

Technical Report

Everyday Life in Urban Heat:

A PHYSIO-ETHNOGRAPHIC HOUSEHOLD STUDY AND IMPLICATIONS FOR HEAT MANAGEMENT CHOICES

August 2026





Everyday Life in Urban Heat: A Physio-Ethnographic Household Study and Implications for Heat Management Choices

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EXECUTIVE SUMMARY

Heat has long been seen as the atmospheric backdrop of everyday life, rather than the subject of public discourse. However, the growing frequency of extreme heat events, induced by climate change, injects an urgency into the study of everyday heat. This report presents findings from Working Group 2 (WG2): Physio-Ethnographic Household Study, conducted under the project *Leveraging Shared Experience of Urban Heat and Bridging Spatial–Temporal Dissonance: Towards a Climate Resilient Citizenry* (CRC) in Singapore. Taking a novel ‘physio-ethnographic’ mixed-method approach, the study closely examines households’ lived experiences with everyday heat, situating households’ heat management practices in their socio-historical context and exploring the physiological implications of their cooling decisions.

Study Design and Scope

Data were collected from 39 households totalling 60 adult occupants across different age groups and residential typologies. The methodology included:

- Household and individual questionnaires capturing dwelling characteristics, individual lifestyle habits, preferences and health conditions, as well as climate attitudes.
- Environmental measurements recording objective indoor environment and microclimatic measurements (e.g., temperature, and relative humidity).
- Physiological measurements (e.g., heart rate, wrist temperature and gradient temperature between wrist and microclimate temperature) monitored through wrist-based wearables.
- Semi-structured interviews covering contemporary and historical thermal experiences and heat management practices.
- Thermal diaries and activity logs utilised to capture daily real-world heat management behaviours across a diverse range of locations and participant activities.

Key Findings

- Heat experiences are highly individual, contingent on multiple physiological, material and psychological factors operating on and across individual, household and societal scales.
- Households’ use of mechanical cooling strategies varied, influenced by their available materials, cultural meanings, and practical competencies. Householders compartmentalised their expectations of thermal comfort in different contexts; while such expectations remained stable from young, householders tended to exhibit practice changes at certain life milestones.
- Though households tended to rely on mechanical cooling strategies (fans and air conditioners), they blended them with a mix of non-mechanical strategies tied to everyday routines. Out of the range of strategies, fans were the most dominant, and most participants were unfamiliar with the more advanced features of their fans and air conditioners.
- Physiological responses were similar among heat management archetypes (AC; Fan; Fan+AC) during sleeping hours.
- Households generally did not problematise their heat management practices in the context of climate mitigation, but were open to reducing use provided that comfort was not compromised.

Implications for Policy and Design

- Close skill gaps in air conditioner and fan usage and promote energy-efficient cooling.
- Prioritise families, and time interventions to engage individuals undergoing major life transitions.
- Address over-reliance on air-conditioning by redesigning spaces to support alternative ways of cooling down and by promoting messaging that highlights heat's positive associations.

Contribution to the CRC Programme and Next Steps

The Physio-Ethnographic Household Study (WG2) generally reaffirmed, extended, and enriched the findings of the Population Household Study (WG1), while informing subsequent CRC work by offering deep and nuanced insights into the factors shaping householders' heat management practices:

- Citizen Dialogues (WG3): Guide the design of dialogues by identifying key knowledge, concerns, and adaptation gaps to be explored collectively.
- Co-Design Workshop and Field Experiments (WG4): Inform the design of targeted interventions.

Graphical Abstract

1. Study Design and Scope



39 households
60 participants

Multiple age groups &
housing typologies



Questionnaires



Environmental
measurements



Physiological
measurements



Semi-structured
interviews



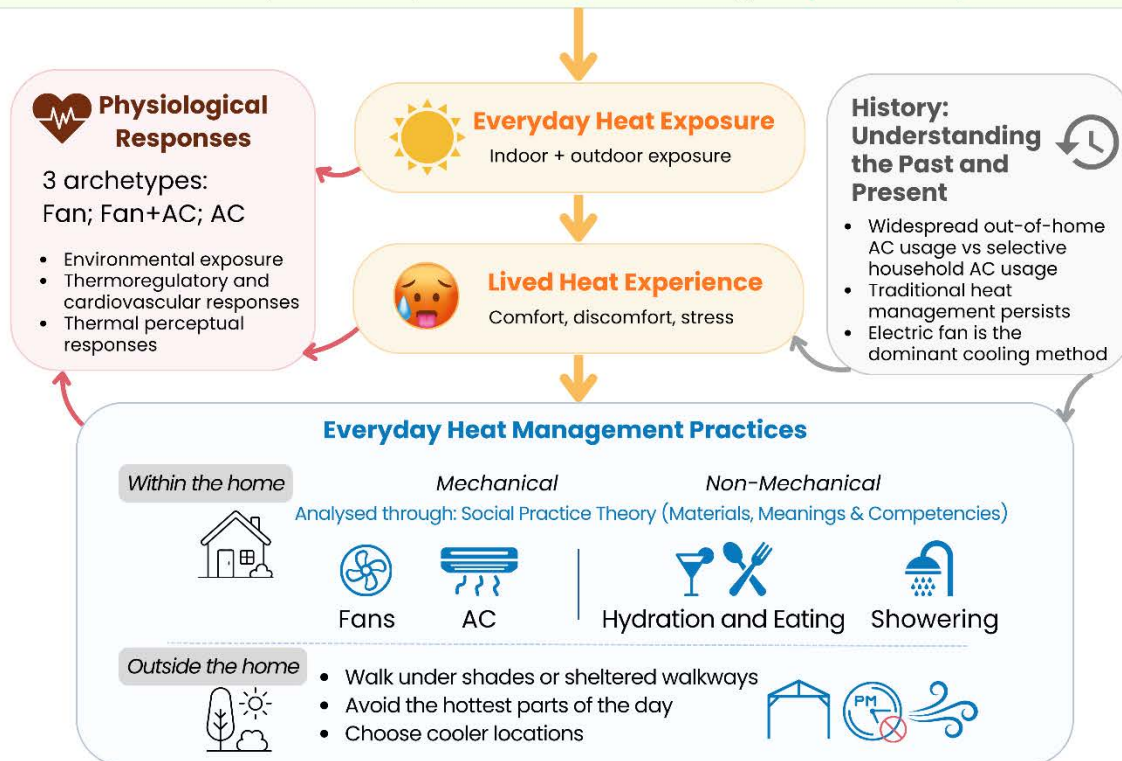
Thermal diaries
& activity logs

Physio-ethnographic mixed-method approach

2. Conceptual Framework

RQs

How do Singapore households **experience** urban heat, and enact **practices** in relation to these experiences?
How do these experiences and practices relate to climate-change **adaptation actions/choices**?



3. Key Findings

- Cooling strategies tend to be stable and moulded from young, but can change at specific milestones.
- Fans were the dominant cooling strategy but most participants were unfamiliar with the more advanced features of their ACs and fans.
- Physiological responses were similar among heat management archetypes during sleeping hours.

4. Implications for Policy

- Time interventions to engage individuals undergoing major life transitions.
- Close skill gaps in fan and AC usage and promote energy-efficient cooling (i.e. Fan+AC hybrid cooling).



Chapter 1

Introduction



1. Introduction

Rapid urbanisation and global warming intensify household heat stress, a growing health concern exacerbated by rising indoor temperatures and the limited adaptive capacity of lower-income and vulnerable groups (e.g., elderly, children, individuals with preexisting conditions). Despite these trends, tropical countries like Singapore have not been typically viewed as sites of concern for extreme heat stress due to their lack of extreme weather fluctuations (Dong et al., 2021; Macktoom et al., 2023). Studies on household heat stress have mostly investigated extreme summer weather conditions and vulnerable populations in temperate countries. These studies primarily report on the severity of heat stress by examining health indicators such as mortality and morbidity, as well as the characteristics of the built environment (D'Ippoliti et al., 2010; Guo et al., 2023; Loughnan et al., 2010; Patz et al., 2005; Smoyer-Tomic et al., 2003.; Wang et al., 2019). The rapid urbanisation of tropical countries and the impact of anthropogenic climate change have disrupted the stability in weather patterns: rising temperatures and frequent occurrences of prolonged periods of extreme heat (i.e. heat waves) are increasingly becoming the norm in the tropics (Frazier, 2019; Ober, 2023). This poses a grave concern, as escalating heat stress will impact all households, particularly in a rapidly aging Singapore where heat is often accepted as a normal part of daily life. This encourages a mindset shift towards actively understanding and managing heat, especially given the rising number of vulnerable individuals who will be exposed to rising heat stress at home.

Examining urban heat management necessitates a focus on household dwellers as actors who respond and adapt to heat stress daily. Conventional studies on heat stress have often adopted a public health perspective, typically framed within the context of emergency management and focused predominantly on morbidity and mortality rates. However, there has been a recent shift towards examining heat and health through on-the-ground circumstances rather than merely through statistical data, thereby bringing visibility to the often-invisible daily lived experiences of heat. Increasingly, scholarship on heat and health recognises the socially stratified nature of heat exposure, vulnerability, and adaptive capacity.

This study (Working Group 2, WG2) is one of four WGs of the Climate Resilient Citizenry (CRC) programme. CRC aims to investigate how households in Singapore experience, perceive and act on climate change in various contexts. Specifically, due to the ubiquitous year-round experience of heat in Singapore, CRC seeks to investigate how the immediate reality of urban heat can be utilised to drive and sustain significant climate engagement. To fulfil this mandate, there is a need to build a fundamental understanding of lived household experiences of heat in Singapore, and the ways in which such experiences intersect with Singaporean understandings and experiences of climate change and urban warming. As such, WG2 drew on a mixed-method approach to bridge this gap and attain a multifaceted and multidisciplinary understanding of household heat in Singapore.

Mixed-method approaches have emerged as a significant means of acquiring multifaceted understandings of household heat experiences and heat adaptation strategies. Our study aligns with quantitative-qualitative mixed-method approaches. Generally, this approach aims to balance the in-depth, 'on-the-ground' data required to engage with personal and social factors often neglected by purely quantitative research, with the integration of physiological temperature sensors, and standardised perceptual tools (e.g., ASHRAE thermal sensation, satisfaction, and preference scales). This allows researchers to get a rich sense of individual thermal experiences, behavioural responses, and physiological insight of personal and household heat, moving beyond traditional emergency management and large-scale quantitative public health studies.



In addition, such approaches are also augmented by demographic surveys and structured focus group, ethnography, and oral history interview sessions to garner quantitative and qualitative data which are broad in scope and targeted in terms of the identification of relevant problems, challenges and behaviours (De Vet et al., 2013; Loughnan et al., 2014; Loughnan et al., 2015; Kemen et al., 2021; Milando et al., 2022).

Specifically, the study employed a novel ‘physio-ethnography’ mixed-method approach that concurrently captured the thermal profile of households through both physiological and environmental measures and deeply explored their thermal culture through ethnographic and historical lenses. By replicating this approach across household units, we aimed to generate rich, contextualised insights and more generalisable patterns to enable the development of robust, culturally relevant, and evidence-based policy principles and solutions within the health domain.

Individual physiological profiling of household members using quantitative methods could provide insights into their heat exposure and thermal perception of the environment through their physiological responses (Nazarian & Lee, 2021). Under heat stress, the body attempts to regulate internal temperature via autonomic (e.g., vasodilation, sweating, etc.) and behavioural (e.g., turning on air conditioner) responses (Schlader et al., 2010). Such responses are triggered at discrete elevations in mean skin or body core temperatures (Gagnon & Kenny, 2012). The changes in skin temperature further attributed as the main signal that influences thermal perception in a behaviourally unrestricted setting, which in turn initiates thermoregulatory behaviours (Cabanac, 1971; Cabanac et al., 1971; Mower, 1976; Schlader et al., 2009). In addition to physiological profiling, both ethnography and oral history provide us with the appropriate qualitative tools to highlight their heat management agency, particularly to examine everyday experiences and means of managing extreme heat and varying weather conditions (Oppermann et al., 2018, 2020; Strengers & Maller, 2017). Insights from social practice theory (SPT), including the ways in which weather-related practice memories and histories ‘are materially carried [and employed] by the body’, were used to shape the semi-structured interview questions (Strengers & Maller, 2017). We have also used SPT as a key lens to analyse the interview data in the ethnographic and history sections of this period.

Accordingly, this technical report addresses the following research questions (RQ):

RQ1: How do Singapore households experience urban heat, and enact practices in relation to these experiences?

RQ2: How do these experiences and practices relate to climate-change mitigation actions/choices?

This technical report outlines the findings emerging from a mixed-methods approach, which integrates physiological monitoring, ethnographic interviews and observations, and historical analysis. By synthesising these distinct data streams, we provide a comprehensive overview of how residents experience, adapt to, and perceive heat within the Singaporean context. Specifically, the ethnographic data highlights the diversity of heat management practices in Singapore and explores the nuances undergirding household level heat management, while the physiological data gives us insight into the individual physiological implications of householders’ cooling decisions. The historical analysis deepens and contextualises these findings within the evolution of Singapore’s housing and industrial histories since 1965. Finally, this report integrates the findings from all three pillars to develop multidimensional implications and recommendations, providing a holistic framework for strengthening climate change resilience in Singapore.



Chapter 2

Methodology



2. Methodology

2.1 Study Participants

39 households, totalling 60 adult occupants, were recruited for this study. Participants were recruited to represent a diverse range of residential types, including: (a) one- to two-room Housing & Development Board (HDB) flats; (b) three-room HDB flats; (c) four-room HDB flats; (d) five-room HDB flats; and (e) condominium and executive condominium apartments.

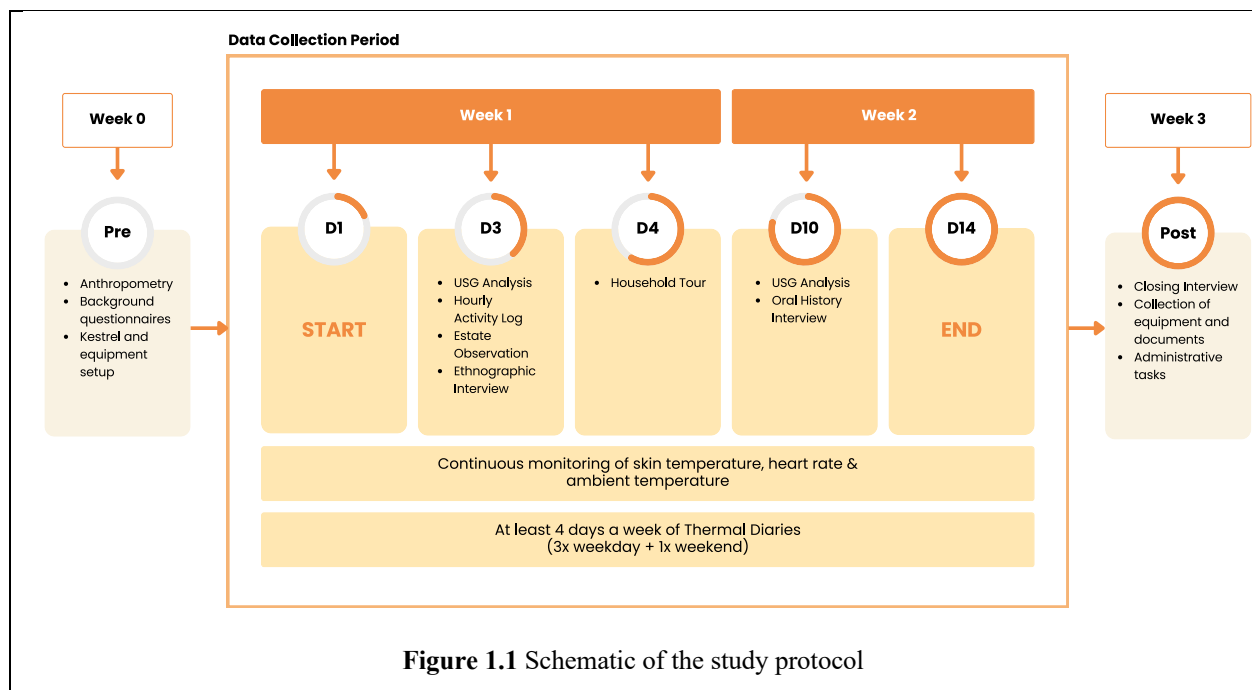
Two criteria were used to select regions for participant recruitment: (1) the classification of regions as having higher or lower heat stress and (2) the age of the public housing estates/new towns. Regions were classified based on the Urban Heat Vulnerability Analysis conducted by Philipp and Chow (2020), who designated four regions in Singapore as areas of higher heat stress, and two as areas of lower heat stress. Areas of higher heat stress (characterised by higher temperatures during the day and night) include the northern region (Sembawang and Yishun), eastern region (e.g., Pasir Ris and Tampines), northeastern region (e.g., Sengkang and Punggol) and eastern part of the central region or central-east (e.g., Marine Parade, Geylang and Kallang). Conversely, areas of lower heat stress (characterised by lower temperatures during the day and night) include the western region (e.g., Jurong West, Choa Chu Kang, and Bukit Panjang) and western part of the central region or central-west (e.g., Bukit Merah, Queenstown and Tanglin). Out of these regions, we selected the northeast, central-east, central-west and western regions of Singapore to recruit participants. We also ensured that a mix of households were recruited from older and newer estates within each region. “Newer” referred to estates in the northeastern and western regions of Singapore which were built from the 1990s onwards and the 1980s to 1990s respectively. “Older” referred to estates in the central-east and central-west regions of Singapore which were built in the 1960s to 1970s and 1950s to 1970s respectively.

Photographs, audio recordings and video recordings were taken during various components of the research study. Participants were informed that these photographs and recordings would be de-identified (via censoring or redaction) if they were used for any form of presentation, publication or sharing. Participants consented to be photographed and video- and audio-recorded when participating in the study. Failure to give consent resulted in exclusion from the study.

2.2 Research Approach and Data Collection Protocol

There were nine components to the profiling protocol for each individual household (Figure 1.1). They include:

1. Setting up environmental meters, anthropometry, and issuing of wrist-based wearables
2. Administration of background questionnaire
3. Thermal reflection diary entries and urine colour chart completed at least 4 times a week across 2 weeks
4. Continuous 14-day physiological monitoring through wrist-based wearables
5. A 12-hour rapid physio-ethnography session (on a weekday) and urine specific gravity analysis
6. A household tour
7. Urine specific gravity analysis and oral history interview
8. Collection of wrist-based wearables and environmental meters
9. Closing unstructured interview and administration



Participants were required to complete all nine components of the protocol (Components 1 to 9). The details of each component are as follows:

(1) Setting Up Environmental Meters, Anthropometry, and Issuing of Wrist-Based Wearables (Day 1; D1-X). Environmental conditions of up to two most commonly used rooms (as determined by the participants) was recorded using an environmental meter (Kestrel 5000/5400 Environmental Meter, Nielsen-Kellerman, Boothwyn, PA, USA). General wind direction in the room was determined by the researcher using a wind vane prior to placement of the environmental meters.

The height and weight of each participant were measured using a stadiometer (or equivalent) and a digital weighing scale (or equivalent) respectively.

Each participant was issued a Fitbit watch (Fitbit Sense, Fitbit Inc., San Francisco, CA, USA) which had iButton thermistors (iButtons, Maxim Integrated Products, Inc., Sunnyvale, CA, USA) affixed onto the watch strap via a harness. The iButtons were used to collect wrist temperature and microclimate temperature and relative humidity (Nazarian et al., 2021). Participants were required to wear these watches from D1 to D14.

(2) Administration of Background Questionnaire (D1-X). Participants were required to complete background questionnaires. For households that had two participants, the first part of the questionnaire was answered together; and the second part of the questionnaire was answered individually. The questionnaires collected basic information about the participants and their house from four perspectives: (i) socio-economic demographics; (ii) built environment; (iii) medical and physical activity; and (iv) climate change knowledge and behaviours.

(3) Thermal Reflection Diary Entries and Urine Colour Chart (D1 to D14). Participants were required to complete a thermal reflection diary in either hard or soft copy during the 14-day profiling period. They were required to complete at least 8 diary entries at a frequency of four times a week over the 14-day (two week) profiling period, with minimally 3 weekdays and 1 weekend entry per week. For each diary entry, participants were asked to indicate their physical location, attire and thermal comfort three times daily (morning, afternoon, and evening). Thermal comfort was rated using a modified ASHRAE thermal comfort scale (ASHRAE Standard 55-2023), which included a 9-point scale for thermal sensation, a 7-point scale for thermal satisfaction, and a 3-point scale for thermal preference. Participants were then required to reflect on their overall thermal experiences in the evening. This included a log of the major activities that raised their thermal discomfort levels, and a reflection on their thermal comfort experiences. A list of activity prompts was provided to assist the participants in their reflections.

Accompanying the thermal diary entries were an assessment of their hydration status via a urine colour chart. On the same days those participants submitted an entry of thermal reflection diary, they were required to collect their mid-stream urine sample between 4 pm and 8 pm to better understand their hydration status. Urine sample bottles and a urine colour chart (Kostelnik et al., 2021) were provided to participants, and participants were asked to compare and report the corresponding letter that best depicted their urine colour in the thermal reflection diary. To ensure that participants were familiar with the diary entry processes, they were required to make diary entries on D1 and D2, with feedback provided by the researchers. A total of 1,416 entries were collected throughout the study, with 24 entries recorded per participant.

(4) 14-Day Physiological and Environmental Monitoring through Wrist-Based Wearable and Environmental Data Logger (D1 to D14). Participants were required to wear the Fitbit watches equipped with iButtons from D1 to D14 continuously (24 hours per day). Participants were reminded to charge their assigned Fitbit watches to full battery capacity every 4 days. Researchers downloaded data from the Fitbit watches and iButtons at each touch point with the participants. Participants were advised to remove their Fitbit watches before bathing, swimming or any water activities, and wear it as soon as possible (~30mins after). Microclimate temperature (T_{micro}), wrist temperature (T_{wrist}), microclimate relative humidity (RH_{micro}), heart rate (HR), and sleep data were continuously monitored at 20-minute intervals over a 14-day period. A total of 398 hours of T_{micro} , T_{wrist} , and RH_{micro} were recorded. HR measurements were observed over 363 hours, with an average of 12 ± 3 nighttime sleep cycles detected per participant.

In addition to physiological monitoring, environmental readings encompassing ambient temperature, relative humidity, and wind speed were continuously recorded every 20 minutes in the participants' hallways and bedrooms from Day 1 to Day 14. A total of 398 hours of ambient meteorological data (temperature, relative humidity, and wind speed) were observed throughout the 14-day study period.

(5) 12-Hour Rapid Physio-Ethnography Session (D3). The day of the rapid physio-ethnography session was arranged based on the participants' schedule. This session was done at least 2 days from D1 to ensure sufficient information was available for the interview sessions. This session comprised three parts:

A. Urine Specific Gravity Analysis and Activity Log

Participants were told to collect a mid-stream urine sample during 4pm to 8pm to represent general hydration status throughout the day, and proceed to document or report their self-reported hydration status using the urine colour chart; the same urine sample was used by researchers to measure urine specific gravity using a refractometer (Pen-Urine S.G, ATAGO, Japan). A total of 59 urine samples were tested on Day 3 throughout the study period. In addition, participants collected and rated 16 independent urine samples using a colour chart to self-assess their hydration status on Day 3.

Participants were briefed on the activity log that they were required to fill throughout the 12 hours of profiling. A total of 804 hours of data, averaging 13 hours per participant, was collected from the activity log throughout the study. Participants were tasked to document their (i) location, (ii) activity, (iii) thermal sensation (9-point scale), (iv) thermal satisfaction (7-point scale), (v) thermal preference (3-point scale), and (vi) attire in one-hour intervals. Depending on their preferences, both online and hardcopy versions of the activity log were available. The activity log provided data with greater resolution, which supplemented continuous physiological data and personal environmental heat exposure data.

Participants were also asked to identify some of the areas around the neighbourhood that they may go to for respite from the heat or to aid them in cooling down.

B. Semi-Structured Interview

This session took place in the evening after working hours, and lasted up to 2 hours. For households that had two participants, both took part in the same interview. Audio-recording was captured via a Dictaphone. A total of 39 sessions, totalling 43 hours of ethnographic interviews, were obtained throughout the study period. Researchers conducted the interviews using an interview guide, supplementing questions with data from the background questionnaire, participants' thermal reflection diary entries on D1 and D2, and the

activity log. Findings collected from this interview session were used to refine the approach for the household tour (Component 6).

