Executive summary

Heat is a threat to health. As outdoor temperatures go up beyond certain thresholds, people are more likely to get sick, go to hospital, or die. This pattern has been observed in cities all over Australia, and can be observed from daily mean temperatures as low as 23°C.

Housing can keep people safe from outdoor heat. In summer, decent housing heats slowly and cools quickly. However, many people in Australia do not have such housing. In particular, people who rent tend to live in homes that are less energy efficient and have fewer options to stay cool. No Australian jurisdiction has explicit requirements for cooling devices in rental properties. This leads to more time spent in unhealthy elevated temperatures, with negative impacts on health and quality of life.

Through the summer of 21/22, Better Renting observed this phenomenon. We recruited fifty 'Renter Researchers' from across Australia to install temperature tracking devices in their bedrooms. Unlike a mere thermometer, these devices record temperature at intervals, creating a detailed record of the temperature changes and patterns observed in rental homes. In addition, we obtained qualitative data from Researchers through surveys and interviews, helping us to understand observed temperature patterns and gain an insight into the human impact of high indoor temperatures.

From these data we observed:

- Rental homes routinely exceed safe temperature limits, with indoor temperatures above 30°C for about an hour a day on average. Night-time temperatures were hot enough to impair sleep almost 50% of the time.
- Renters' experience of heat is entangled with experiences of renting more broadly. The ability to keep a home healthy in summer is affected by landlord-tenant power dynamics and affordability challenges.
- COVID-19 was a unique challenge through the summer of 21/22, with working from home or self-isolation more difficult in hot homes.

These findings support a recommendation for governments to establish minimum health and safety standards for rental homes, along with other measures to keep our cities liveable through summer.

Background

While many may look forward to the advent of summer, others dread the impact of perpetual heat on their lives. Exposure to extreme heat, and heatwaves in particular, has well-documented harmful effects on health. These effects are most adverse for some groups in particular, but even those who are not at risk of death or disease still endure impacts to their mental health and wellbeing. Quality housing can play a vital role here, keeping indoor temperatures low even as the outdoors heats up. But those without such housing, often people renting or on low-incomes, have no such opportunity. This may be exacerbated during the ongoing COVID-19 pandemic, with people forced to isolate at home and unable to access cool spaces.

In this section we provide some background on the impacts of summer heat on people in Australia. We first explore the health effects that have been documented in Australia and around the world and trends that may worsen these. We then consider the role of housing and the role it can play in alleviating or exacerbating the impact of heat. Finally, before we turn to the findings from our Renter Researchers project, we consider existing findings with relations to renters and rental housing in particular.

Heat and health

Exposure to high temperatures causes death and disease. Generally, these risks follow a U-shaped curve: risk goes down as outdoor temperatures move from cold to moderate, then begins to increase again as temperatures go beyond moderate and into hot. The mortality risk is greatest from cardiovascular disease: as blood vessels expand and move towards the skin in an effort to cool down, the heart experiences increased strain.[1] Other significant causes of death are respiratory disease and cerebrovascular disease.[1] Heat-related suicide, while leading to fewer deaths overall, can have a greater impact on years of life lost, as it is relatively more likely to kill younger people.[2] These effects are generally most pronounced on the day(s) of extreme heat,[3] although effects can lag for up to two weeks.[4]

These relationships are established and well-documented all over the world, including in Australia. A study in Western Australia found a relationship between heatwaves and attendance in emergency departments, with children or those over 60 years old being more at risk.[5] A Brisbane study of mortality data found that life-years lost begins to

increase as daily mean temperatures exceed just 23°C, even though the population might be expected to be accustomed to hot weather.[6] Similar patterns have been observed in Adelaide, Hobart[4], Melbourne[8], and Sydney[9]: as temperatures increase, people are more likely to go to get sick, go to hospital, or die.

While these effects are strongest in periods of extreme heat, it is striking that they begin to occur even for daily mean temperatures below thirty degrees. A longitudinal study of mortality data from Melbourne, Brisbane and Sydney found that mortality was at its lowest for daily mean temperatures just below 23°C.[10] Risk increases as temperatures rise above 25°C. Figure 1 illustrates this, demonstrating the U-shaped pattern of temperature-mortality data.

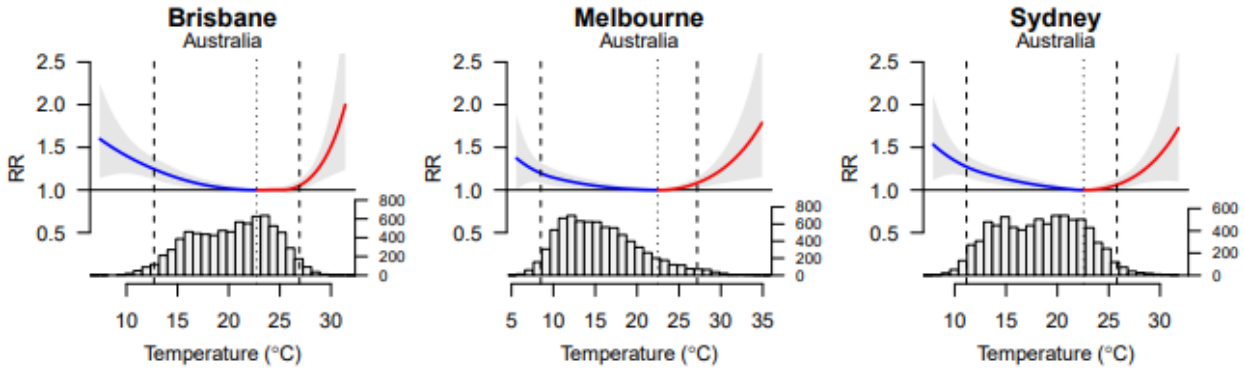

Figure 1: Exposure-response relationships in Brisbane, Melbourne, and Sydney. The minimum mortality temperature (MMT) and the 2.5th and 97.5th percentiles are added as dotted and dashed lines, respectively. The Y-axis shows the relative risk (RR) of mortality for different temperatures. (Gasparrini et al., 2015)[10]

Current trends are likely to increase deaths from hot weather. Climate change is predicted to increase the frequency, duration, and severity of heatwaves, and this would lead to more deaths from heat.[11] There is already evidence from every continent of increased heat-related mortality due to climate change.[12] Given that older people are more susceptible to heat-related illness, Australia's ageing population is also more at risk.[13] Older populations may also relocate to urban areas to be closer to services, but then face more risk due to urban heat island effects, which can increase local temperatures by up to 10°C relative to nearby rural areas.[14]

Exposure to heat is linked with adverse health outcomes, even for moderate temperatures below 30°C. This relationship has been documented in Australian cities as far apart and as different as Perth, Brisbane, and Hobart. On current trends, including climate change, the health risks from heat are likely to worsen.

Housing affects whether heat is dangerous

Housing can protect people from outdoor heat.But poor-quality housing can worsen the impact of heat, trapping people in unhealthy, almost unlivable environments.

As the WHO Housing and Health guidelines note, "protection against outdoor heat is a key characteristic of healthy housing."[15] In a healthy home, indoor temperatures will remain within a healthy range, even as outdoor temperatures vary. Such a home might have external shading and nearby trees, ceiling insulation, ventilation, and access to efficient air-conditioning. On the other hand, poor quality housing means higher indoor temperatures, and those temperatures last longer. This is characteristic of homes with minimal insulation or shading. It means that people are exposed to higher temperatures for more time.

Dwelling quality makes an important difference when it comes to getting through hot weather unscathed. As an example of this, researchers modeled Melbourne's 2009 heatwave and considered how the mortality rate would have been different if homes were more energy-efficient.[16] They found that if every property had been efficient enough to achieve at least a 1.8 star rating, deaths could have been reduced by 35%. If all properties had achieved 5.4 stars, this could have saved 337 lives. As the danger from heat increases, the energy efficiency of our homes is a critical point of intervention to reduce loss of life. Without action to improve existing housing stock, heat-related mortality is predicted to double.[16]

Adapting with air-con: blowing hot and cold

Access to air-conditioning can make a life-saving difference for individual households. However, usage of AC contributes to global warming and urban heat and can encourage the design of inefficient, AC-dependent homes. Many urge caution when it comes to using AC to adapt to the threat from increasing heat.

At the micro-scale, access to AC can prevent health risks during hot weather. This means having an appliance in the first place, that it is in working order, and that a household can afford to use it. Where these conditions are met, the household benefits are undeniable: a meta-review of various studies estimates that having working home air-conditioning reduces mortality risk from heat by 77%.[17] AC can save lives during heatwaves.

However, AC could be considered a 'maladaptation' that does more harm than good.[18] While AC may benefit the households that have it, the energy usage contributes to greenhouse gas emissions, abetting the problem it is meant to be solving.[19] Reverse-cycle AC also heats the immediate urban environment, cooling those with AC at the expense of those without.[20] Low-income households are not only less likely to have access to AC, but are less likely to use it, due to cost concerns.[21] Moreover, air-conditioning requires network investment that is funded by all households: in 2013, the Productivity Commission estimated that customers using AC at peak times received an implicit subsidy of $350 per year, paid for by all other customers.[22] And the availability of AC can promote poor housing design, leaving people less comfortable than those in better-designed dwellings.[23] AC may offer benefits, but also many costs, and these costs are often borne by those who miss out on the benefits.

How do renters fare?

Renters have a worse experience of heat than owners, who have more control over their housing conditions. This is partly due to rental properties and rental laws, and partly due to the demographics of renters.

When it comes to properties and laws, rental properties tend to be in a worse state of repair, to have poorer energy-efficiency, and to be less likely to include cooling appliances such as AC. Such properties are harder to live in in hot weather. In addition, renters cannot make structural changes to improve their home's energy performance and also lack security of tenure. This means it's harder for renters to make changes; even when permission may be forthcoming, it's harder to justify an outlay when there is no confidence of being able to remain in a property long-term.

