Perceptions of thermal comfort and coping mechanisms related to indoor and outdoor temperatures among participants living in rural villages in Limpopo province, South Africa

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Abstract

Global heating is considered one of the greatest threats to human health and well-being. Supporting human resilience to heating threats is imperative, but under-investigated. In response, this article reports a study that drew together results from quantitative data on perceptions of thermal comfort and mechanisms for coping with thermal discomfort among 406 households in a study in Giyani, Limpopo province. Indoor dwelling and outdoor temperatures were also analysed. Most participants perceived their dwellings to be too hot when it was hot outdoors. People relied on recommended heat health actions such as sitting outdoors in the shade or opening windows. While this agency is meaningful, resilience to climate change requires more than personal action. In light of the climate threats and climate-related disaster risks facing South Africa, an all-encompassing approach, including education campaigns, climate-proofed housing, access to basic services, and financial considerations that will help support resilient coping among South Africans is urgently required.

Keywords

adaptation, climate change, coping, environmental health, global warming, heat, multisystemic resilience

Recently, the Intergovernmental Panel on Climate Change (IPCC) launched their Sixth Assessment Report synthesising the latest evidence on climate change and related human health impacts (IPCC, 2021). Among these impacts, the climate change toll on mental health is of growing concern (Clayton et al., 2021). A major climate change threat is global heating or rising temperatures. Temperature affects a person's thermal comfort and subsequently impacts quality of life (QoL) and mental health (Thompson et al., 2018). QoL, which evades many South Africans (Møller, 2013), is best explained as subjective satisfaction with life (Moons et al., 2006). Increasingly, there are calls to support people to develop resilience to the negative impacts of rising temperatures (e.g., dissatisfaction with life) and other climate change effects

(Brown & Westaway, 2011; Masten et al., 2021), with emphasis on psychologists' role in developing that resilience (Stringer, 2022).

Historically, resilience science has emphasized the role of psychological strengths in people's capacity to experience positive outcomes (e.g., QoL) even though they are exposed to threats (e.g., rising temperatures). For example, people's psychological capacity to regulate their behaviour/emotion, solve problems, or take enabling action has long been emphasised in accounts of why and how people adjust well to significant stress (Masten, 2015). Currently, however, resilience theorists are unequivocal that psychological resources cannot fully account for resilience. Social, institutional, and ecological resources (e.g., supportive families, accessible mental health services, quality housing, and green spaces) are as important as psychological ones (Masten et al., 2021; Ungar & Theron, 2020). In other words, resilience is rooted in multisystem resources. To illustrate, recent studies of resilience to rising temperatures have reported the importance of social and ecological resources (e.g., community education, heat stress resistant buildings, and urban parks) along with psychological coping skills (Aram et al., 2020; Hatvani et al., 2016). People are often motivated to use ecological resources (such as parks) when they have companions who do so with them (Chen & Ng, 2012).

The World Health Organization (WHO) Housing and Health Guidelines (WHO, 2018) drew together data from multiple systematic reviews to provide recommendations for managing indoor dwelling temperatures. The guidelines emphasise actions to take when it is hot, including keeping dwellings cool, keeping out of the heat, and keeping the body cool and hydrated, helping others and seeking medical care if necessary (WHO, 2022). Multisystemic resources are implicit in these actions (i.e., personal agency, social interaction, institutional supports/services, and environmental resources).

Increasing temperatures and South Africa

In South Africa, temperatures are expected to warm more than the global projected mean temperature (Engelbrecht et al., 2015; Engelbrecht & Monteiro, 2021). Some parts of the country will experience drying and other parts will become wetter, and the certainties for ‘by how much’ and ‘exactly where’ remain, in part, debated or unknown, hence preparedness and resilience are key. To understand adaptation requirements, we need to know how communities perceive their current situations related to global heating. If we are to support human resilience to heating, we also need to understand what community members perceive as constraining and enabling of that resilience (e.g., what resources are available to support behavioural coping with heat).