C. Estate Observations

Researchers conducted ground observations of (1) the space located just outside the household; (2) the apartment block that the household was in; (3) neighbouring apartment blocks and its environment; and (4) neighbourhood or estate and its environment. The aim of the estate observations was to get an understanding of the thermal and materials contexts of the profiled household's neighbourhood. This included a descriptive account of the proximity and extent of shaded spaces in comparison to non-shaded spaces, as well as the accessibility of shaded or cool spaces near the profiled household. Photographs and videos (GoPro Hero 8/9/11, GoPro Inc., San Mateo, CA, USA) were taken to collect visual data of the neighbourhood's thermal context. A thermal imaging camera (FLIR One Pro, Teledyne FLIR LLC, Wilsonville, OR, USA) was used during the tour to capture the surface temperature of various objects of interest.

(6) Household Tour (D4). This session took place in the evening of D4. The day of the household tour was scheduled based on the participants' preferred time. For households that had two participants, both took part in the same household tour. The session was recorded with a video camera, along with the use of a Dictaphone. A thermal imaging camera was used during the tour to capture the surface temperature of various objects of interest.

An interview guide was used to facilitate the household tour, where the participants explained their heat experiences and practices in sensorial terms. A total of 39 sessions, including 47 hours of household tour interviews, were conducted throughout the study period. These household tour interviews required a memory recall, demonstration, and walkabouts around the house (and possibly the surrounding areas of the house and the block) to give the researchers a sense of their daily experiences and practices. The household tour was informed by the findings from the 12-hour rapid ethnography session and the daily diary entries from D1 to D2.

(7) Urine Specific Gravity Analysis and Oral History Interview (D10). The same protocol was used to measure the urine specific gravity as outlined in Component (5)A on D10. A total of 60 urine samples were tested during D10 throughout the study period. The oral history interview took place on the same evening. The session took up to 2 hours. For households that had two participants, both took part in the same interview. The session took place in the participants' house. A Dictaphone was used to audio-record the session. A total of 39 sessions, comprising 55 hours of oral history interviews, were conducted throughout the study period. As this session required substantial memory recall, participants were provided with a summary of the questions on beforehand and were advised to think through and prepare. Participants were encouraged to go through any personal collections that could yield interesting documents or artefacts that could serve as evidence in support of their past and present heat experiences and practices (e.g., photographs of their old house and cooling methods). Photographs of these documents or artefacts were taken. As with the semi-structured interviews on D3, the research team presented a scrapbook of images containing a variety of practices relating to domestic and non-domestic cooling in Singapore, as well as historic settlements (urban, rural, and squatter estates) from the 1960s to the 2020s (i.e. since Singapore's independence) for the oral history interviews. The memory scrapbook was presented in three sections according to the seven decades (i.e. 1950s to 1960s, 1970s to 2000s, and 2010s onwards). Each section

contained images on cooling practices and settlements in Singapore that were meant to represent that time period. The scrapbook was used by the researchers to prompt the participants when they were attempting to recall their experiences and practices.

Researchers improvised questions on the spot according to the participants' answers. Information gathered from the previous profiling sessions and diary entries were used to enhance the quality of the interview questions during the session. Participants could skip questions if they felt uncomfortable.

(8) Collection of Wrist-Based Wearables and Environmental Meters (D14+X). Upon the completion of at least 14 days of continuous physiological monitoring, and the continuous recording of the environmental conditions in their house, arrangements were made for the researchers to collect the wrist-based wearables and environmental meters from their home.

(9) Closing Unstructured Interview and Administration (D14+X). Where required, a closing unstructured interview session was conducted with the participants. The purpose of the interview was to clarify any questions or interpretive issues that may have arisen from the various sources of information which were collected from the participants (i.e. thermal reflection diary entries, interview sessions etc). The interview was audio-recorded through a Dictaphone. A total of 22 sessions, comprising 2 hours of closing interviews, were conducted throughout the study period.

2.3 Ethical Procedures and Consent

The study procedures were approved by the National University of Singapore Institutional Review Board (NUS-IRB-2024-80) in accordance with the Declaration of Helsinki. All experimental procedures and possible risks were explained to each participant before obtaining their written informed consent. Participants 65 years old and above were asked some questions to assess their understanding of the research study prior to them signing the consent form.

2.4 Reporting Approach

The findings from our study were synthesised across four interconnected sections. The first section provides a descriptive overview of the study sample, encompassing participant demographics, socioeconomic status, and residential characteristics; geospatial distribution and household energy consumption patterns; and the environmental conditions recorded across the 14-day monitoring period. This contextual foundation establishes the physical and social landscape within which heat management behaviours were observed. The subsequent three sections then present the core analytical findings across ethnographic, physiological, and historical dimensions respectively. Each dimension provides an in depth understanding of heat management approaches and adaptive strategies within its particular interpretive lens.

The ethnographic analysis examines what, why, and when people adopt specific cooling approaches in everyday life, offering insight into the behavioural and cultural dimensions of thermal adaptation. The physiological analysis presents the body's responses to different heat management strategies, with particular focus on physiological recovery during sleep. Finally, the historical analysis elaborates on how past experiences and influences shape the way people choose and maintain certain cooling measures throughout their lives. Together, this multi-dimensional analytical approach reveals the underlying mechanisms, dynamic interactions, and everyday responses that characterise heat mitigation choices in free-living environments.



Chapter 3

Sample Description

3. Sample Description

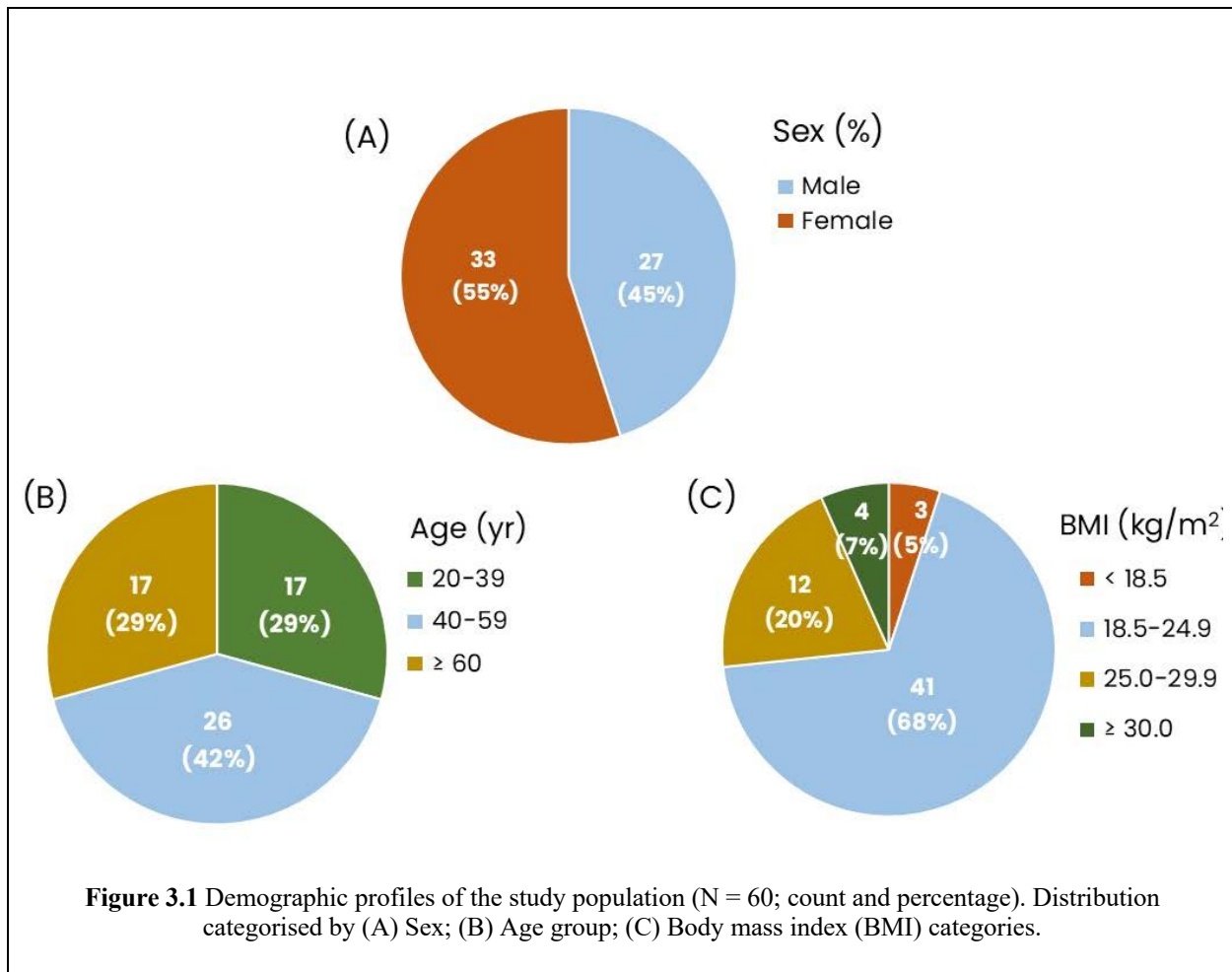
This section establishes a comprehensive profile of participant characteristics, acknowledging the influence of demographic factors such as age, gender, socioeconomic status, and specific residential typologies on individuals' heat experiences and management strategies. Describing and attending to the geospatial distribution of these households also allows us to better define the baseline environmental exposures experienced by residents within the tropical urban context of Singapore.

3.1 Section Highlights

- Data collection was conducted over a one-year period from July 2024 to June 2025.
 - A total of 60 adult participants (27 males and 33 females) from 39 middle-income Singaporean households were recruited for this study.
 - The study population had an age of 48 ± 3 years and a body mass index of 23.4 ± 4.2 kg/m² (in mean $\pm$ standard deviation).
 - Participants represented a diverse range of educational backgrounds and residential locations, with the majority residing in identified high-heat-stress areas across Singapore.
-

3.2 Demographics, Socioeconomic Status, and Residential Types

The demographic characteristics of a total 39 households, comprising the 60 participants, are summarised in Figure 3.1. The recruited participants consisted of slightly more females than males (Figure 3.1 A). The largest age group were middle-aged participants (40-59 years), while the younger (20-39 years) and older (≥ 60 years) age groups were equally represented (Figure 3.1 B). Among the participants with available body mass index (BMI) data, the majority were within the normal weight range, with smaller proportions classified as overweight or obese (Figure 3.1 C).



The socioeconomic characteristics of the participants are presented in Figure 3.2. The majority of households reported a monthly household income between SGD 3,000 and under SGD 13,000 (Figure 3.2 A). In terms of the highest level of education attained, nearly half of the participants held a bachelor's degree, and an additional 16% had completed a postgraduate degree (Figure 3.2 B). The most common housing types were 4-room and 5-room HDB flats, which each accounted for 30% of the participants (Figure 3.2 C).

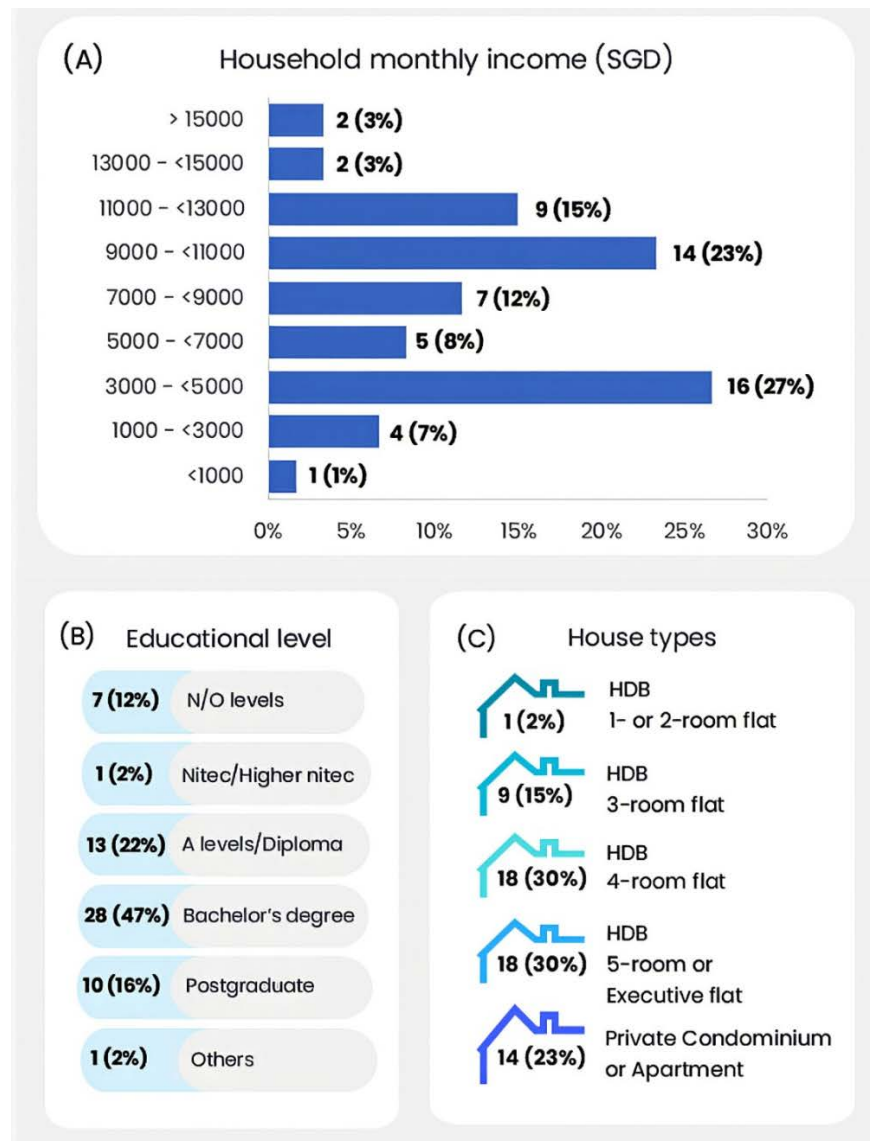
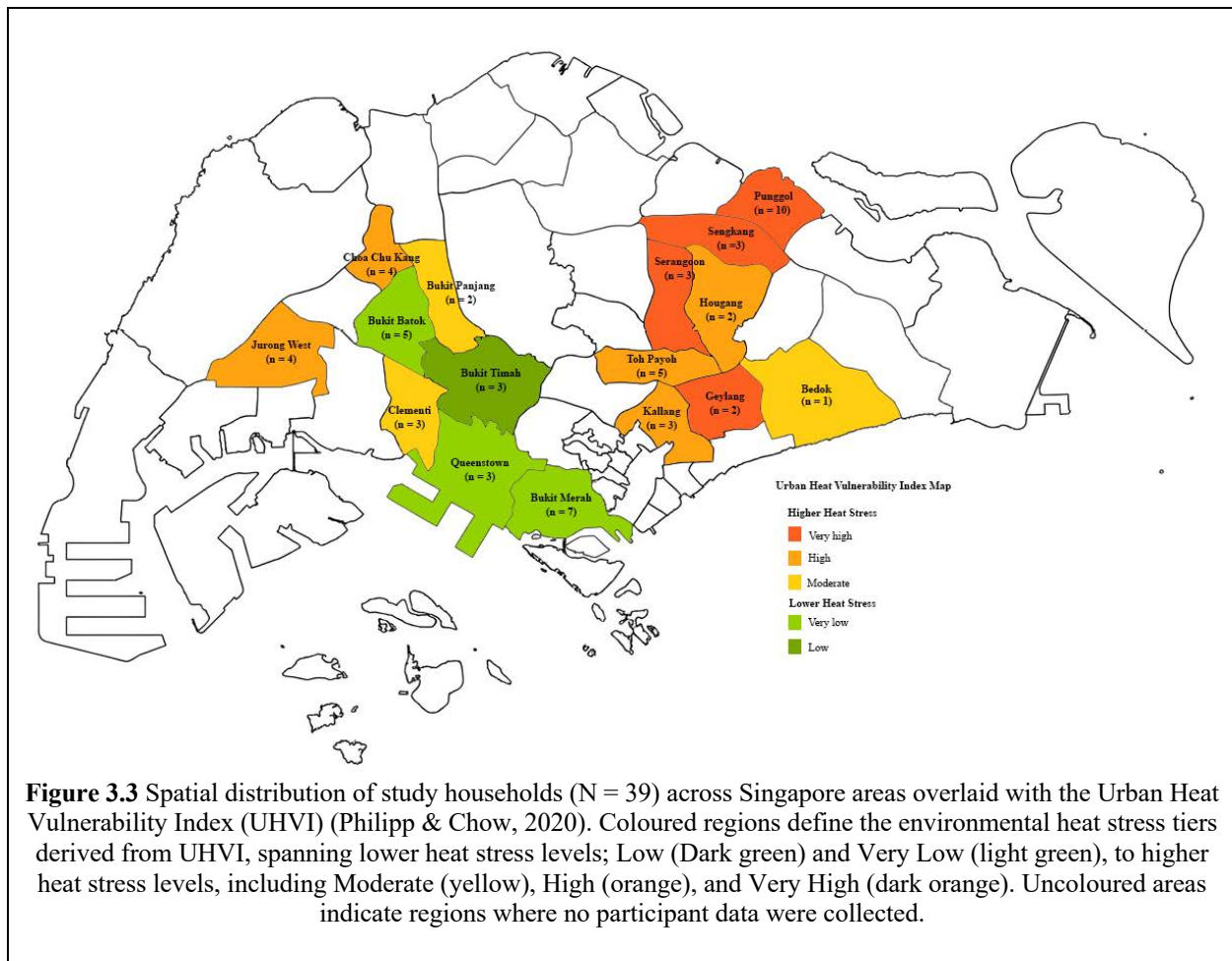


Figure 3.2 Socioeconomic profiles of the study population (N = 60; count and percentage). Distribution of participants categorised by (A) Household monthly income; (B) Highest level of education attained; (C) Residential housing types, distinguishing between various Housing & Development Board (HDB) flat sizes and private accommodations.

3.3 Geospatial Distribution and Household Energy Consumption

Participants were categorised into regions of higher or lower heat stress defined based on the findings of the ‘Urban Heat Vulnerability Analysis for Singapore D 2.4 – Vulnerability Map’ report (Philipp & Chow, 2020). The geographical distribution of the 60 participants is shown in Figure 3.3 (refer to section 2.1 for a description of the higher and lower heat stress regions). A majority of participants ($n=42$, 70%) resided in areas designated with higher heat stress (moderate to high heat stress regions in the Urban Heat Vulnerable Index Map), with the largest concentration found in Punggol ($n=10$), located in the northeast. The remaining participants ($n=18$, 30%), categorised under lower heat stress, were located in the central-west and west regions, with Bukit Merah ($n=7$) being the most represented area in this group.



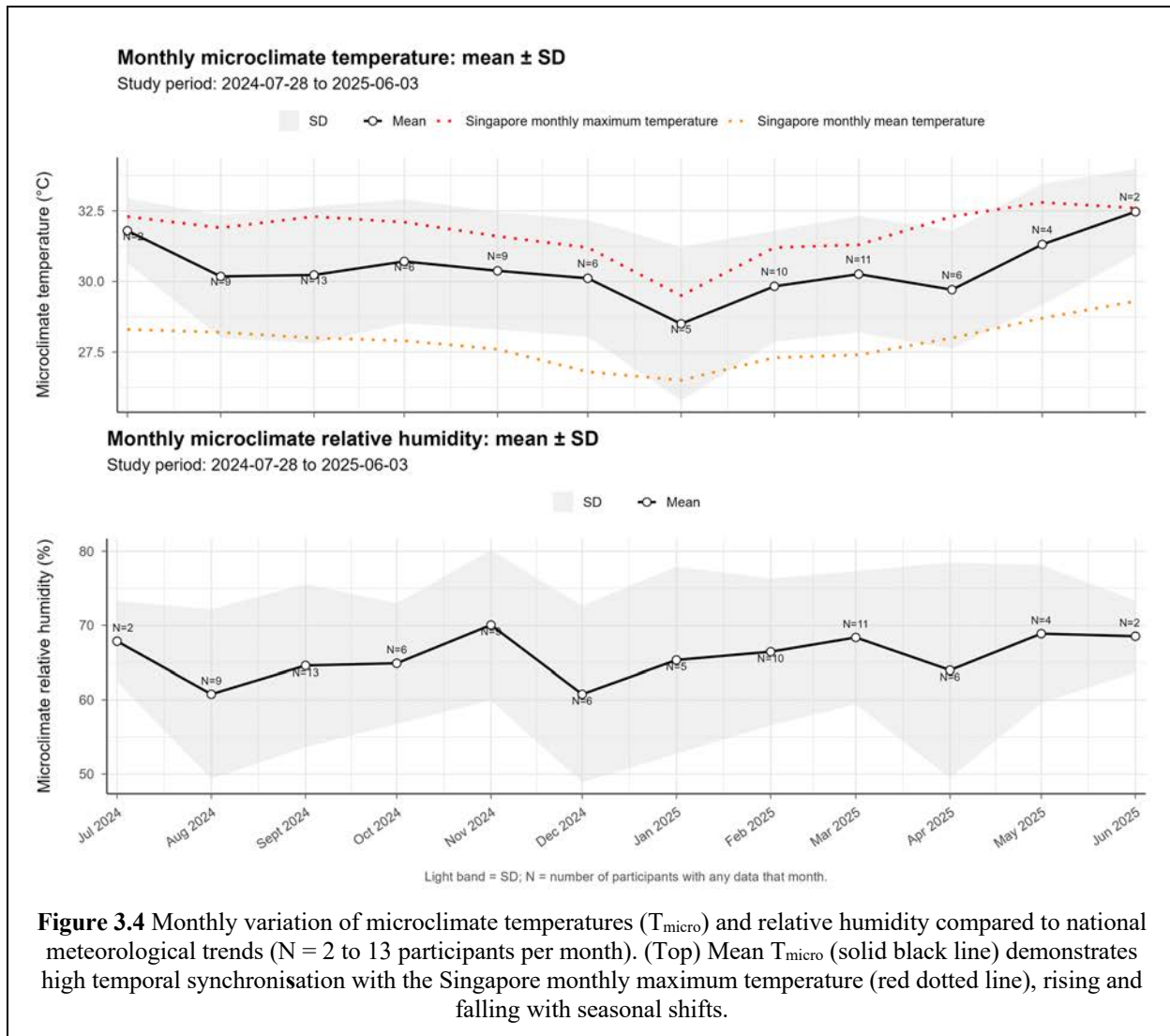
In terms of household energy consumption, air-conditioning use varied widely: 15% reported no air conditioner usage, 35% indicated low use (occasional, non-daily use based on specific needs), 38% reported medium use (daily use, primarily at night while sleeping), and 12% reported high use (extensive daily use, including daytime hours), suggesting that while cooling is common, most households do not rely on air-conditioning intensively. Consistent with this pattern, monthly utility bills (inclusive of water, electricity and gas) clustered in the mid ranges, with 45% of households spending SGD 100 to 200 and 32% households spending SGD 200 to 300, compared with 11% of households spending SGD 50 to 100 and 12% of households spending SGD 300 or more monthly. To contextualise these observed distributions against national baselines, we drew upon official household consumption data released by the Ministry of Sustainability and the Environment (2025). According to this official dataset, the average monthly utility expenditure stood at approximately SGD 180 for a 4-room flat and SGD 215 for a 5-room flat. The heavy concentration of our participants within the combined SGD 100 to 300 brackets (accounting for 77% of the cohort) and 4- to 5-room HDB flat categories aligns with these official benchmarks, demonstrating that our sample's utility consumption reflects broader national averages.

3.4 Environmental Conditions Across 14-Days

Data collection spanned from July 2024 to June 2025, capturing a full annual cycle of Singapore's tropical climate. During this period, monthly average microclimate temperature (T_{micro}) was recorded by iButton Hygrochron loggers (Maxim Integrated, San Jose, CA, USA), which were secured to Fitbit wrist-based wearables (Fitbit LLC, San Francisco, CA, USA) via custom 3D-printed harnesses (Nazarian & Lee, 2021). These T_{micro} values ranged from 28.2°C in January 2025 to 32.2°C in June 2025 (Figure 3.4). While these personal temperature readings generally followed the natural seasonal changes of the island, specific periods demonstrated a notable separation from outdoor trends. For instance, in August 2024, September 2024, and April 2025, the average T_{micro} remained significantly lower than the reported Singapore monthly maximum temperatures. In April 2025 specifically, the T_{micro} decreased compared to the previous month, even though official outdoor temperatures were rising. This suggests that during these warmer periods, participants likely spent more time in climate-controlled indoor environments or air-conditioned (AC) spaces.

