MONASH University
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THE UNIVERSITY OF SYDNEY

"Fan-First" Cooling – a low-carbon way to improve heat resilience in a changing climate

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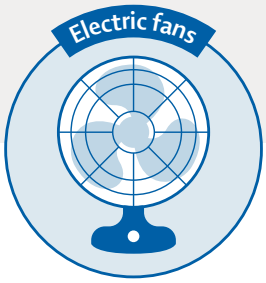
Sustainable and accessible ways to keep cool

Mitigating climate change is vital, but inevitable rising temperatures means that identifying sustainable cooling strategies is also important. Strategies at the individual scale that focus on cooling the person instead of the surrounding air can be effectively adopted, even in low-resource settings.



- ⊕ Can provide effective cooling for young healthy adults up to 42˚C (108˚F) in 50% humidity
- ⊖ Effectiveness is reduced with low humidity, and in older adults (>65 years), unless accompanied by self-dousing
- ⊖ Increases dehydration, but can be offset by drinking an extra glass of water per hour

- ⊕ Can reduce heat strain and dehydration up to 47˚C (117˚F) if dousing is sufficient to keep the skin wet
- ⊕ Can be used during power outages
- ⊖ Low compatibility with high clothing coverage

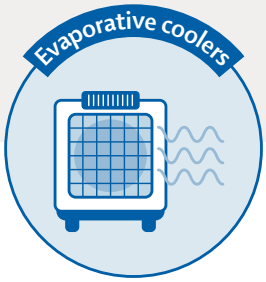
- ⊕ Can reduce dehydration and thermal discomfort in hot and humid conditions
- ⊕ Can be used during power outages
- ⊖ Risk of slips and falls

** Feet immersed above the ankles in 20˚C (68˚F) water*

- ⊕ Provides high evaporative heat loss without needing to sweat
- ⊕ Can be used during power outages
- ⊖ Clothing must be re-soaked roughly every 60 min

Electric fans can be used below these temperatures irrespective of humidity:

- **39˚C / 102˚F** — *Healthy young adults (aged 18 to 40 years)*
- **38˚C / 100˚F** — *Healthy adults (aged over 65)*
- **37˚C / 99˚F** — *Over 65s taking anti-cholinergic medication*



- ⊕ Can cool air temperatures in dry conditions
- ⊖ Minimal effect in high humidity
- ⊖ Risks creating mosquito breeding sites without proper maintainence

- ⊕ Lowers air temperatures in hot and dry conditions
- ⊖ Must be used in well ventilated or outdoor areas otherwise humidity increases offset any benefit
- ⊖ Risk of slips and falls

- ⊕ Can reduce core temperature and cardiovascular strain in conditions up to 45˚C (113˚F)
- ⊖ Requires access to ice
- ⊖ Labour-intensive to prepare

** Crushed ice wrapped in a damp towel applied to the neck and chest*

- ⊕ Can provide internal cooling
- ⊕ Water should be ingested at a temperature that is most palatable (~10˚C/~50˚F) to ensure optimal hydration
- ⊖ If person has already started sweating, not effective at lowering core temperature

Read the full paper: Jay O, Capon A, Berry P, et al. Reducing the health effects of hot weather and heat extremes: from personal cooling strategies to green cities. *The Lancet* 2021. Published online August 19

Figure 1 - The Lancet © Sustainable Individual Cooling Strategies, Lancet Series on Heat and Health

https://www.thelancet.com/infographics-do/cooling-strategies

Key messages

1. Heatwaves are already responsible for more deaths and hospitalisations than all other natural disasters. Air-conditioning (AC) offers protection against heat-related illness. But widespread AC creates enormous peak energy demand, risks extended power outages and threatens countries’ abilities to meet net zero commitments. AC is also largely inaccessible to the nearly 2 billion people living with poverty globally.

2. By moving air across the skin, electric fans can provide a cooling effect of up to 4°C, allowing temperatures at which AC units turn on to be set at around 27°C. A ‘fan-first’ cooling approach reduces potential annual energy demand for cooling by up to 70%. Fans use less than 5% of the electricity used by AC, providing affordable and accessible cooling during extreme heat events.

3. But in very hot and dry conditions, fans may worsen physiological heat strain. Safe fan use temperature thresholds are 39˚C for young adults, 38˚C for older adults, and 37˚C for older adults taking anticholinergic medication (used for a variety of medical conditions).

4. Where power is not available, or temperatures exceed these thresholds, applying water to the skin reduces heat-induced strain on the heart, improves thermal comfort, and slows the development of dehydration in heatwave conditions up to 47˚C.

5. Buildings can offer heat health protection through design that takes into account current and future climate conditions, including insulation, orientation, shading and natural ventilation.