Several studies in Africa have explored communities’ and households’ perceptions of risks related to climate change. However, these studies have typically not considered heat impacts on QoL, particularly thermal comfort in their dwellings. In Zimbabwe, for instance, participants recognised hazards arising from meteorological and hydrological causes, but did not make the link between such hazards and climate change (Ncube & Tawodzera, 2019). In South Africa, rural people living in Vhembe, Limpopo province, identified erratic rainfall, extreme temperature, extreme droughts and flooding as climatic events in their community (Ofoegbu et al., 2016). However, the connection between these events and the threat they pose to their forest-based livelihoods was not perceived. In Agincourt, Mpumalanga, interviewees reported that temperatures, especially summertime temperatures, had been rising over the past years and health effects from the heat were considered apparent, more so in relation to morbidity than mortality (Mayuchi et al., 2022). Rankoana (2016) considered community perceptions of climate variation (temperature and rainfall) and their ability to adapt to protect the production of subsistence crops. Another study considered workers' perceptions of heat risks and behavioural coping mechanisms in occupational settings (Wright et al., 2017). Typically, study participants used clothing to cover exposed skin and portable shade to eliminate heat and bright light to try and keep cool.

Except for the previously mentioned study that considered coping mechanisms, there has been no focused attention to what enables human resilience to rising temperatures in the South African context. This inattention, as well as related gaps in understandings of what might support South Africans to show resilience to heating and other climate change effects, is particularly worrying, given that the vast majority of South Africans are challenged by structural violence (Tshishonga, 2019). Typically, structural violence obstructs people's access to the social, economic, and environmental resources that are fundamental to coping resiliently with climate change threats, including rising temperatures. Key among these in the South African context are social protection (including employment), housing and infrastructure, and education (Ataguba et al., 2015). In the absence of completed schooling, quality housing, and other resources, South Africans could struggle to implement the WHO recommended strategies to manage heat, including keeping dwellings cool, keeping out of the heat, and keeping the body cool and hydrated (WHO, 2022). Put differently, their resilience to heat impacts is likely to be jeopardised by the inaccessibility of multisystem resources.

The current study

The current study seeks to redress the inattention to how South Africans are coping resiliently with rising temperatures. To that end, we investigated perceptions related to indoor and outdoor temperature in a sample of adults from one structurally disadvantaged community in Limpopo province and investigated how they responded adaptively to thermal discomfort. The research objectives were to investigate individuals' perceptions of the thermal comfort of their dwelling and secondly, to explore what individuals did to cope with thermal discomfort. In line with the multisystemic resilience theory (Masten et al., 2021; Ungar & Theron, 2020), the possible responses suggested for coping mechanisms included social and ecological resources (e.g., electrical cooling devices; shady trees). Given that ecological resources (e.g., green spaces or reliable electricity to power cooling devices) are often more readily available to people who are financially better off (Abbas et al., 2020; Mensah et al., 2016), we also asked households to report income levels. The data from this quantitative study provides baseline knowledge on perceptions of thermal comfort in dwellings and coping mechanisms related to heat among South Africans living in Limpopo province.

Methods

Participants

Participants were part of the environmental health, infectious Disease Early Warning System (iDEWS) study (Kapwata et al., 2018) that aimed to assess the prevalence of climate change-related diseases in rural villages in and around Giyani to inform the development of an early warning system for infectious diseases.

Instruments

Questions on perceptions of thermal comfort in dwellings and coping mechanisms for temperature, specifically heat, were extracted from the larger iDEWS study structured questionnaire. Participants were asked: 'When the weather is warm, how does the house feel indoors' (cooler than outside, same as outside or warmer than outside). They were also asked, 'During very hot weather, what do you do to cope?' The suggested responses were sleep; sit or lie on the floor indoors; sit under a tree or other shaded areas outdoors (not specified but either alone or with friends/family); use a fan; use an air conditioner; take a cold bath or shower; drink cold beverages; drink hot beverages; remove clothing; open windows; open doors; open curtains/blinds; switch off lights; wet your clothing; and/or swim. Multiple responses were possible.

Socio-demographic and economic questions included biological sex (male; female), population group (Black African, Coloured, Indian / Asian, White), and housing type (formal [i.e., typical Reconstruction and Development house (Nokulunga, Didi and Clinton, 2018)], informal dwelling, traditional dwelling [i.e., hut], and backyard dwelling [second dwelling on the plot of land]). Also, household income (No income, ZAR ≤ 1 000, ZAR 1 001 – ZAR 5 000, ZAR ≥ 5 001, Do not know) and presence (yes) or absence (no) of running water and flush toilet inside dwelling.

