggregated data in environmental epidemiology: a tutorial. 2024. International Journal of Epidemiology.

Conditional Poisson (quasi-Poisson) regression models

R code: `gnm(Case ~ HeatwaveSeverity + PublicHoliday + PM2.5, data = dataframe,
family = quasipoisson, eliminate = factor(stratum)).`

where the stratum is a concatenated variable of SA2:Year:Month:Day of the week (e.g. DarwinAirport:2001:1:5)

Controlled for Air quality & public holidays

Stata equivalent

`glm Case HeatwaveSeverity PublicHoliday PM2_5 i.stratum, family(poisson) link(log) vce(robust)`