A second set of factors is about renters themselves. Renters are typically on lower incomes than owners, so energy costs are a higher proportion of their expenses, and they may attempt to manage energy costs by rationing the use of cooling appliances.[24] Renters generally have worse mental health[25], and evidence indicates that this can lead to worse outcomes in heat: for example, certain psychotropic medications may affect thermoregulation.[17] Poor quality housing and rental affordability stress also exacerbate mental illness.[26]

We can see evidence of these trends in the Australian Housing Conditions Dataset, a survey of 4500 people about their housing.[27] Because the survey includes both renters and owners, it allows us to compare the experience of renters with that of others. In this survey, renters were almost five times more likely than owners to report struggling to stay

comfortable during hot summer weather (19% vs 4%). Five in twenty renters reported experiences of financial strain, compared with two in twenty owners. Around 20% of renters reported a diagnosis of a mental health condition, compared with 13% of owners.

Another survey of 854 tenants in Victoria, commissioned by DELWP, reached similar conclusions. Almost two in three tenants, 63%, reported difficulties maintaining a comfortable temperature. Almost one in three tenants, 31%, said they have avoided cooling or heating their homes because of cost barriers.[28]

What we see in the rental sector is that the people who are most at risk from heat are also those living in lower-quality, inefficient dwellings that make summer even harder to bear.

Figure 2: One reason renters struggle more in summer is investors' neglect of their repair responsibilities.

Existing obligations

Property investors currently have minimal legal obligations with respect to reducing the negative impacts of summer heat.

Where cooling appliances already exist, lessors are required to maintain them. This requires a tenant to bring the matter to the attention of their landlord or real estate agent,

and then for that actor to complete the repairs. In reality, this means that many repairs are not attended to. Tenants may hesitate to ask for repairs due to fear of persecution such as rent increases or a retaliatory eviction. Even where tenants ask for repairs, real estate agents may not act on such a request, or some landlords will simply ignore it, sometimes to the frustration of tenants and property managers alike. Nonetheless, while it may be difficult in practice to get repairs done, it is at least an existing legal duty when a property already has cooling devices.

However, there is not a clear legal duty for a lessor to add cooling devices to a property that doesn't have them.

In general, lessors have a duty to ensure that rental premises are fit for habitation. For example, the New South Wales Residential Tenancies Act declares that "a landlord must provide the residential premises in a reasonable state of cleanliness and fit for habitation by the tenant."[29] In Victoria, a residential rental provider must provide and maintain rented premises "in a reasonably fit and suitable condition for occupation".[30] These particular clauses give an indication of the sorts of requirements that exist across the country. Where premises are not fit for habitations, tenants have the option to terminate a tenancy, and they may be eligible for a rent reduction or compensation.

However, such terms are typically understood to refer to significant structural damage such as might be caused by a fire, flood, or storm. It is rare that tenants are successful in arguing that high indoor temperatures obligate a landlord to install cooling devices. For example, in a 2015 decision, *Casey Harris v Aboriginal Housing Office*, the NSW Civil and Administrative Tribunal (NCAT) found that a particular rental dwelling must contain cooling in order to be habitable.[31] However, the 2017 decision *Dwyer v Department of Justice and Attorney General* reversed course, with the NCAT member stating that "bearable temperatures are matters of individual taste" and disagreeing that appropriate cooling was needed for premises to be habitable.[31] The Australian Legal Information Institute records no published decisions from the Victorian Civil and Administrative Tribunal since 1998 regarding fitness for habitation in regard to excessive heat.[32]

Some jurisdictions have minimum standards for rental properties. In some cases, these standards specify a requirement for heating infrastructure: Tasmania requires a fixed heater in the main living area[33], and Victoria will require a fixed energy-efficient heater from March 2023[34]. In practice, Victoria's requirement may promote the installation of reverse-cycle systems that can supply both heating and cooling. However, no jurisdiction has an explicit requirement for cooling infrastructure, whether that be air conditioning, ceiling fans, or even simply fly screens on windows.

Methodology

Existing material indicates that heat poses a threat to health and that heat might be more of an issue for renters, who are more likely to live in low-quality dwellings and have less capacity to afford cooling costs. In this citizen science project, we aimed to gather hard data on temperatures in rental properties and to better understand the phenomena shaping renters' experiences of heat.

Key questions we wanted to investigate were:

- What indoor temperatures are renters experiencing?
- What effect does heat have on renters?
- How does the housing of renters affect their experiences of heat?

To answer these questions, we recruited renters from across Australia to become 'Renter Researchers' and track summer temperatures in their homes. Starting in October 2021, we received 121 applications from renters wishing to participate. We selected applicants to achieve a diverse sample of participants in terms of geography and various household characteristics, as well as through our own evaluation of how reliably they would track data and participate in the project. We selected 70 applicants, of whom 49 ended up taking part, recording data, and remaining active through the project. Participants came from capital cities and regional areas, and all walks of life.

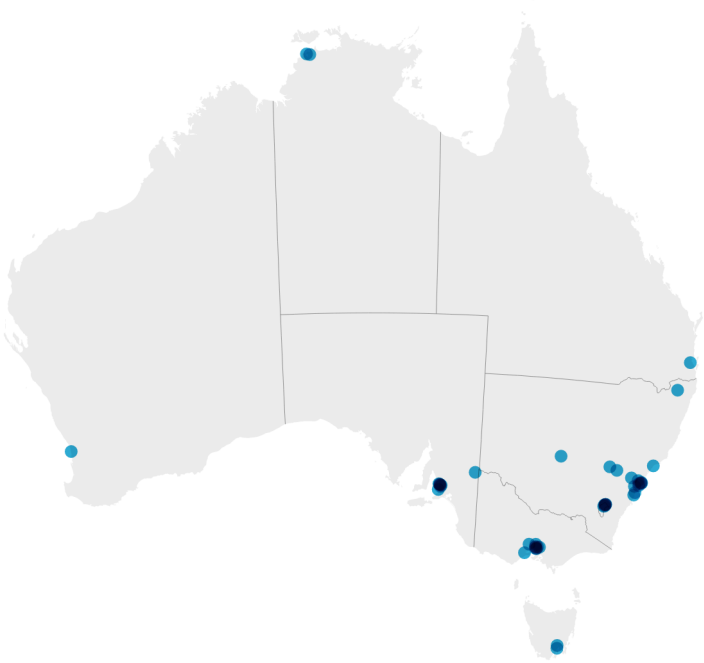

Figure 3: The distribution of Renter Researchers across Australia.

Our aim with this project was not to establish a representative sample of all renters' experience, nor to make a definitive finding about how the experience of renters differs from that of owners. Rather, we were aiming for an indication of what heat is like for those renters who struggle with it, and what shapes this experience.

Researchers recorded temperature data using Govee H5075 tracking devices, which they were instructed to place in their bedrooms (verification was performed by asking Researchers to submit a photo). Qualitative data were sourced through three participant surveys, phone interviews, and an ongoing WhatsApp group that Researchers were invited to join. Quotations in this report are derived from these inputs.

Figure 4: A collage of temperature trackers in Researchers' homes.

The summer of 21/22 was affected by La Niña, so daytime temperatures were generally cooler. As such, our recording period does not capture a particularly hot summer, nor even a typical one. Nonetheless, even in a mild summer, we observed experiences and temperature that were cause for concern. In the future, it could be valuable to carry out this project again through a more representative summer.

Findings

This section explores our findings from this project. The first part looks at the temperature data from Govee trackers. One interesting finding is the lack of relationship between AC and cooler temperature. The next section pulls out central themes that emerge from these data and the qualitative inputs. We then look at three specific heat events, from Adelaide, Perth, and Melbourne, using tracker data and Researcher interviews to understand the temperatures that people experienced and how they coped. The final section delves into our qualitative data in greater detail, looking at the effects that the heat had on Researchers and what people did to cope.

Aggregate tracker data

Below is a summary of temperature data obtained from 49 trackers across Australia. Data cover the period from 1 December 2021 to 22 February 2022. Some individual trackers have gaps in the data, but overall this is a robust dataset: 18 trackers are 100% complete, 50% of trackers are over 95% complete, and 80% of trackers are over 70% complete. Any gaps in data are likely to be effectively random.

A useful aggregate measure is the 'mean maximum' for each location. We took the maximum recorded temperature from each tracker and then calculated the mean across the maxima for each location. This gives a sense of the hottest it got in each location.