Temperature data

Hourly measurements for daily ambient temperature, humidity and wind speed data were obtained from the South African Weather Service (SAWS) for the monitoring station located in Giyani, Limpopo province. Data were provided from December 2016 to March 2017 in Microsoft Excel format. SAWS has procedures in place for data quality assurance and quality control. These include removing impossible values resulting from human error or instrument malfunction, outliers and duplicated values.

Temperatures inside the houses were recorded using LogTag temperature loggers in degrees Celsius (°C). The logger was placed in a room frequently used by household occupants and affixed to a wall or high piece of furniture with double-sided tape to minimise tampering and to be as unobtrusive as possible in the home. Data were recorded at one-hour intervals. Data were downloaded from the loggers' .txt files into Microsoft Excel. Before analysis, data were checked for inconsistencies where after data from all dwellings were merged into a single file for further analysis.

Procedures

The study was a cross-sectional survey of randomly selected households from four villages. The questionnaire survey was administered during the summer months in 2016 to 2017. Questionnaires were administered in Xitsonga following informed consent from the head of the household (18 years of age or older, hence child-headed households were not included).

Ethical considerations

Research ethics clearance was obtained from the South African Medical Research Council: iDEWS (EC005-3/2014).

Data analysis

We present and interpret the descriptive findings from the dwelling temperature perceptions and coping questions from the questionnaire. Temperature data are shown as a times series on a plot. To establish if there was a link between socio-economic conditions and fan and air conditioner use as cooling mechanisms, logistic regressions were performed to ascertain the effect of income on the likelihood that a household would use active cooling mechanisms for heat coping such as a fan or air conditioner to cope indoors in hot weather. These active mechanisms were included in the questionnaire since they are commonly recommended to cool indoor spaces (Morris et al., 2021). However, as they require that households have the resources (i.e., income, electricity) to apply them, we thought it an interesting relationship to consider here. Having no household income was the reference category in these analyses. STATA version 16 (Stata Corp, 2019) was used to analyse the data.

Results

Sample description

A description of the study participants is given in Table 1 and includes demographic and socio-economic variables. There were 406 participating households.

Table 1. Description of the study participants (N=406).

Variable	Frequency *n*	Frequency %
Sex		
Male	77	19
Female	329	81
Population group		
Black African	406	100
Coloured	0	0
Indian/Asian	0	0
White	0	0
Housing type		
Formal house	377	93
Informal dwelling	12	3
Traditional dwelling	16	4
Backyard dwelling	1	<1
Household income		
No income	121	30
ZAR ≤ 1 000	96	24
ZAR 1 001 – ZAR 5 000	100	24
ZAR ≥ 5 001	17	4
Do not know	72	18
Running water inside dwelling		
No	284	70
Yes	122	30
Flush toilet inside dwelling		
No	398	98
Yes	8	3

Questionnaire findings

About 75% of study participants reported that their house was as warm or warmer than outside (Table 2). Participants' most common coping mechanisms during hot weather were to sit outside under a tree or other shaded area outdoors (alone or in the company of others) or to open dwelling windows and / or doors. Similar numbers (n = ~160) of participants used fans and/or drank cold beverages.

Table 2. Participants' perceptions of how their house felt during warm weather and what coping mechanisms they used during very hot weather.

			Frequency	
	Question	Responses	*N*	%
Summer campaign	When the weather is warm, how does the house feel indoors?	Cooler than outside	107	26
		Same as outside	105	25
		Warmer than outside	196	48
	During very hot weather, what do you do to cope?	Sleep	42	10
		Sit or lie on the floor indoors	41	10
		Sit under a tree or other shaded areas outdoors	241	59
		Use a fan	161	39
		Use an air conditioner	17	4
		Take a cold bath or shower	138	34
		Drink cold beverages	168	41
		Drink hot beverages	7	2
		Remove clothing	80	20
		Open windows	220	54
		Open doors	116	28
		Open curtains / blinds	24	6
		Switch off lights	31	8
		Wet your clothing	2	<1
		Swim	1	<1

Temperatures recorded during the study period

The daily indoor and outdoor temperatures experienced by study participants during summer months in Giyani are shown in Figure 1. Outdoor temperatures reached beyond 40°C while indoor temperatures peaked at about 36°C.