The accuracy of the iButton sensors was established by comparing them against official Singapore weather station data (Annual Climate Report: Meteorological Service Singapore, 2023). Analysis revealed a regular difference, or bias, of +2.59°C. This temperature bias could have been a result of metabolic heat radiation and the microclimate created by clothing. Even in cases of light clothing (e.g., short sleeves), the body radiates heat into the immediate boundary layer, while the garment further stabilises a warm microclimate around the sensor (Kwon & Choi, 2013). Despite this predictable difference, the sensors demonstrated a strong connection to official weather trends. Because the personal readings rose and fell with the outdoor environment variation for most of the year, the data indicates that weather was the primary factor affecting the heat load experienced by participants.

The dips in T_{micro} during August, September, and April highlighted a distinct divergence between T_{micro} and ambient temperature. In these months, participants' microclimate temperatures did not rise alongside the peak outdoor temperatures, suggesting that indoor sheltering or mechanical cooling successfully shielded participants from the external heat extremes. This interpretation is further supported by the relative humidity (RH) levels, which averaged between 60% and 70% but showed higher variability during these same months (Figure 3.4). While factors such as insulative clothing or occasional air-conditioning use may introduce localised noise into the data, the overall alignment confirms that the sensors captured a realistic mix of both natural heat exposure and the cooling behaviours used to manage it.





Chapter 4

Ethnography: Understanding Heat Management at the Individual and Practice Level



4. Ethnography: Understanding Heat Management at the Individual and Practice Level

What do Singaporeans normally do, in their homes, offices and neighbourhoods, to deal with the heat, and how do they do it? Which strategies are more common in Singapore society, and why? Understanding the answers to these questions is a crucial first step toward the promotion of more sustainable heat management strategies. After all, we cannot hope to nudge Singaporeans into cooling more sustainably without a baseline understanding of their everyday practices.

As our interest lies in shared practices across society, we adopted Shove et al. (2012)'s Social Practice Theory (SPT) as our main analytical framework. The theory conceptualises social practices as composed of three elements: materials, competencies and meanings. According to Shove's (2012) framework, materials denote the tangible objects, technologies, and infrastructures used for a given practice; competencies denote the skills and knowledge required by that practice; and meanings denote the symbols, ideas, and aspirations that underlie it. SPT is most apt for our purposes as it focuses on practices as the primary unit of analysis and aims to account for their stability and change. By decentring the individual, SPT is shackled to neither structural nor agentic explanations of how people are recruited into performing a certain practice (Mesenhöller, 2025). This enables SPT to do justice to the recursive relationship between individuals and the social structures in which they live (ibid.).

While SPT can, in broad strokes, account for why certain heat management practices are more prevalent and persistent, and is therefore the main framework with which we conducted this analysis, we side with Hess (2018)'s broad contention that SPT cannot fully account for "individual or sub-group variations in the performance of collectively shared practices" (p. 184), particularly in the context of heat management. We argue that this is because heat is a deeply personal experience that is mediated by one's physiology and psychology.

This section is broadly structured in two parts. First, we synthesise data from all three interview types to paint in broad strokes the most common heat management practices found among our participants, before using the SPT framework to account for their prevalence. Second, we outline how individual subjectivities influence one's heat experiences and how these subjectivities not only account for differences in heat management practices between individuals, but also across an individual's life over time. Analyses on whether participants factored climate change into their heat management practices can be found in the Appendix.

4.1 Section Highlights

- Participants tend to rely on mechanical (or active) cooling strategies and prefer to cool down at home rather than outdoors or even in their immediate vicinity.
 - Heat is a deeply personal experience; heat attitudes are fluid, contextual and specific.
 - Cooling strategies tend to be stable and moulded from young, but can change at specific milestones.
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4.2 How do Singaporeans Generally Manage Heat

Heat Management Practices Within the Home

Our participants generally considered their homes to be the premier place to return to and cool down, reflecting general social expectations that the home should be a place of comfort and rest. Rather than travelling outdoors, even to communal spaces in their immediate vicinity, most participants reported that they would relocate to cooler spots in their home. Within the home, their strategies can be broadly classified into mechanical and non-mechanical strategies.

Mechanical Heat Management Strategies

Within the home, the most common (and intuitive) heat management practice was the use of mechanical appliances such as fans and air conditioners. During the daytime, most participants reported using stand, wall or ceiling fans to manage indoor heat. Most participants' use of appliances was sensitive to the time of year. During cooler periods in the year, most reported lowering their fan speeds or increasing the temperature settings on their air conditioners as the weather did not warrant significant cooling. A minority of participants reported habitually leaving their fan and air conditioner settings unchanged regardless of the season, suggesting that appliances were generally used on an as-needed basis. Compared to ceiling- and wall-mounted fans, participants were more flexible with their use of stand and table fans, as their portability enabled participants to redirect airflow to different parts of their home or bodies. Participants also differed in their levels of comfort to direct air exposure, with some reporting symptoms such as migraines when exposed to direct "wind" (e.g., CRC35), and others being fine with the experience.

Notwithstanding a few participants who relied on air-conditioning as their main cooling strategy, daytime use of air conditioning was typically reserved for select occasions, such as for activities that require greater mental concentration (e.g., working and studying) and periods of intolerably hot and humid weather. Across households, air conditioning was more commonly used at night to ensure quality sleep, sealing rooms and bodies away from unwanted elements such as heat, noise, dust and insects. Participants differed in how they used their air conditioners. Among the 45 participants who used their air conditioner for any duration on hotter nights, 16 reported running their units throughout the full duration of their sleep. The remaining 29 set timers, interrupted their sleep to switch off their air-conditioner, or engaged in pre-cooling, where they used their air conditioner for only a few hours before switching to the fan to save electricity. Participants who generally used air conditioning while sleeping set their temperature settings to a mean of 24.8°C (median = 24.5°C). The number of participants who reported relying solely on fans or natural ventilation for sleeping more than doubled from 15 on hotter nights to 39 on cooler nights, implying that participants used air-conditioning pragmatically, adjusting their nighttime cooling method based on actual thermal conditions. In the subsequent section on physiology, we explore the physiological implications of participants' predominant heat management strategies, segmenting them into three archetypes distinguished by their primary cooling mode at night.

Non-Mechanical Heat Management Strategies

Participants also described a variety of non-mechanical heat management practices, mostly built around existing routines. Here, we focus on hydration and eating, and showering.

Hydration and Eating

Hydration was a universal cooling practice across participants, with individual differences arising from beverage choice (plain water; carbonated or sweetened drinks; Traditional Chinese Medicine (TCM) teas and beverage temperature (hot, lukewarm, or cold). In tropical Singapore, where chilled beverages are ubiquitous, the widespread preference for lukewarm or room temperature water is particularly interesting. We explore this finding in greater detail in Section 4.3, examining the rationale behind these preferences.

Nearly 40% of our participants adhered to standard hydration recommendations, with 20% drinking exactly 8 cups (2000ml), and 19% drinking more than 8 cups (> 2000ml) a day. In contrast, 4% of participants disliked drinking water, consuming only 1–2 cups daily. Although this group represented a minority, the reasons for their aversion were still of interest, as they could highlight barriers to proper hydration. Regarding beverage temperature, participants can be broadly divided into two groups: 13 preferred hydrating with cold water, and 47 opted for warm or hot water. Those who favoured cold or ice water offered various reasons for their preference, with some consuming cold water for immediate relief from tropical weather, and others consuming water out of habit. Other participants were staunchly against consuming warm or hot water out of personal preference. This included CRC03B, whose preference was so strong that she continued to drink cold water during menstruation, despite acknowledging that TCM advised against doing so. Similarly, CRC19 consumed cold water out of personal preference, even when he felt cool. Participants' rationales for drinking cold water can be categorised into immediate environmental adaptations and behavioural habits. For many, the habit of drinking cold water began as a functional coping mechanism for the tropical weather. Over time, this repeated sensation of relief solidified into a deeply ingrained habit, where the preference for cold water becomes automatic.

Majority of participants (47) were staunchly against consuming iced or cold water, preferring instead to cool themselves down by consuming hot, lukewarm or room-temperature water. Participants who were averse to drinking cold water were further grouped into three camps according to their rationale. The first group denoted participants who were regular TCM users. These participants avoided drinking cold water in accordance with TCM, which holds that cold water disrupts *Qi* and bodily balance. The second group comprised participants who eschewed cold water, not because they were regular TCM users, but because they had habitually consumed lukewarm or hot water since childhood. Many of these habits stemmed from their upbringing; their parents, subscribing to the TCM belief that cold water is deleterious to health, instilled these practices in them from young. Consequently, their habits reflect a long-standing childhood preference rather than a commitment to TCM, illustrating how practices can be transmitted intergenerationally, even when the knowledge and beliefs underlying the original practice are lost.

CRC09 (ET)	We don't take cold water. We just have normal water, that's like a normal thing, which we do. In the morning when we wake up, we tend to have hot water. Yeah, that's something my father taught me, actually. He said, you should have hot water. It's good for your body in the morning, passing your motions and everything.
CRC25 (ET)	But actually I don't really learn from the TCM about this... [N]aturally, I prefer to drink warm water. Because I know it's not good. Because when your body very hot you have the heat. It's no good to drink cold water. Just imagine something hot you pour cold water. The thing will steam. So it's bad for health.

The final group denoted participants who, despite drinking cold or iced water in their youth, began to avoid it as they aged due to personal illness, embodied experience, or TCM advice. This group attests to the fluidity and dynamism of practices, with individual practitioners abandoning old practices when their underlying meanings—in this case, the idea that cold water does not have an impact on human health—no longer resonate.

CRC08B (ET)	Since young, I guess I drink cold water, but I don't know since when lukewarm, but I guess I read somewhere two years back that it's not good to drink cold water.
CRC32 (ET)	I don't really buy into that (TCM). But it's over time I skewed to agree with the Chinese belief in that aspect because I do see that the symptoms of cramp reduce if I stop drinking cold water. And I felt that my body circulation is probably better because my palms get warmer compared to the days when younger. As a child after PE exercise you always go for cold water and then water cooler and everything. Right then I feel that my palms are actually cooler so I don't feel that the circulation is as good.

Showering

Showering as a cooling practice was often allied to the use of fans—unlike air conditioners, fans did not prevent participants from perspiring when exerting themselves, prompting participants to shower or wipe themselves down to avoid feelings of stickiness and discomfort. In turn, participants who primarily relied on fans for cooling generally had a higher frequency of showering compared to their peers. As with hydration and consumption habits, there was no consensus among participants on which practice—in this case, shower temperature, was most effective for cooling down. Some participants subscribed to the belief that showering in warm or hot water was more salubrious; others believed that showering in cold water cools the body down faster.

Heat Management Practices Outside the Home

Most participants did not travel outside the home for the sole purpose of cooling down, as the home environment was generally deemed comfortable and well-furnished enough to avoid making an additional effort. Some participants also noted the hassle and time-cost of doing so.

CRC10B (HT)	I think it's still generally okay. Yeah, it's still tolerable. So for me myself, I don't really go out my way to go like shopping malls to cool down. Normally I just take a shower at home because it's more convenient than going out.
CRC11 (HT)	...[T]he other reason is I have a comfortable space with a good temperature that I can chill at home. So I don't see a need to chill outside.
CRC33A (HT)	Whatever just to escape the heat? Yeah, no. Because to the time span and then the journey to make it there, I think. Right. So anyway, to move with a family of five.

Participants reported having to practice heat management more strategically when removed from the comforts of the home. During commutes outdoors, participants optimised their travel routes to minimise exposure to direct sun. Where walking was unavoidable, most participants took advantage of Singapore’s urban infrastructure—walking under sheltered walkways or in the shadows of HDB blocks—to shelter from direct sun exposure. If such infrastructure was lacking, some participants reported carrying umbrellas, handkerchiefs or handheld fans on their person, though others preferred to endure the heat if exposure was short-lived. A few participants who took showers as a cooling strategy at home adapted to a lack of shower facilities outdoors by wiping or dousing themselves with water in public restrooms. When scheduling outings and outdoor recreational activities, participants often avoided the hottest parts of the day or chose locations they perceived as cooler to moderate heat exposure. Participants also responded to changing environmental conditions in real time, postponing activities if the heat was too unbearable.

In contrast to open-air environments, cooling often became less intentional in public and indoor spaces such as shopping malls, public libraries and train stations, as participants ceded their cooling agency to centralised systems that catered to the thermal preferences of the majority. Some participants thus reported being “incidentally” cooled when going about their regular routines.

CRC07 (ET)	No lah, if a place has to be aircon, right. Let's say for example a public place, let's say library has to be aircon anyway. Right. So but I say I don't go to these places just because of the aircon. But I mean I go wherever the weather is basically because you know, I need to go there to do something.
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For the handful of participants who left home deliberately to cool down, most did so to access air-conditioning that—whether by choice or circumstance—they lacked or chose not to use at home. For instance, participants CRC05A, CRC13, CRC19 and CRC31 mentioned that on hot days, they would travel to nearby shopping malls and libraries for air-conditioning. Similarly, CRC14A and CRC14B opted to take their children to Punggol Plaza and the nearby integrated lifestyle and community centre, One Punggol, for public air-conditioning, rather than running their home air conditioner all day. However, SC14A noted that this “urgency” to leave the house abates during cooler periods, as “you can just chill at the house” (ET).

Open-air communal spaces (e.g., corridors, benches and void decks) were rarely mentioned as places participants deliberately went to cool down, functioning more as temporary stopovers for rest rather than destinations in themselves. For instance, clarifying her daughter’s comment that she would sometimes sit on a bench at her bus stop to cool down, CRC05A mentioned that she would not “go purposely to do that” and that she herself did not notice how often she does so, quipping to her daughter, “see how many times I do la” (HT). Most participants denied that they used void decks for cooling—some because their blocks lacked public furniture and seating areas, but more commonly because the idea had never occurred to them; their homes were comfortable enough.

CRC18 (HT)	No, never [stayed at the void deck] for the cooling purpose. Because my house is just upstairs. I just go up. I mean...Corridor? No, I don't really go to the corridor and do anything. Yeah, don't have.
CRC19 (HT)	No. Yeah. Not something that I would do.
CRC33A (HT)	If it's the daytime, it's not that cool even outside.

Only two participants—both from the same household—reported using public spaces in their immediate vicinity, either currently or in the past, to cool down. During her childhood in the 1970s, CRC15B recalled congregating after dinner in a large open space in the corridor near the lift lobby, partly to socialise with her neighbours.

CRC15B (OH) on her childhood in Bukit Merah	So we have. So in the evening we like to go out. There's a common corridor, right? That's what we oversee then next to us there's a big, big space. I think maybe at least this big, you know, like a common space. Right... So yeah, everybody would go there. It comes like a gathering after dinner.
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However, at the time of the household tour, CRC15B no longer frequented public spaces within or near her block to cool down. When asked about other heat management strategies, CRC15B haltingly suggested that her husband would go down to the void deck in the evenings. CRC15A, however, confirmed that his primary reason for visiting the void deck was to smoke, and any cooling he felt was merely incidental.

CRC15B (OH)	I think like evening, for example, I think it might be a bit cooler outside. That's why you walk the dog, take a longer walk. I think he [CRC15A] goes down and smoke like one hour or two hours, wondering where did he go?
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The general tendency of participants to eschew open-air communal spaces in their immediate vicinity in favour of private, indoor spaces reflects broader societal shifts, both in Singapore and abroad. Across the globe, the rapid diffusion of mechanical cooling appliances such as electric fans and air-conditioners in domestic spaces diminished individuals' reliance on natural ventilation, shifting cooling from a communal to an individual activity (Guan, 2025; Courtney, 2023; Kobi, 2024). Meanwhile, modern notions of what it meant to be a good neighbour have shifted away from more intensive modes of neighbouring to one that was characterised by arms-length, 'hi/bye' relations, where neighbours respect each other's space and keep to themselves rather than frequent communal spaces (Nallari & Poorthuis, 2022).

Corridors and void decks, once sites for social life, are thus recast as liminal spaces that one merely passes through rather than spaces people actively turn to for refuge against the heat.

Outside the home, participants' hydration practices depended on personal effects such as water bottles as well as networks of private establishments and communal spaces where participants could access or purchase plain water or drinks. A third of participants shared that they carry water bottles habitually whenever they left the house. Those who refilled their bottles outside did so at water coolers found in public spaces such as community centres and sports halls (CRC37), as well as semi-communal spaces like schools (CRC13, CRC20B, CRC27B), offices (CRC12B, CRC30A), and convention centres (CRC10B). There was no consistent pattern to the places where participants purchased their drinks outdoors. Some bought them at convenience stores (CRC01B), small "mama" shops, hawker centres, and larger sit-down establishments such as Starbucks and IKEA (CRC31). Roughly equal numbers of participants shared that they stayed hydrated by buying drinks and by using public sources (e.g., water coolers or tap water), indicating that public hydration resources were not utilised to their fullest potential. For instance, though tap water was entirely potable across the island, only five participants reported that they would drink straight from the tap when outdoors:

CRC01A (HT)	Then I'll bring iced water out. If I carry. If I don't carry, then I just drink from the toilet tap.
CRC15B (HT)	Then I rather. Actually, between water cooler, I rather go tap, actually. I think the tap taste better...Even if it's like a toilet. Nicer toilet in the mall.
CRC31 (HT)	No, tap water everywhere. So as long as you have toilet, it's okay. You just remember some of the country you can't drink.

Most other participants did not consider tap water to be a viable hydration source when outdoors, preferring to tap on dedicated water coolers or purchase bottled drinks to quench their thirst. Despite this disconnect between participants' preferences and the near universal availability of potable water in public spaces, participants generally related that staying hydrated outdoors was not particularly challenging to achieve. In other words, most participants could satisfy their hydration needs with the current network of public and private infrastructure and did not problematise the consumption of bottled or canned drinks, even if doing so was more resource-intensive than drinking plain water straight from the tap.

4.3 Heat Management as a Social Practice

According to SPT, practices are animated and sustained by the integration of materials, meanings and competencies. Once a practice gains enough traction among a multitude of practitioners, it becomes taken as the norm across individuals, households, and society at large. However, practices are dynamic, receding when the connections that sustain them are severed with new ones taking their place. In the following subsections, we apply SPT to account for the three most common practices identified in the earlier section: switching on the fan, turning on the air conditioner and hydrating in various fashions. We discuss what makes these strategies so reflexive and effortlessly natural in recent decades, when in recent memory, it was more common to exclusively rely on passive forms of cooling such as natural ventilation.

Materials

In this sub-section, we focus our attention on the materials undergirding hydration and the usage of both fans and air conditioners, outlining how contemporary heat management practices are shaped by changes in the built environment and household furnishings. These changes will also be explored in Section 6: History.

Materials Undergirding Fan and Air Conditioner Usage

Part of the reason why mechanical cooling has become the dominant cooling strategy for most households is that ownership of these appliances has become more accessible for the average household. As disposable incomes rose and manufacturing costs fell, appliances such as fans and wall-mounted air conditioners became more affordable. Ownership of these conveniences steadily became more commonplace. According to the 1981 HDB Household Survey, as cited in Chang (2022), 85.2% of HDB households owned an electric fan. Almost two decades later, the air conditioner would become a household staple – according to the Household Expenditure Survey 2023, 81.9% of resident households owned an air conditioner (Department of Statistics, 2024).

Reflecting these social trends, almost all households possessed at least a wall-mounted air conditioner and electric fan, with households owning an average of 1.6 electric fans and 1.2 air-conditioning units per household member. There were a couple of routes by which participants came to own an electric fan or an air conditioner. Most commonly, participants made a conscious decision to purchase or install the appliance themselves. A few, however, reported that their appliances were inherited from their apartment's previous owners, attesting to the normalisation of mechanical cooling across Singaporean households. The most extreme example of this phenomenon was SC17A and SC17B's household. Even though SC17A and SC17B rarely use air-conditioning, to the extent that SC17B declared that "regardless of day or weekends. we don't use [air-conditioning] at all" (ET), the couple owned four air conditioners, one in their living room and the rest in their three remaining rooms.

As the succeeding Section 6: History argues, ownership alone is not predictive of future air conditioner dependence. However, material and environmental factors relating to the structure, design and geography of their homes and neighbourhoods can make the use of mechanical cooling solutions feel like an inevitability. At the household level, participants living in apartments with an east–west orientation reported experiencing greater levels of heat. These participants were generally more likely to compensate with mechanical cooling. For instance, during their household tour, CRC33A lamented that their master bedroom wall was directly exposed to the sun throughout the day, radiating so much heat into the night that they felt the need to pre-cool the bedroom before sleeping.

CRC33A (ET)	So that whole wall will retain heat. In fact [during] the evening the heat retention will be higher because that's when you've been absorbing all energy from... So we attempt to on the aircon earlier ...
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The floor of residence had a nuanced effect on participants' heat exposure. On the one hand, participants living on the highest floor tended to benefit from strong winds while also receiving the most sun exposure; on the other hand, those on lower floors generally had fewer issues with direct sun exposure but received less airflow. Several participants observed that their homes were not particularly designed with natural

ventilation in mind, locking them into using mechanical cooling to cool their homes. This was the case for CRC01A and CRC01B, whose building developers designed their block with awning windows that did not admit much wind into their unit, leading CRC01A to comment that the window is “quite useless [in] the way [it] is designed” (HT).

Neighbourhood characteristics can also impact the amount of heat and airflow an apartment receives. Participants who currently or previously lived in denser estates—for instance, CRC04—reported feeling “enclosed” by the urban environment. This is because surrounding buildings emit heat while blocking natural airflow, necessitating the use of mechanical cooling. CRC04’s thermal discomfort was so palpable that he described “living in the wrong, badly designed old HDB precinct” as a “misfortune,” warning that “you get very little natural ventilation” (OH). Neighbourhood density can also impact the amount of ventilation a household receives by influencing their lifestyle habits. Many participants shared that they kept their windows closed to compensate for a lack of privacy and to keep out negative externalities arising from dense urban living, namely noise, dust, pests such as mosquitos and urban wildlife such as pigeons. However, doing so seals off natural ventilation, creating stifling conditions that necessitate mechanical cooling. This trade-off between natural ventilation and managing urban externalities was often more stark at night, as participants had lower tolerance for any disturbances—noise, rain or mosquitoes—that could rouse them from sleep. This explains why participants such as CRC09, who ordinarily favoured natural ventilation, felt compelled to use air-conditioning in the night and justified his use as a necessity:

CRC09 (ET)	No, because I shut everything. I don't feel anything in the night, which is not the right thing, to be honest, because you should be exposed to the natural environment. But unfortunately, I can't do it. And the residents have also felt the same because they all like to keep the windows open. They can't because of the noise which comes in from there... Yeah, it's very very disruptive. Some of them have even called the police also but nothing has happened. So, yeah, it's because it's just way too noisy.
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Materials Undergirding Hydration Practices

As with mechanical cooling, participants’ hydration practices were shaped by the advent of consumer durables such as refrigerators and domestic water dispensers, which enabled participants to control their beverage temperature. Nearly a third of households reported owning a domestic water dispenser, enabling instant access to warm or cold water, though among these participants, more used their dispensers for warm rather than cold water to make beverages such as tea or hot milo. All households owned at least one refrigerator, consistent with the Household Expenditure Survey 2023, which reported ownership rates of 98.2% among resident households (Department of Statistics, 2024). Even though all households owned a refrigerator, only half reported having ready access to ice cubes.

Participants’ hydration practices at home were also enabled by beverage packaging technology. Households reported stocking their fridges with a diverse range of drinks, including canned carbonated drinks (CRC13, CRC14AB); milk (CRC14AB); and cooling herbal drinks or teas like coconut water, green tea and/or chrysanthemum tea (CRC08AB, CRC12AB, CRC30AB). Participants who consumed traditional cooling drinks such as 凉茶 (herbal tea), barley water, 罗汉果 (monk fruit tea), chrysanthemum tea, 羚羊水 (tea made from the horn of the Saiga antelope), and 白花蛇草 (Oldenlandia drink) generally reported that they purchased these drinks in ready-made bottles from Chinese medical halls. Only one participant, CRC36A,

reported that she brewed barley tea themselves at home. Among households, the practice of stocking the refrigerator with pre-packaged drinks (e.g., coconut water and carbonated drinks) was slightly more common (12 participants) than storing chilled plain water (9 participants), probably because participants with water dispensers had another way of accessing cold water.

Meanings

Meanings act as a “unifying glue” motivating practitioners to bind different materials and competencies together in the performance of a practice. In this section, we endeavour to untangle some of the meanings underpinning hydration, fan usage and air-conditioning. For brevity, we limit our discussion to the most salient meanings as well as any other interesting findings.

