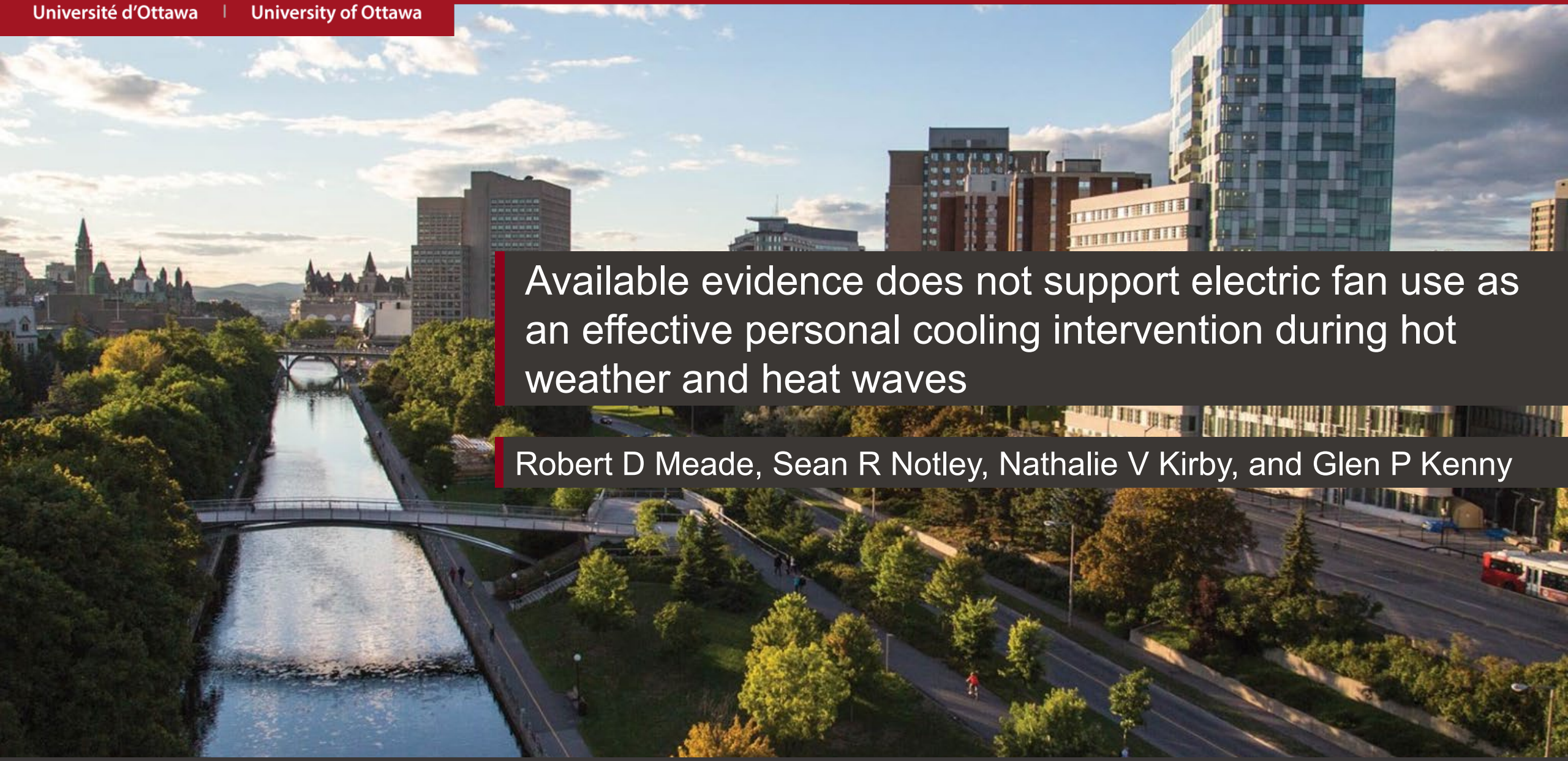
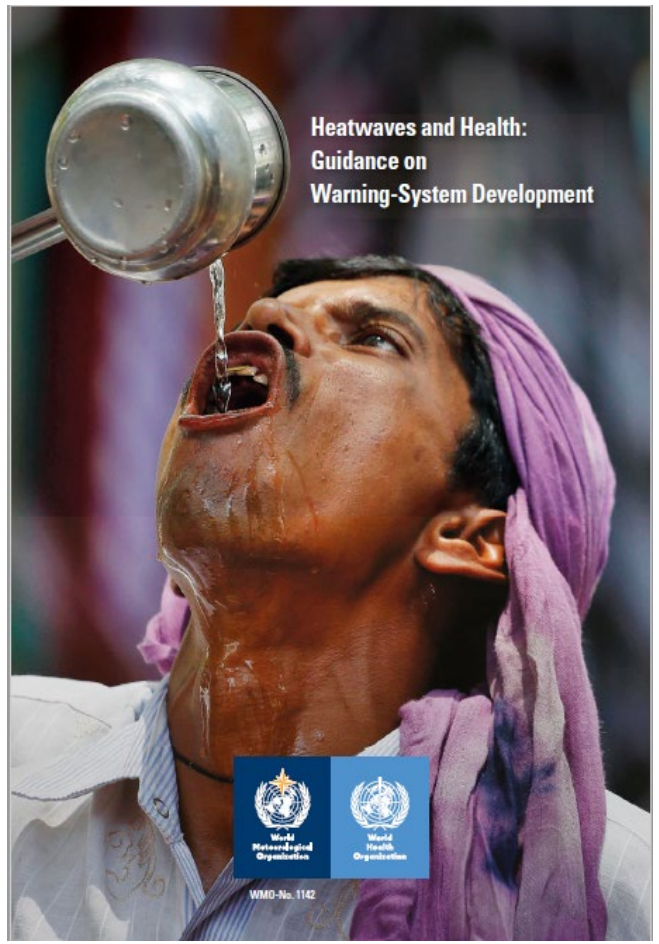


Available evidence does not support electric fan use as an effective personal cooling intervention during hot weather and heat waves