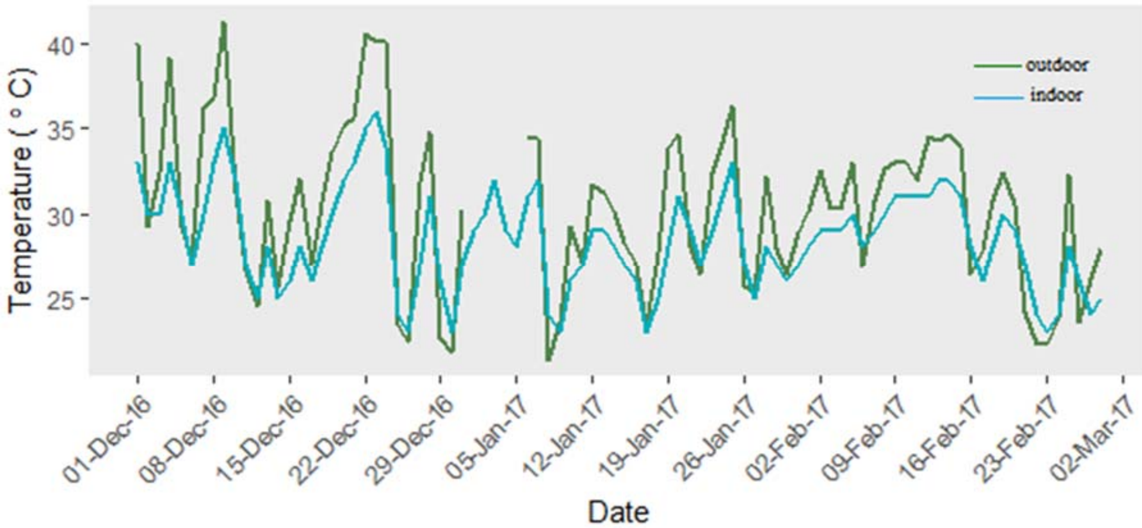

Figure 1. Daily indoor and outdoor temperatures recorded during summer months in the study area.

Relations between household income and active cooling mechanisms

Logistic regressions were performed to ascertain the effect of income on the likelihood that households would use a fan or air conditioner to cope in hot weather. Results showed that households with an income were more likely to use a fan during hot weather than those without income (OR = 1.97, 95% CI: 1.23 – 3.16, p = 0.005). Households with an income also had higher odds of using air conditioners (OR = 2.53, 95% CI = 0.71 – 9.07) although this was not statistically significant due to the low prevalence of air conditioner use among the study population (4%).

Discussion

We considered dwelling thermal comfort perceptions and coping mechanisms for temperature (heat) reported by a sample of adults from a structurally disadvantaged community in Limpopo. Our findings suggest that participants did not find their dwellings thermally comfortable. Seventy-three percent of households reported that their dwelling was either the same temperature as outdoors or warmer than the outdoor temperature. According to the outdoor and indoor temperature data, there were several days during the study period when indoor and outdoor temperatures were comparable. Therefore, the occupants of dwellings that experienced this dynamic had no reprieve from heat due to similar thermal conditions inside and outside the dwelling.

Our particular interest was in how households coped with heat. The most common adaptive responses were to sit under a tree or other shaded area outdoors (alone or in the company of others) or open dwelling windows. These actions, which were reported by just over half of the households, fit with the WHO Housing and Health Guidelines (WHO, 2018) and related recommendations for managing indoor dwelling temperatures (WHO, 2022). While participants in our study sought shady areas during hot weather, as recommended by the WHO (2022), their capacity to enact some of the other recommended actions to keep cool (e.g., 'spend 2-3 hours of the day in a cool place such as an air conditioned public building') was probably stymied by the structurally disadvantaged nature of their community and the quality of their housing (e.g., on very hot days, indoor temperatures were similar to outside ones). The fact that almost two thirds of the participating households did not report WHO-recommended actions such as staying hydrated/nourished or taking a cool shower/bath can be similarly linked to inequitable access to ecological resources. Access to water and food in some rural areas is difficult (Nhamo et al., 2018); services providing basic needs, such as clean water, do not always exist or supplies are unreliable (Lebek et al., 2021). In short, while our findings draw attention to household agency, they also show how that agency is limited by a lack of institutional and ecological resources.