Meanings Underlying “Heat”

Though accepted as a geographical reality in Singapore, heat itself was generally viewed by participants as an undesirable experience. A majority associated heat with discomfort, variously describing their recent heat experiences as “terrible” (CRC02B, CRC29A and CRC39A), “frustrating” (CRC02B, CRC13, CRC21B, CRC27A and CRC34), “irritating” (CRC02A, CRC11, CRC29B, CRC31, CRC33A, and CRC38) and “demotivating” (CRC07 and CRC18). Some likened the feeling of direct sun exposure on their skin to a “burning” sensation, while others described heat as something to “hide” or “escape” from.

Sweating, the bodily response to heat, was also evaluated as an undesirable experience by most participants, not just because it might exacerbate skin conditions such as eczema, but also because its presence went against social norms that a clean and presentable body was one free from sweat and odour, and not one that was, in CRC21B’s words, “sweating like a pig” (ET). In keeping with these social norms, most participants reported showering, dousing themselves with water, or wiping themselves with a handkerchief upon encountering perspiration. CRC32, a former sales professional, mentioned that she would keep a spare change of clothes in her car and showered in between client appointments to keep perspiration at bay (OH). For CRC38, perspiration meant that she had to forgo wearing make-up as “it’s all gone by the hour” (ET). This dissonance between her desires and the practical constraints imposed by the weather partially explains her “[hatred]” of the heat in Singapore. Here, heat and sweat were not merely sensory irritants; they also represented limits on self-expression some participants sought to project.

A minority of participants, however, had a positive view of heat. Some, including CRC12B, CRC17B, CRC27B and CRC37, traced their positive attitudes to a personal preference for warmer environments, with CRC27B describing herself in the ethnographic interview as preferring to sleep in the “Sahara Desert” in contrast to her husband and child, who were more partial to cooler environments. CRC15A and CRC17A’s perspectives went further by challenging conventional perspectives that heat is a negative experience. To CRC17A, heat was preferable to the cold as “it’s easier to deal with”, and even served as a motivating force, “[encouraging] him me to go out and run sometimes” (ET). Likewise, CRC15A’s positive attitude towards the heat stemmed from his view that in Singapore, heat and by extension perspiration was natural—essentially a “part of living in Singapore”—and this quality made perspiration “good in a sense” (ET). Positive views towards heat were not unconditional, with participants often switching their stance once their ‘goldilocks’ zone for heat tolerance had been breached. For instance, CRC27B shared that she could not withstand direct sun exposure in the afternoon in Singapore, and that in such situations she would “chiong or like rush through so that... [her husband and herself] can don’t suffer so much” (ET).

Conversely, even heat-averse participants associated heat with healing, health, and vitality in some situations. This suggests that participants compartmentalise their attitudes towards different forms and sources of heat, often holding divergent meanings concurrently. This can be seen in the case of CRC29A, who ordinarily used an umbrella to shield herself from the sun as her heat sensitivity caused her to break out into an itch. Yet upon her doctor's advice, she found herself "[taking the] morning shift just to suntan [herself]" on the roof of a carpark as doing so allowed her to benefit from more vitamin D (ET). In private contexts and spaces where social norms are momentarily suspended, participants might even come to reveal hidden preferences in favour of the heat. CRC20A, for instance, shared that she enjoyed sweating in the privacy of her garden even though she showered before work to avoid perspiration (HT). Messaging on the benefits of heat acclimatisation should therefore accentuate heat's positive associations to resonate with the public.

Meanings Underlying Air Conditioner Usage

Air-conditioning took on different meanings as it evolved from a technology encountered only in workplaces or elite homes into an everyday appliance owned by most Singaporean households. Initially, air-conditioning was associated with luxury and frivolity; households had cheaper and less energy-intensive ways of dealing with heat. Consequently, air conditioning was not deemed an intuitive or viable solution to indoor heat. As CRC40 put it, "During the 1980s, it never occurred to us to have air con" (OH). As air-conditioning became more accessible, the appliance took on new meanings, becoming a marker of a well-furnished and "modern" home. This shift in meanings can be seen in the following quote by CRC24:

CRC24 (HT)	The TV aircon, water heater, fridge, washing machine. These 5...It's like getting married and you got the 四点金 [Chinese betrothal gifts customarily gifted by the groom's family to the bride] you buy a house you must have all these things.
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In drawing this comparison, CRC24 asserted that, much like purchasing betrothal gifts, owning an air-conditioner was essential for establishing a new household. Today, the ownership of air-conditioning has become so normalised among Singaporean households that many landlords consider it a basic amenity to provide to tenants. In his analysis of small-holder landlords in Singapore, Guan (2025) goes a step further in asserting that air-conditioning was the very technology that enabled HDB owners to carve out parts of their apartments to rent in the first place, as the ability to externalise indoor heat allows strangers within the same space to shut their doors and "[co-reside] without intimacy" (p. 2). Most households who rented out their homes attempted to provide air-conditioning for their tenants. For instance, CRC32 recalled asking her tenant if "she want aircon or not" (HT), while CRC40 shared that their family only installed an air conditioner upon their tenant's request. Speaking from their experience as a tenant, CRC17B recalled that they used the air-conditioner "24/7, 365 [days a year]" (OH) till the air-conditioner was faulty, however, their landlord did not object to their usage patterns.

Meanings, however, do not develop in an orderly, linear fashion. Instead, they are perpetually contingent and contested, as individuals internalise or resist meanings according to their lived experiences and thermal preferences. As such, although changes in material circumstances created new meanings around the ownership of air conditioning, older impressions of air conditioning as an expensive, gratuitous indulgence did not disappear altogether; they lived on in participants' memories and were passed down to the next generation as family values. CRC35, a mother to a young boy, shared that much like her father did when

she was young, she was trying to teach her son to be less reliant on air-conditioning (OH). The contested meanings associated with air-conditioning—where ownership is considered essential but usage extravagant—thus explain why most participants, despite owning a unit, did not use it for daytime cooling at home. CRC01AB, for instance, only permitted their children to use the air conditioner during the day when they were studying, despite having the household income to support full-day air-conditioning. In Section 6: History, we develop this argument further, exploring how participants compartmentalised the diverse meanings associated with air-conditioning, applying different standards to the use of air-conditioning in the workplace and at home.

A small segment of participants associated the air conditioner with personal indulgence not in a financial sense, but an environmental one. These participants were more cognisant of the underlying mechanisms of air-conditioning—how it functioned by displacing indoor heat outdoors, and how its use contributed to climate change through higher energy consumption and increased greenhouse-gas emissions.

CRC20B
(ET)

And this is a concept that I brought up during the previous interview, the fact that just this idea of refrigeration or air-conditioning is technically, although you are feeling cooler, like it's like artificially created coldness and this is at the expense of creating a lot of electricity, which means somewhere else in the planet there's like something is burning, you know, to provide that energy. So it's like, I just don't subscribe to that whole idea. So I have greater peace of mind.

Here, the use of air-conditioning takes on a moral slant, framing users as personally complicit in the climate crisis. Framing air-conditioning as an environmentally destructive behaviour can, as was the case for CRC20A and CRC20B, deter more eco-conscious participants from using air-conditioning. However, it can equally trigger feelings of eco-shame, prompting individuals to downplay or hide their usage to avoid social censure (Nielsen et al., 2024). Such was the case with CRC24's daughter, whom her father described as ordinarily quite environmentally conscious. She felt ashamed when CRC24 disclosed her usage pattern to the research team; CRC24 later recounted that after the home tour concluded, "She locked the door. She said 'paiseh' [embarrassed] to let other people know she's using the aircon to sleep" (HT). CRC20B and CRC24's daughter are among the minority however, as most framed air-conditioning as an issue of cost rather than with climate change and were generally unwilling to forgo their personal comfort. For instance, when questioned if he would reduce his air-conditioner usage in the consideration of the climate, CRC34 declined, reasoning that: "aircon is still essential. I can't give this up for, you know, for eco-friendly reasons" (ET). Even among the participants who did associate their use of air-conditioning with climate change, most rationalised their use as lower than what it could have been (e.g., CRC04) or licensed their use by pointing to other ways in which they practice environmentalism in their everyday lives.

Meanings about the healthfulness of air-conditioning were more influential in shaping participants' habits. Several participants believed—whether based on experience or hearsay—that air-conditioning is harmful to human health. Variations of this belief include the belief that the body has optimal ways of cooling down and that air-conditioning interferes with this process, either by overcooling (CRC24) or causing too "drastic" a drop in temperature (CRC37); the belief, rooted in TCM, that air-conditioning introduces too much "wind" into one's body (CRC29A) or weakens one's body constitution (CRC06); and the belief that the air circulated by an air conditioner is stale, unnatural, and "recycled" (CRC24).

Only a handful of participants connected their use of air-conditioning to a reduction in heat tolerance. CRC05B, for instance, shared that she was “scared” that she “will be too adapted to aircon” and “feel more hot when [she goes] out”, hence would try to “tahan [colloquial for endure] first” whenever she feels hot and “try not to on the aircon all the time” (HT). Participants who attributed their loss of heat tolerance to air-conditioning generally moderated their air-conditioning use, however, these participants were among the minority: most did not problematise their air-conditioning use in this way. Taken together, these findings attest to the “stickiness” of air-conditioning, suggesting that policy is better served by promoting reductions in use rather than outright abandonment, and that messaging should amplify meanings that discourage use.

Meanings Underlying Fan Usage

In contrast to the air conditioner, participants associated electric fans with tradition, seeing them as an extension of time-honoured practices such as manual fanning. Participants also associated electric fans with necessity. For most participants, material baselines for thermal comfort were defined not by the air conditioner, but by the fan. While participants generally related that they could live without their air conditioner during cooler periods, electric fans were a primal necessity throughout the year. The centrality of electric fans to everyday life was best summarised by the following quotes from CRC20A, CRC24 and CRC38.

CRC20A (HT)	So it's a necessity for me. It's, like, my basic thing that I need to have. I'd rather spend one time and get a proper fan and live comfortably then every day feel moody not having a fan, you know?... Food, that kind of thing. It's a basic necessity for me.
CRC24 (HT)	No. I just go and sit in front of the fan. Get the fan pointed to us. Must ah. Die eh.
CRC38 (HT)	Yeah, fan for sure will be one. It will never be a day where the fan is not turned on. I don't know anybody who lives in Singapore who doesn't use the fan.

Because fans are cheaper and less energy-intensive to operate, their use was also seen as frugal and environmentally conscious. For instance, CRC20A noted that while she “cannot help” using her fan, she was able to avoid feelings of “guilt” as according to CRC20A, “at least we are not switching on aircon” (ET). While fans were the primary heat management device for most households, there was also a general sense among participants that fans were less effective than air-conditioning. When interviewed about the relative effectiveness of fans versus air-conditioning, most participants identified air-conditioning as the superior appliance in terms of cooling effectiveness and efficiency. However, due to cost concerns, many participants reported having “no choice” but to “make do” with fans, their resignation reflecting a hidden preference for air-conditioning. These sentiments are best encapsulated by the following quotes:

CRC05B (HT)	If there's no cost of money. Like, if I put the money factor aside. Of course I'll put aircon, yeah.
CRC29A (HT)	Get used to it. I think, of course, the body needs time to get used to it. So after that we got used to, you know, always having the fan on. [Responding to the interviewer's follow up-question on how long they took to get used to the fan] ... Not long, lah. Because beggars can't be choosers.

Though participants generally recognised that fans were less efficient in cooling bodies and rooms, some participants did not think they were worse off for relying on fans, challenging assumptions that air-conditioning was necessarily more desirable. For CRC39B, fan usage goes beyond the mere use of an appliance but symbolises being “well trained” from young to endure the heat (ET). In this way, fan usage can even become a point of personal pride, as users are framed as tough, resilient and enduring. For CRC37, fans represent forbearance precisely because they cool the body more gradually; by contrast, he characterises air-conditioning as “instant gratification” (HT), associating air-conditioning with negative attributes such as impatience and short-termism.

Beyond the appliance itself, fan usage is also contingent on a related set of meanings on what constitutes “good” air. Most participants preferred outdoor air, which they described as “natural” and “fresh” (CRC10A, CRC24, CRC33B), and some degree of air circulation as opposed to still air, which they associated with being “stuffy” and enclosed. Many participants also held beliefs about the healthfulness of direct wind exposure. Some of these beliefs were rooted in TCM knowledge, for instance the belief that wind can enter one's body through the skin and pores (进风) and disrupt the normal functioning of one's body. For others, these beliefs were grounded in lived experience: direct wind exposure led to physical symptoms such as generalised pain (CRC27B), rheumatism (CRC29B), stomach bloating (CRC32), and headaches and migraines (CRC19, CRC27B, CRC35). In turn, beliefs about what constitutes ‘healthy’ wind exposure shape the way in which participants operate their fans. Some participants keep their fans on a low speed (CRC27AB), oscillate or direct their fans away from themselves (CRC19, CRC32) or cover parts of their body with clothing to prevent direct wind exposure (CRC12B, CRC29B).

Competencies

If meanings serve as the “unifying glue” that motivates practitioners to bind different materials and competencies together, competencies—encompassing skills, know-how, and expertise—serve as the guiding blueprint. In this sub-section, we unpack the competencies involved in participants’ fan, air conditioner, and hydration practices. In so doing, we examine why these practices are so prominent and highlight any key knowledge gaps that should be addressed.

Competencies Underlying Fan and Air Conditioner Use

A key reason most participants reflexively turned to mechanical cooling at first sign of thermal discomfort is that unlike hydration or traditional cooling practices, users need not possess specific skills or knowledge to switch appliances on. Table, stand and wall-mounted fans often come with rudimentary speed and oscillation controls, and though wall-mounted air conditioners and certain models of ceiling fans offer comparatively more sophisticated features, users need only flick a switch or press a button to access their core function. Much of the labour, skills and expertise required to install or maintain ceiling fans and wall-mounted air conditioners had already been outsourced to professional contractors and technicians. As such, most participants had limited knowledge of best practices for using ceiling fans and air conditioners, and generally deferred to their contractors and technicians' advice on optimal settings and use habits.

CRC07 (HT)	<i>(Why are your ceiling fan settings like this?)</i> I don't know. No, this one was actually set by the contractor. I've not changed it.
CRC14B (HT)	<i>(Why does your household not practice hybrid cooling?)</i> Yeah, because our aircon. Because of the dust, then it was kind of like bit. What? Yeah, yeah. Then the servicing guy came and he found out it's clogged and he told us. Yeah. One of the reasons is using the fan as well.
CRC30B (HT)	<i>(Why do you set this temperature when using aircon?)</i> I think it's just recommended by the aircon guy. They say try not to go beyond 25 °C.

While some participants experimented with their air conditioner and ceiling fan settings, most did not seem to be using their devices to their fullest potential. For instance, only two households, CRC17AB and CRC21AB, were aware that their ceiling fan's anticlockwise setting could create a downdraft that circulated cool air throughout their household. Granted, not every ceiling fan had such a function, but awareness of this setting was so uncommon that only CRC30AB, besides the initial two households, acknowledged its existence. However, when questioned why they did not use this setting themselves, CRC30B replied that they did not have the confidence to do so: "we don't really know how to use it. Sometimes the wind just gone because of it" (ET). Likewise with air conditioners, only four households—CRC03AB, CRC11, CRC14AB and CRC34—shared that they regularly used their air conditioner's dehumidifying setting to address humidity concerns. This further corroborates the finding that most households are unfamiliar with the technical settings of their cooling appliances, and that addressing this skills gap might yield energy savings without substantially compromising on thermal preferences.

Competencies Underlying Hydration and Relation to Biomedicine

For most participants, the practice of hydration depended more on practical and embodied knowledge rather than on institutional forms of knowledge. Participants typically described the process of deciding when to hydrate as mundane and reflexive: the weather is hot, the body sweats, fluid is lost, thirst is triggered, and so one drinks.

CRC01A (ET)	And then cold water only. I drink cold water usually only when I go out for a walk, I come back. So usually after exercise, I come back. Then I use cold water. So normally my drinks are hot drinks.
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As hydration was seen as a quotidian and everyday affair, most participants perceived hydration practices to be unrelated to Western medical practices or biomedicine, which many associated instead with pharmaceutical intervention. Evidence of this disconnect can be seen in how 26 out of 60 participants unequivocally denied being influenced by biomedicine in their everyday cooling strategies.

CRC14A (ET)	I don't recall receiving any advice in that area. I also never asked.
CRC17A (ET)	I've never heard of it before.
CRC35 (ET)	No. Because maybe I hardly see so I don't really know what they provide. Basically no.
CRC40 (ET)	Manage heat. No. Is there a medicine to cool down?

Only one participant, CRC32, specifically linked hydration to biomedicine, drawing upon their experiences volunteering in the military in their response.

CRC32 (ET)	Heat management (learnt from doctors)? I mean drink more water. That's one. That was also partly due to when were. I'm actually volunteer cadet. I'm SAF volunteer cadet. Because of that we were under hot weather training sometimes. Right. They have a rating then also there's a lot of water parade. I also agree that drinking water actually help to cool our temperature in the body down.
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Despite participants' prevailing perception that their practices are completely independent of biomedicine, hydration—a practice universally adopted across participants—has long been extolled by biomedicine as a first-line preventive measure against heat-related illnesses. For instance, the Singapore Armed Forces (SAF), which relies heavily on sports medicine and evidence-based research, institutionalised water parades (enforced water consumption) as a primary pillar of heat injury prevention since in the 1980s (Sim and Lee, 2023). In a similar vein, the Ministry of Manpower's revised framework for outdoor workers (modified in 2024) recommends specific quantities of water intake (e.g., 300ml per hour) based on Wet Bulb Globe Temperature readings.

Out of 60 participants, only three explicitly affirmed that at least one of their heat management practices was influenced by biomedicine. Interestingly, two referenced the same hydration-adjacent practice of adding salt to water, which enabled recovery through electrolyte replenishment.

CRC04 (ET)	Western science. Well, actually, I don't know whether it's western. Isn't. To me, it's just a way of cooling down, like in the salts and all those. Those are you put inside the water, you dissolve, then drink it...
CRC24 (ET)	Salt and water lor. When we run we lose a kilogram of water- sweat every 10 kilometers. So we lose. Then they will take isotonic drinks. So you know like the little packets. So we will mix it in.

Though these two participants' present-day consumption of salt water illustrated how early scientific advances could assimilate into everyday life, the fact that only two participants mentioned this practice suggests that it had yet to assimilate into the mainstream. More importantly, the prevailing perception among participants that their heat management practices—hydration or otherwise—were completely independent of biomedical science implied that messaging from formal healthcare and educational institutions might not be fully reaching the general public. Though science-based recommendations to deal with heat had been published in the mainstream media, interviews with participants suggest that the public might not be consciously internalising these pieces of advice.

Competencies Underlying Hydration and Relation to Traditional Medicines

While day-to-day decisions on when to hydrate are often a function of embodied knowledge, decisions on how to hydrate are often influenced by traditional medical systems such as TCM. Unlike biomedicine—which most participants flagged as having little influence over their everyday cooling practices—25 participants explicitly identified themselves as TCM users and/or infusing TCM principles into their everyday hydration and consumption habits. This group of participants generally understood TCM's founding theories (e.g., the classification of foodstuff as having hot or cold properties), possessed basic skills to manage thermal conditions, and associated thermal heat with the term “heaty”, a direct translation of TCM's concept of re qi. To these participants, heat manifested not only as elevated body temperature but also as sore throat and inflammation. To cope with or prevent these conditions, they stayed hydrated using herbal tea, Barley water, Luo Han Guo (monk fruit), chrysanthemum tea, Ling Yang (Antelope Cooling Water), and Oldenlandia water (Baihua she cao shui), while avoiding “heaty” foods like durian.

CRC02B (ET)	For me, like if I find myself like heaty in 发热, like in case I going to get sick, I would like bring those liang cha. Let's say, like, say when people say you eat too heaty food, right? Like eat durian or rambutan ... I will drink tea. So when, if I would say like heat, the warm, the kind of heat, then I will have ice cube and then Coca Cola like this. Or maybe like green tea like this.
CRC29A (ET)	When I feel heaty. Right. And then I will boil a barley or Chrysanthemum.
CRC16B (ET)	Barley water, Green bean soup..(to regulate the heat). Because my body feels rather hot. We drink these cool-nature things on hot days.

Discussions regarding perceptions of TCM and heat revealed three distinct modes of usage among participants. The first group of participants viewed internal body heat and external weather heat as inherently related. Rather than conflating the two, their perspective aligned with the holistic philosophy of TCM. In TCM, the universe, the seasons, and the body were all seen as part of the same complex dynamic, sharing the same fundamental substrate of *qi* (Hsu, 1999; Smith, 2018). Because they understood environmental heat and internal heat to be deeply interconnected, they trusted TCM's efficacy in resolving heat-related issues broadly, and utilised the same herbal remedies to address both types of heat (e.g., CRC11, CRC17B's ET).

These participants contrast with a second group of TCM users who subscribed to a more compartmentalised paradigm. This group treats internal body heat as a distinct issue from external weather heat, noting that the two manifest different symptoms. For them, herbal remedies are prescribed exclusively to treat internal body imbalances when they feel unwell and encounter sore throat, acne or other issues. A few explicitly proclaimed that they were unaware of any TCM interventions intended to combat environmental heat.

CRC05A (ET)	<i>(Do you drink herbal tea when weather is hot?)</i> Drink herbal tea is because body heaty, not the weather hot.
CRC27B (ET)	I enjoy drinking liang tea. Like the taste of it. But does it really cool me down? I don't know. Maybe it cools my body so much that's why I need more heat to counteract it.
CRC17A (ET)	<i>(As you are a TCM user, do you know any TCM methods to deal with heat?)</i> Deal with heat? Not. not particularly. There's no specific thing that I can think of.

The presence of these two camps of TCM users speaks to the uneven localisation of TCM since its introduction into Singapore by Chinese immigrants beginning with the nineteenth century (Yang, 2022). While some participants leaned into the holistic theory of TCM, others clung to paradigms that separated internal systemic heat from external weather conditions, leading to the plural landscape in which “heat” took on multiple meanings depending on one’s familiarity and experience with TCM.

Adding to the complexity of this plurality was a third group of participants, who adopted select aspects of TCM to guide their hydration and consumption habits, despite their overall scepticism towards TCM.

CRC14A (ET)	I do not believe in TCM mostly. Liang Cha not really from, my parents. I just. Tried it and I kind of liked it.
CRC14B (ET)	It's not really a belief but maybe just a habit that 蛇草水 (Oldenlandia water) just makes you feel more. Less heaty. More cooling. my parents yeah. Would give me those TCM but it's so bitter and awful tasting that I definitely wouldn't use it for myself in adulthood.
CRC17A (ET)	Yeah, I mean we do practice that in terms of when ... we drink 凉茶 (herbal tea). I think every Chinese likely to believe that lah. I think it will be quite frequent in that sense, maybe every month. We'll probably end up drinking some 凉茶 (herbal tea) or whatever.

These participants' tendency to outwardly disavow TCM, but selectively adopt certain aspects when it proved expedient, reflects the peculiar position TCM occupies within Singapore society. Though efforts had been made to integrate TCM with biomedicine, TCM continued to occupy a subordinate position and carries lingering labels that it was "alternative, fringe, primitive [and] unscientific" (Chang & Lim, 2019, p.238). However, TCM was mainstream enough that heat management practices rooted in TCM theories and principles had diffused to more sceptical populations.

4.4 Heat as a Deeply Personal Experience

While the analysis above showed that SPT could account for the prevalence of certain practices on a societal scale, we share Hess et al.'s broad view that SPT cannot fully account for "individual or sub-group variations in the performance of collectively shared practices" (2018, p.184). As Piscicelli et al. notes, this is because "conceptions of 'normality' are culturally and socially shared as much as [they are] personally negotiated" (2015, p. 23) – personal traits and preferences can and do mediate the degree to which individuals are influenced by social norms. We argue that heat management practices are particularly prone to individual and sub-group variations for two reasons. Firstly, we expect that in the comfort and privacy of one's home, the setting in which most participants reported that they preferred to cool down, one had more latitude to deviate from social norms. Secondly, practices meant to remediate thermal discomfort were necessarily subject to individual-level considerations.

Participant interviews attested to the unique nature of heat experiences. Even within the same household, participants supplied unique accounts revealing how their heat experiences were the product of multiple factors operating on and across individual, household and societal scales.

On the individual scale alone, heat experiences could diverge drastically based on attributes such as one's sex, physical fitness and presence of chronic illnesses, parental upbringing and even one's present emotional state. The onset of chronic conditions could permanently shift one's thermal perception. For instance, CRC02A, a heart bypass patient, related in his ethnographic interview that he physically cannot withstand the cold, when in the past, he was comfortable sleeping shirtless. Participants' immediate heat experiences were also influenced by their emotional and psychological state. Several participants flagged encountering large crowds during their commutes as a significant heat amplifier even though their body temperatures did not increase. In contrast, some participants related that positive mindset shifts can aid in attenuating feelings of heat. This was the case for CRC21B, who, by simply reframing her expectations that "Singapore is going to be like that forever," was able to reduce feelings of "[anger]" towards the heat, a change which ultimately "[helped her] feel better" (ET).