Robert D Meade, Sean R Notley, Nathalie V Kirby, and Glen P Kenny

Personal cooling interventions



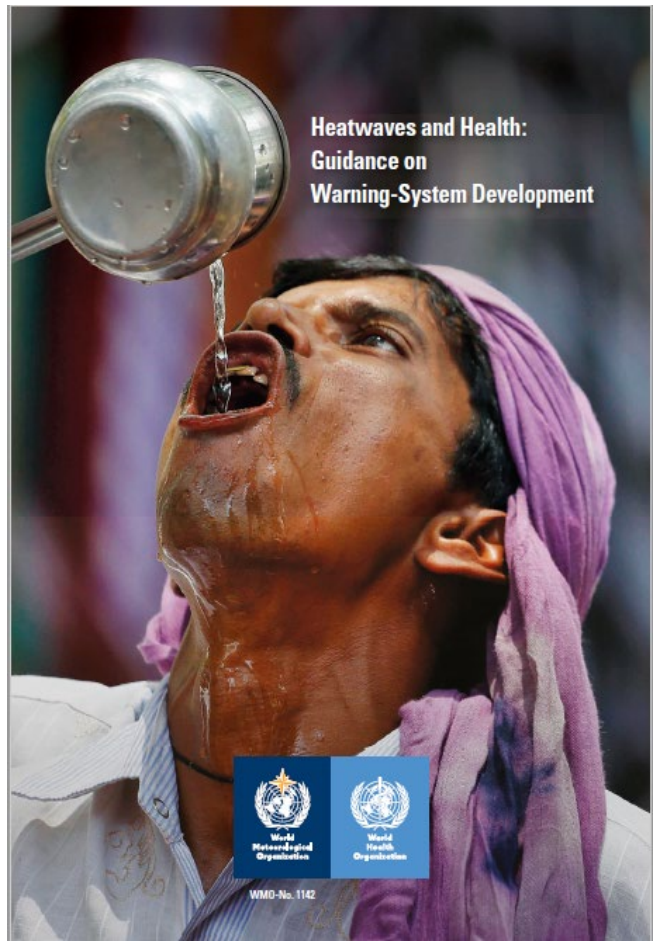
HEAT INTERVENTION

The intervention measures instituted by the community and the actions taken by individuals when heat warnings are issued by an HHWS determine the extent of a heatwave's impact. These measures are highly variable from one locale to the next and depend on available resources, the political structure and the awareness that heat is a major health problem. The basic goals of intervention strategies during a heatwave are to help individuals:

- Maintain their core body temperature within a healthy range through appropriate changes in behaviour and activities;
- Recognize, in themselves and in others, the signs and symptoms of heat stress; and
- Know what actions to take to reduce heat stress.

- McGreggor et al. 2015. *WMO/WHO (Report No. WMO-No. 1142)*

Personal cooling interventions



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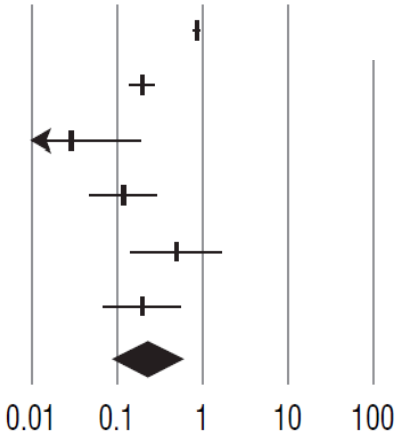
Air conditioning

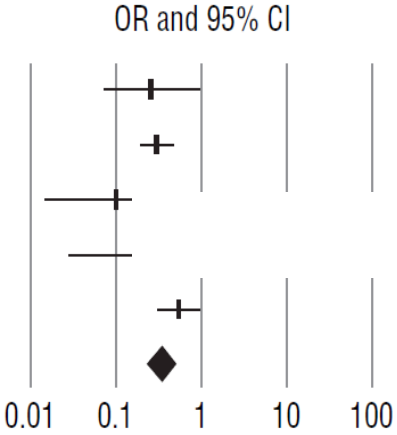
Has working home air-conditioning

	OR (95% CI)
Kilbourne et al,[16] 1982	0.85 (0.8-0.9)
Semenza et al,[20] 1996	0.20 (0.1-0.3)
Kaiser et al,[15] 2001	0.03 (0.0-0.2)
Naughton et al,[17] 2002	0.12 (0.0-0.3)
Bretin et al,[18] 2004	0.49 (0.1-1.7)
Lorente et al,[19] 2005	0.20 (0.1-0.5)
0.23 (0.1-0.6)*	



Visited other air-conditioned places

	OR (95% CI)
Kilbourne et al,[16] 1982	0.26 (0.1-0.9)
Semenza et al,[20] 1996	0.30 (0.2-0.5)
Kaiser et al,[15] 2001	0.10 (0.0-0.7)
Naughton et al,[17] 2002	0.20 (0.3-1.0)
Bretin et al,[18] 2004	0.54 (0.3-1.0)
0.34 (0.2-0.5)*	