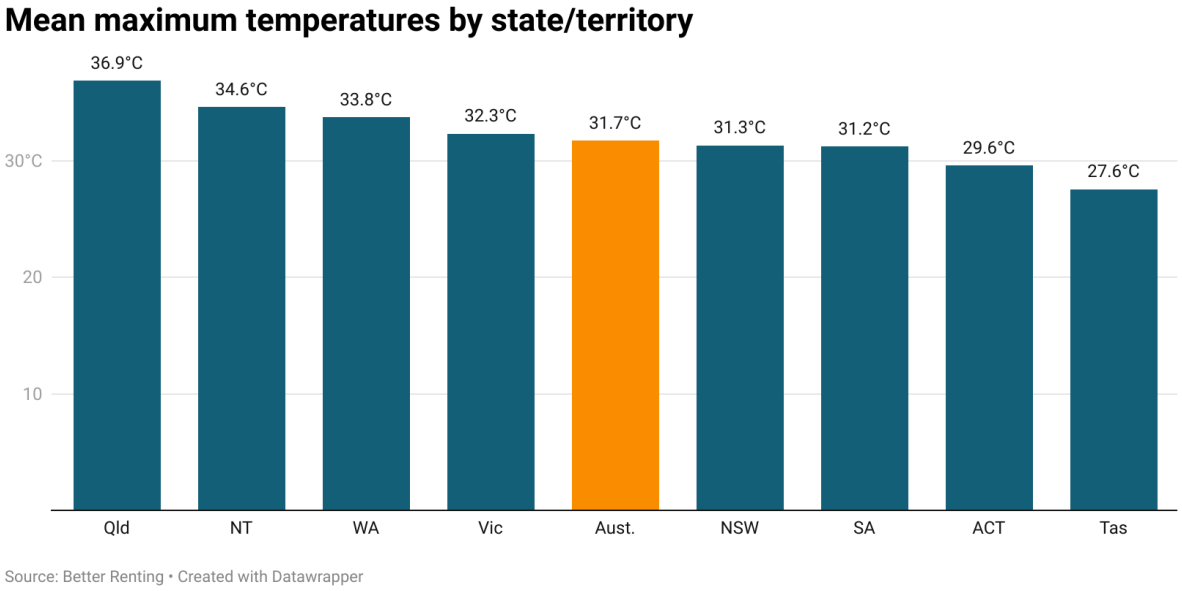

Chart 1: Mean maximum temperatures by state/territory. Full chart at https://www.datawrapper.de/_/Qof0J/

However, this measure tells us how hot it got at only one point. It doesn't give us a sense of what a home was like overall, or how long people spent in hot temperatures. A better way of grasping this is to look at the proportion of time a tracker recorded temperatures in different ranges. The next chart shows, for each state and territory, the proportion of time trackers recorded temperatures below 25°C, between 25 and 30°C, and above 30°C.

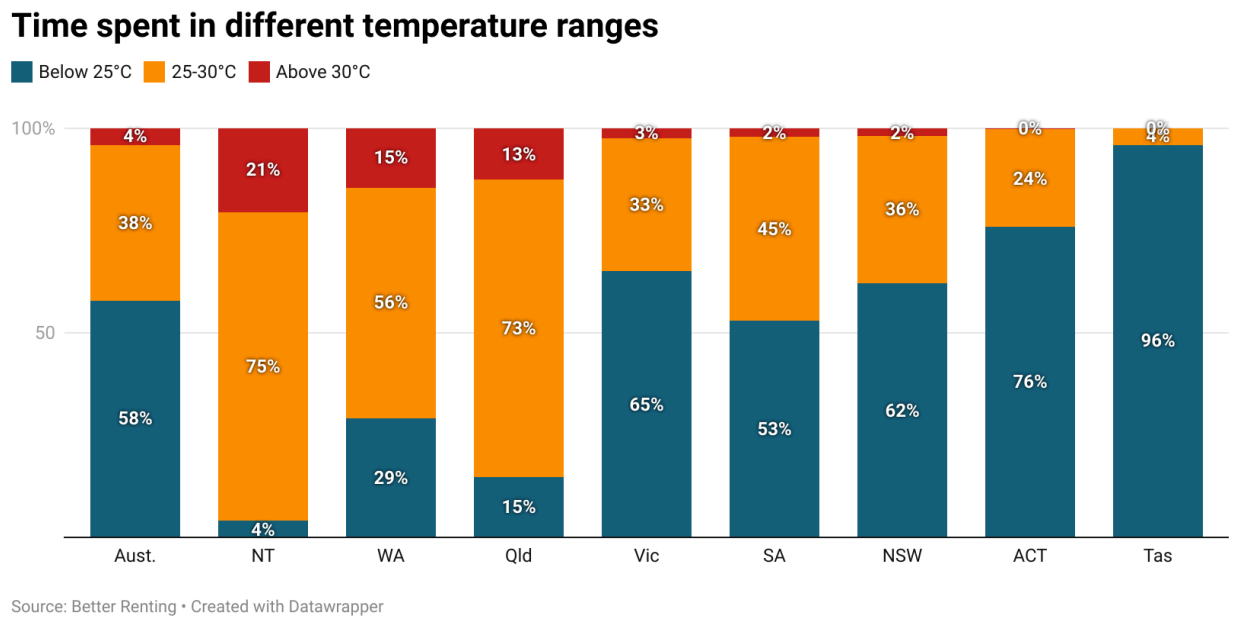

Chart 2: Time spent in different temperature ranges, by state/territory. Full chart at https://www.datawrapper.de/_/SG5HO/

We were also especially interested in night-time temperatures because many Researchers described difficulty with sleep. We thus reviewed tracker data for the hours of 9pm to 6am in particular in an attempt to get a sense of what temperatures people are encountering when trying to sleep. Compared to the above chart, we see less time above 30°C, which perhaps makes sense, because the night is generally cooler. However, we see *more* time above 25°C. In fact, night-time temperatures were commonly above 25°C in many locations. This helps to explain why sleep was challenging for so many of our Researchers.

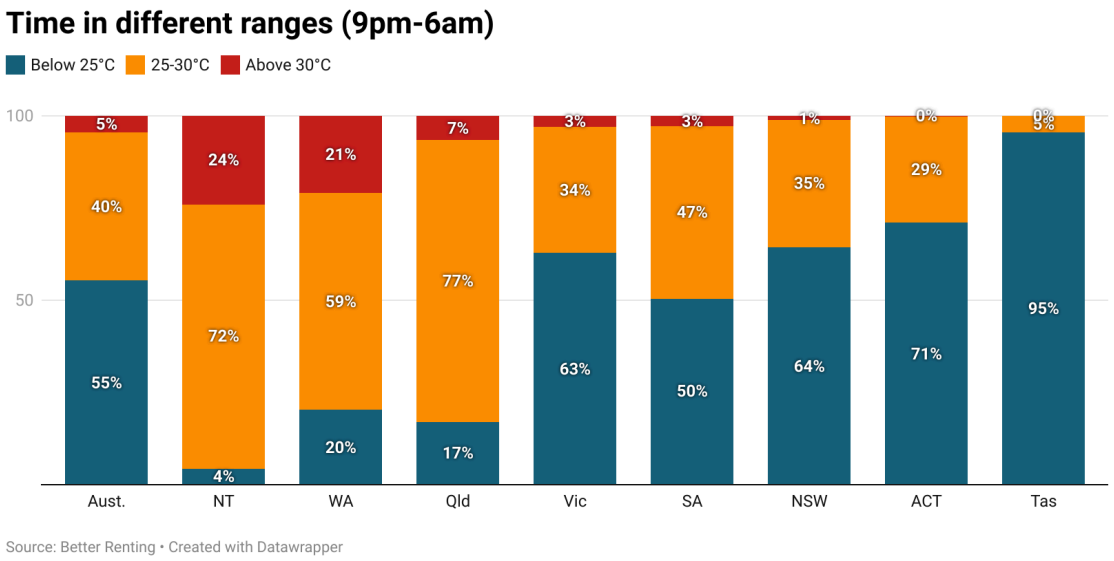

Chart 3: Time spent in different temperature ranges between 9pm and 6am, by state/territory. Full chart: https://www.datawrapper.de/_/zb6lc/

Another dimension we were interested in was what effect air conditioning has. Prior research suggests that AC does not guarantee healthy temperatures, and many Researchers reported to us being reluctant to use AC or finding it ineffectual. How does AC affect recorded temperatures? We answered this by looking at the comparative experience between households with and without AC. Unfortunately, in some jurisdictions there was not a decent sample of households of each type. The below data thus compare households with and without AC for NSW and for Australia as a whole. We first compare mean maximum temperatures and then time spent in different ranges.

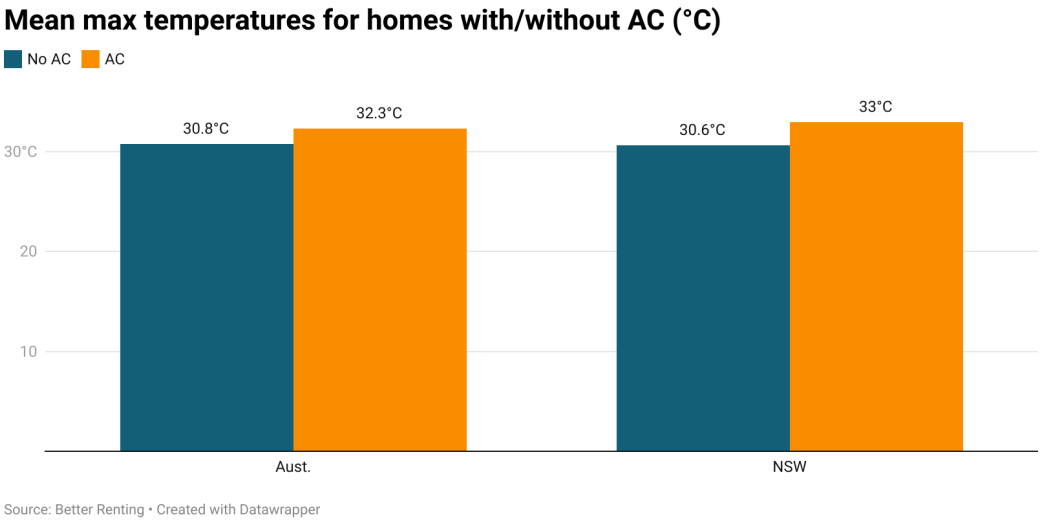

Chart 4: Mean maximum temperatures for Australia and NSW, separated based on AC status. Full chart at https://www.datawrapper.de/_/ky56W/

These charts suggest that having AC is correlated with higher maximum temperatures and more time spent in high temperatures (see Chart 5, below). This is perplexing. There is some risk here of confusing causation and correlation: it's implausible that the mere presence of AC is *causing* households to be hotter. It is, however, less implausible that the *availability* of AC perhaps causes buildings to be built to be less energy-efficient, and maybe people with AC spend less effort trying to keep their homes cool in other ways. Some of these ideas are explored elsewhere in this report.