In this context, vulnerable communities' adaptive capacity entails considering heat impacts within a broader context of societal conditions (Maller & Strengers, 2011). Put differently, building household resilience to heat impacts will require much more than recommending protective actions, such as those recommended by the WHO (2018, 2022). While people's capacity to take action (their agency) to manage heat exposure — as in our study — should be celebrated, it should also be sustained. To sustain that capacity will require attention to societal conditions and how they inhibit/enable access to resources across multiple systems. Relatedly, psychologists will need to advocate for infrastructure, green spaces, basic service delivery, policies, and other resources that are key to sustaining individual and collective coping behaviours (Aram et al., 2020; Hatvani et al., 2016). Such advocacy will be even more important if household agency to manage heat impacts is to be sustained in disadvantaged communities.

Further, psychologists can glean useful pointers about how best to champion resilience to global heating from multisystemic resilience theory and its emphasis on adaptive capacity's rootedness in multisystemic resources rather than only psychological ones (Masten et al., 2021; Ungar & Theron, 2020). For instance, in addition to strengthening psychological resources such as problem solving skills or self-regulation, psychologists can support/educate people to draw on social supports (e.g., neighbours who can keep them company when they sit outside to keep cool), institutional resources (e.g., health services), and ecological resources (e.g., shady areas) to cope well with heat. As part of this, it will be important to discover a household's social and cultural understandings of comfort and vulnerability, their practical knowledge about how to moderate heat stress, and accessible cooling technologies and practices that may help inform interventions that can be rolled out in similar communities. Teaching households to use simple mitigation strategies (e.g., opening windows early in the morning to allow cool air inside but closing them when it begins to get hot for the remainder of the day) can help keep indoor dwelling temperatures cooler. Teaching households to enact mitigation strategies in collaboration with other households is likely to support collective resilience to heat impacts, given that people are motivated to use resources that mitigate against heat impacts when others do so with them (Chen & Ng, 2012).

Limitations

These questions and responses from the iDEWS study were collated here and not presented elsewhere before. They were part of an epidemiological study that used a quantitative questionnaire and was not designed to interrogate qualitative aspects of heat exposure. The iDEWS study could have benefited from an in-depth qualitative research design to understand the motivations, ways of knowing, underlying drivers and barriers across multiple systems, and detailed coping mechanisms by which individuals in different physical and socio-economic environments were adapting to rising heat in their daily lives. Future environmental health surveys should strive to include a qualitative component. Other studies, such as Manyuchi et al. (2022) that include ethnographic observations and/or focus groups/interviews and case studies provide such qualitative data that are needed to understand heat adaptation strategies in different parts of South Africa.

The iDEWS study questionnaire did not include variables on dwelling characteristics such as roof type, floor type, etc., which was an oversight. These variables have since been used in other studies (for example, Teare et al., 2020). In terms of responses suggested for heat coping mechanisms, the iDEWS question did not explicitly include social resources (e.g., asking a neighbour for assistance; specifically stating sitting outside under a tree with a friend). Similarly, there was no explicit investigation of institutional supports (e.g., education campaigns about how to cope with heat; mental health services) or opportunity for participants to identify resources in the built or natural environment beyond their home/yard. Future studies should investigate these multisystemic resources and not limit participants to suggested responses (i.e., not only use closed ended questions with fixed response categories to understand heat adaptation among communities). It was also not possible to stratify participants by thermal comfort perception of dwelling and their selected coping mechanisms since participants could select more than one coping mechanism (out of a total of 15). In the future, it would be better to group coping mechanisms by category, e.g., social, ecological, etc.

Conclusion

In our study, we found that most people living in a structurally disadvantaged community perceived their dwellings to be too hot when it was hot outside. In other words, their homes offered too little respite. To compensate, people took adaptive action that relied predominantly on sitting in the shade or opening windows. While this agency is meaningful, resilience to climate change requires more than personal action. In light of the climate threats and climate-related disaster risks facing South Africa, an all-encompassing approach, including education campaigns, climate-proofed housing, access to basic services (including electricity), and financial considerations that will help support resilient coping among South Africans is urgently required.

Declaration of conflicting interests

It is hereby declared by the authors that there has been no involvement of any other person in this research, nor has there been the incentive of any financial or other advantages which may have influenced the outcomes of the study, both while the data were being collected or when the research document was being written.

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