Bouchama et al *Arch Int Med.* 2007

Electric fans

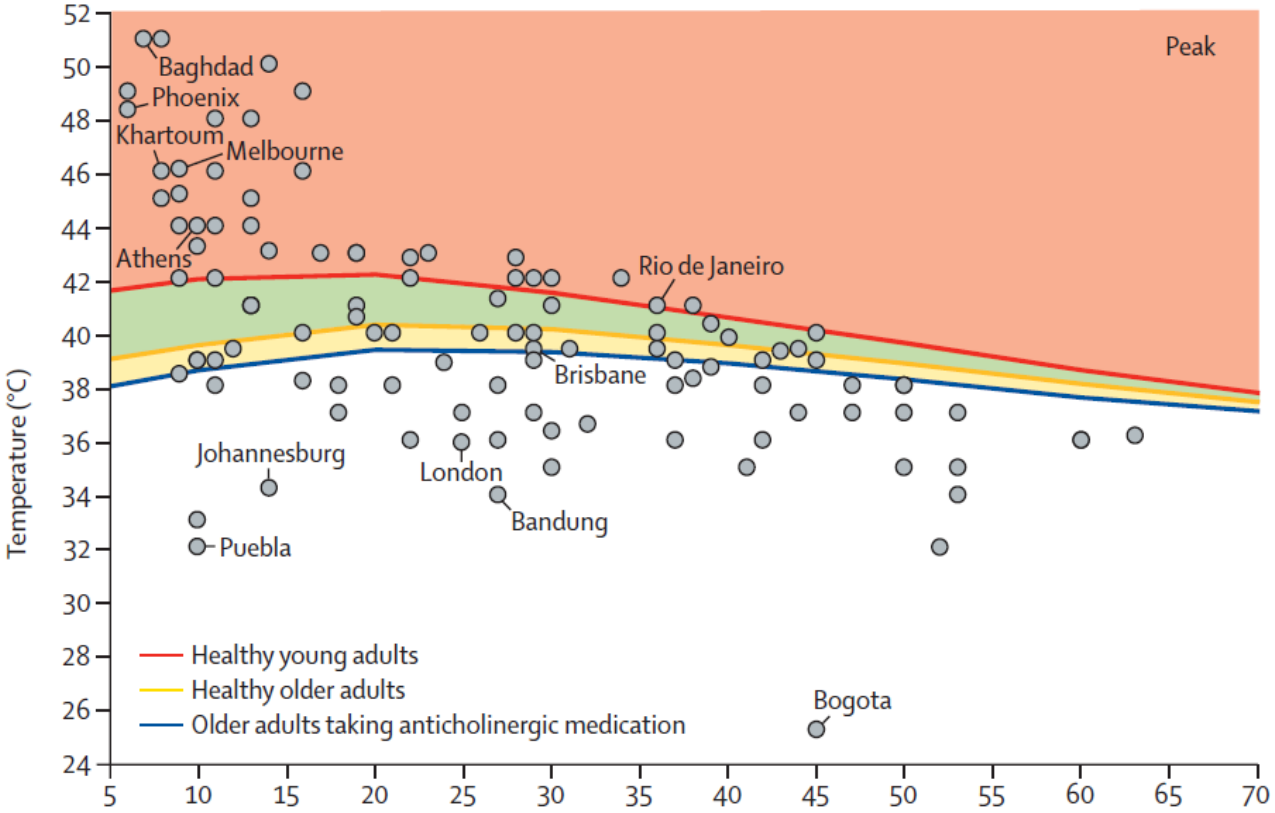
*"If you have ceiling fans or other fans, they can help **as long as the humidity isn't high**."*

- Government of Canada

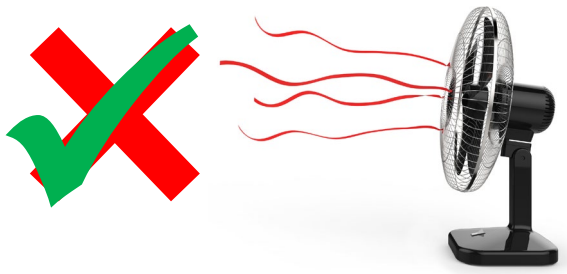
*"If the **[air] temperature is higher than 35°C**, the hot air passing over the skin **can make an individual hotter**... Generally, the use of fans should be **discouraged** unless they are bringing in significantly cooler air."*

- McGreggor et al. 2015. *WMO/WHO*

Biophysical modeling studies on the effectiveness of fans



Fans beneficial



Increase in heat gain

Increase in evap *potential*

*"A 2021 biophysical modeling study… proposes new **simplified temperature thresholds for safe fan use** that can be directly used in **public health heatwave policy documents**. These are **39°C for younger**, healthy adults [and] **38°C for older**, healthy adults."*

- Jay et al. *Lancet.* 2021

Morris et al *Lancet Planetary Health.* 2021; Jay et al *Lancet.* 2021

Purpose: Evaluate the effectiveness of electric fans for reducing *resting core temperature* during heat exposure.

Primary analysis

1. Simplified heat balance model

- Estimate the required sweat rate for heat balance in 30-50˚C air temperature and 10-90% relative humidity (Morris et al)
- Extend the model using laboratory-data to estimate fan-induced reduction in resting core temperature

2. Sensitivity analysis

- Evaluate the robustness of our primary model by varying key model inputs
  - *i) mean skin temperature, ii) minimal sweating efficiency, iii) fan- and age-induced changes in skin wettedness, iv) thermosensitivity of the sweating response, v) maximal sweat rate vi) model for convective heat exchange*
- Total of 2160 models