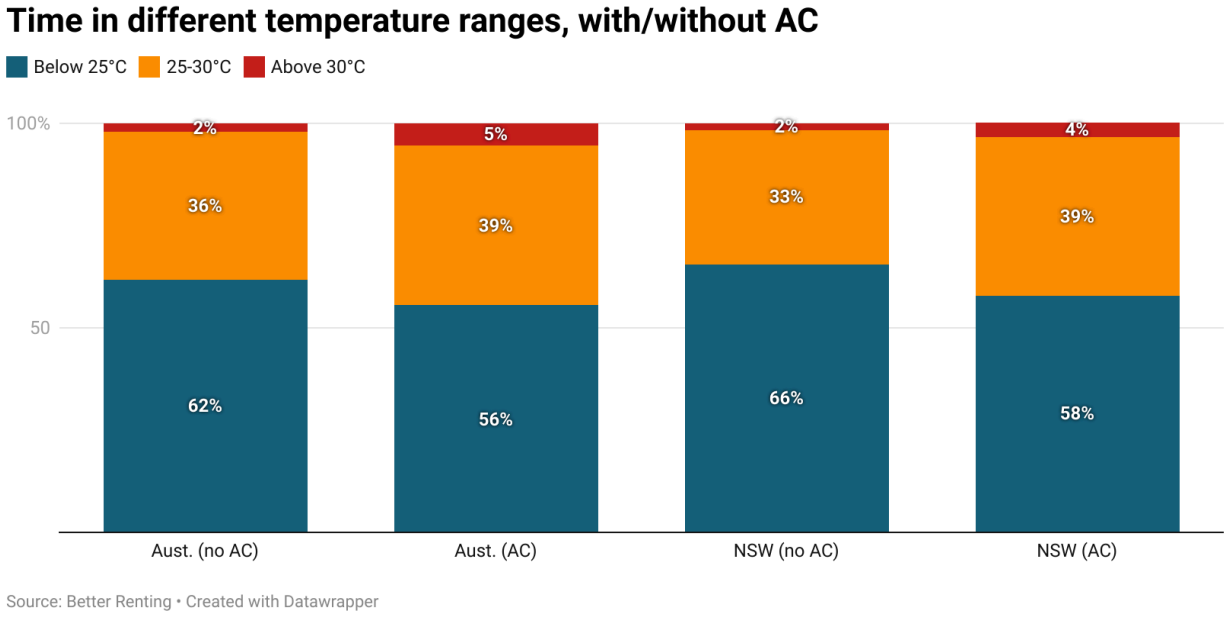

Chart 5: Time spent in different temperature ranges for Australia and NSW, separated based on AC status. Full chart at https://www.datawrapper.de/_/Jw9fR/

A final explanation worth considering is that households with AC do manage to have cool homes when it matters most: when they are home. If this is what is going on, then we would expect households with AC to show cooler temperatures overnight (when people are home and value cooling most) compared to households without AC. We consider this in the next chart, looking again at the hours of 9pm-6am. In this case we focus on NSW to create a fairer geographical comparison. Again, however, we observe that AC households spend more time in hotter temperature ranges.

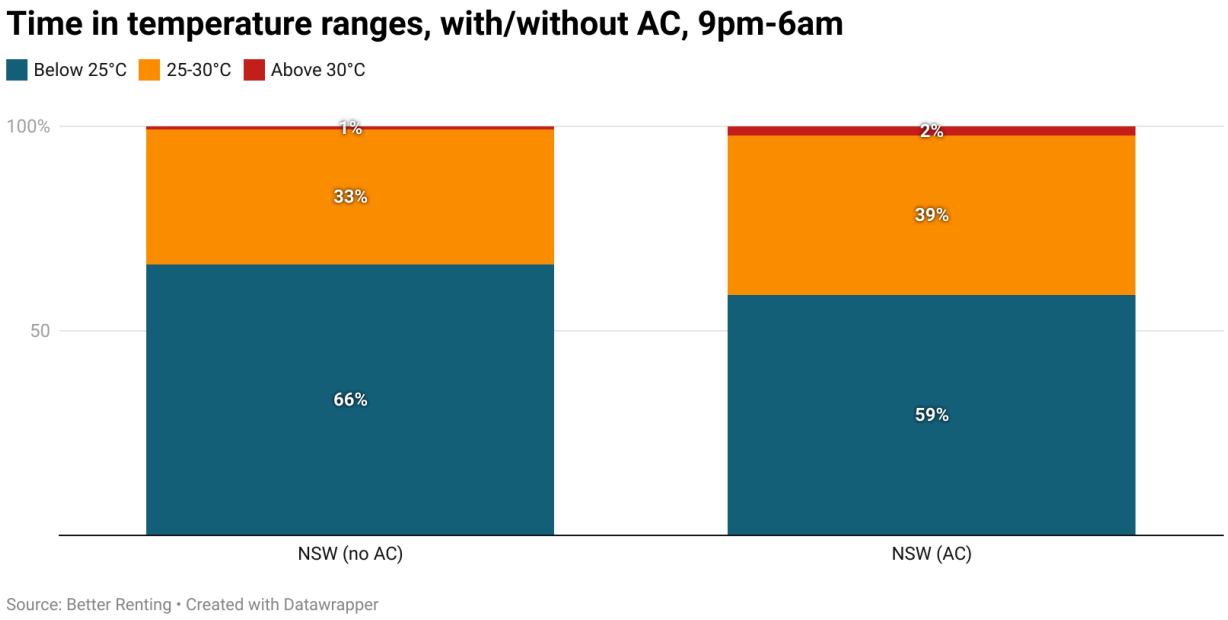

Chart 6: Time spent in different temperature ranges for NSW, 9pm-6am, separated based on AC status. Full chart at https://www.datawrapper.de/_/vVoLj/

Our tracker data allow us to make some observations about temperatures in Renter Researchers' rental homes. We can see that it is routine for temperatures to be in unhealthy ranges, with a large amount of time spent in a range that compromises comfort and wellbeing. Smaller amounts of time were spent above 30°C, but in WA, the NT, and Queensland, the proportion exceeded 10%. Australia-wide, it was 4%, or about an hour a day on average. This is a lot of people spending a concerning amount of time living in temperatures that are shown to increase the risk of hospitalisation.

The data on air-conditioning are intriguing. What we can see is that the relationship between AC and lower temperatures is vexed at best: the bedrooms of households with AC generally experienced higher maximum temperatures and spent more time in hotter temperature ranges. This unexpected finding warrants further exploration.

Key findings

Four key findings that emerged from this project are:

1. For renters, adverse experiences of indoor heat are tangled up with adverse experiences of renting more broadly.
2. Newly-built dwellings do not provide immunity to summer heat.
3. Peculiar to the summer of 21-22, COVID-19 made heat worse (and vice-versa).
4. An air conditioner alone does not guarantee healthy home temperatures.

Experiences of heat were inseparable from renting

An early theme that emerged from this work was how people's experiences of hot homes were bundled up with other adverse experiences of renting. It's not just that rental properties tend to be hotter in summer, but that the renting experience itself compounds the harms of this and makes it harder to achieve a remedy.

Part of this is powerlessness. Hot weather can make people feel powerless, because one reaches a point where there is no more that can be done to deal with the heat. This is worse for people who rent, because they are also powerless to change their dwelling. But this powerlessness in the face of heat sits within a broader experience of powerlessness. If you rent, you can't control when and how repairs happen in your home, you can't predict and plan for housing costs, and you can be forced to leave your home with as little as four weeks' notice, sometimes without even a reason provided. When people who rent feel impotent to do something about the heat, it is of a piece with a broader feeling of subject-hood that arises from the very experience of renting in Australia.

We observed this through conversations in our WhatsApp group for Renter Researchers. In addition to discussing direct experiences of heat, many people also described regular forced moves, worries about rent increases, and issues around privacy and inspections.

A clear related trend is a reluctance to self-advocate. Some people were hesitant to even ask for basic repairs; in this context, asking for an improvement like air conditioning is out of the question. This hesitance stemmed from a fear of retaliation (through a rent increase or lease termination) and a sense of futility.

"I have asked a friend to fix a leaky tap because I didn't want to go through real estate agent app rigmarole. Too scared of rent increases to ask for the owner to consider putting in a/c."

"I only ask for repairs if they're undisputedly "urgent" because I live in fear of eviction. "

"I have no air-conditioning or ceiling fans, and my landlord has repeatedly refused my prior requests so I won't even bother asking again."

These accounts point to the absurdity of expecting market interactions in the private rental market to solve the problem of inefficient, unhealthy homes. In the current market, a tenant might hesitate to exercise the rights given to them under law, let alone to stick their head above the parapet and suggest improvements.

Figure 4: Concerns about retaliation mean that people are reluctant to pursue repairs, let alone perceived improvements.

People in new dwellings were not safe from heat

When we began this project we expected that renters in newer buildings, most of which are apartments, would have a milder experience of summer compared to those in older and less efficient detached dwellings. To our surprise this was not the case. Even though new dwellings are built to higher energy efficiency standards, the people living in them still reported struggling with summer heat.

> *"Large exposed glass windows and walls aren't double glazed, or shaded. Units don't include effective sun blocking blinds, or even a sturdy curtain rack to replace the flimsy blinds with our own ones that really block glare. The huge concrete walls are unclad, unpainted and lack shade from roofs or balcony blinds."*

> *"...the west facing outside wall, which makes up the majority of my apartment, is covered with dark grey metal cladding outside that heats up a lot in the afternoon sun and thus heats up the apartment incredibly."*

> *"Our house is a new build which you would think means better quality - no! Despite being less than three years old there are very poor design and quality issues that would have been easily and cheaply fixed or better designed that would have a noticeable impact on the liveability of the premises"*

We suspect a few factors are at play here.