6. Governments, employers, service providers and communities should critically examine their approaches to heat health protection, including policies, guidance and communications, and maximise the accessibility, affordability and use of low carbon and low-cost cooling strategies.

How does heat affect the body?

- The body responds to heat stress in two main ways, by diverting blood away from the internal organs to the skin to improve heat transfer away from the body, and by sweating, which allows cooling through evaporation.

- Heat-related illness occurs when these thermoregulatory mechanisms are constrained (for example as a result of older age, chronic diseases, and certain medications) or when environmental heat stress is so high that they are insufficient, which can occur even in young, healthy adults.

- People living in housing constructed of low-cost materials with poor thermal performance are exposed to higher levels of heat stress, especially in densely built urban settings where the urban heat island effect further amplifies heat exposure. People with limited mobility, especially if living in isolation, are often unable to engage fully in heat-avoidance behaviours.

Doesn’t air conditioning solve the problem?

- Air conditioning (AC) is now the leading heat coping strategy globally. AC is also widely recommended by public health authorities as the best mitigation for reducing heat-related illness and death. Yet, because of high capital and operational costs, AC is often inaccessible to people living with poverty.

- Widespread AC-use during heatwaves creates enormous peak energy demand, risking extended power disruptions, and potentially leaving people defenceless, if other cooling strategies are not deployed. AC-use exhausts hot air into already overheated urban environments.

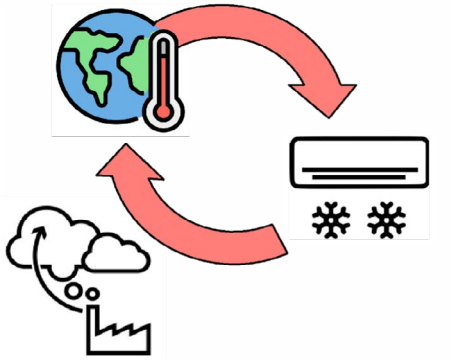


Figure 2 - Maladaptive cycle of AC

- AC use is expected to triple by 2050. As more people adopt AC worldwide, the escalating need for electricity, feeds a maladaptive cycle of higher emissions, accelerated global heating, and a greater demand for AC. AC also uses hydrofluorocarbon (HFC) refrigerants, which are potent greenhouse gases.

- While renewable energy sources of electricity are being rapidly introduced, and the phasedown of HFCs under the Kigali agreement is being implemented, the mounting demand for cooling is unsustainable and will threaten the success of energy transitions and the ability of countries’ to meet their net zero commitments.

How can electric fans help?

- Thermal comfort models show fan-generated air movement provides the equivalent of as much as 4°C of cooling. This allows AC thermostats to be set at higher temperatures (~27°C), meaning that on warm days, AC units will typically turn on later, and turn off earlier.

- Fans are relatively cheap to buy and use less than 5% of the energy used to power AC, making them a more readily accessible and affordable approach to cooling.

- Using Australia as a case study, “fan-first” cooling has the potential to reduce annual electricity demand and greenhouse gas emissions from AC by more than 70% throughout a typical year. Even greater benefits would be expected in tropical climates with warm year-round temperatures.

- This approach is also relevant for countries facing energy insecurity. During the 2022 summer, governments in Italy, Greece, and Spain all mandated minimum thermostat set-point temperatures of ~27°C to conserve energy reserves and reduce reliance on Russian gas.

- A cost-curve analysis to assess the emissions abatement potential of adopting a fan-first cooling strategy to reduce air-conditioner use demonstrated a superior net benefit than the switch from incandescent to LED home lighting.