Quantifying the effectiveness of fans

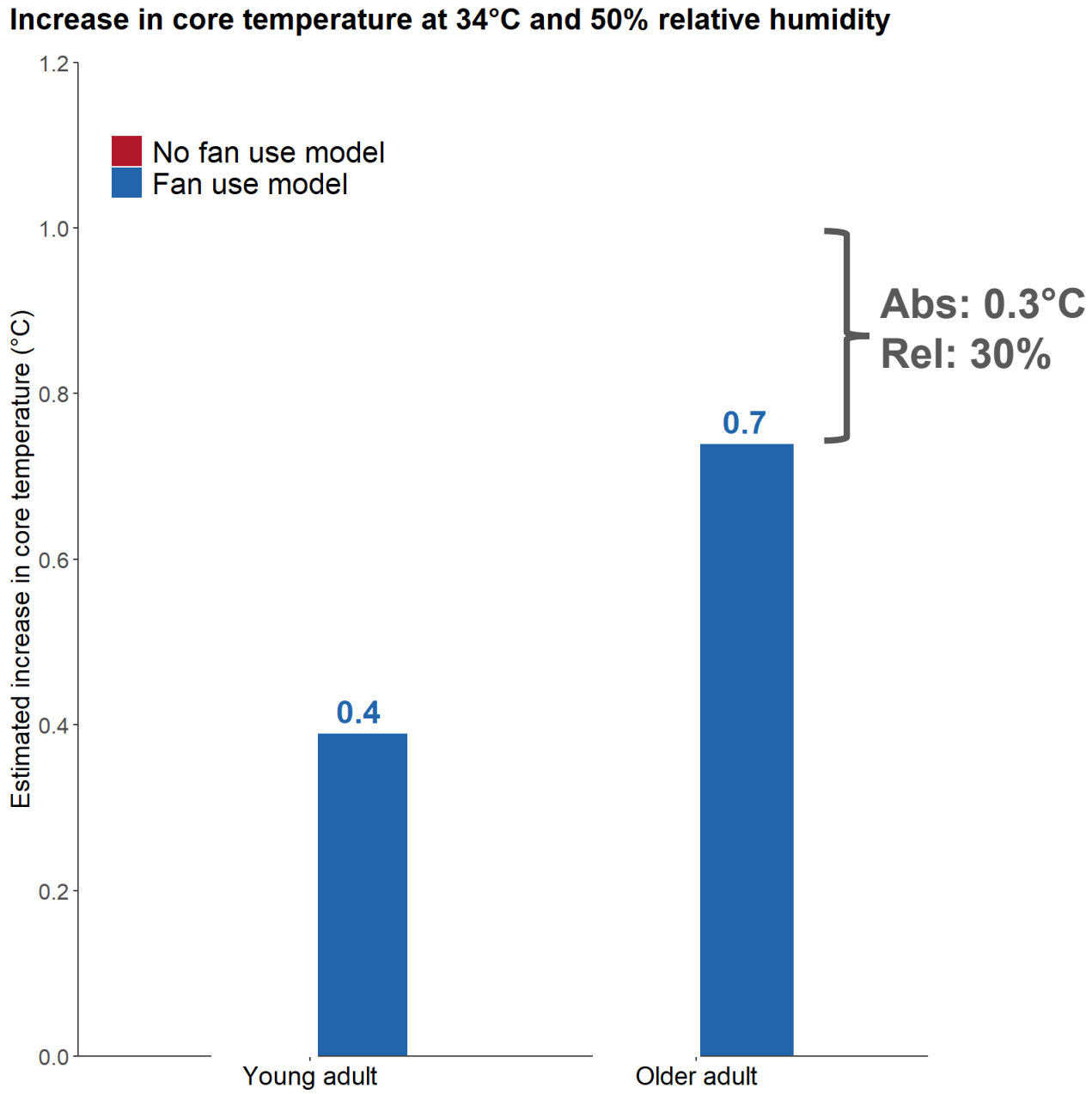
Absolute change in core temperature

- Beneficial: ≥0.3°C reduction
- Detrimental: ≥0.3°C increase

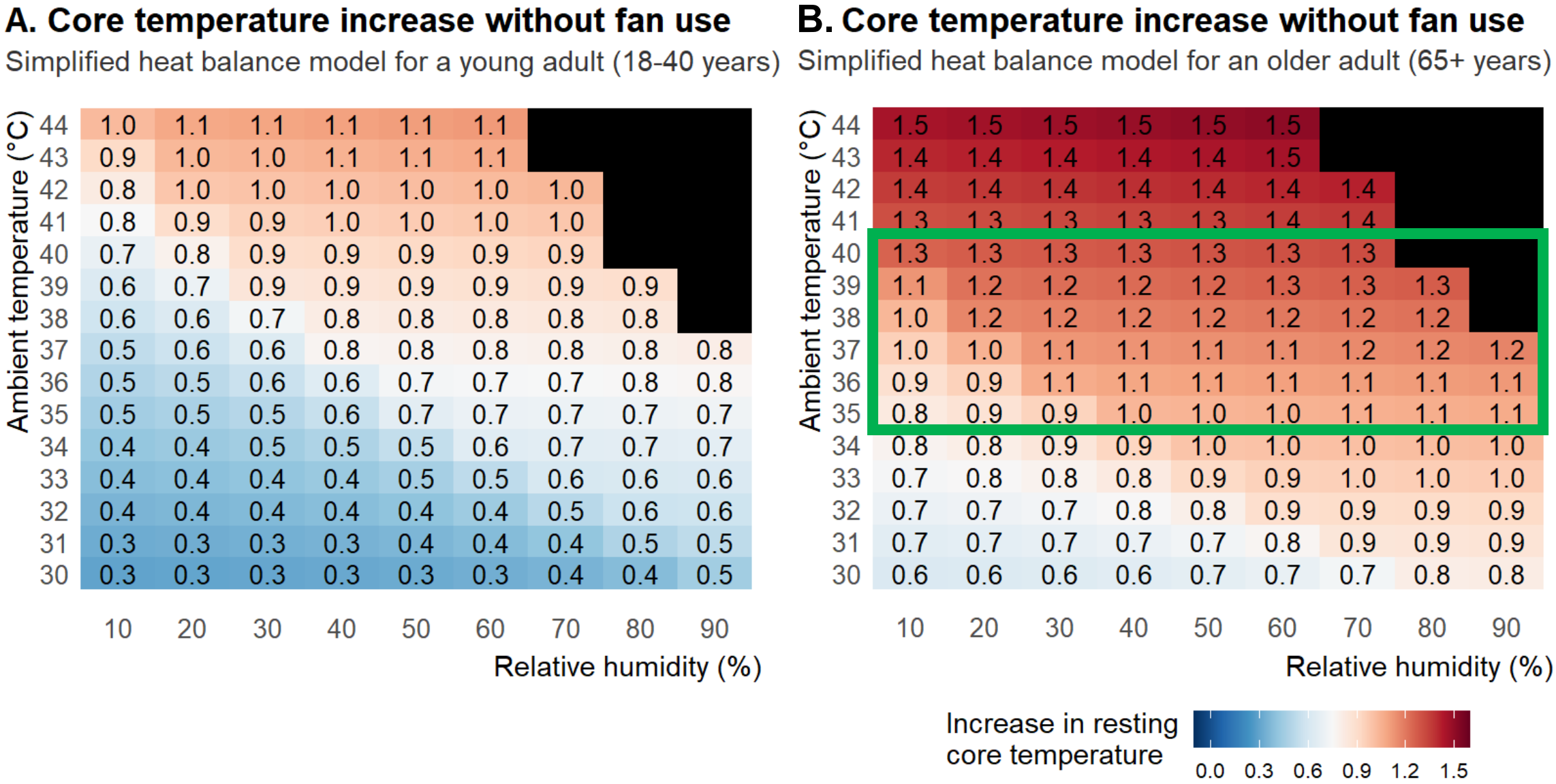
- Morris et al. *Ann Int Med.* 2019

Core cooling effect relative to direct cooling

- Effectiveness of the fan for reducing core temperature quantified relative to direct cooling sufficient to maintain a thermoneutral ambient environment
  - Central air conditioning
  - Sustainable building level cooling strategies