- **The current rating is simply too low.** The National Construction Code requires new buildings to achieve a 6-star NatHERS rating to demonstrate their energy performance. While this standard improves upon the historically woeful performance of Australia's housing stock[35], it is still far from ideal energy performance. The experience of our Researchers indicates that a 6-star rating is still too low.
- **It is cheaper for builders to reduce heating loads than cooling loads.** The NatHERS rating for a new building corresponds to the total energy per square metre needed over a year to maintain a comfortable indoor temperature. Because this amount is calculated over the year, a building might meet the standard by having very low heating needs in winter, even if it has more cooling needs in summer. As such, a 6-star rating does not necessarily indicate year-round thermal comfort. While insulation and air-tightness are desirable, they can make it harder to expel built-up heat in summer, increasing the risk of discomfort or excessive indoor temperatures.[36,37]

Figure 4: The hot summer sun bearing down on a block of apartments.

- **NatHERS assumes window usage.** The NatHERS software assumes that occupants open windows to maximise the cooling effect of ventilation. In reality, there are many reasons that occupants may not use windows.[38] Although our Researchers wanted to use their windows for ventilation, they identified numerous concerns about doing so: urban noise, security concerns, mosquitoes and other pests, or potential pet escape. When actual behaviour does not align with idealised assumptions about window usage, a dwelling may be hotter in summer than modelled.
- **Obliviousness to local micro-climate.** NatHERS employs a large number of climate zones — 69 — to determine energy requirements. Thus, a dwelling in Tasmania is assumed to have less need for summer cooling than the same dwelling in Brisbane. However, this neglects local micro-climate. A dwelling in a very urbanised area with no parks, street shading or nearby water will have more cooling needs than the same dwelling, in the same climate zone, that is surrounded by local cooling sources.
- **Climate zones don't reflect current global warming effects.** NatHERS climate zones are based upon historic climate data. However, due to global warming, Australia's climate has been changing rapidly. This means there is a misalignment between the amount of heat modelled in NatHERS software and the actual heat

that buildings experience in the contemporary climate. As such, cooling needs may be higher than modelled.

COVID-19 added to the challenges of summer heat

We were also struck by the role that COVID-19 and related issues played in how people experienced heat. The most common issues were with working from home, but people also reported challenges around self-isolation and with contracting the virus itself.

Since the advent of COVID-19, many more people have been working from home. With the emergence of the delta and omicron variants in late 2021, people who might have returned to the office were once again working from home. This was a challenge for our Researchers. Some used air conditioning but needed to run it virtually all day, leading to concerns about energy costs. Others didn't have air conditioning, which directly affected their ability to work, reducing focus and concentration, or in some cases making work itself impractical.

Figure 5: Stuck at home due to COVID-19, renters struggled to work in hot homes.

But the interaction of COVID-19 and summer heat was not limited to uncomfortable home offices. As case numbers grew, some Researchers or their family members contracted COVID-19 themselves and were forced to stay at home. Others were required to self-isolate following exposure. A common adaptation to hot weather is to leave the home and seek a cool environment elsewhere. These Researchers lost this opportunity and had to stay shut in hot homes. In addition, COVID-19 made heat less bearable, and vice-versa.

> ***"Not being able to leave my room while isolating was really hard as our only way to cool down is to go to the beach."***
>
> ***"My son and I have been at home sick with covid and pneumonia. Having fevers and chills on top of sweating from the heat was unbearable and made our recovery much harder....My bedroom should have been my place of rest, comfort and recovery, but it's a place I dread and avoid on hot days....We couldn't leave the house to go to an air-conditioned venue or friends place for respite."***
>
> ***"My partner and I both had COVID and we struggled being unwell when it was so hot. The heat made our fevers worse, and although we were able to run our airconditioner in the bedroom for a week or so straight, this will make our next bill very expensive."***
>
> ***"Usually on very hot days I'll go to an air-conditioned place to cool down. But because I have to isolate, there's no possible respite from the heat."***

Many types of households would have had challenges around COVID-19 and working from home during the heat. However, people who rent have a distinct experience. In particular, people who rent have less free space in their homes. The 2016 Census shows owner households are more likely than renters to have a spare room: for example, four in five two-person owner households have three or more bedrooms, compared to less than 50% of two-person renter households. This lack of space makes it more likely that someone with COVID-19, for example, would have to remain cooped up in a hot bedroom, rather than have a spare room or separate living area to use. A smaller home makes every aspect of COVID-19, from working from home to self-isolating, more challenging.

The limitations of air-conditioning

One implication of our research is that air-conditioning does not result in lower temperatures. If anything, people with AC were hotter. What does this suggest?

Firstly, the data could be misleading here. It's plausible that people in hotter climates are more likely to have air-conditioning: AC was more common in Queensland, the NT and WA, but much less common in NSW. However, this doesn't seem to explain all the variation: even within NSW, people with air-conditioning had warmer temperatures. Too, our trackers were in bedrooms, and in some cases AC units were in lounge areas, so they may not have had much effect on recorded temperatures.

On the other hand, there are plausible reasons that air-conditioning would not consistently lead to lower temperatures. A number of our researchers had concerns about cost or climate impacts that meant they were reluctant to use their AC. Others had AC that was not working, due to landlord neglect. Or, the AC was simply inadequate to the cooling challenge: a low-powered device might be contending with a large amount of thermal mass and an uninsulated, poorly-shaded dwelling.

> ***"I've been running the air con in the living room set to 16 all day but it hasn't gotten below 24."***
>
> ***"After a few hot days the whole building can be hot. It's a competition between aircon cooling and walls/ceilings heating."***
>
> ***"...our place has a very small amount of insulation in the roof and that's it...even though we do have an aircon it is a lot less effective than it could be***

Another possibility is that people who have AC don't feel a need to employ other measures to keep their home cool. For example, people with AC may not use natural ventilation such as fans and windows, for convenience but also because an open window would counteract the effectiveness of AC. This could go some way to explaining how AC was associated with, in fact, higher temperatures.

Overall, Researchers with air-conditioning were glad to have it, and many without AC wished they did have it (with some using their participation in this project to approach their landlords, sometimes with success). As noted above, AC offers both costs and benefits. Our research suggests these benefits may be more ambiguous than previously thought.

Experiences of heatwaves

This section considers three heatwaves:

- Adelaide, December 29-31,
- Perth, January 17-24, and
- Melbourne, January 25-27.

For each heatwave we show tracker data from select households. We combine this with household interviews that help us to understand what the tracker data show.

Adelaide heatwave, December 29-31

In late December, Adelaide experienced a relatively brief heatwave with three days of maximum temperatures above 34 degrees, peaking at 39 degrees on New Year's Eve. Data from our Researchers show a variety of responses and coping strategies.

Two of our researchers managed to keep their bedroom temperatures below 30 degrees through this entire period. One of them, Bernie, achieved this using air conditioning, and her tracker shows this, with a fairly jagged line that drops precipitously for short periods, not necessarily overnight. Other Researchers' homes reached temperatures above 30 degrees.

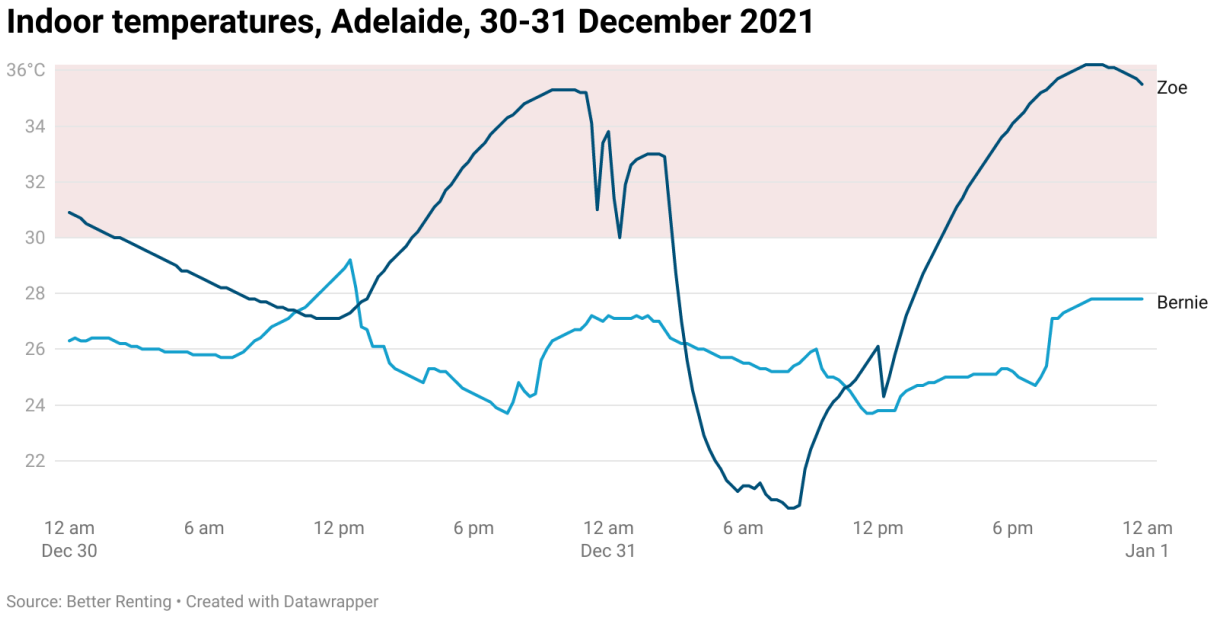

Chart 7: Data from two Researchers for Adelaide, 30-31 December 2021. Full chart at https://www.datawrapper.de/_/YBGK3/

Perhaps what is most striking is Zoe's experience. Zoe's bedroom reached 34 degrees on the evening of December 30 and then the temperature dropped dramatically, to almost 20 degrees by the next morning. However, the reprieve was short-lived: Zoe's tracker then records an increase from about 20 degrees at 8am to about 36 degrees by 10pm, a remarkable increase of 16 degrees over 14 hours. This hints at the limitations of air-conditioning: while it may offer relief, various barriers mean it cannot be a panacea to prevent elevated indoor temperatures during heat extremes.