The deceptively simple relationship between raw sensory input and heat experiences is further complicated by the role of memory as a lens by which participants interpret and make sense of heat. When questioned on their general understanding of heat in Singapore, participants often used past experiences as benchmarks of present-day heat, comparing their current experience to memories of Singapore's past climate, or their experiences of other countries' climates. For some participants, exposure to other countries' climates deepened their appreciation of Singapore's weather. Experiencing "the real cold" in Switzerland made CRC35 realise that she "[doesn't] really like cold", causing her to cut down on her air-conditioning usage

upon her return to Singapore (OH). To other participants, overseas exposure provided them with the vocabulary and framework to articulate how hot and uncomfortable Singapore's climate really is.

The sheer complexity of heat experiences, mediated by factors interacting and operating on multiple scales, thus points to heat experiences being deeply individual and personal in nature. No two participants' heat experiences are exactly alike, and participants' heat perceptions often shift as they age and accrue a wider range of thermal life experiences. Accordingly, participants shared that their memories of past heat experiences—the benchmark by which they measure present-day heat—might be unreliable as growing older often meant that their reference points had changed. For CRC01A, this meant relying on “logic” to intuit that “it's hotter nowadays compared to 30 years ago”, even if he remembered that “the hot, the perspiration... the feeling, it's no different” to when he was a child (OH).

Given the highly individualised nature of heat experiences, we suggest that heat management practices cannot be analysed at the level of practices alone, as implied by SPT. Instead, they must be examined in tandem with individual-level factors influencing the adoption, modification, and abandonment of these practices. We argue that both analytical approaches—one focusing on the scale of practices, the other on the individual—yield equally important insights for policymakers. Using SPT to analyse heat management at the scale of practices forces us to confront the underlying reasons for the dominance of more energy-intensive cooling practices. Conversely, taking an individual scale approach to understanding when and why participants maintained or changed their heat management practices over time gives policymakers deeper insight into optimal intervention windows when people are most receptive to change. In the following subsections, we examine how differences in cooling practices can be attributed to individual factors like one's upbringing by tracing the continuities and discontinuities in participants' heat management practices.

Continuity

Most participants ascribed their current heat management practices to their childhood and upbringing rather than formal institutions such as schools, suggesting that the development of heat management practices primarily began within the family. These influences often followed children into their adulthood, rendering their contemporary heat management strategies a mix of personal agency and familial inheritance.

Overall, we observed that heat management practices that were nurtured from young were mostly stable, an argument we flesh out in greater detail in Section 6: History. Except for specific circumstances that would be explored in the next subsection, most participants did not significantly change their heat management practices, unless their thermal preferences at adulthood substantially diverged from those of their parents. Interview data offers two main explanations to account for this stability. The first explanation was that—having served them for so long—participants had come to perceive these practices as effective, and that this perception alone was enough to ensure their continued performance regardless of their actual efficacy. Secondly, practices rooted in childhood often transcend their utility and become embedded in participants' personal beliefs, becoming difficult to abandon.

The next subsections identified three ways in which parental or familial influence manifested in participants' contemporary heat management practices. Participants demonstrated varying levels of acceptance and

resistance: some unquestioningly adhered to their families' teachings, others unintentionally emulated their parents' behaviour, and a third group selectively adopted certain aspects while resisting others.

Explicit Instruction and Adherence

The first group consists of participants who attributed their heat management practices to their parents' explicit teachings and instructions, instructions that they internalised from childhood and adhered to well into their adult lives. Many of these exhortations—often on subjects such as optimal showering routines and drink temperatures—were rooted in general health advice (i.e. “drinking cold water is bad for health”), rather than advice specific to thermal regulation (i.e. “drinking cold water is less effective to cool down”). This was the case for CRC09 and CRC21A, whose present-day aversion to drinking cold water stemmed from their parents' belief that cold water caused one to fall ill. CRC09's parents believed that the human body should be allowed to experience the full range of temperatures present in nature; artificially bringing down the temperature using air-conditioning would only cause one to feel warmer in the long run. This mentality was ingrained into CRC09 from young, serving as the basis of his present-day heat management practices.

CRC09 (ET) on how his worldview on heat was influenced by his parents	My parents, when I was small, they kept telling me, don't drink cold water because you will get cold, cough...they never believed in antibiotics or any of the western medicine as such. Yeah, that's why from an early age, they never allowed me to take cold water... Your body should experience everything. Let it be heat, let it be cold, let it be anything. But it should just be a natural process. And when you're trying to artificially cool it down, then when you go out, you're going to feel very very warm...I think that from growing up, years that's what, I think it's very like my parents believed in it, so I think that somehow it ingrained into me.
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Unintentional Emulation

The second group denoted participants whose heat management practices were only indirectly influenced by their parents. Unlike the first group, where practices were transmitted through explicit instruction, participants in this group subconsciously emulated their parents' heat management practices and, through routine performance, came to perceive them as the norm. CRC07, for instance, mused that she did not have a habit of drinking cold water to cool down because since childhood, her family had never kept cold water in the fridge. Drinking lukewarm water thus became the norm for CRC07, such that in her adulthood, she could not imagine drinking cold water to cool down. CRC08A's family had exactly the opposite norm, stating: “I think it's passed down from my mom la. My mom also drinks ice water... Nobody taught me to drink cold water. Just a habit since childhood” (ET).

Parents also indirectly shaped participants' heat management practices by dictating the material conditions of their childhood, and by extension, the environment in which participants first learned to cope with heat. This had a lasting impact as practices adapted to the material conditions of childhood became the benchmark by which participants considered what is 'normal' to do in adulthood. CRC02B, for instance, shared that she does not see air-conditioning as a necessity precisely because she and her husband were brought up without air-conditioning, and she felt that she could “carry on without it” even after she married (ET).

Selective Adoption: A Blend of Both Emulation and Divergence

The third group denoted participants who selectively incorporated aspects of their parents' practices, while rejecting the belief systems that underpinned them due to perceived ineffectiveness, dislike or inconvenience. Practices are thus retained, albeit in a diluted, hollowed-out form. For instance, CRC11 consumed green bean soup or herbal teas like monk fruit and chrysanthemum whenever her body signalled a feeling of internal "heatiness". She attributed these habits to her upbringing, noting that her parents simply told her that these drinks were beneficial without explaining the underlying rationale. As such, she viewed these practices as intuitive habits developed through upbringing and trial and error. Similarly, CRC12B continued to consume herbal drinks as his family brewed them on the weekends. However, the purpose of these drinks had been lost on CRC12B, as he viewed them as desserts rather than for any cooling purpose.

This group of participants could be distinguished by their pragmatism; they adopted practices such as consuming cooling herbal teas and avoiding "heaty" foods either through familial influence or by personally experiencing their benefits. Crucially, while these individuals acknowledged the efficacy of these practices and were fluent in vernacular hot-cold notions and related symptoms, they did not perceive themselves as practitioners or believers of traditional Chinese medicine, and these everyday practices were not equated with a formal commitment to its knowledge system. This phenomenon was closely reflected in the popularity of commercial herbal beverages in Singapore. Herbal teas today play a dual role: they function both as medicinal products and as easily accessible consumer drinks. Unlike prescriptions from traditional Chinese medicine practitioners, which are typically personalised and part of a long-term treatment process, these beverages are standardised, convenient, and widely available for everyday consumption. Their accessibility allows a broad range of people to experiment with them. Once individuals perceive benefits, such as improved bodily inner balance or relief from heat, these practices can gradually become habitual.

This helped explain why the consumption of herbal teas has persisted as both a social and everyday practice. As argued by Shove et al. (2012), "stability and routine are not the end points of a linear process of normalisation" (p. 24). Instead, practices should be understood as an "ongoing accomplishment in which similar elements are repeatedly linked together in recognisable ways" (p. 24). In this case, this group of consumers successfully integrated the convenience of ready-made herbal drinks with an accessible understanding of "heatiness", thereby creating new, practical meanings for these traditions in everyday life.

Discontinuity

In the following section, we outline the most common circumstances compelling participants to change or discontinue their heat management practices. Understanding when and why participants change their practices—and the factors underlying the longevity of those changes—is essential for crafting recommendations that nudge participants towards more sustainable cooling habits, as it allows us to identify "windows of opportunity" when participants are the most receptive to change.

Marriage and Changes in Household Composition

Changes in household composition were among the most common reasons cited by participants for changing their heat management practices. Marriage might involve the union of two parties with drastically different thermal preferences and heat management strategies, necessitating some degree of negotiation and compromise when sharing the same space. We generally observed that couples who shared a bedroom tended to converge in their thermal habits and preferences as they negotiated their differences. However, the outcome of these negotiations—whether the household relies on a fan or an air conditioner as the dominant cooling appliance—depends on couple-specific relationship dynamics and individual characteristics, including personality, body type and health status, finances, as well as values and priorities.

In couples where one partner strongly preferred air-conditioning and could afford to realise that preference, the other partner typically acquiesced and adapted to their partner. This was the case for CRC03AB and CRC01AB, both of which will later be expounded upon in greater detail in Section 6: History. In CRC03AB's household, CRC03A acquiesced to his wife's preference as she had stronger opinions and paid for the bills; however, doing so compromised his own heat tolerance, as he was constantly exposed to air-conditioning both at home and at work. By the beginning of their study, CRC03A had become so accustomed to his wife's thermal preferences that he admitted, "without aircon [he] will feel hot" (ET), and jettisoned the blanket he initially relied on to withstand CRC03B's preferred settings.

In couples where one partner is more cost-conscious than the other, the other partner typically compromised by moderating their use of appliances. For instance, marriage meant that CRC21B—who hailed from a family wealthy enough to afford a landed property—could no longer switch on the air conditioner as he pleased, as his wife, CRC21A, was raised to be frugal with money. Compromise went both ways in their household. While CRC21B accommodated CRC21A's values by limiting his air-conditioning to short periods—when previously at his parents' house he would use air-conditioning more liberally—CRC21A compromised by allowing any use of the air conditioner at all, as she grew up without air-conditioning. Over time, living in the same space thus led to the couple converging in their thermal tolerance:

CRC21B (OH)	Yeah. So I think, like, we kind of like compromise. So I think she may have, like, dropped in her heat tolerance a little bit because she got accustomed to my aircon usage and my heat tolerance increased because after a short while of using the aircon, she would say it's time to switch it off.
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Among couples, ownership of the home also played a role in determining whose thermal preferences were prioritised. CRC37's relationship with his girlfriend illustrated this dynamic. Though CRC37's girlfriend typically slept with air-conditioning in her own home, when she stayed overnight in his flat, she had to contend with sleeping only with fans. When questioned on how his girlfriend coped with the warmer environment, CRC37 responded: "But I think she has no choice. Therefore, that's how she cope[s]" (HT).

Couples who slept separately generally did not converge in their thermal preferences, though it is not entirely clear whether couples slept separately because they failed to reach a compromise, or because separate arrangements lessened the pressure to pursue one. Participants who slept separately from their spouses retained full autonomy over their thermal environments. For instance, sleeping in his own room meant that CRC09 could keep his air conditioner on throughout the night at its maximum fan speed without

imposing on his wife, who found these settings intolerable. Similarly, sleeping separately enabled CRC35's husband to set his air conditioner to his preferred temperature of 23°C, whereas previously he had to set the temperature to 25°C when CRC35 was still in the same room.

Compared to their spouses, with whom heat management practices are often negotiated, we observed that participants frequently made greater concessions for their dependents, particularly young children. This difference in treatment largely boiled down to differences in power disparities and duties of care. While marriage usually entailed the union of consenting adults, the power dynamic in parent-child relationships is lopsided. Dependents were entirely at the mercy of their caretakers, who in turn had a duty of care towards their dependents. Across interviews, examples abound of parents taking great pains to accommodate the thermal preferences of their infant children, even if they did not necessarily align with their own. CRC27A and CRC27B, for instance, created a smart-home system which at the push of a button, draws the living room curtain and switches on both the fan and the air conditioner to their daughter's preferred setting, all so that in CRC27B's words, "[their daughter can] sleep peacefully in the pram when [they] reach home [from weekend classes]" (HT).

Moving House

Moving house was another common reason that participants changed their heat management practices over time. Relocating exposed individuals to new thermal conditions, as even minute changes in one's immediate surroundings could alter the microclimate one experienced. Additionally, relocation often coincided with major life events. Marriage, divorce, childbirth, and significant career changes can drastically alter an individual's financial and familial circumstances, and by extension, their ability to manage heat.

For most participants, heat was not an overriding factor in choosing their first home, unless they had significant issues dealing with heat in their previous home that they could directly attribute to their former residence. The general tendency among participants to underestimate heat explained how some participants inadvertently moved from a cooler to a warmer place, only to experience a form of 'buyers' remorse' upon fully realising the thermal conditions of their new home.

CRC01A (HT)	Like what she said last time, we used to be west facing, so we learned our lesson. So now we know what facing to look for. So it's not only the outside. Right. You also need to know the orientation. But if it's west facing, no matter how good the view what, I don't think I will go for it. Just the direction wise because the heat never goes away. Imagine at night, you know, the wall is warm.
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CRC14B (HT)	Yeah. So actually I've always wanted... After because I would say I was inexperienced in choosing house when we first got married. So we didn't consider factors like wind and flooring for the ventilation and the breeze. So my ideal I told him was to find a unit that is more breezy.
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In most participants' housing calculus, heat considerations were generally outweighed by more practical factors, such as cost, overall convenience, proximity to essential facilities (like transportation and preferred schools), closeness to parents and relatives, and a unit's potential for asset appreciation. Even if participants

wanted to consider heat as part of their decision-making, information asymmetry was a major challenge preventing many from making informed decisions. For one, property viewings were often conducted after working hours to accommodate the schedules of prospective buyers; however, these timings painted an unrealistic picture of daytime heat. Additionally, some heat-related issues might not be discernible upon first viewing. As CRC01A put it, “you have to stay in for a few days. Then you will realise what are the [heat-related] problems [with a property]” (HT). Despite having a better understanding about their property’s heat conditions, sellers are also disincentivised from disclosing this information for fear of jeopardising their property value, further compounding this information asymmetry. CRC37’s reluctance to participate in an interview with the mass media illustrates this point. As CRC37 was actively selling his property, he declined to participate, saying:

CRC37 (HT)	That's why I didn't agree to the interview because I don't know how ST [Straits Times] would actually frame the article. And then if, let's say someone sees on the Straits Times right now, they might not want to buy the house.
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For the reasons given above, participants’ relationship with heat when moving into a new home was more reactive rather than anticipatory. Participants responded to weather conditions in real time, adjusting their thermal practices to suit present conditions as they saw fit.

Beyond entailing a physical shift in space, moving makes changes in heat management practices more likely because symbolically, relocation represented a break from the norm, offering individuals a ‘window of opportunity’ to acquaint themselves with new competencies, materials and meanings that might culminate in new practices. CRC13’s account of how her habit of drinking cold and fizzy drinks developed after she moved to Punggol illustrates this point. When questioned about how her habit developed, especially since she previously never desired cold beverages, she explained that her preference might have started when she and her partner began stocking their fridge with 1.5-litre bottled drinks for housewarming guests. Their new Punggol home was so hot that she frequently described feeling “very sweaty” and flushed to the point of feeling itchy. When guests could not finish the drinks, CRC13 and her husband began consuming the beverages themselves to avoid wastage and relieve their thermal discomfort.

CRC13 (OH)	I don’t remember. Just happened we started drinking I also don't know... [When questioned on how her habit started] Maybe. Okay, maybe if I remember lah, we very hot. We want to drink. Then either we drink ready, then no more water or whatever reason we find that it's time to stock up our fridge with drinks. Then maybe because we always have housewarming, many people come in. So we have drinks there... So haven't finished. Then we drink it, Then maybe from then on then we continue maybe.
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While relocation offered the most obvious “window of opportunity” for participants to change their heat management practices, short-term programmes that replicate the disruptiveness of relocation, without requiring permanent moves, could also achieve a similar effect. This was the case for CRC06, who capitalised on the Home Improvement Programme (HIP) to install a wall-mounted air conditioner at home. Administered by HDB, the HIP rejuvenates aging HDB precincts by financing essential maintenance works and subsidising optional upgrades to individual units. Prior to their block being confirmed for the HIP,

CRC06's father—the owner of the unit—had forbidden CRC06 from installing a wall-mounted air conditioner, as he was uncomfortable with any renovation works that require drilling. However, as the HIP had already primed his father to accept some level of renovation, bundling the air conditioner installation with the HIP enabled CRC06 to secure his father's approval. The HIP thus marked a significant point of discontinuity in CRC06's heat management practices, as CRC06 went from only using the fan at night to pre-cooling his room with the air conditioner on a nightly basis.

CRC06
(ET)

Okay. So last month I would say was most of our days was really warm. So I tend to on the aircon quite frequently, especially during daytime, towards the early afternoon when the heat gets unbearably hot. Then also at night before, usually 1 hour before I go to bed to cool down the room. Then after that I will switch to fan. Because actually I've been used to fan already since growing up. In fact, the aircon was, I would say was installed like ten years ago during the estate upgrading project. So I tried not to make it a habit to use the aircon when I sleep at night.



Chapter 5

Physiology: Understanding the Physiological Implications of Heat Management Practices



5. Physiology: Understanding the Physiological Implications of Heat Management Practices

In the previous section on Ethnography, we sought to capture the diverse range of heat management practices found among participants and, using SPT as an analytical lens, unpack the materials, meanings and competencies driving the prevalence of the most common practices—namely using electric fans and air conditioners. Building on these findings, this section turns to the physiological implications of these practices, asking: what are the consequences of relying on a fan, a combination of fan and air-conditioning (AC), or continuous air-conditioning as a primary heat management strategy during sleep?

To address this, participants were segmented into three heat management archetypes: Fan, Fan+AC, and AC. We characterised participants' bedroom environments, examined how these exposures were reflected at the body surface, assessed thermoregulatory and cardiovascular responses during sleep, and evaluated thermal perception across sensation, satisfaction, and preference scales.

5.1 Section Highlights

- 60 participants were categorised into three mutually exclusive archetypes: Fan (n = 16), Fan+AC (n = 24), and AC (n = 20), reflecting distinct nighttime cooling strategies ranging from passive fan-only ventilation to continuous air-conditioning use.
 - Heat management archetypes differed markedly in bedroom temperature and humidity; the AC group maintained a bedroom nearly 4°C cooler than Fan users (24.9 vs 28.8°C), yet wrist skin temperature between the two groups differed by less than 0.5°C (32.9 vs 33.3°C) during sleep. Body-surface humidity more directly reflected each group's cooling strategy, with AC users recording substantially lower wrist microclimate humidity than Fan users throughout sleep (58 vs 72%).
 - Wrist skin temperature rose sharply at sleep onset across all three archetypes before gradually declining through the remainder of the sleep period, consistent with the peripheral vasodilation that accompanies normal sleep initiation. Heart rate rose gradually following sleep onset and continued to increase across the sleep period in all three archetypes, with no evidence of a nocturnal decline, suggesting persistent cardiovascular loading throughout the night regardless of cooling strategy.
 - Thermal perception reports were broadly consistent across archetypes, with all three groups reporting predominantly neutral to slightly warm sensations and general acceptance of their thermal environment, though a persistent preference for cooler conditions across all groups, including AC users, suggest that no cooling strategy fully met participants preferred thermal environment.
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5.2 Introducing the Three Heat Management Archetypes

These classifications represent distinct heat management archetypes defined by the primary cooling strategies employed during nighttime sleep. Data for these classifications were obtained through semi-structured interviews and questionnaires, where participants reported their predominant nighttime thermal management behaviours. 60 participants were categorised into three mutually exclusive archetypes:

- Fan (n = 16): Participants in this group relied exclusively on mechanical fans or passive natural ventilation for cooling during sleep and did not utilise AC at any point during the night.
- Fan+AC (n = 24): Comprising the largest cohort, participants in this group adopted a hybrid strategy, in which AC was used to pre-cool the sleeping environment for several hours prior to sleep onset, after which the AC was switched off, and a mechanical fan was employed for the remainder of the night.
- AC (n = 20): Participants in this group relied on continuous AC operation throughout the entire nighttime sleep period.

5.3 Environmental Exposure Across Heat Management Archetypes

Environmental exposure was characterised at two spatial scales: the bedroom environment, measured using a Kestrel environmental logger (Nielsen-Kellerman, Boothwyn, PA, USA), and the individualised body-level thermal microclimate, measured using an iButton thermistor (Maxim Integrated Products, Inc., Sunnyvale, CA, USA) positioned at the wrist (Nazarian & Lee, 2021).

The Kestrel loggers monitored bedroom ambient temperature (T_{bedroom} ; °C) and relative humidity (RH_{bedroom} ; %). The loggers were placed on the bedside table or the nearest stable surface. To minimise measurement bias, the device was positioned away from direct airflow sources (fans, air-conditioning vents, and open windows), direct sunlight, exterior walls, and heat-generating appliances. Placement consistency across all participant bedrooms was verified throughout the 14-day monitoring period, and photographic records were taken to document each deployment configuration. The wrist-level microclimate temperature (T_{micro} ; °C) and relative humidity (RH_{micro} ; %) was recorded via the iButton at 20-minute intervals, to determine the extent to which room-level thermal conditions were transmitted to the immediate environment surrounding each participant during sleep. Together, these measurements captured both the room-level thermal conditions and the individualised thermal exposure experienced at the body surface during sleep.

Bedroom and Sleeping Microclimate: Temperature

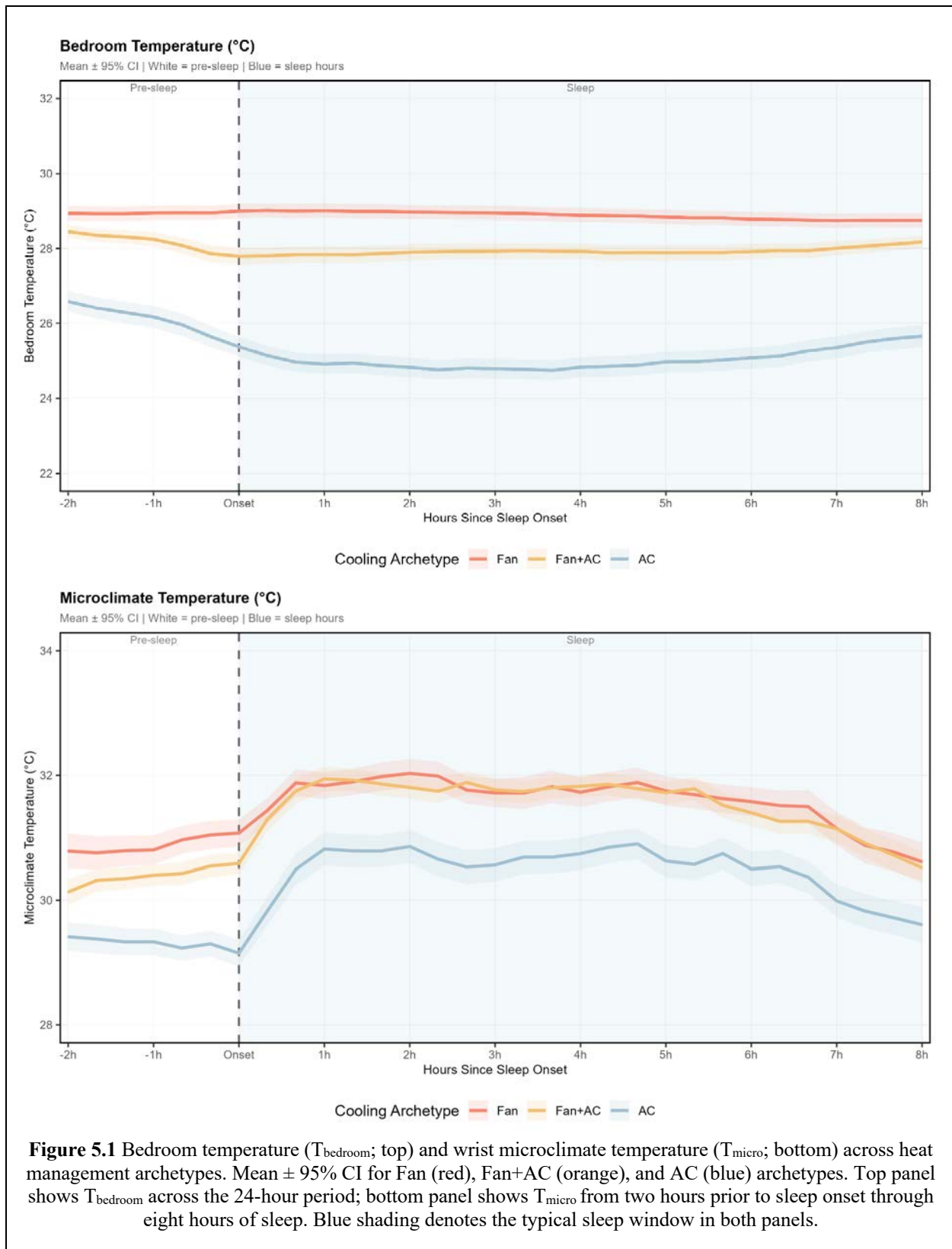
T_{bedroom} profiles across the 24-hour period differed markedly between archetypes, reflecting the thermal consequences of distinct heat management strategies (Figure 5.1: top-panel). The Fan group maintained the warmest T_{bedroom} during the sleep period ($28.8 \pm 1.3^{\circ}\text{C}$; median: 29.0°C ; range: $24.7\text{--}31.9^{\circ}\text{C}$), remaining consistently stable across the sleep period with minimal variation between early and late sleep (early sleep: 29.0°C ; late sleep: 28.7°C). This was partly consistent with the finding from Section 4: Ethnography, that many households, including Fan users, closed their windows at night to insulate themselves from noise and insects. Therefore, they effectively removed natural airflow, resulting in elevated bedroom temperatures

throughout the sleep period. The Fan+AC group showed the drastic decrease in T_{bedroom} during the first two hours sleep onset. This pattern reflects the hybrid cooling strategy reported by Fan+AC in Section 4: Ethnography, whereby AC was used to pre-cool the bedroom for several hours before sleep onset, after which a fan was employed for the remainder of the night. The Fan+AC group recorded an intermediate T_{bedroom} ($27.9 \pm 1.9^{\circ}\text{C}$; median: 28.4°C ; range: $20.8\text{--}32.0^{\circ}\text{C}$), reflecting the residual cooling effect of pre-sleep AC use that gradually dissipated across the night (early sleep: 27.8°C ; late sleep: 28.0°C). In contrast, the AC group recorded the lowest nighttime T_{bedroom} ($24.9 \pm 2.3^{\circ}\text{C}$; median: 24.9°C ; range: $19.1\text{--}31.0^{\circ}\text{C}$), remaining consistently cool across the full sleep period, reflecting the sustained cooling effect of continuous AC operation.