Primary analysis



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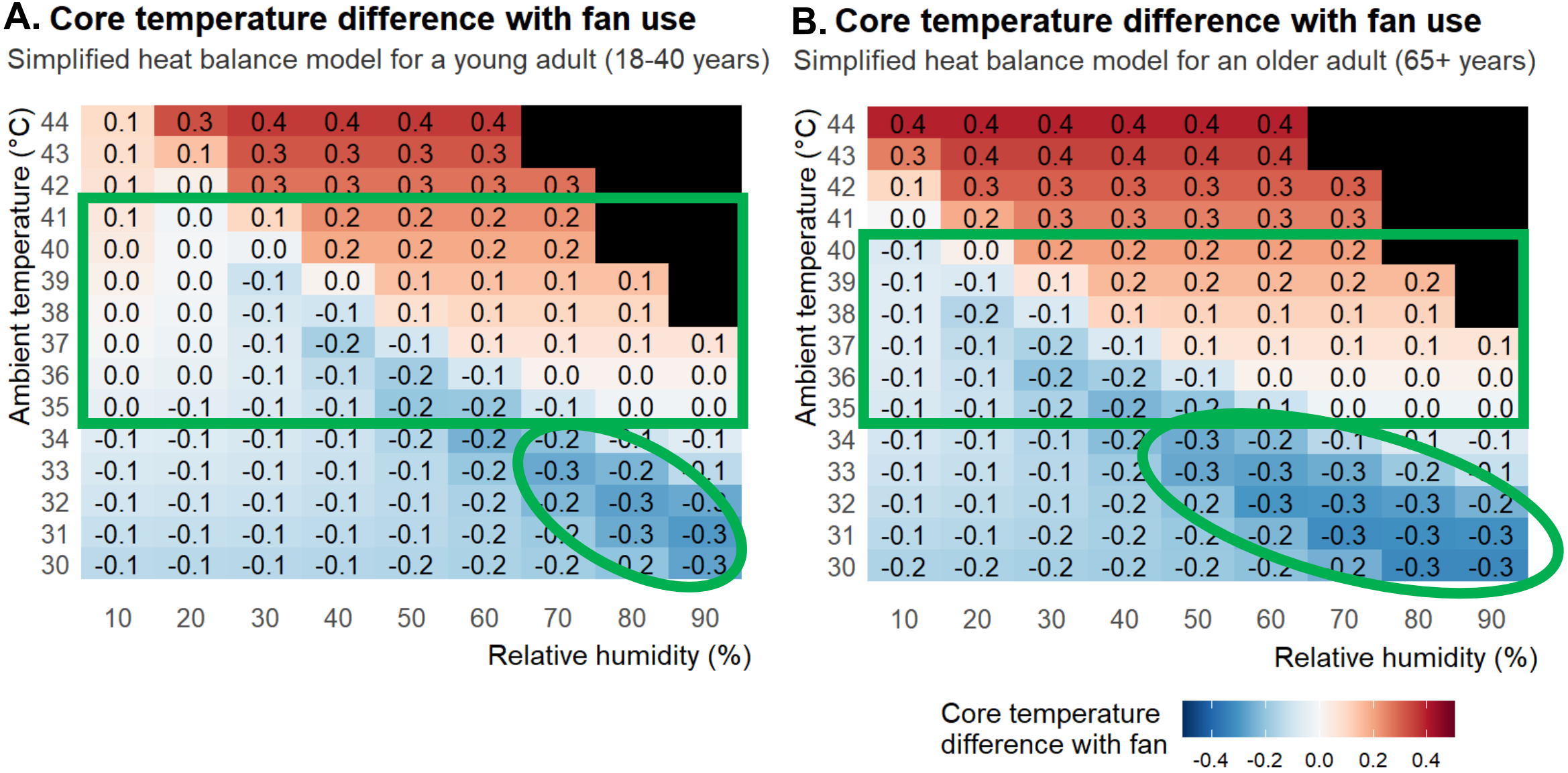
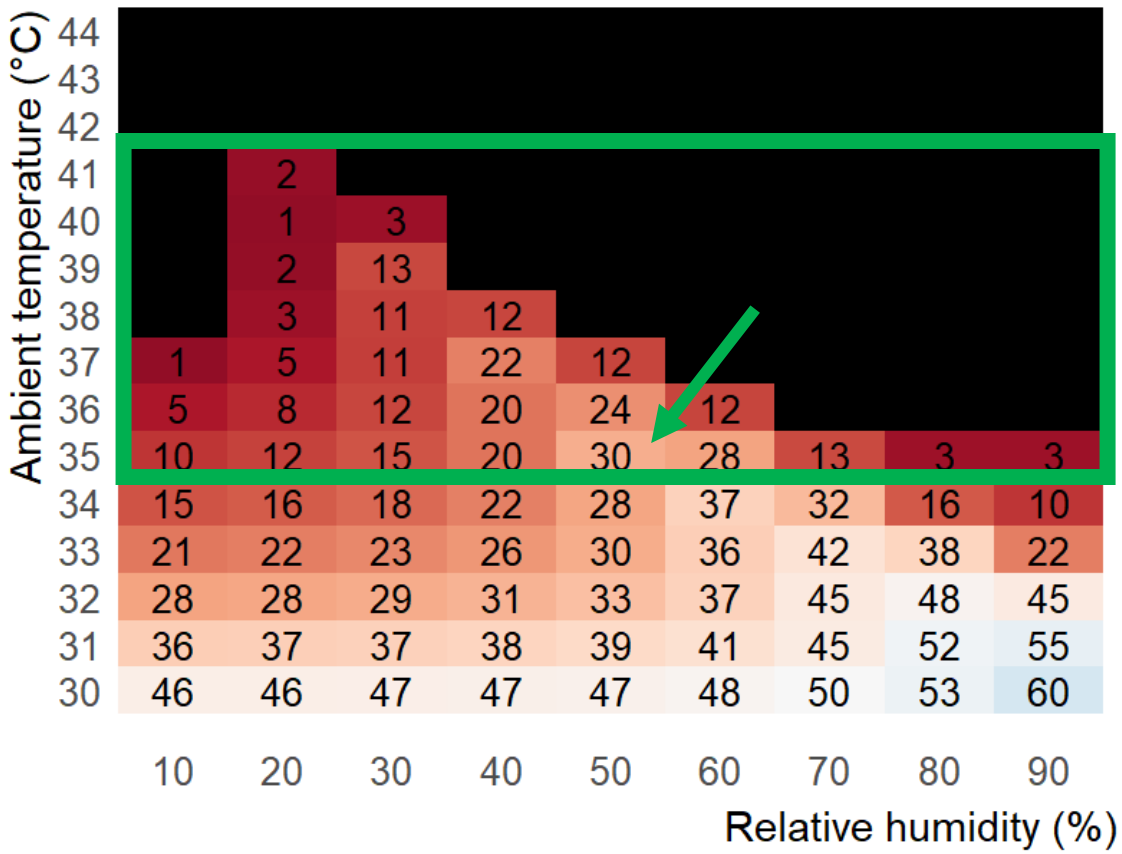