Through interviews with Bernie and Zoe we were able to understand how their different housing conditions influenced these temperatures and the effect this had on their behaviours.

> *"...if it's hot for more than a few days in a row you just have to use the AC overnight.* ***I get so anxious thinking about going to bed****."*

Bernie lives in an old semi-detached brick house that has ducted air-conditioning throughout. During the heatwave, she used the AC to keep her home cool during the day, relying on ceiling fans overnight in her bedroom. This was due to worries around high electricity bills and concern about the environmental impacts of usage. The above chart shows how Bernie's temperatures go down in the afternoon and evening and then rise again when Bernie switches to the ceiling fans for cooling. The heatwave harmed Bernie's sleep, and she tried to use ice packs on her neck to cool down. On the hottest day, Bernie left home to spend time with a friend who had a cooler home by the beach.

Figure 6: Bernie escaped to the beach with her partner and dog to avoid the heat in her home

Zoe came to Australia from the Middle East five years ago, and says she is still adjusting to the heat in low-quality, uninsulated rental homes. Unlike Bernie, Zoe doesn't have access to ducted cooling. Instead, her home has a single AC unit in the lounge. Her home receives a lot of daytime sun, with little shading, no insulation, and poor window treatments.

Zoe adapts to this by planning to leave her home on hot days. The night before, she cooks the next day's meals with a fan propped up on her microwave to try to keep the cooking area cool. The next day she wakes up early, packs three meals, and leaves by 7am, waiting until later to eat breakfast so she can escape the heat as quickly as possible. Zoe's high daytime temperatures are both a cause and an effect of this adaptation: she leaves the home because it gets hot, but because she is not home she does not need to cool the house.

Figure 7: Zoe props a small portable fan on her microwave to try to keep her kitchen cool.

As the evening arrives and the day is slightly cooler, Zoe returns home and promptly turns on her AC. As the lounge is the only conditioned room, she sets up a makeshift bed on a small fold-out couch, where she will spend the night, closing off the lounge room to make the most of the AC's cooling. This corresponds with the above figure, which shows how indoor temperatures begin to drop sharply in the evening when Zoe gets home and begins mechanical cooling. The sharp increase the subsequent day is once she has left again.

Perth heatwave, January 17-24

This most recent summer was Perth's hottest on record, with an average maximum temperature of 33.2°C.[39] During this searing summer, Perth experienced eight days in a row with maxima above 30 degrees, from January 17 to 24. Six of these days, January 18-23, had maximum temperatures above 40 degrees. Our Researchers have tracker data covering this period.

The data from our Perth-based researchers show the impact that this heatwave had on indoor temperatures. From the 17th, while homes cooled down each night, this was not sufficient to combat the onslaught of heat, and homes gradually rose higher and higher in temperature. By January 19, the homes of Researchers had crossed 30 degrees inside.

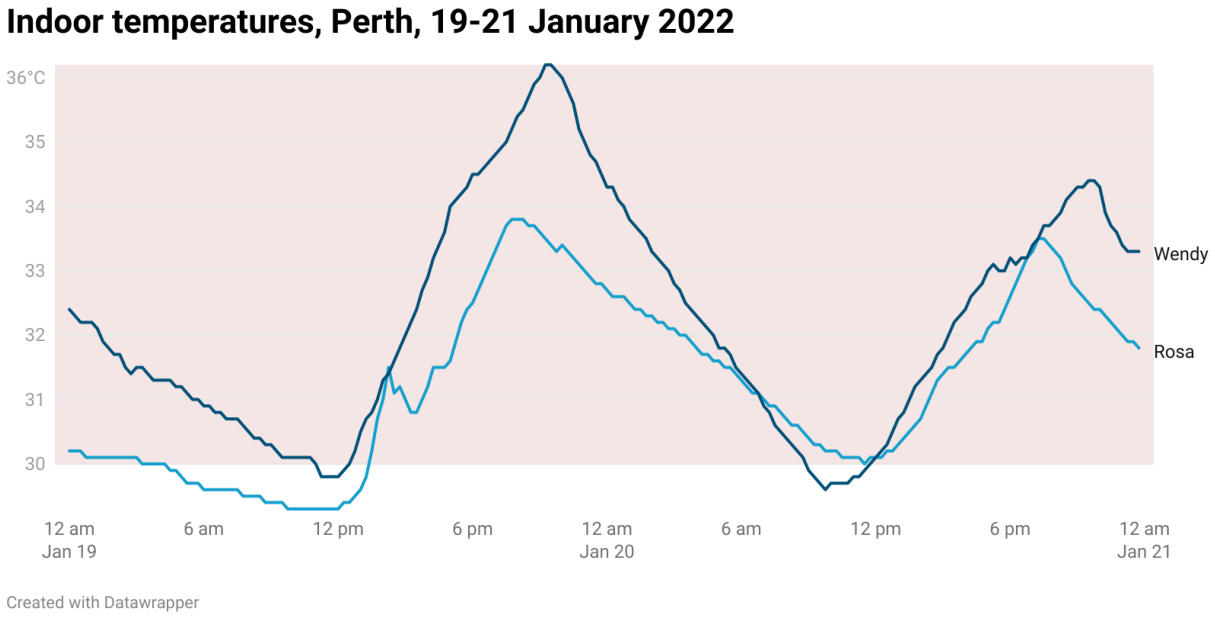

Chart 8: Data from two Researchers for Perth, 19-21 January 2022. Full chart at https://www.datawrapper.de/_/Ecrjr/

However, the heat was unrelenting. For all Researchers, temperatures remained above 30 degrees for close to four days. The highest temperature was reached on January 19, when the outdoor maximum temperature was 42.1 degrees; one Researcher's home reached over 35 degrees inside. At temperatures like this, there is increased risk of hospitalisation. People toss and turn all night, waiting in vain for a sleep that, like Beckett's Godot, never comes.

One Perth-based Researcher told us about the impact of this heat on them.

Wendy lives in a small unit close to Cottesloe beach, but her home receives none of the benefits of the famous beachside breeze. When Wendy gets home from work, she's met with a house that is hotter than outside. She feels like she's walking into a baking oven.

Immediately she is faced with the anxiety of how she is going to cope throughout the evening and night. She sets about making plans, moving bedding into the lounge room to prepare for a night sleeping on the couch under the only air conditioner. During this heatwave, she could hardly sleep through the night. Waking up fatigued, she would sometimes miss work or force herself to push through the exhaustion.

> *" Over this whole summer,* ***my bedroom has been like an oven.*** *When I get home the house is hot and* ***when I go to bed it's even hotter."***

Wendy describes the distress and shame she feels about living like this, feeling so embarrassed about sleeping in the lounge that she avoids inviting over friends and family. Due to ongoing treatment for breast cancer, Wendy is experiencing early menopause, causing hot flushes that are much worse in the hot months.

> *"I'm already spending half of my pay on rent. The bills are going to be terrible.* ***But I have no choice****."*

There was an upside to Wendy's experience. After she saw her tracker record 34.5°C overnight, she was inspired to contact her landlord. They agreed to install an air conditioner, and she says the difference has been "literally life changing". She has slept better than any time in the last three years, and no longer dreads going to bed. Yet, while AC has made a huge difference for Wendy, she is also concerned that it was only due to her landlord's goodwill, and that other tenants may not be as fortunate. Wendy is also worried about the electricity costs — but for now at least, it's worth it to be able to have a decent sleep.

Melbourne heatwave, January 22-26

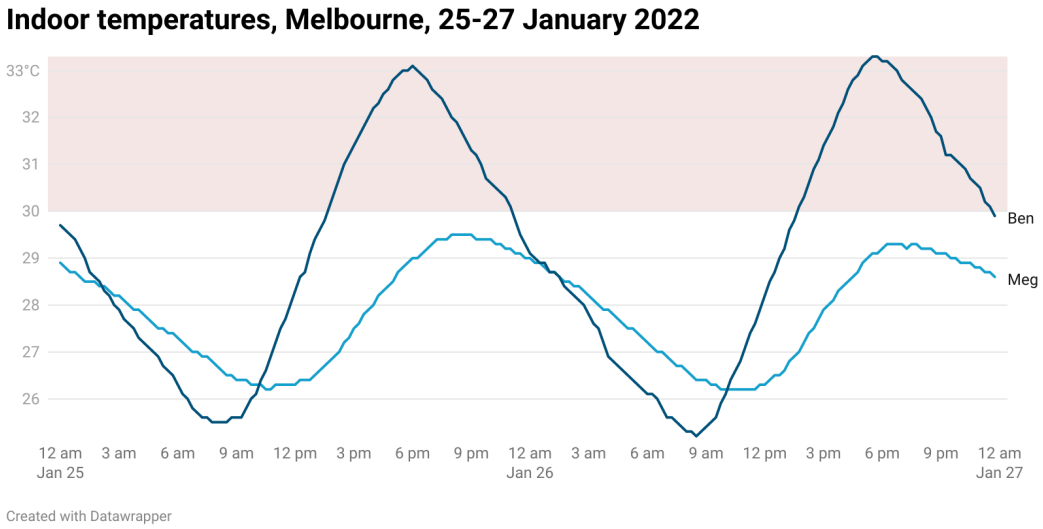

Chart 9: Data from two Researchers for Melbourne, 25-27 January 2022. Full chart at https://www.datawrapper.de/_/SDrZY/

From January 22 to January 27, Melbourne experienced six days in a row with maximum temperatures above 30 degrees, reaching a high of 36 degrees on January 26. The figure above shows the tracker data of two of our Researchers during this period, Ben and Meg.