Across all groups, 95% confidence intervals remained narrow throughout the 24-hour period, indicating low within group variability and supporting the reliability of the observed archetype-level differences. Linear mixed-effects modelling revealed a main effect of archetype ($\chi^2 = 44.5$, $\text{df} = 2$, $p < 0.001$), a main effect of hours since onset ($\chi^2 = 28.1$, $\text{df} = 1$, $p < 0.001$), and an archetype $\times$ sleep period interaction ($\chi^2 = 73.7$, $\text{df} = 2$, $p < 0.001$) on T_{bedroom} , indicating that the three archetypes followed distinctly different T_{bedroom} trajectories across the sleep period.

Despite these room-level differences, the transmission of bedroom thermal conditions to the body surface was notably attenuated across all archetypes, with T_{micro} (Figure 5.1: bottom-panel) remaining substantially elevated relative to T_{bedroom} during sleep. Fan and Fan+AC participants recorded near-identical sleep-period T_{micro} values (Fan: $31.6 \pm 1.6^{\circ}\text{C}$; median: 31.6°C ; range: $23.6\text{--}36.1^{\circ}\text{C}$; Fan+AC: $31.5 \pm 1.8^{\circ}\text{C}$; median: 31.5°C ; range: $22.7\text{--}37.0^{\circ}\text{C}$), approximately 3°C above their respective bedroom temperatures, suggesting that fan-based cooling provided little attenuation of body-surface thermal exposure during sleep. The AC archetype recorded the lowest T_{micro} of the three groups ($30.4 \pm 2.1^{\circ}\text{C}$; median: 30.4°C ; range: $20.8\text{--}36.0^{\circ}\text{C}$); however, given the markedly cooler bedroom environment maintained by this group, the modest reduction in T_{micro} relative to Fan and Fan+AC participants indicates that cooler ambient conditions only partially moderated body-surface thermal exposure.

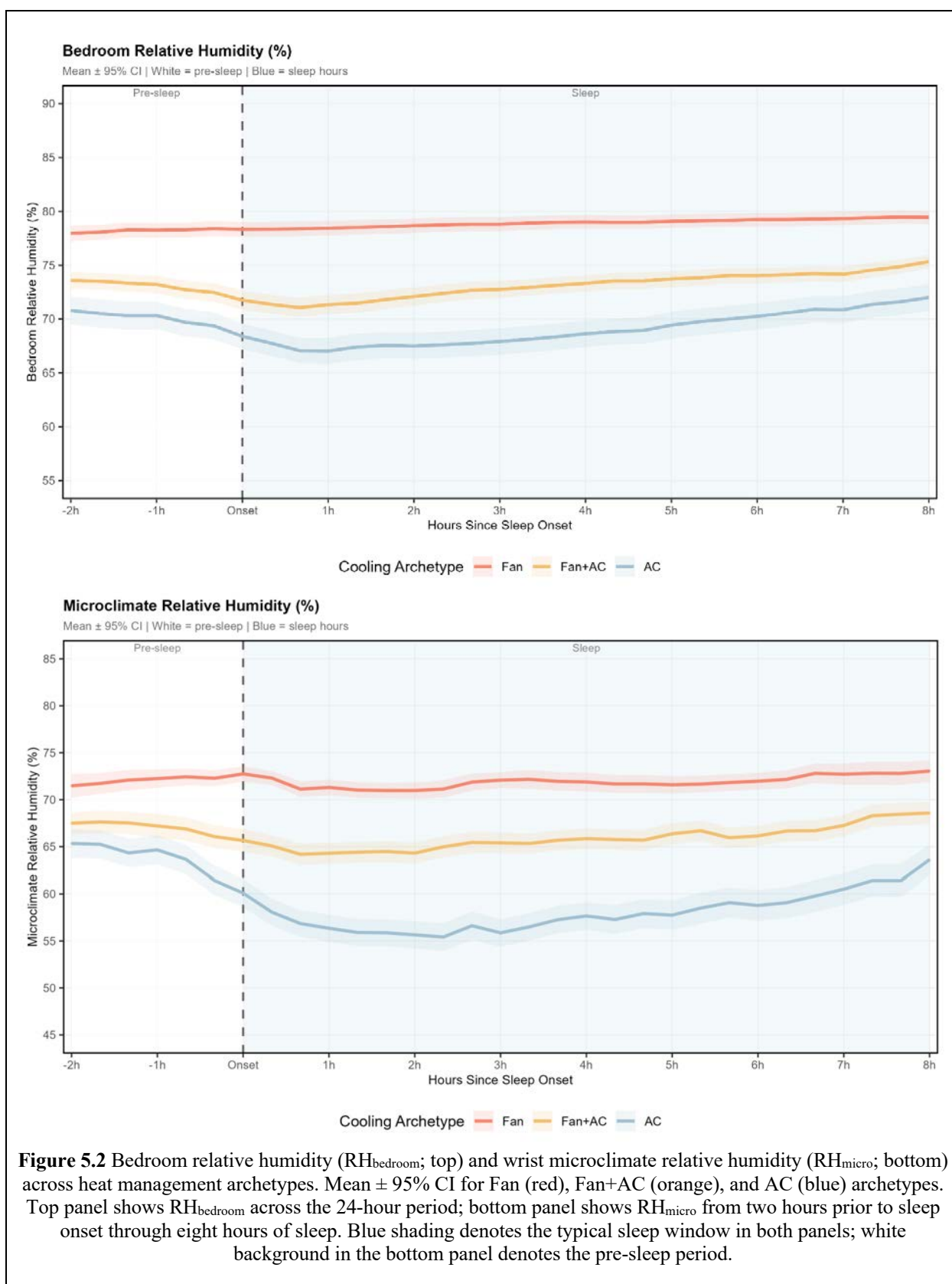
This moderate elevation of T_{micro} relative to T_{bedroom} across all archetypes may be explained by behavioural factors; specifically, participants may have covered themselves with clothing or bedding during sleep. Such behaviours insulate the skin surface from the cooler ambient environment, thereby attenuating the transmission of room-level conditions to the wrist microclimate. Additionally, the elevation of T_{micro} is likely compounded by the physiological rise in T_{wrist} during sleep, driven by sympathetic-adrenergic withdrawal and peripheral vasodilation as part of the nighttime sleep thermoregulatory response (Raymann & Van Someren, 2008). As wrist skin temperature naturally elevates during sleep, the microclimate sensor, positioned in close proximity to the skin surface, would inherently capture this thermal emission, partially decoupling T_{micro} from the ambient T_{bedroom} . Linear mixed-effects modelling confirmed a main effect of archetype on sleep-period T_{micro} ($\chi^2 = 18.2$, $\text{df} = 2$, $p < 0.001$), hours since onset ($\chi^2 = 159.8$, $\text{df} = 1$, $p < 0.001$), and an archetype $\times$ sleep period interaction ($\chi^2 = 19.0$, $\text{df} = 2$, $p < 0.001$).



Bedroom and Sleeping Microclimate: Relative Humidity

RH_{bedroom} profiles differed markedly across archetypes over the 24-hour period (Figure 5.2: top-panel). The Fan group consistently recorded the highest RH_{bedroom} ($79 \pm 4\%$; median: 80%; range: 64–89%), remaining stable across both early and late sleep (early: 79%; late: 80%). In contrast, the Fan+AC ($73 \pm 7\%$; median: 75%; range: 49–86%) and AC ($69 \pm 10\%$; median: 71%; range: 45–91%) groups maintained lower and broadly comparable humidity levels during the sleep period. The comparable RH_{bedroom} between Fan+AC and AC archetypes is explained by the shared use of AC, where dehumidification occurs as a byproduct of cooling regardless of duration; even the Fan+AC group's pre-sleep AC use was sufficient to reduce bedroom humidity before sleep onset, with the effect persisting into the sleep window. Linear mixed-effects modelling revealed main effects of archetype ($\chi^2 = 22.1$, $df = 2$, $p < 0.001$), hours since onset ($\chi^2 = 756.0$, $df = 1$, $p < 0.001$), and an archetype $\times$ sleep period interaction ($\chi^2 = 111.0$, $df = 2$, $p < 0.001$), indicating that the three archetypes followed distinctly different RH_{bedroom} trajectories across the sleep period.

In contrast to the room-level differences observed for temperature, RH_{micro} (Figure 5.2: bottom-panel) during sleep demonstrated a clearer separation across all three archetypes. The Fan archetype recorded the highest RH_{micro}, remaining broadly stable across the sleep period ($72 \pm 6\%$; median: 72%; range: 41–100%). The Fan+AC archetype maintained intermediate values ($66 \pm 10\%$; median: 67%; range: 31–100%), while the AC archetype recorded the lowest RH_{micro} ($58 \pm 12\%$; median: 58%; range: 32–100%), with a gradual upward drift observed across early to late sleep in all groups (Fan: 72% to 73%; Fan+AC: 65% to 67%; AC: 57% to 60%). Unlike T_{micro}, which converged across archetypes despite differing room-level conditions, RH_{micro} appeared more sensitive to the ambient humidity environment, with the dehumidifying effect of AC use reflected more directly at the body surface. Linear mixed-effects modelling confirmed main effects of archetype ($\chi^2 = 30.9$, $df = 2$, $p < 0.001$), hours since onset ($\chi^2 = 331.5$, $df = 1$, $p < 0.001$), and an archetype $\times$ sleep period interaction ($\chi^2 = 55.4$, $df = 2$, $p < 0.001$).



5.4 Thermoregulatory and Cardiovascular Responses Across Heat Management Archetypes

Having established that heat management archetypes differed meaningfully in both room-level and body-surface thermal and humidity exposures, we next examined whether the differences were reflected in thermoregulatory and cardiovascular responses during sleep. Wrist skin temperature (T_{wrist} ; °C) was recorded using an iButton thermistor logger secured to the dorsal surface of the wrist using a harness, logging at 20-minute intervals throughout the monitoring period. The thermal gradient (T_{gradient} ; °C), defined as the difference between T_{wrist} and T_{micro} , was subsequently derived as an index of the heat exchange driving force between the body surface and the immediate surrounding microclimate.

All three groups showed a sharp rise in T_{wrist} (Figure 5.3: top-panel) at sleep onset, stabilising within a narrow range across the sleep period. Fan and Fan+AC archetypes recorded the highest T_{wrist} values (Fan: $33.3 \pm 1.6^\circ\text{C}$; median: 33.6°C ; range: $25.5\text{--}36.2^\circ\text{C}$; Fan+AC: $33.4 \pm 1.4^\circ\text{C}$; median: 33.6°C ; range: $25.3\text{--}37.0^\circ\text{C}$), with the AC archetype recording slightly lower values ($32.9 \pm 1.5^\circ\text{C}$; median: 33.1°C ; range: $25.0\text{--}36.7^\circ\text{C}$). A gradual downward drift was observed across all groups through the latter sleep hours (Fan: 33.4°C to 33.1°C ; Fan+AC: 33.5°C to 33.1°C ; AC: 33.0°C to 32.7°C), consistent with the progressive dissipation of heat accumulated at sleep onset. This elevation trend was consistent with the rise in skin temperature during sleep. All archetype groups demonstrate T_{wrist} elevation, approximately 1°C compared to two-hours prior to sleep. This reflected a decrease in sympathetic-adrenergic tone during nighttime recovery, which promotes peripheral vasodilation and passive heat dissipation, thereby lowering body core temperature to initiate and sustain the sleep cycle (Rodrigues & Pedrazzoli, 2026; Raymann & Van Someren, 2008). T_{wrist} showed no main effect of archetype ($\chi^2 = 4.5$, $df = 2$, $p = 0.106$) and no pairwise differences between groups, though archetype $\times$ sleep period interaction was detected ($\chi^2 = 6.6$, $df = 2$, $p = 0.037$), indicating that while overall T_{wrist} levels did not differ meaningfully between archetypes, the groups followed slightly different trajectories across the night. A main effect of hours since sleep onset ($\chi^2 = 365.7$, $df = 1$, $p < 0.001$) confirmed a consistent pattern of change in wrist skin temperature across the sleep period regardless of archetype.

The T_{gradient} profiles (Figure 5.3: bottom-panel) further contextualised these findings by quantifying the heat exchange driving force between the wrist surface and the immediate surrounding microclimate (Romanovsky, 2014). The AC archetype maintained the largest T_{gradient} throughout the sleep period ($2.5 \pm 1.3^\circ\text{C}$; median: 2.6°C ; range: $-4.0\text{--}6.7^\circ\text{C}$), reflecting the greater differential between wrist skin temperature and the cooler surrounding microclimate. Fan and Fan+AC archetypes exhibited smaller and broadly stable T_{gradient} values throughout the sleep period (Fan: $1.7 \pm 1.1^\circ\text{C}$; median: 1.9°C ; range: $-4.4\text{--}6.3^\circ\text{C}$; Fan+AC: $1.9 \pm 1.3^\circ\text{C}$; median: 2.0°C ; range: $-5.1\text{--}7.1^\circ\text{C}$), consistent with the narrower differential between their body surface and ambient microclimate temperatures. A modest decline in T_{gradient} was observed across the sleep period in all groups (AC: 2.7°C to 2.5°C ; Fan: 1.8°C to 1.7°C ; Fan+AC: 1.9°C to 1.8°C). For T_{gradient} , main effects of archetype ($\chi^2 = 19.1$, $df = 2$, $p < 0.001$), hours since sleep onset ($\chi^2 = 16.5$, $df = 1$, $p < 0.001$), and an archetype $\times$ sleep period interaction ($\chi^2 = 10.0$, $df = 2$, $p = 0.007$) were observed, with AC users maintaining the largest thermal gradient throughout sleep; Fan and Fan+AC did not differ from each other, while both differed from AC.

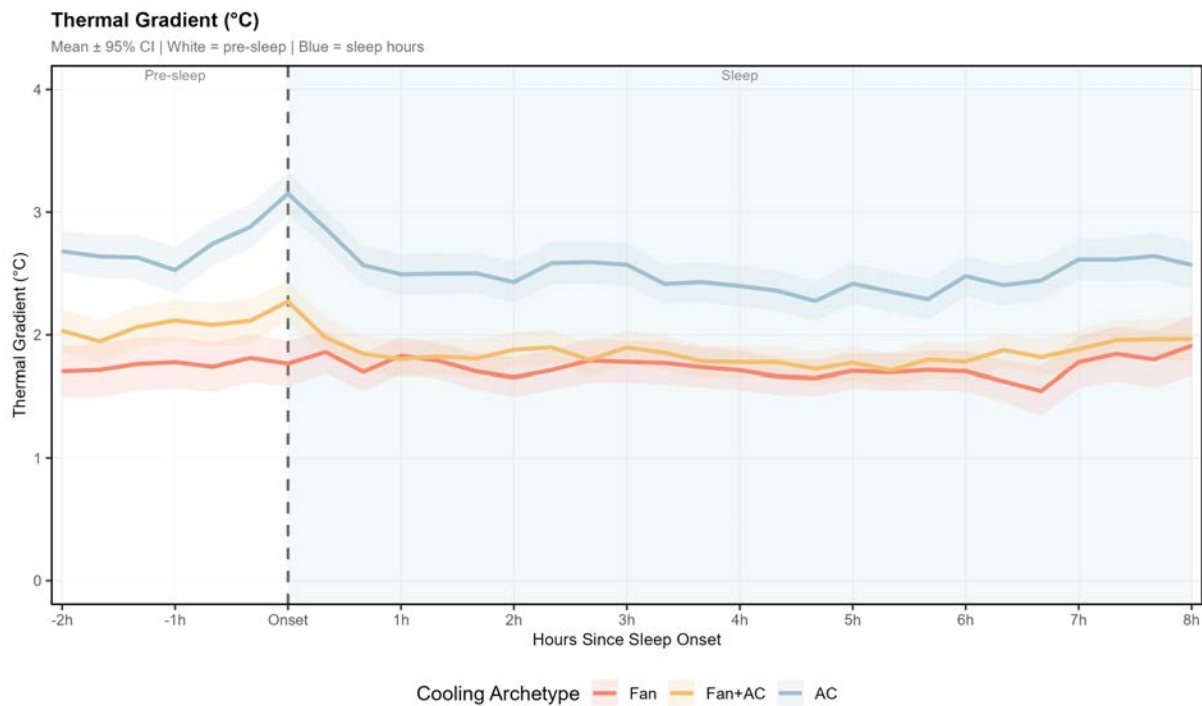
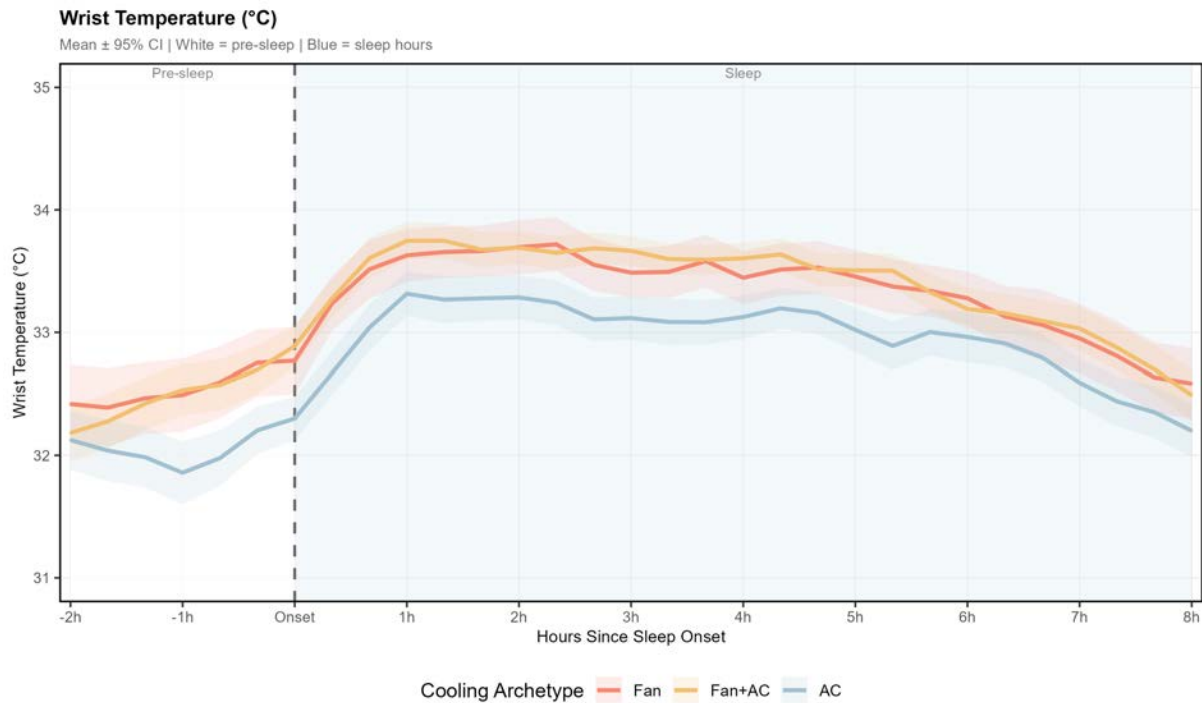
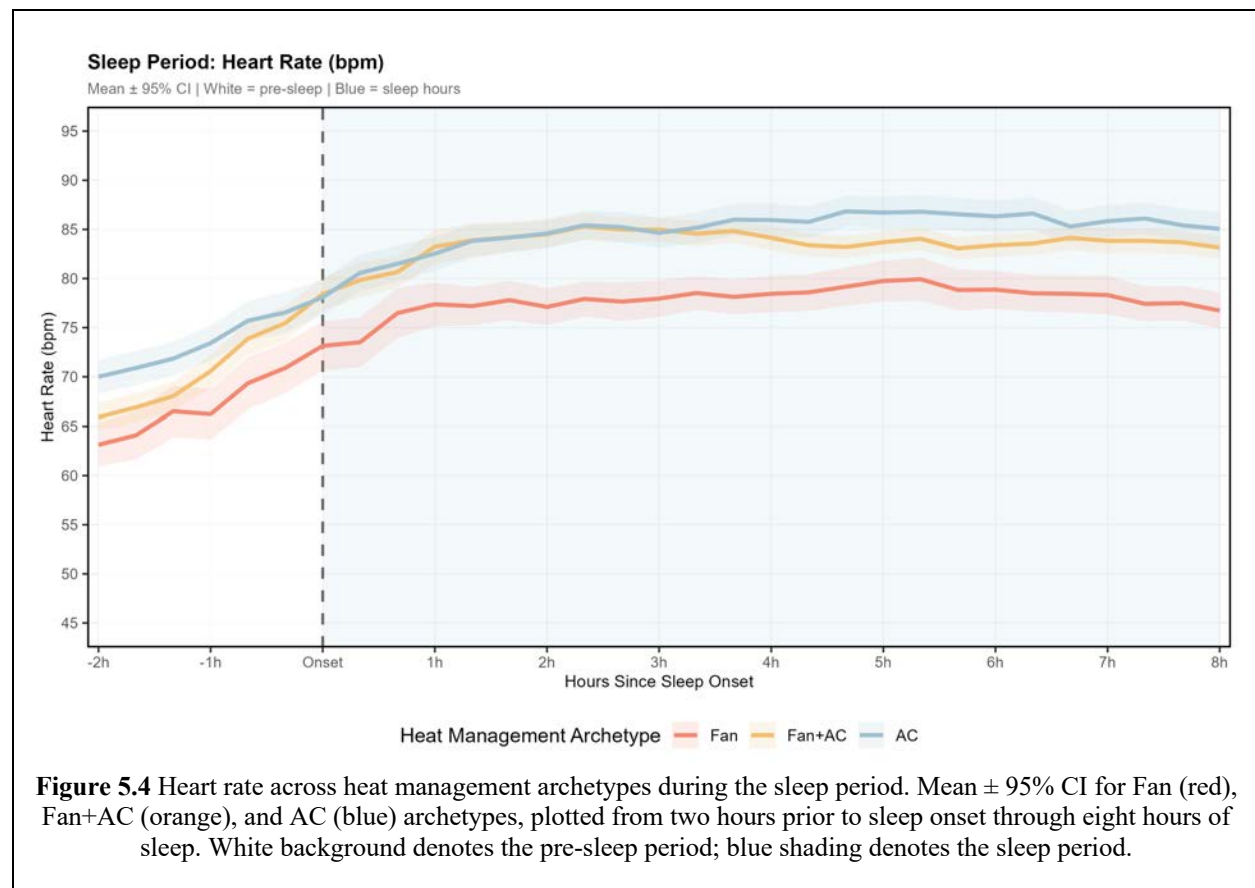


Figure 5.3 Wrist skin temperature (T_{wrist} ; top) and thermal gradient (T_{gradient} ; bottom) across heat management archetypes during the sleep period. Mean $\pm$ 95% CI for Fan (red), Fan+AC (orange), and AC (blue) archetypes, plotted from two hours prior to sleep onset through eight hours of sleep. White background denotes the pre-sleep period; blue shading denotes the sleep period.