Primary analysis

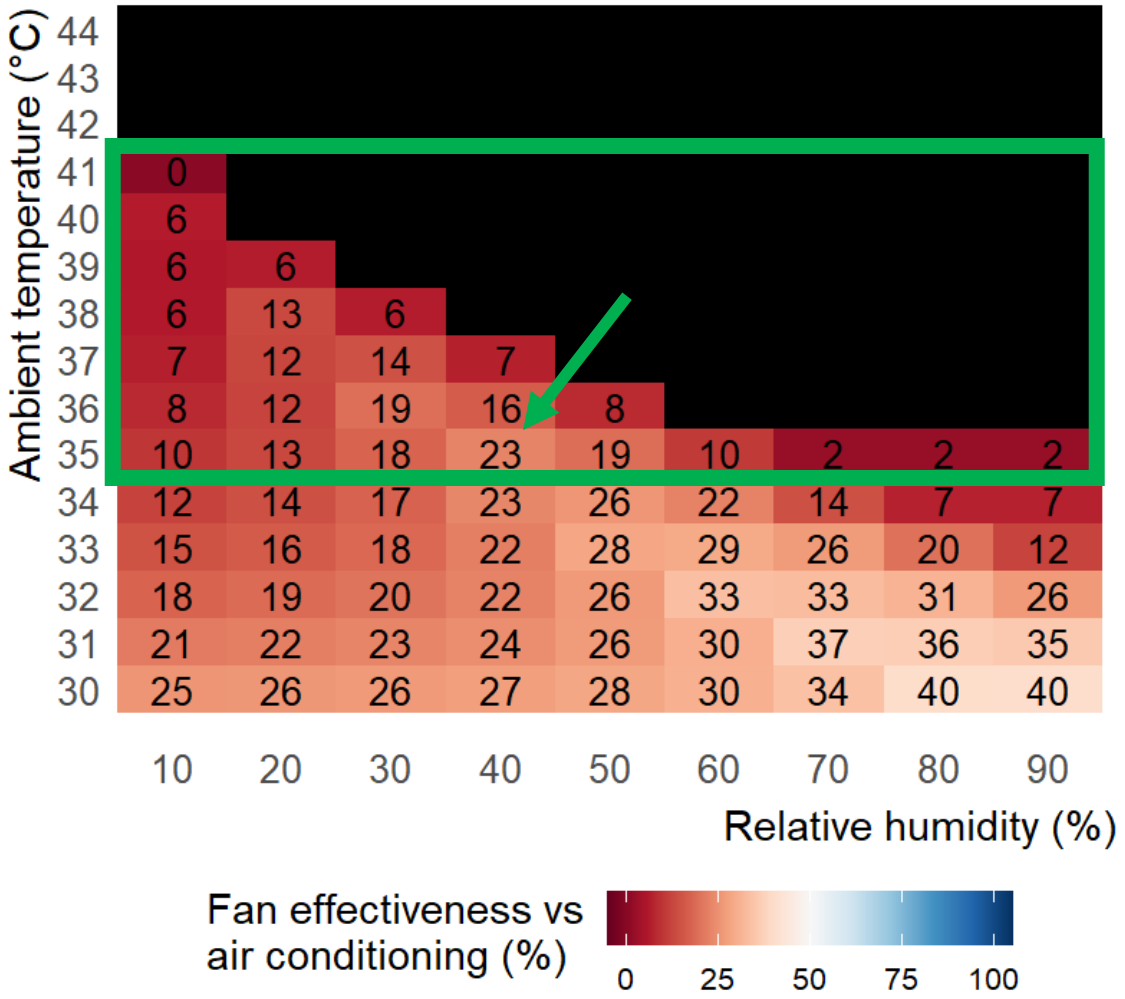
A. Fan effectiveness vs. air conditioning

Simplified heat balance model for a young adult (18-40 years)



B. Fan effectiveness vs. air conditioning

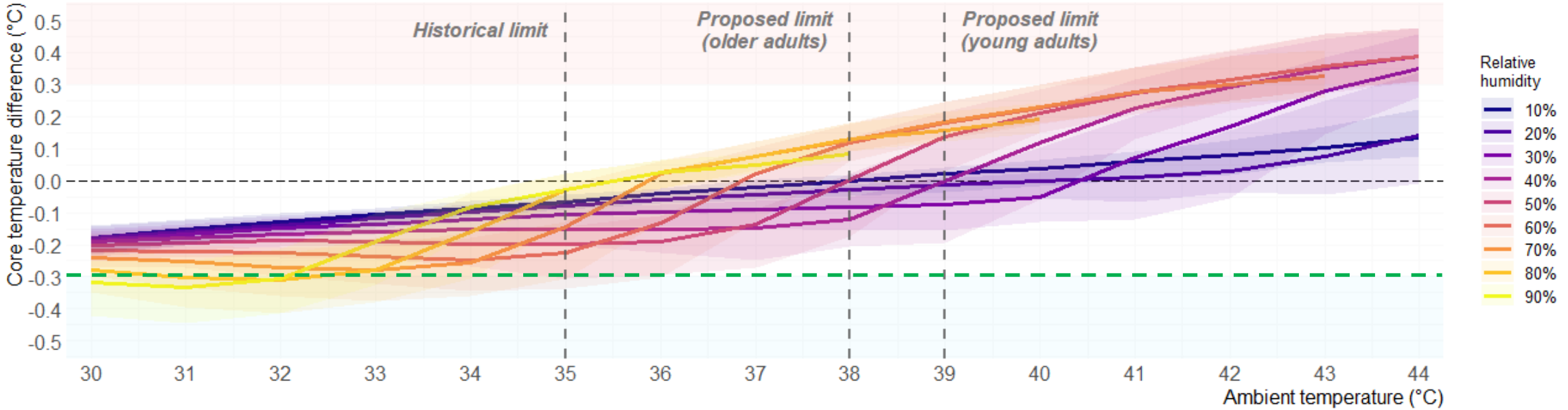
Simplified heat balance model for an older adult (65+ years)