Both Ben and Meg experienced a similar pattern, with the temperatures in their homes rising over the day and slowly dropping through the night. The lowest temperatures in their homes were recorded between 7 and 11am before temperatures gradually increased again over the day. We can see from these data that both homes stay hot well into the evening, which would affect sleep quality. We spoke with Meg and Ben to better understand what was happening in and outside of their homes to cause these patterns and how they attempted to adapt.

Figure 8: Meg's home, though inefficient, at least has the benefit of vegetation and shading.

Meg lives in an old weatherboard home, uninsulated, with single-glazed windows and gaps in the walls. Given this, she has developed an elaborate routine to keep her home cool on hot days. Waking up early, she begins the process of closing up her home, targeting windows, curtains, and blinds. Unfortunately, her home is poorly sealed, making it much harder to keep hot air out. Meg has been working at home through the day, sitting directly in front of a fun, but even so the heat leaves her unmotivated and sapped of energy. The lack of natural light exacerbates her depression.

> "When I'm trying to sleep, **it's just this feeling of being really exhausted from the heat** but then I can't fall asleep"

Meg's house is sometimes hotter than the outside, so she can escape the heat by leaving: either to a friend's house, or perhaps to the beach. On hotter days, however, Meg has to cope at home. At night, Meg and her housemates avoid cooking or using the kitchen. Before bed, Meg has a cold shower, turns on her fan, and opens the window — but this makes little difference when it's still hot outside.

Figure 9: Ben's house gets minimal shade. The brick patio absorbs and retains the sun's heat, reaching up to 60°C.

While Meg's home is by no means exemplary, it still performs better than Ben's. Ben lives with his partner and cats in a 1970s brick house that gets no daytime shade. Although Meg's bedroom has a nearby tree that provides some shade, Ben's home is blasted by the sun from dawn until the sun goes down. This goes some way to explaining the noticeable difference in their home temperatures.

> "I felt the heat literally radiating, on the top of my head, **the ceiling was radiating heat.**"

This forces Ben to expend mental energy trying to keep his home cool: he reports that once the heat gets in, it can take his home days to cool down. Ben also closes up his home as much as possible and uses blackout curtains to help with this. While his home has an AC, it is almost fifty years old, and it is hopelessly outclassed by the summer heat. On hot days it is nearly impossible for Ben to sleep at night: while we can see the temperature dropping overnight during the heatwave, at no point does it reach a comfortable temperature for sleep. Having spent countless hours and dollars trying to keep his home cool, Ben has done all that he can as a renter, and he feels defeated.

Coping with the effects of heat

Figure 10: People described heat as an ordeal.

Although summer 21-22 was a relatively mild La Niña summer, Researchers still described intensely hot homes. Heat becomes almost an anthropomorphic presence, an intruder stalking people in their homes. People talked about candles or make-up melting in the heat, and concern for the wellbeing of dependents. Researchers could pinpoint how their homes had features that made the heat worse or lacked features that would have mitigated against the heat: brick walls that absorb and radiate heat, non-existent insulation, minimal shading or vegetation, inadequate AC units. A common complaint was that homes would be hotter than the outside, often cooling slowly even as outdoor temperatures declined.

*"The difference between the outdoor temp and indoor temp is negligible…**I can touch the inside walls and feel the radiant heat.**"*

Figure 11: Some Researchers' experiences of summer heat.

While some Researchers reported more positive experiences, due to improved housing or the milder summer, others narrated a myriad of adverse impacts. In this section we discuss these impacts: difficulties with sleep, financial costs, physical health effects, and mental health effects. We also describe some of the coping measures that people described.

Heat made it hard for people to sleep properly

Many Researchers highlighted the impact of hot weather on their sleep quality. Hot bedrooms made it difficult for people to fall asleep, especially on nights of elevated outdoor temperatures. In some cases, measures to improve subjective thermal comfort made sleep difficult in other ways: Researchers who used portable AC noted that the noise interfered with sleep, even if the cooling had benefits; some people left windows or doors open for ventilation but then had to contend with mosquitoes.

Effects of high temperatures on sleep have been documented elsewhere, affecting both sleep duration and quality.[40] A 2012 survey of Adelaide residents found that "sleeping well" was a top issue during a heatwave.[41] Poor-quality sleep may contribute to the psychological impacts of heatwaves. The harmful effect of heat on sleep quality also has concerning implications for how well our society can cope with increasing heatwaves, as sleep deprivation may affect the faculties and performance of vital workers such as bus drivers, nurses, and paramedics.

"My daughter has had to sleep with me in my room as hers was unbearably hot even with the window open and two fans on full blast"

"My son sleeps on the tiles in the kitchen at night as his room gets full sun in the afternoon."

"On the night that it was 34.5 in my bedroom I woke up constantly through the night sweating and unsettled. I hardly slept. When my alarm went off I was too physically exhausted to go to work and had to work from home."

Hot weather imposes financial strains

In general, people who rent have lower incomes than others, and people living below the poverty line are disproportionately renters. For low-income households, a greater proportion of weekly income is spent on energy costs.[42,43] Or low-income households may avoid elevated energy bills by rationing energy usage to the point that it may be harmful.[24]

"We've spent $1000 on ACs for this place and it's just liveable now."

"My symptoms are a lot worse when I get hot, so I've basically been running the bedroom aircon 24/7. Really not looking forward to my electricity bill."

"Worry about upcoming hot days, added financial stress as I have to purchase curtains, shade cloth and temporary blinds especially as 2 large trees were recently removed."

We found these issues to be a recurring theme for Researchers. Many people were reluctant to use cooling appliances because of worries about the cost — this concern extended even to fans, which are much cheaper to run than AC. In other cases, renters would use AC to keep their home at a liveable temperature, but then acknowledge worries about forthcoming bills. Such a response was more common for people with caring responsibilities or chronic health issues. A third phenomenon was people incurring significant one-off costs to buy window treatments, fans, or portable AC. Unfortunately, portable AC units are often more expensive to run, less effective, and noisier than their fixed equivalents. Finally, numerous Researchers mentioned avoiding cooking and ordering takeout instead, thus avoiding heat, but increasing their food costs.

Hot weather affects physical wellbeing

While heat can cause health consequences as extreme as death or hospitalisation, it also causes physical wellbeing impacts that are less severe but much more widespread. Many Researchers reported such adverse health impacts. Most common was lethargy or fatigue, due both to heat directly and to difficulties with sleeping. People also described dehydration, headaches, nausea, moodiness, and exhaustion.

> *"I have pre existing health conditions. So does my elderly Mum who lives with me now. Air conditioning is a necessity for us to be able to function. Without it both of us could end up in hospital."*

> *"High heat triggers my asthma and migraines and vertigo. My son also lives with several disabilities which are harder for him to manage in high heat. He is on numerous medications and the heat has an impact on this and the side effects. Because he can't sleep in the heat, it exacerbates his disabilities."*

> *"I am already sensitive to the heat from my ME/CFS. Anything over 25 degrees and I feel like I'm in hell."*

A key interaction was between hot temperatures and existing health conditions. About one in two Australians has a chronic health condition[44], and the testimony from our Researchers highlights how this leads to a worse experience of heat. Heat exacerbated issues with asthma, migraines, sinus infections, hay fever, sleep apnoea, high blood pressure, CFS, and Raynaud's syndrome. This is consistent with other work that found worse heat impacts and greater reliance on air conditioning for people with chronic health conditions.[45] Given high rates of chronic health conditions and increasing rates of renting, the interaction of high rental temperatures and physical health is a cause for concern.

Hot weather affects mental health

Prolonged high temperatures also have a negative impact on the mental health of people who rent hot homes. Mild impacts we heard about included increased moodiness, irritability, and stress. This is partly due to the heat itself, but also due to a sense of impotence and helplessness in the face of heat. That is, owner-occupiers can exercise agency in the face of heat and take measures to improve their home. While renters can purchase fans or cover windows (as many of our Researchers did), limitations on modifications and unresponsive lessors leave renters with fewer options and a greater sense of powerlessness.

"It's a terrible feeling when
home feels like a place you need to escape from
to function properly."

Some people also referred to anxiety and depression, related to energy bills, the heat itself, or a sense of resignation and not being able to have a decent home. This is consistent with a 2019 systematic review that considered the relationship between housing disadvantage and mental health. The review found the most associations between housing disadvantage and depression, with "housing disadvantage" including measures such as "housing tenure", "subjective perceptions of inadequate housing", and "physical housing conditions".[26]

> ***"The mental health part is a big bit of it for me and my partner, you're worrying about a new baby and it's just extra stressful trying to make the environment at least bearable if you can even manage that."***

> ***"The lack of control over my own comfort makes you feel really helpless. You go through a period of anger and desperation, and then you just give up. If a house doesn't serve its purpose - as a place to feel comfortable and safe - then there's nowhere you can really relax. You're helpless and anxious all at once."***

> ***"I've had to take sick days due to the lack of sleep and mental health impact from the heat."***

Figure 12: Inescapable heat had a negative effect on mental health.

People get creative to cope with the heat

While heat posed a challenge for many of our Researchers, they were adaptable and resilient in the face of summer. People deployed a range of measures to help them or their loved ones to reduce, endure, or avoid high temperatures.

The first line of defence was to reduce incoming heat. Although there is much people who rent cannot do in this regard, Researchers were ingenious in coming up with options to try to keep their home cooler in the first place. To a large extent, this was trying to stop heat gain through windows. Some people would also try to restrict the heat to certain parts of the home. Here, necessity is the mother of invention, and it is striking the lengths that people are forced to go to in an attempt to keep their home cool.

"I put up white corflute panels cut to fit the window cavities as an extra insulator, and I've purchased metallic film to put in the windows also to reflect radiant heat when it gets mega hot."