Heart rate (HR) profiles across the sleep period are presented in Figure 5.4. In three cooling archetypes, HR gradually increased during the first two hours after falling asleep, levelled off in the middle of the night, and then slowly declined toward morning. This pattern was broadly consistent with normal sleep physiology, though the relatively high HR observed throughout the night, compared to what is typically seen in cooler, laboratory settings, likely reflected the warmer sleeping environment experienced by participants in this study (Okamoto-Mizuno & Mizuno, 2012). The Fan archetype maintained the lowest mean HR throughout the sleep period (78 ± 13 bpm; median: 78 bpm), followed by Fan+AC (84 ± 12 bpm; median: 83 bpm) and AC (85 ± 14 bpm; median: 85 bpm). Linear mixed-effects modelling revealed a main effect of archetype on HR ($\chi^2 = 6.2$, $df = 2$, $p = 0.044$), a main effect of hours since sleep onset ($\chi^2 = 108.7$, $df = 1$, $p < 0.001$), and an archetype $\times$ sleep period interaction ($\chi^2 = 33.2$, $df = 2$, $p < 0.001$), indicating that the archetypes diverged in their HR trajectories across the night. However, when this model was further adjusted for body characteristics (age, sex, and BMI), the archetype effect on HR was no longer detected, suggesting that the observed differences were influenced by underlying demographic and body composition differences between groups rather than cooling strategy alone.



5.5 Thermal Perceptual Responses Across Heat Management Archetypes

Thermal perception data were gathered from thermal diary and activity log entries completed during the waking hours, capturing participants' appraisal of their thermal experience. As direct perceptual reporting during sleep was not feasible, these daytime reports provide the closest available proxy for participants' subjective evaluation of their thermal environment and should be interpreted alongside the objective environmental and physiological measures reported in Sections 5.3 and 5.4. To explore the distribution of subjective thermal reports across the three heat management archetypes, each scale score was expressed as a percentage of total reports within each archetype, allowing any archetype-level differences in perceptual trends to be identified across the three cooling strategies.

Thermal perception reports across sensation, satisfaction, and preference scales revealed broadly similar distributions across archetypes, though with notable dynamic nature of thermal perceptions (Jiang & Niu, 2024) and differences in the spread and skew of responses (Figure 5.5).

Thermal sensation was distributed across the warm side of the scale for all three archetypes, broadly consistent with the warm and humid sleeping environments documented in Section 5.3. The Fan archetype showed the broadest distribution, with responses spread across scores -1 to $+3$ and a notable concentration at $+1$ (approximately 25%), suggesting that a substantial proportion of Fan participants perceived their environment as slightly warm, consistent with the elevated T_{bedroom} and T_{micro} recorded in this group. The data obtained from ethnography interviews also supported this finding, describing Fan participants as having normalised their thermal environments through long-term habituation: CRC29A's "got used to it" and CRC39B's "well trained" framing; which explains why Fan participants' sensation reports were distributed across a broader range with less extreme hot sensation, despite objectively warmer conditions. Having habituated to variable thermal conditions, Fan participants would be expected to report a wider range of sensations than AC users whose environments were more precisely controlled.

The Fan+AC archetype exhibited a distribution shifted towards neutral, with the largest proportion of responses clustering at 0 (approximately 31%), suggesting that pre-cooling the bedroom prior to sleep onset was associated with more thermally neutral overnight appraisals. The ethnographic data directly explains the Fan+AC group's clustering around thermal neutrality. Pre-cooling the bedroom with AC before sleep onset would produce a thermally neutral or slightly cool environment at the period most salient for thermal appraisal, consistent with the higher proportion of neutral (0) sensation reports in this group. The AC archetype showed a broadly similar distribution to Fan+AC, with responses concentrated around 0 to $+1$, though with a slightly higher proportion at $+2$ (approximately 22%), suggesting that despite maintaining the coolest bedroom environment, a meaningful proportion of AC participants still perceived some degree of warmth. This may partly reflect a reporting tendency toward neutrality over extreme values when thermal expectations are met, as suggested by Schweiker & Wagner (2020), consistent with the controlled and predictable nature of the AC environment.

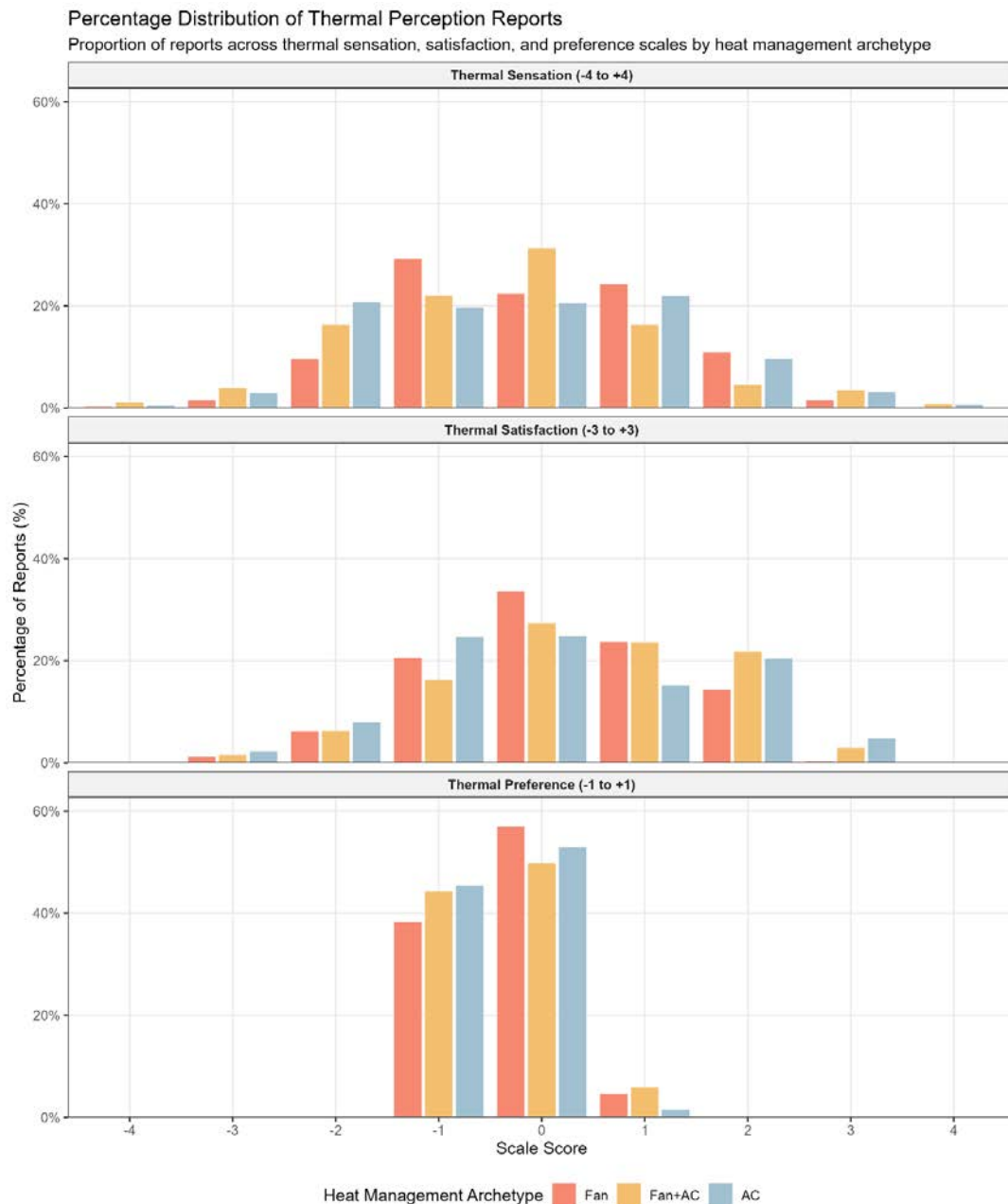


Figure 5.5 Percentage distribution of thermal perception reports across thermal sensation (top), thermal satisfaction (middle), and thermal preference (bottom) scales by heat management archetype. Fan (red), Fan+AC (orange), and AC (blue). Thermal sensation is scored from -4 (very cold) to +4 (very hot); thermal satisfaction from -3 (very dissatisfied) to +3 (very satisfied); and thermal preference from -1 (cooler) to +1 (warmer), with 0 indicating no change desired or neutral.

Thermal satisfaction was similarly concentrated around neutral to moderately satisfied scores across all archetypes, indicating that participants were broadly tolerant of their thermal environments irrespective of cooling mode. The ethnographic data on thermal resignation is directly applicable here. CRC29A's "beggars can't be choosers" resignation to fan cooling, CRC05B's acceptance of fans due to cost constraints despite a "hidden preference" for AC, and the general framing of home as a comfortable refuge all point to a cultural norm of thermal tolerance that would suppress dissatisfaction responses across all archetypes, consistent with the broadly similar satisfaction distributions observed. The Fan archetype showed the highest concentration at 0 (approximately 33%), with a moderate spread towards positive satisfaction scores, suggesting that while Fan participants perceived warmth, many remained thermally satisfied with their conditions. This is consistent with evidence that occupants in tropical climates tend to report higher thermal satisfaction at elevated temperatures compared to temperate climate occupants, likely reflecting acclimatization and adaptive expectations shaped by long-term exposure to warm and humid conditions (Tochihara & Saat, 2022).

The Fan+AC and AC archetypes showed broadly comparable satisfaction distributions, suggesting that active cooling, whether through pre-cooling or continuous AC, produced similarly satisfactory thermal conditions overnight, with both groups peaking at 0 (approximately 27–28%) and a gradual spread towards positive and negative scores. The AC archetype recorded a slightly higher proportion of responses at +2 (approximately 22%) relative to the other groups, suggesting marginally greater thermal satisfaction among participants using continuous AC, though the overall distributions remained closely aligned across archetypes, reinforcing the view that thermal satisfaction in this population was shaped by adaptive tolerance and cultural expectation.

Thermal preference responses were consistent across all three archetypes, with the large majority of reports concentrated at 0 (no change desired), ranging from approximately 50% in Fan+AC and AC archetypes to approximately 57% in the Fan archetype. A substantial proportion of responses in the Fan (approximately 39%) and Fan+AC and AC (approximately 45–46%) archetypes indicated a preference for cooler conditions (score –1), while very few participants across any archetype expressed a desire for warmer conditions (score +1). In the previous Section 4: Ethnography, many fan-reliant participants harboured a "hidden preference" for AC if cost were not a consideration, with CRC05B stating "of course I'll put aircon" if money were no object. This latent preference for cooler conditions, suppressed by cost rather than genuine thermal satisfaction, directly explains why even Fan participants expressed a preference for cooler conditions in a substantial proportion of reports. Despite already occupying the coolest environment among the three archetypes, AC users' average setting of 24.7°C appeared to have been adequate but not ideal, pointing to an underlying preference for even cooler conditions.



Chapter 6

History: Understanding the Past and Present of Heat Management in Singapore



6. History: Understanding the Past and Present of Heat Management in Singapore

What can history, particularly WG2's oral history interviews and Singapore's national historical context after 1965, tell us about the heat experiences of Singapore households? How did the shift from rural to urban high-rise public housing change the heat experiences, and how did such a shift shape household heat management practices? Taking WG2's main research question of Singaporean households' heat experiences as the starting point, we used Shove's Social Practice Theory (SPT) framework to interpret the oral history interviews, triangulating the interviews' findings with the ethnographic and household tour interviews. Through such analysis, we pioneer a historical interpretation of household heat management in Singapore.

6.1 Section Highlights

- The relationship between exposure to AC space cooling in the workplace does not lead to a direct transfer or replication of standards and practices in domestic spaces. Our findings show that air-conditioning practices and standards are primarily determined by household circumstances and needs.
 - There was continued carriage of past heat management strategies into the present, regardless of the level of air-conditioning usage at home. In other words, mixed heat management strategies continued in both high and low AC usage situations, and one should not presume that a shift towards high AC usage and dependency will lead to a displacement of time-honoured heat management practices.
 - Electric fans emerged as an essential skill and technological tool that constantly mediated the heat and humidity of high-rise household living conditions. The fan was mostly used in conjunction with different passive ventilation techniques, making household living conditions more bearable. The fan also enabled the continued adoption and employment of time-honoured practices, especially heat tolerance, where several participants continued to adopt a non-air-conditioned, warm-oriented lifestyle for the long-term.
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6.2 Introduction

At the end of the oral history interview (OH) with participants CRC14A and CRC14B, a husband-and-wife couple with three children who stay in Punggol (the northeastern part of Singapore), CRC14B shared an insightful perspective on how her thermal history influenced her decision to buy a new Built-To-Order (BTO) public flat. ‘So I think the past residences and habits have shaped my choices’, she stated as-a-matter-of-factly (OH). She continued:

So...when I'm young I eat ice cubes or dress light like PE [Physical Education] attire or go under sheltered walkways as much as possible when walking from home to school... And seeing my parents' choice of housing in more well-ventilated breezy areas so influence[d] my current vision [sic], which is, I don't eat ice cubes [anymore]...but like I'll eat ice cream and cold drinks as a heat measure. And at the same time, I can't think of any other heat management strategies apart from...dressing lighter and also using a lot of aircon and fan so which led to my future vision [sic]. I realised the best heat management strategy is on top of what I'm doing now [in terms] of drinking cold drinks and dressing light and aircon/fan, [that] is to buy a house that is high floor [and] more unblocked and better facing. Which is what we did... And I noticed another thing that is, apart from the house itself, the windows and doors facing the corridors matter a lot. If I look back at my Hougang, Marine Parade houses...the corridors are very well-ventilated. There's no full walls blocking the air outside [sic]. So it's very breezy along the corridors and some of that [wind] flows in[to] your house... It's only after moving here [that] I realised we don't have a lot of unblocked corridors... So I did make sure that [for the BTO flat]...the corridors of the block...super allows for very good wind flow.

CRC14B's account is significant in two ways. First, she highlights that since her younger days, heat management comprised a mixture of practices, including light dressing, ingesting ice cubes, using sheltered walkways, and a well-ventilated home. These practices stayed similar when she moved into her current house but evolved to include ice cream consumption and high usage of AC and electric fans. The high usage of mechanical cooling devices was due to the house's lack of natural ventilation and direct sunlight. “[W]e're restricted by what we can do to cool down the house”, CRC14B commented exasperatedly. Their solutions were “[j]ust fan speed, aircon... and we draw the curtains” (household tour; HT). Second, she concluded that following her parents' “vision” of buying a well-ventilated house—which included core features like a high-floor unit, lack of blockage from other high-rise buildings, north-south facing apartment orientation, and an unblocked corridor—was the ultimate strategy for heat management as it could significantly reduce the usage of air-conditioning and electric fans. As CRC14B put it, “My childhood home...in Marine Parade [is] so breezy...I didn't need much aircon and fan” (HT).

From a social practice lens, CRC14B comes across as a skilled practitioner of household heat management who looked to maximise the range of strategies she had learnt since her youth and implement them in her present circumstances. She demonstrated a nuanced grasp of (i) the meanings/understandings, skills/competences and materials needed for undertaking the mixed range of strategies in her current situation, as well as (ii) how to create a more effective combination of strategies for her family's thermal future by strategising a shift to a potentially well-ventilated high-rise unit (Strengers & Maller 2017). This also made her an embodied ‘carrier’ and producer of mixed household heat management practices, in terms of how her time-honoured practices, especially those which she deemed as effective, directly shaped her current strategies and decisions for the future (Strengers & Maller 2017). Interestingly, though she admitted a strong reliance on AC space cooling, her account reduces the role of the AC and repositions it as part of

a combination of strategies to manage heat at home. She even went as far to imagine a probable future with low AC reliance. This goes against the dominant narrative of Singapore as a highly AC-dependent nation (or what we call the ‘AC Nation’ narrative) and highlights the need to look at household heat management in a multifaceted manner—a point which this section makes.

This section aims to understand the heat management histories of Singapore households through a social practice lens. Specifically, this means placing an analytical emphasis on the diversity of strategies, as well as the usage patterns of these strategies to craft a people’s history of household heat management that engages the voices and practices of the participants of WG2 on their own terms. Historiographically, this analysis moves away from reductionist interpretations of high AC dependence and usage—as represented by the AC Nation narrative—which impose a top-down, nation-state modernisation view on Singapore’s thermal history since the country’s independence in 1965.

As Singapore made rapid transitions into an industrial, high-technology and wealth-based economy since independence, this required the construction of hermetically sealed high-rise industrial and commercial spaces, as well as an extensively interconnected transport network which were all cooled by the AC. Such a narrative presumes that Singapore households took on a similar trajectory—especially in terms of thermal comfort standards—and moved inexorably towards the adoption of AC as a primary household heat management method. An oft-cited study of the AC experiences and perspectives of eight Singaporean young adults (20s age group) during the 2000s also makes this case, overstating, on the basis of their small sample size, that they “could easily imagine many Singaporeans becoming locked into a cycle of increased reliance on air conditioning... [As] for the moment it is clear that many young people in this country [Singapore] feel increasingly unable to live without air conditioning” (Hitchings & Lee, 2008). A lack of humanities and social science scholarship on AC usage and thermal experiences in Singapore has allowed such interpretations to persist without correction. Therefore, we seek to revise interpretations on the inevitability of high AC reliance in Singapore by arguing that the selective usage of the AC, mixed household heat management practices, and constant usage of the electric fan as an essential strategy were key practice elements that emerged in the heat management histories of the WG2 households.

It is pertinent to note that we agree with wider historical literature on the trend of increased AC ownership and the concomitant increase of AC usage in Asia since the second-half of the twentieth century (Courtney 2023; Razem & Sunikka-Blank 2022; Sahakian 2014; Wilhite et al. 1999). However, the point we are seeking to make through the WG2 household data is that increased AC ownership and usage does not necessarily lead to AC reliance, which we define as a dependence on AC cooling over other forms of heat management. For instance, while rapid urbanisation, structural factors, and the increasingly extreme summer urban heat temperatures by the 2000s led to a direct linkage between Wuhan’s AC ownership rates and reliance on AC cooling because “they had few alternative options [e.g., sleeping outside the house] to make the heat tolerable” (Courtney 2023), this is not the case in Singapore’s context. As we shall see, many households selectively adopted AC for specific purposes, such as sleeping at night or as an emergency measure, indicating that households do not merely rely on the AC as a primary heat management strategy.

Methodologically, the section draws from the data of the oral history interviews of the 39 CRC households (n=60 participants) through a case study approach. This is supplemented by the data from the ethnographic and household tour interviews. Though these two latter interview categories stress current heat management practices, participants would often articulate statements which reflect the long-term nature and origins of their practices. Thus, when required, each household’s oral history interview data is triangulated and

corroborated with data from the other two household interview types. This section draws on selected household case studies to support the main arguments. To ensure balance, households with both low- and high-AC reliance are used in the analysis. As with most historical analyses, the section's findings and arguments should not be taken as universal truth-claims; instead, they provide insights and perspectives that can be considered for policy making or the formulation of interventions for specific contexts.

The broad observation of this section is the high level of continuity that persists in household heat management practices, particularly when tracing from earlier contexts where there was lower availability and less usage of mechanical cooling devices like fans and AC. Heat management in the household, we argue, continues to be shaped by time-honoured practices, such as light dressing, hydration, bathing, passive ventilation strategies, consumption of traditional medical, herbal and food remedies, and lying on the floor. Time-honoured practices can thus be understood in two senses: they comprise both everyday and/or commonsensical, and medically-shaped materials, competences and meanings for heat management. The former can be taken as “know-how”, that is, “practical knowledge, as distinct from factual or theoretical knowledge’...householders draw on to make sense of what to do during weather than may be at risk to health”. The latter, on the other hand, can be seen as both know-how and “know-what” (i.e. “formal knowledge”), due to both its epistemological basis in traditional medicines and flexible/commonsensical usage as a daily tool for heat management (Nicholls & Strengers 2017). One key shift, we propose, is the emergence of the electric fan as a key mediator in maintaining a basic level of tolerance for a hot-humid environment. With the loss of windy and naturally ventilated conditions in rural living due to the nationwide shift to high-rise living, the electric fan became the replacement that mitigated this loss of natural wind in household environments. We unpack this broad observation through the following three sections: (a) Different Standards and Practices, (b) Not Just the AC, and (c) The Electric Fan.

6.3 Different Standards and Practices: Widespread Out-of-Home AC Usage vs. Selective Household AC Usage

The AC Nation view, originally coined by Cherian George as a critique of Singapore's politics of “comfort” and “central control”, seems to broadly suggest the inevitability of an insatiable demand for the AC and its cool comfort occurred in accordance with rising aspirations for higher living standards as Singapore modernised and grew wealthier under the People's Action Party government (George 2000). As mentioned, Hitchings and Lee (2008) extend this interpretation from a bottom-up perspective, positing the strong likelihood of a high-AC reliant and low heat tolerance future in Singapore on the basis on the thermal experiences of eight Singaporean young adults. Statistics on rising household AC ownership have been used to support this view. George (2000) mentions that ownership of a single household AC unit increased significantly from 1988 to 1997, from less than a fifth to more than half of households in Singapore. A recent media commentary cited that 99% of condominiums in Singapore own AC units (Muruganathan, 2021). Hicks (2018) reports a projection that the amount of energy for cooling Singapore—which derives mostly from AC—is expected to rise by 73% from 2010 and 2030. Understood from these various angles, the data suggests that Singapore has been on the path of normalisation towards high AC usage and dependency, especially in the residential setting.

Findings from our oral history interviews (and the other interview types) suggest the contrary. While most households owned AC units, ownership did not necessarily equate with the normalisation of high AC usage and dependency in their daily domestic lives. Importantly, though many participants worked in indoor-based jobs which exposed them to long hours in AC environments, such indoor work-based standards and practices of AC usage did not automatically translate to a trend of higher household AC usage. What we find is that, historically, there was a development of differing AC usage standards and practices between indoor workspaces and the home, and this can be observed by the selective adoption and appropriation of AC usage in the households.

Some historical context is needed to clarify why such a finding arises. Two major nation-wide changes occurred in post-independence Singapore which drastically reshaped the built environment context. The first was the two phases of industrialisation. The first phase witnessed the rise in mass production of lower-end goods (e.g., textiles, toys, electronics) for export and large-scale industrial development (e.g., Jurong Town Corporation) during the 1960s and 1970s. This was followed by a shift towards a knowledge-based economy and industrialisation since the 1980s, focused on sectors like biomedical research, advanced manufacturing and the production of high-end technology, along with the development of a strong financial sector. Industrialisation created many jobs for Singaporeans, which meant a general society-wide occupational shift towards indoor-based work in mass industrial complexes and commercial buildings. Indoor occupational work became the norm, and not the exception. By extension, this led to high levels of AC exposure in such workplaces. The second major shift was the national transition to mass high-rise public housing, which begun in the late 1960s. This transition occurred alongside industrialisation, and facilitated the entry of electric fans, and subsequently, window and split-system AC units (along with other electrical appliances, as well as private vehicles like cars) into public housing (see, Chew 2023; Industrial Revolution n.d; Menon 2015). The bridge between industrialisation and public housing was that job creation and security through industrialisation generated the wealth needed for Singaporeans to afford these mechanical cooling devices for household use. Thus, a critical question that emerges was whether the concurrent rise of industrialisation and public housing also led to some kind of transfer of the high AC usage standards and practices from the industrial/commercial settings to the public-housing domestic contexts of Singaporeans?

Three cases from WG2 illustrate that such a transfer did not largely happen. Rather, domestic reasons and circumstances dictated the selective adoption of AC at home:

CRC12A's Account. CRC12A, a retired administrative professional who was born in the late 1950s, experienced Singapore's concurrent industrial and public house transition. After staying in a rented subdivided shophouse unit in Chinatown from 1958 to 1984, she transited to the public housing system, staying in a total of four rental and owned flats in the central, western and eastern regions of Singapore. Professionally, CRC12A started to experience daily exposure to the AC when her administrative career in the government began in the early 1980s. Prior to that, her job experience comprised short-term jobs in departmental stalls, factory production, and a confectionary. These short-term jobs exposed her to a variety of thermal environments.