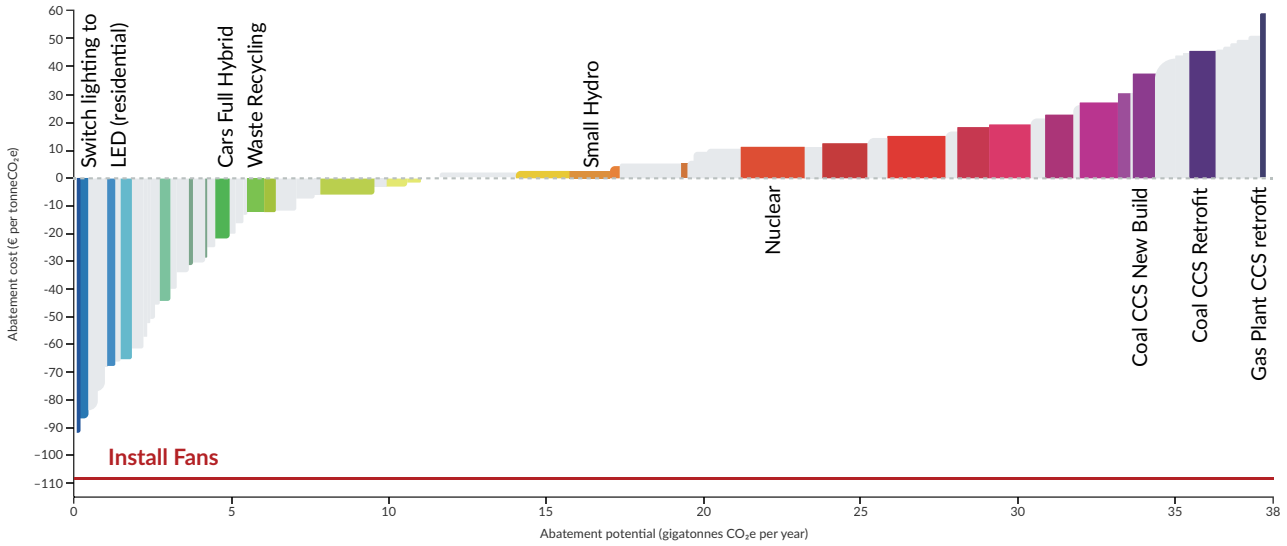


Figure 3 - fans as a greenhouse gas abatement strategy (reproduced from Malik et al 2022)

When shouldn’t electric fans be used?

- Some authorities advise that fans should not be used at temperatures above 35˚C. However this is not supported by evidence, and is likely to be due to a misunderstanding about the way fans cool the body through the evaporation of sweat.

- Human physiologists have observed a protective effect of electric fan use up to 42˚C in young healthy adults. But in very hot (45˚C) and dry (<15% relative humidity) conditions fans can worsen heat strain as the body cannot produce enough sweat to cool itself and the fan pushes more hot air into the body.

- Since the benefits of fans depend on sweating, the temperatures at which fans provide effective cooling are lower when people are less able to sweat (e.g. older age, or taking widely-used anticholinergic medications). The actual temperature at which fans should be turned off depends on humidity, but most people do not know the humidity. Simplified temperature thresholds have therefore been developed that are protective, irrespective of humidity: 39˚C for young adults, 38˚C for older adults, and 37˚C for older adults taking anticholinergic medication.

What if it’s too hot to use a fan or there is no power?

- Applying water to the skin using a spray bottle or sponge, or putting feet in a bucket of cold water for 10 mins every 20 mins, improves thermal comfort, and slows the development of dehydration in heatwave conditions up to 47˚C.

- Such interventions may be useful for people living in very low resource environments without access to any electricity or as an emergency intervention for people during power outages.

How can buildings help keep people cool without the need for air conditioning?

- Insulating walls, shading windows from the sun, and using reflective roof surfaces, reduces heat gain from external temperatures and keeps cool air from escaping.
- Designing spaces with opening windows and higher ceilings enables natural ventilation and air movement removes warm air and reduces the influence of humidity.
- Orienting buildings so that principal rooms can be protected from direct sun-light, and catch cool breezes reduces the heat load and enhances natural ventilation
- Providing user control improves perceived thermal comfort by for example, designing multi-function cool rooms that people can move to if they feel hot, and providing window shades that people can operate.

What should governments, employers, services and communities do to promote 'fan-first' cooling?

- All organisations with a responsibility for the welfare of workers or communities - particularly in heat sensitive settings such as aged care facilities, informal settlements, workplaces, schools and mass-gatherings - should review and update their heat health policies, plans and advice to include effective low energy, low-cost interventions, for regular and emergency use
- Public communications and behaviour change campaigns for health protection in extreme heat should highlight the individual and community benefits of the safe use of electric fans, keeping AC in reserve for population groups and settings where it is most warranted. This could include hospitals and community 'safe havens'.
- Fan manufacturers should consider including an automatic stop function when air temperatures reach safety thresholds for health.
- Building regulations should mandate passive cooling and greater access to fan-based cooling, in the design, construction and retrofitting of buildings.

Sources

1. Jay, O., Capon, A., Berry, P. et al. (2021) 'Reducing the health effects of hot weather and heat extremes: from personal cooling strategies to green cities', *The Lancet*, 398 pp. 698-708. DOI:https://doi.org/10.1016/S0140-6736(21)01209-5
2. Malik, A., Bongers, C., Mc Bain, B. et al. (2022) 'The potential for indoor fans to change air conditioning use while maintaining thermal comfort during hot weather: an analysis of energy demand and associated greenhouse gas emissions', *The Lancet Planetary Health*, 6(4) pp. 301-309. DOI:https://doi.org/10.1016/S2542-5196(22)00042-0
3. Jay, O., Malik, A. and Capon, T. (2022). 'Fan-first cooling to combat climate change', *360info*. Available at: https://360info.org/fan-first-cooling-to-combat-climate-change/ (accessed 15 Nov, 2023)