"...block sun from shadeless windows with curtains, blinds or cardboard."

"I've hung sheets in front of the blinds to help keep radiant heat out, as the blinds are very old and have quite a lot of gaps in them."

The second line of defence was to try to cool down one's body within a hot home. Fans were very popular. Researchers would also use showers, ice cubes, or water to cool down. When that wasn't enough, people might use their freezer to cool down materials they could then use against their bodies to draw away heat. Measures like these can be remarkably effective and will likely become more widespread as parts of a repertoire of adaptations to help people in Australia deal with hotter summers.

Figure 13: One Researcher's attempt to keep out the sun's heat.

"The evaporative cooler was useless on humid nights, however, so we'd put pillow cases in the freezer before bed."

"Have a spray bottle handy and sit next to the fan. Lots of showers during the day to cool down. "

"Go to bed with several ice packs by the bed fan, wet hair before trying to sleep….Keep a chilled water spritzer in fridge, to cool skin between showers. Wet small cloth then put in freezer, to use as cooling scarf when chilled."

The final option was to try to avoid the heat altogether. Researchers could do this by changing *when* or *where* they did things. For example, people described waiting until the late evening to do housework or cooking because it was otherwise too hot in the home. Concerning location, a common coping strategy was simply to leave the home: destinations might include a swimming spot, a cooled public building, or an air-conditioned home belonging to friends or family.

Figure 14: An improvised attempt to improve a fan's cooling.

"Most housework was done between 8pm and midnight."

"We have intentionally timed trips away from the home to coincide with what we know will be the hottest days of summer."

"Cram daily chores into the cooler period between 11pm and 3am."

"We have had to avoid the house by going to a public building ."

While the actions described above helped people to cope with the heat, they reflect a status quo that is far worse than it ought to be. While behavioural adaptation to heat is to be expected, it should complement other measures, and cannot be a substitute for them. These coping mechanisms impose costs and difficulties on people who rent, and they are not available to everyone.

Given this, governments at the local, state, and federal levels, should all be doing more to address the growing challenge presented by summer heat. The next section of this report recommends measures to ensure that homes can be more liveable through future summers.

Recommendations

Our Renter Researchers project has identified a number of problems facing people who rent. We suggest four responses to address these problems:

- Establish minimum energy efficiency standards for rental properties,
- Improve energy efficiency standards for new buildings,
- Improve the design of our cities, and
- Reduce climate emissions to mitigate climate impacts.

We discuss each recommendation below.

Establish minimum energy efficiency standards for rental properties

Our project has identified the impact of summer heat on people who rent, including disrupted sleep, cost of living pressures, and worse physical and mental health. These impacts are made worse by the quality of rental housing and the fact that renters cannot readily implement changes to improve the energy efficiency of their homes.

Minimum energy efficiency standards for rental properties would address this by requiring rental providers to take action to make it easier and more affordable to keep a rental home at a healthy temperature. Such action is supported by a recommendation in the World Health Organization's *Housing and Health Guidelines* that member states can address the health risks of indoor heat through "regulations on minimum requirements for ventilation, insulation and air conditioning measures".[15] Current standards in Victoria and Tasmania that require heating only should be built upon to support cooling measures. Standards must cover social housing in addition to private rental.

However, standards should not merely require air-conditioning without any measures to reduce the need for air-conditioning in the first place or to reduce the cost burden. Ceiling insulation can reduce heat gain from hot roof spaces.[46] 'Economic ventilation' offers people who rent a way to cool themselves without reliance on costly AC[45]; an electric fan can be fifty times cheaper and cleaner than air conditioning[47]. Many Researchers identified that the simple addition of fly screens or security doors would make it easier for them to cool their homes during hot weather. Rooftop solar PV is not an efficiency measure in itself, but could enable renters to use AC with less cost and climate impact. While AC likely has a role to play in reducing health risks from heat, it should be

complemented by measures that reduce the need for air conditioning and enable renters to meet that need with lower economic and environmental costs.

Improve energy efficiency standards for new buildings

Some of the Researchers in this project were living in relatively new dwellings built to the current energy efficiency requirements in the National Construction Code (NCC). Yet even these homes got too hot in summer, leaving residents struggling with the heat.

Two changes can help to address this.

Firstly, the energy efficiency requirements in the NCC should be increased to require a minimum 7-star NatHERS rating for new homes. A disproportionate number of new apartments are bought by investors and rented out: higher energy efficiency requirements would mean that these apartments spend more time in a healthy temperature range through summer, with less need for air conditioning. The code currently allows a developer to average ratings across a development, such that some units might exceed the requirement and some fall below it, with the minimum for any individual unit being 5 stars. In the case of a 7-star NatHERS requirement, this minimum should increase to a NatHERS rating of 6.5 stars.

A 7-star NatHERS requirement indicates energy load per square metre to keep a comfortable temperature. The next iteration of the NCC should also incorporate an 'energy budget' approach that considers the energy efficiency of the appliances used to meet this energy requirement. While building energy efficiency can lower the cooling need, an efficient RCAC means this need can be met at reduced cost and with less energy demand. An 'energy budget' approach in the NCC will incentivise the use of more efficient appliances in new dwellings, making it easier and cheaper for people to keep their homes at a comfortable temperature. This will also further reduce the strain on electricity networks from summer cooling loads.

Improve the design of our cities

In addition to improving design at the level of individual dwellings, we can develop heat-resilience by improving design at the level of our neighbourhoods. As the WHO recommends, we can help keep our cities cool through "planning codes that acknowledge

the importance of urban design".[15] Various features of our cities can contribute to or mitigate against urban heat.

Figure 15: Street trees provide shading and reduce temperatures directly through evapotranspiration.

One feature is "green infrastructure", including street trees.[48] Trees provide shade and contribute to a localised cooling effect through evapotranspiration. This improves comfort for people in the area and reduces energy demand in nearby buildings.[49] The NSW Government has already committed to planting 5 million trees by 2030, recognising their contribution to sustainability and liveability.[50] Beyond trees, green spaces like parks and reserves reduce urban heat absorption and retention, as well as providing cool spaces for people to go during hot weather. Such spaces in urban areas are associated with reductions in death and disease from hot weather.[51]

Another measure is ensuring that rooftops absorb less heat from the sun. This can typically be achieved by using lighter-coloured rooftops.[52] This has benefits beyond the scale of the individual household, because a lighter rooftop means there is less heat present in the local area for other households to try to deal with. While existing

technologies already offer advantages, new "super cool roofs" can reduce peak temperatures by up to four degrees.[53] APEC modelling suggests that cool roofs could save Australia as a whole over $3 billion annually.[54]

Street shading and light rooftops will reduce temperatures, but people may still need places to go to during days and nights of extreme heat. Governments should consider establishing 'heat refuges' to offer a safe escape from unhealthy temperatures.[45] While air-conditioned malls or cinemas can offer this, it's important to have free or low-cost options for low-income households. For example, local libraries or public swimming pools could open for longer hours during heatwaves.

Reduce climate emissions to mitigate climate impacts

If climate change continues to worsen, people in Australia will face extreme weather events that are more frequent, more severe, and longer in duration. This will lead to more deaths from heat; potential for acclimatisation is limited.[55] An essential approach is to reduce the climate emissions that are trapping heat and contributing to hotter summers. As *The Lancet* noted in a 2021 editorial[11], governments should adopt heat action plans to keep their citizens safe, but adaptation is not a substitute for tackling the root cause of extreme heat, and governments must also prevent climate change by reducing greenhouse gas emissions. In Australia, this includes our domestic emissions, but also the fossil fuels that we export to other countries.

Australia's climate has warmed by over 1°C in the last sixty years, more than quintupling the incidence of very high monthly maximum temperatures and very warm monthly night-time temperatures.[56] The experience of our Renter Researchers shows how these new heat extremes are already affecting people in Australia. To some extent, these Researchers are the canary in the coal mine, showing what we may all face unless more is done to address the problem at its source. As we adapt to climate impacts, Australia must also play its part in reducing its contribution to global warming.

Conclusion

Australian summers offer the promise of long, light-filled days: of Christmas holidays, outdoor picnics, and days spent at the beach. But, for a growing number of people in Australia, they also pose threats: of sleepless nights, of feeling sicker and sadder, of a home that offers not sanctuary but an unrelenting heat that lingers even as the outside cools. This experience is worse for people with worse homes or with less control over their home's energy efficiency. In this, people who rent are a key group.

With this 'Renter Researchers' project, we sought to get inside this issue. We equipped renters across Australia with devices to track indoor temperatures, and we stayed in close contact to explore a few key questions:

- What indoor temperatures are renters experiencing?
- What effect does heat have on renters?
- How does the housing of renters affect their experiences of heat?

In general, our findings corroborate existing literature. Renters experience high temperatures during summer (which we would expect to be even higher without La Niña). This affected their sleep, finances, and mental and physical health. And this experience was mediated by housing: people with better ventilation, or shading, had a more reasonable experience of summer compared to those whose homes lacked insulation, were difficult to ventilate, and absorbed heat during the day. What our research adds is the fine quantitative data on just *how* hot homes get and for *how* long: this is particularly illustrative looking at periods of heatwaves. It's also noteworthy how little difference air-conditioning seems to make, and that people in newly-built dwellings still suffer. COVID-19 was a novel phenomenon, with summer heat making it difficult to self-isolate or work from home.

These facts require intervention at the level of the household, the local community, and the nation. Improved standards for rental properties and for new buildings will support health and safety for individual households. Climate-sensitive urban planning can help keep neighbourhoods cooler and provide public sanctuary when people need to leave a home to stay cool. And action to reduce climate emissions is essential to mitigate against worse heatwaves to come.

Australia has always been hot. But it has never been *this* hot. It is a crucial collective challenge to do what is necessary to ensure that everyone in our community can have a safe, healthy home, for every month of the year.

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