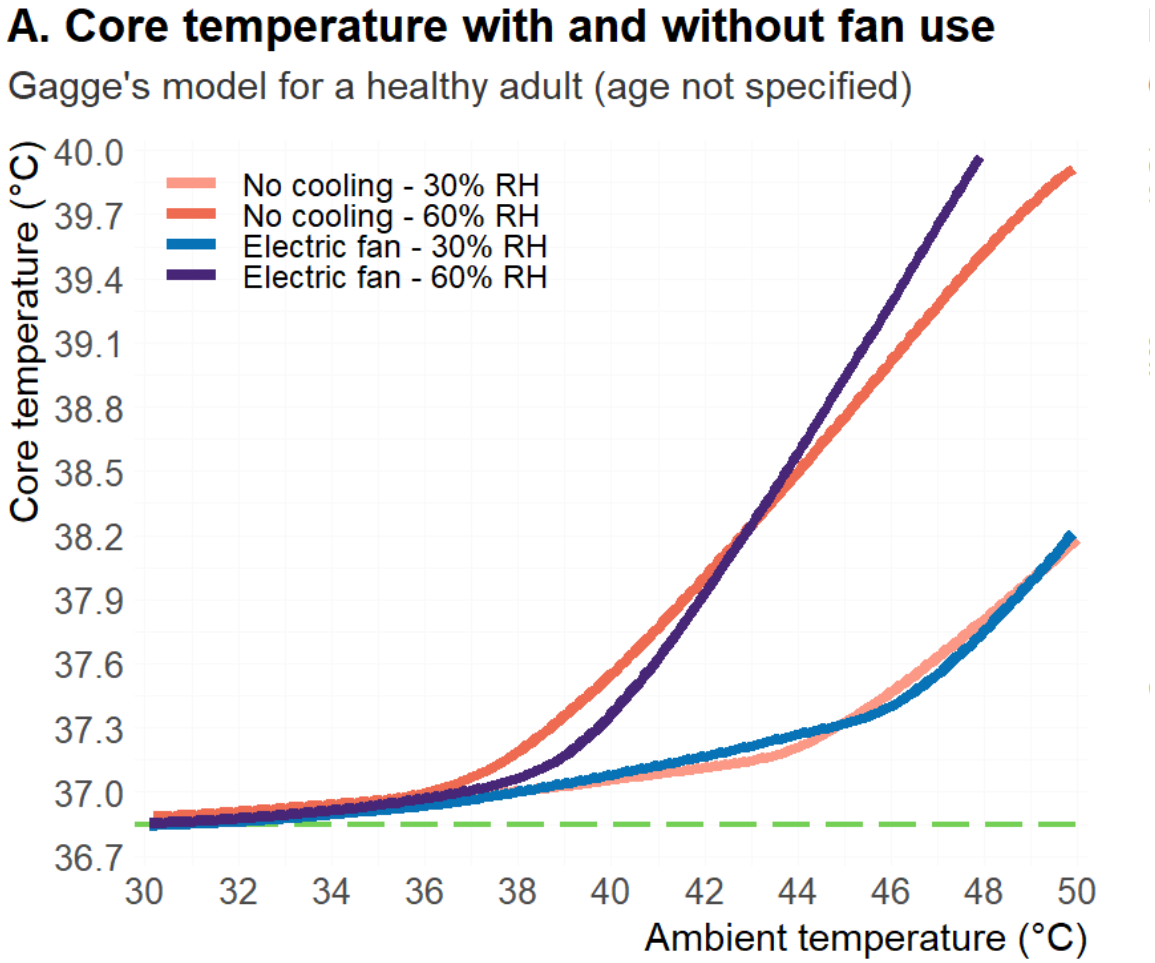
Sensitivity analyses

A. Fan-induced difference in core temperature across 2160 models with adjustments made to key inputs

Simplified heat balance models for young (18-40 years) and older adult (65+ years) combined



Secondary analysis - Modelling study using Gagge's model



Tartarini et al *Build Environ.* 2021

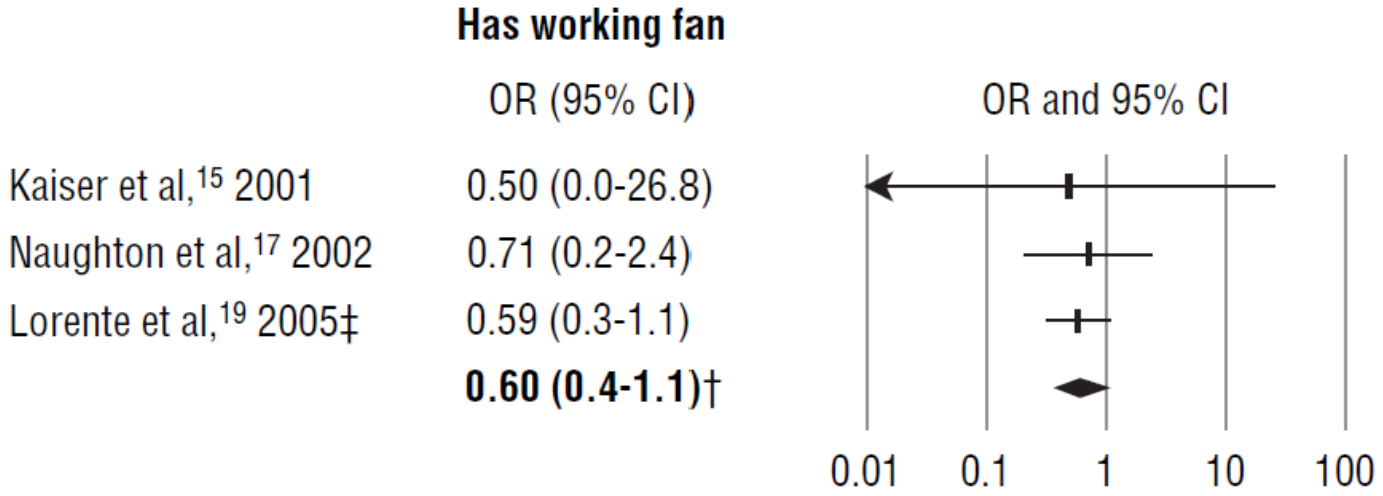
Secondary analysis - Laboratory-based heat exposures

Table 2. Findings from laboratory-based studies on the effectiveness of pedestal fans for reducing core temperature in resting persons.

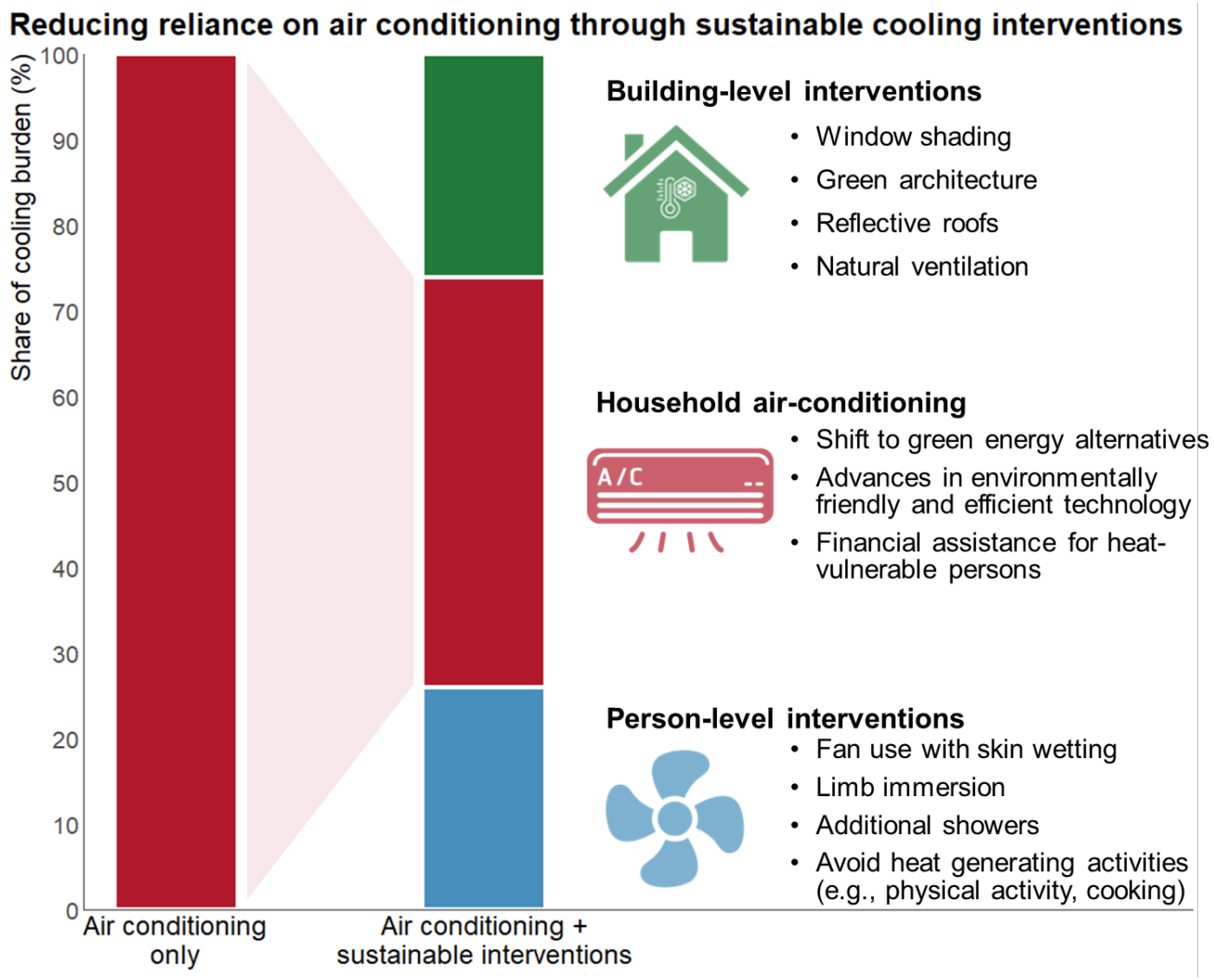
Study	Sample *n*	Age *years*	Duration *min*	Ambient conditions [a]		Increase in core temperature [b]			Effect vs. AC [c]
				Temp, °C	Humidity, %	No fan, °C	Fan, °C	Mean diff [95%CI]	%
Heat event simulations [d]									
Morris et al 2019[24]	12	29	120	40	50	0.4 (0.3)	0.3 (0.2)	-0.1 [-0.2, 0.0]	25
	12	29	120	47	10	0.3 (0.2)	0.6 (0.3)	+0.3 [+0.1, +0.5] †	-
Morris et al 2018[30] [e]	12	28	120	46	11	0.4 (0.2)	0.4 (0.3)	0.0 [-0.1, +0.1]	0
Cramer et al 2020[31] [e]	9	68	120	42	34	0.9 (0.2)	0.9 (0.2)	-0.1 [-0.1, +0.1]	11
Humidity ramp protocols [f]									
Ravanelli et al 2015[32]	8	24	120	36	28-91	0.4 (0.2)	0.3 (0.2)	-0.1 [-0.2, 0.0]	25
	8	24	120	42	22-67	0.9 (0.1)	0.6 (0.1)	-0.3 [-0.4, -0.2] *	33
Gagnon et al 2017[33]	9	26	100	42	30-70	1.2 (0.2)	1.0 (0.3)	-0.2 [-0.3, -0.1]	17
Gagnon et al 2016[34]	9	68	100	42	30-70	1.3 (0.2)	1.6 (0.5)	+0.3 [+0.2, +0.4] †	-
Pilot work (published) [g]									
Morris et al 2018[35]		Young	-	36	70	-	-	-0.1	-
		Young	-	45	50	-	-	+0.2	-

Key takeaways

1. Available evidence does **not support electric fans as an effective cooling intervention** for reducing core temperature in ambient temperatures exceeding 35°C.



4. Holistic strategies combining building- and person levels cooling interventions with direct cooling can be used to **reduce the economic and environmental burdens** of air conditioning while **still protecting the most vulnerable.**



Acknowledgements

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