On an individual level, daily exposure to AC in her early years of government work did lead to some level of transfer in standards and practices, but not in the form of AC use: she purchased her first electrical fan, which she considered a luxury item in the early 1980s. As she put it, the cool pleasure of AC at work invoked a personal response for seeking thermal comfort at home. She asked, "Then I also feel that why is it I cannot have a fan [since I feel hot at home]? You know, I mean...I can stop using a handheld one [fan]."

So, I ended up...pass[ing] by an electrical shop...[and] since I still have money to spare...I went to buy one [electrical fan]" (OH).

Such transfer of standards and practices did not occur at the household level. While electrical fan usage became normalised in the flats that she stayed in, AC units were not installed in those flats until she moved into her current Jurong West apartment in 1994. When questioned on why she did not install AC units in those flats, she replied that the flats were "cooling" and AC installation "didn't cross our mind" (OH). In Jurong West, the AC units were initially used for cooling on certain nights. However, due to higher electricity bills and the development of asthma in her two young children, AC usage was gradually reduced to the point where it became "void", and they "more or less [got] used to fans" (OH). In this sense, AC usage was adopted according to the needs of CRC12A's household.

CRC01A&B's Account. A lack of transfer in standards and practices is also observed in the household of CRC01A and CRC01B (born in the late 1960s and early 1970s respectively). They are an upper-middle class married couple with two children who live in a private apartment in Bukit Timah, one of the most expensive residential areas in Singapore. As both have worked in professional careers since the 1990s, they were mostly exposed to indoor AC work environments throughout their working lives. In their marriage homes in Bukit Timah, both developed the habit of sleeping in the air-conditioning, despite coming from households which did not use much AC.

Nonetheless, high exposure to workplace AC was not the reason for their selective adoption of AC for sleeping. Instead, it was largely due to CRC01A's influence, who started adopting the habit of sleeping with AC when he moved into a condominium in Pasir Panjang with his family in the 1990s, prior to their marriage. Before moving into the Pasir Panjang condominium, he managed heat in his previous homes through natural ventilation and electric fans.

CRC01A's new habit of sleeping with AC was thus passed on to CRC01B when they got married. This was encapsulated in her phrase "last time I remember he [CRC01A] told me he's an aircon man; now, I have also become an aircon woman" (OH). What this phrase means is that CRC01B acquired the habit of sleeping in AC from CRC01A and became increasingly reliant on the AC for sleeping after marriage. Before her marriage, CRC01B would sleep in a non-AC room, mainly dependent on natural ventilation without any usage of electric fans. As she put it, she was able to sleep "even though it's very hot" (OH). This acquired habit of selective AC reliance also extended to her choices for outdoor recreational and social activities, such as choosing AC eateries over non-AC eating spaces to manage outdoor heat, as well as her preference for working in the cool office environment. These AC choices and preferences, nevertheless, did not feedback extensively into their domestic environment and reshape their household AC habits. Despite their wealth, CRC01A and CRC01B were disciplined about maintaining their usage of AC at home. There was no sense of desiring the same level of household AC exposure to what they experienced in the office or through their AC preferences for social activities. This was especially evident during the COVID-19 pandemic period, where both worked from home—no AC was used for their work-from-home schedule in the day. The value of frugality, which was repeatedly brought up in all the interviews, shaped this discipline. CRC01B put it this way: "What I learnt from CRC01A is that we always have to exercise restraint... Okay, so we...know, of course you like to have aircon [for] 24 hours. Then you have to ask yourself whether this is a want or...need. Then you exercise restraint. It [AC] comes only when you sleep" (OH).

CRC34's Account. A counter example is CRC34 (b. early 1990s), a computing professional working for a government-linked investment company who lives alone in a small condominium apartment near Outram, located in the central-western part of Singapore. Contrary to most of the households in CRC, CRC34 lives a fully air-conditioned lifestyle at home, like that of an indoor office environment.

CRC34's story of embracing an air-conditioned domestic lifestyle—which included moving out to a separate apartment—was not due to the influence of increased AC exposure at work or while he studied at Institutes of Higher Education. Rather, it was due to his need to assert his agency over his parents' thermal preferences. As someone who was born in the 1990s, CRC34 grew up in a period where domestic AC systems were becoming commonplace in Singapore. CRC34 grew up with AC in his childhood public flat home in Tampines, but his parents' frugality meant that they rarely used the AC and cooled the house down mostly through electric fans and natural ventilation. "So the aircon is there", he recalled, "but...I don't think they [his parents] turn it on often. Only when it's really hot or we complain it's hot, then they will turn it on" (OH). When he moved to his own bedroom in his childhood years, this low-usage AC habit continued. This stemmed from his parents' philosophy of raising him "with the mentality of not using aircon" (OH).

CRC34 sought to change this situation after he graduated from university and worked in a job that supplied him with financial circumstances to afford daily home-based AC usage. As someone with a warmer body constitution (ET) who disliked the warm conditions at home, he "decided to solve the problem" by paying for his Tampines' home's electricity bills, and that allowed him to "use the aircon as much as I want" (OH). This also factored into his move to the Outram apartment—the whole house had to be airconditioned, a requirement which was provided by the condominium's developer as they pre-installed AC units (OH). Here, we observe that it was the financial independence that was afforded to him through his profession that enabled CRC34 to embrace a fully-AC domestic lifestyle.

Argument from Standards and Practices. Shove et al (2014) consider workplace standards for AC to be shaped by the requirements of specific sectors. For instance, the provision of AC is needed for hotels as AC "has become a normal and expected feature of (at least) high-end hotels in cities around the world" (Shove et al., 2014). This differs for hospitals, where AC requirements can be "framed in terms of specific requirements for clinical performance drugs and different grades of hospital staff" (Shove et al., 2014). That said, they also argue that sectoral standards are mutually reinforced by the social practice of AC usage, where practices like the "conduct of office work" (e.g., wearing business suits), nursing care of patients in intensive care units, and staying in luxury hotel chains have become deeply associated and "synonymous with mechanical cooling" (Shove et al., 2014). Walker et al (2014) illustrates that the convergence of multiple requirements and practices which required AC cooling resulted in the formation of AC as a "need" and standard feature in a British hospital setting. This included the introduction of new monitoring equipment which had to be kept at a cool temperature for continued functioning and the overheating of different parts of the hospital because of a mismatch between building design and the high amount of heat-emitting equipment and people. As these circumstances had a direct effect on clinical and occupational practices, AC cooling became a need and standard to ensure that such crucial work was not compromised.

As we can see, while participants of these selected cases worked in AC conditions in their offices, that was kept as a separate standard and practice from how the AC was used at home. Unlike the occupational settings, there was no uniform AC cooling standard in their homes that was mutually reinforced by multiple practices that required such a standard. Why and how AC was used or perceived as necessary at home was determined by domestic circumstances and bodily preferences. A minor exception is in the case of CRC12A,

where we observe a small transfer of standard from the office to the domestic context. Nonetheless, the outcome from that transfer in standard was non-AC related as CRC12A purchased an electric fan instead of an AC unit. In other words, she substituted the office standard with a standard and practice that was more appropriate for the domestic settings: The electric fan, then considered a luxury (but more affordable) electrical cooling device item which was being purchased by some families for their homes in the 1980s. To be fair, her decision to purchase an electric fan over an AC unit can also be attributed to cost—as she had just started working, she probably did not possess the financial means to purchase an AC unit.

Specifically, framing this analysis through the social practice framework of meanings/understandings, skills and materials, we observe that these CRC participants kept a separate track of AC practices for the home context which was distinct from their workplaces. In particular, the meanings/understandings element stands out: all three cases framed their meanings/understandings of AC for home usage through their domestic circumstances and values. For CRC12A, it was the effects of AC on the health circumstances of her children, while for CRC01A&B and CRC34, the value of frugality shaped their domestic AC usage decisions in different directions (also see CRC16A, who was exposed to AC at work and liked the coolness, but provided household AC because he was concerned about his children’s welfare, [OH]). To be sure, skills or know-how also affected their domestic AC usage choices: The CRC01 couple knew the importance of AC in providing comfort for sleep (ET); CRC34 understood the benefit of AC in helping him to manage his warmer body constitution; and CRC12A knew that reducing AC usage was helpful for managing her children’s asthma. In short, when analysed from a case-by-case basis, we find that the practices for AC usage at home largely emerged from each household’s thermal history, know-how in terms of AC usage and cooling experiences, and context, and were not learnt and transposed directly from the workplace.

6.4 Not Just the AC: Households with Mixed Heat Management Practices

Extending from the previous part, we supply two case studies of high AC usage and low AC usage households to demonstrate that they continued to “carry” mixed heat management practices from the past to their current households, regardless of the level of AC usage. We argue that the AC did not displace and marginalise other heat management practices; rather, mechanical cooling devices (including the AC) were integrated into a mixed spectrum of practices that was tailored according to each household’s circumstances.

Before proceeding with the case studies, we provide a short historical description of mixed heat management practices in Singapore households since the 1950s.

- Kampung (rural) living or older type properties (1950s to 1980s): Based on CRC accounts, electrical cooling devices were not common in these properties in this period.
 - Various practices included: Dependence on natural ventilation; drinking “cooling” or herbal drinks or eating “cooling” fruits; hydration; manual fans; showering and splashing body with cool water; splashing water on zinc roofs to cool property down; dressing lightly; and tolerating the heat (see CRC02A&B, CRC04, CRC10A&B, CRC16A&B, OH). CRC16A’s family seems to be an exception. Staying in a kampung house in Bedok from the 1960s to 1980, CRC16A was able to enjoy electrical appliances like standing electric fans and refrigerators as his grandfather, who built the kampung house, had the financial capacity to purchase such items. Fan usage was mainly reserved for the occasional hot weather and CRC16A considered these appliances, especially the refrigerator, a “luxury”, explaining that

“Not many have it [a refrigerator]. You have an old fridge. You are lucky” (OH). Extreme heat and heat stress was not a concern in that period. As CRC04 puts it, “having grown up in the kampung, I believe the heat then was still manageable, even [on] a hottest day. Nobody in those days use sunblock [lotion]...Everyone was about bareback flying kite, you know, playing” (OH).

- Public flats (from late 1960s): Most of the practices continued in the public flats, except for specific practices like splashing water on zinc roofs, which were not needed anymore (see Fernandez n.d. for an account of zinc-roof kampungs). The main practice which was introduced alongside the mixed range of practices was the use of mechanical fans and other electrical appliances like refrigerators. As CRC04 put it, “That [moving into the public flat] was the time when we bought our first electric fan... Each bedroom had one, then living room. The fans were relatively affordable... Then same thing. Wear light clothing at home. Really cannot tahan [take it] [as it] is too humid... So what you do is shower. Shower one time two time, three times, or at least wet towel [for] clean[ing]” (CRC04 OH).
 - o The small size of the public flats and large family sizes also meant that staying in the in the house was a squeeze. By circumstance, family members had to sleep on a straw mat that was placed directly on the floor, or in the corridors. As the floor was made of cement (and possibly with a rubber laminate covering it), it was cooling (CRC02A&B, OH). In this sense, sleeping on the floor can be considered an additional cooling strategy that was added. With the introduction of flooring material that was cooler in later years (e.g., marble), there are accounts of participants using sleeping on the floor as an intentional heat management strategy (e.g., CRC12B). In the 1970s, some households were able to afford window AC units, which were placed in specific rooms. By the 1980s and 1990s, split-unit AC systems, especially those from Japan gained popularity, displacing the window AC units (Sahakian 2014). Like the introduction of mechanical fans, the accounts show that AC was integrated into the existing range of mixed heat management practices.

CRC03&B’s Account. CRC03A and CRC03B are a working professional married couple (b. late 1980s) who stay near Bukit Merah (central-western region) with their pet dog. They are the case with high AC usage. The AC is usually turned on whenever they are home. Historically, both do not come from families which promote high levels of AC usage, although CRC03B relied on household AC usage more extensively than her spouse. This means that they have always drawn on a mixture of heat management practices throughout their lives. Despite the high AC usage in their current home, other practices were not displaced but incorporated into their daily heat management routine.

The couple grew up with different thermal preference trajectories. CRC03A was mostly brought up without the use of AC. According to CRC03B, he could “tank [endure] with a fan then” (HT), suggesting he had was tolerant of heat. He stayed in a flat in Sengkang which he considered windy and well-ventilated (OH). Thus, fan and natural ventilation were his family’s main heat management strategies (even though they owned AC units), along with lukewarm or cold showers. An exception was during his CRC03A’s National Service period: he used the AC more frequently when he was home as his Army camp environment was “very hot”. When he returned home from camp, he would “blast [the] aircon and have [a] nice shower”. This habit of turning on the AC for acute relief stopped after he completed his National Service (OH).

CRC03B, on the other hand, was someone who was sensitive and intolerant to Singapore's heat and humidity. Throughout the interviews, she characterised herself as a "polar bear"—a phrase that was key to her current thermal identity and her historical thermal preferences. In one interview, she described it in this manner, "For me, first thing is because the aircon is off, then my reaction will be very hot because it's like I'm in [an] aircon room, [and] suddenly the aircon just [turn] off on me... like immediately I cannot stand [it] one... I need to be like polar bear, very cold" (ET). While she was able to use the AC at home during her growing up years, the usage was negotiated with her father, who shared a room with her. This meant that she was able to use the AC in the room until her father returned home from work, where "he will usually just off it" and switch on the electric fan. This led to instances where she would "be sweating because I really cannot endure just fan" (OH).

Due to CRC03B's thermal preferences and her assertiveness in ensuring that she could live in a cool environment at home, AC was adopted as the main heat management strategy in the marriage home. CRC03A had to adapt to her preferences. As CRC03B puts it, "To me, its 'I want it cool... I'm like a polar bear... So I need it to be cold. And then actually last time he [CRC03A] is not so durable to cold. I think now he is being influenced by me... He used to be okay with just fan then" (CRC03A&B, ET).

A few points should be highlighted about this case, especially regarding their mixed heat management practices:

- This cannot be considered as a case of transfer of workplace standards to the home. As can be seen, the adoption of a fully air-conditioned environment at home was primarily due to CRC03B's thermal preferences. Moreover, although CRC03A is a computing professional who has been working in a perpetually cold AC environment due to industry requirements, he did not transfer his workplace standards to his current home or previous houses. He only started to adapt to a highly-airconditioned lifestyle after getting married to CRC03A. "Like before I got with her [CRC03B]", CRC03A explained, "I was staying with my parents and my parents don't usually [turn] on aircon. It was only recently, like at [this current] home we got aircon and most of the time at office also aircon. So it's like throughout the 24 hours it's...90%...aircon. I can feel the sudden change, without aircon I will feel hot" (CRC03A&B, ET).
- The adoption of a highly-airconditioned lifestyle did not diminish their use of other heat management practices. Firstly, a compromise was reached between the couple regarding AC usage—the AC will be set at the "ideal" temperature of 25°C, along with the ceiling fan, which will be set at speed 3 and 4 to circulate the cool air and ventilate the room. "If I have to choose, I will choose the aircon", CRC03B shared, "But because of my spouse, he's more of a fan person... So we just [turn] on both" (ET). Secondly, besides the combined use of fan and AC, other strategies remained crucial to their heat management: cold water for immediate relief (CRC03B), light dressing (CRC03A&B), regular hydration of lukewarm water (CRC03A), use of the dehumidification mode for the AC (CRC03A), primarily fans and natural ventilation for cooler periods and steamboat gatherings (CRC03A&B), and cold showers (CRC03A).
- Overall, it is evident that the AC and electric fan play a dominant role in their mixture of heat management practices, alongside other time-honoured practices. Despite CRC03B's assertion of her AC thermal preferences in their current home, it is remarkable that their compromise practice and combined AC and fan usage meant that CRC03A was able carry his historic practice of electric fans into the current home as a major strategy. The AC did not displace the different heat

management practices. Rather, the pattern of using these practices was reconfigured in light of their compromise and combined AC and fan usage.

CRC17A&B's Account. CRC17A and CRC17B are a working professional married couple (b. mid 1990s) who stay in a public flat in Bukit Batok (western region of Singapore). They are a case of a household with low AC usage. Their flat is located on a high floor and enjoys unblocked views as it faces a low-lying private estate. This means the flat receives a high amount of wind and ventilation, and this passive ventilation forms an important part of the family's heat management practices. Although they own a split AC unit system, they rarely turn it on, only using it for social occasions or to ensure that they are working (ET). With such low use of the AC, they rely on a mixed set of practices to manage household heat.

The key difference between CRC03A&B and CRC17&B is that the latter couple have thermally convergent historical backgrounds. This meant that they were able to converge on an ideal solution for their heat management strategies: the mixed use of ceiling fans and natural ventilation, along with the usage of other practices which were tailored according to individual variation. For CRC17B, she grew up in a public flat in Woodlands (northern region of Singapore), with a family that was extremely conscious about electricity usage due to their lack of wealth. Other than experiencing nighttime AC usage for sleeping (which was set to turn off automatically after 4 hours) during her primary school years, she adapted to the usage of fans and ventilation for most growing up years. This situation arose because her family did not repair the AC units after they broke down. She described her childhood home as “very hot” (OH). She added. “...overall I just remember that it's [the home, particularly her room] freaking hot. That if I close the door, which I do at night...and I step out of the room, I can feel like the difference in the heat because it's really warm” (OH). As such, CRC17B utilised a large range of strategies to keep herself cool. This included: the heavy use of fan, high levels of hydration, cold water showers, use of shopping malls or water parks to cool down, natural ventilation, and cooling Chinese medicine desserts which were served cold.

CRC17A comes from a wealthier background and stayed in public and private apartments with the following qualities: high floor units and ample wind flow. Thus, even though his homes were equipped with ACs and electric fans, he grew up mainly relying on fans and natural ventilation. This was partly because he had sinus issues, which made him sensitive to the AC. By contrast, his parents slept with the AC. Besides the fan and natural ventilation, CRC17A employed several strategies: drinking cold drinks, eating ice cream, bathing, drinking copious amounts of water (learnt from National Service), and the use of cooling snake powder (learnt from National Service). In terms of electric fans, CRC17A veered towards a preference for ceiling fans—a practice that he picked up staying in his parents' private apartment—because of their bigger area of coverage, as compared to wall fans which he considered “very targeted and...troublesome to clean” (OH).

Similar thermal backgrounds of CRC17A and CRC17B meant that it was easy for them to find a consensus on the primary heat management strategies at home—the use of fans and natural ventilation. This first occurred when CRC17B moved into CRC17A's parents' private apartment and experienced the high level of cross-ventilation that his room received. As she put it, “Yeah. I think 95% of [the] time we use the wall fan... because his room opens up to the balcony, so [when] we open...the balcony door a little bit and then wind comes in” (OH). Subsequently, they carried these primary strategies over to their marriage home and used them alongside the other time-honoured heat management methods from their younger days.

A particular point that stands out in this section's analysis is the continued carriage of past heat management strategies into the present, regardless of the level of AC usage at home. In other words, mixed heat management strategies continued in both high and low AC usage situations, and one should not presume that a shift towards high AC usage and dependency will lead to a displacement of time-honoured heat management practices. Strengers and Maller (2017) highlights the body as a “carrier...of social practice” which “implies the carriage of historical baggage, including our past experiences”. Memories of these practices do not just disappear even when the practice stops; “potential resurrection” can occur when carriers of these social practices are met with new circumstances (Strengers & Maller, 2017). This was especially pertinent in the case of CRC03A's carrying over of the electric fan practice despite CRC03B's dominance in asserting her thermal preference. CRC17A and CRC17B also continued to carry over their past practices (e.g., CRC17A's hydration habits from his army days) even after settling on their highly consensual household heat management practice of fans and natural ventilation.

6.5 The Electric Fan: A “Silent” Technology That Enables Time-Honoured Heat Management Practices

This section argues that the electric fan became the “silent” mechanical cooling device that enabled household heat conditions to remain bearable as the mass transition to public housing began in the late 1960s. For the transition, it partially mitigated the loss of the natural ventilation as Singapore residents moved from their low-lying, open air rural kampung residences to high-rise apartments that were clustered together. Within the public flats, the fans served to alleviate the hot indoor conditions, serving as a “baseline” to make things bearable. CRC17B put it that she “would imagine it [not turning on the fan] would be hot” and that she did not think her family “ever not [had] the fan [turned] on” (OH). Of course, approaches to using electric fan were not monolithic. For example, CRC11 recalled alleviating the heated conditions in her room during the hot months by placing a bucket of ice in front of her fan, allowing the fan to blow cool air on her body (OH). CRC09, who migrated from India to Singapore, mentioned that the table fan in his first rental flat in Tanglin Halt was insufficient for heat management. To solve the problem, he imported a well-known Indian-made ceiling fan (Crompton Greaves brand) made of metal blades and equipped with fast speeds that made the thermal situation “better” (OH).

By making conditions bearable, the electric fan served as a household environmental “baseline” that enabled the continued adoption and employment of time-honoured heat management practices. In other words, the electric fan acted as a complementary mechanical cooling technology which produced conditions that sustained the viability of such practices. This can be contrasted with accounts of the adoption of fully-airconditioned homes in North America and China which led to the displacement and disappearance of time-honoured practices like cooling at the patio of the house and sleeping on bamboo beds outside the house (Cooper 2002; Courtney 2023). On the contrary, time-honoured practices like outdoor sleeping on a bamboo bed were easily paired and used in conjunction with electric fans (Courtney 2023). Specifically, we also propose that the electric fan enabled (and continues to enable) a minority of CRC participants to retain the time-honoured practice of heat tolerance, that is a willingness to accept, bear, preference and live with warm environments. We draw on four case studies to demonstrate these points.

CRC06's Account. CRC06 (b. late 1980s), a male working professional who has been staying in his public flat in Bukit Panjang (western region) since he was a child, grew up without any AC units at home, until he installed a split-AC unit system in his and his sister's bedroom in 2014, when his flat underwent the government-subsidised home improvement programme. Growing up, he relied primarily on the fan and natural ventilation ("occasional winds") to manage the heat at home (OH). CRC06's AC usage was strategic and selective: he used it mainly to cool down his room at night for short periods, before sleeping with the fan and natural ventilation; the AC would also be turned on during unbearably hot days, while only the fan will be used during the cool periods (ET and HT). This aligns with the first part on standards and practices, which shows that domestic AC usage in households is shaped mostly by the domestic context and concerns—an outworking of such a logic is the selective usage of AC for nighttime sleeping. That said, CRC06 preferred AC environments outside (e.g., gym, shopping malls), and he also admitted that working in an office-based environment made him "used to aircon" (ET).

Though CRC06's household AC usage started and became a norm during his adulthood, his usage can be characterised as disciplined and limited. This meant that he remained a heavy fan user, a practice consistent with his growing up years. In a sense, it can be suggested that the AC was utilised to augment his heat management experience at home and did not displace or interfere with the various time-honoured practices he grew up with. As argued in the previous section, AC became part of the mixture of his heat management strategies. Along with his electric fan usage, these practices included the use of natural ventilation (i.e. frequent opening of doors and windows), using open-air spaces around his neighbourhood to cool down (i.e. he frequented a kopitiam near the river/canal, which he found cooling), and his regular use of Chinese medicine herbal remedies and food therapy (which he learnt from his mother) to counterbalance his body's heatiness, due both to hot weather and his "heaty" body constitution (ET and OH).

CRC10A&B's Account. CRC10A (b. mid 1960s) and CRC10B (b. late 1990s) are a mother-son pairing who live in a public flat in Holland Village (central western region). Prior to their move to Holland Village, they lived in a public flat in Commonwealth (central western region). While AC units were installed in both their previous and current places, they have been used strategically and selectively, such as being reserved for night sleeping usage but only for the "very hot season" (OH). This practice continued into the present day, with CRC10B describing it as a "last resort" measure. In contrast to CRC06, the AC was not used to augment their heat management, but rather as a supplementary tool when their current practices became inadequate in meeting their heat management demands. In CRC10A's and CRC10B's household, this meant that electric fans played a central role in meeting heat management demands, along with other practices. This included a range of practices like frequent cold-water showers, constant hydration (a practice passed down by CRC10A), natural ventilation, light dressing, and light cooking (i.e. quick cooking by CRC10A who focused on one-dish meals due to heat in the kitchen). CRC10B recalled the relationship between the electric fan and such practices:

CRC10B (OH)	So I think since young, I personally also kind of grew accustomed to showering with cold water. So...normally I'll just...take another shower because I find that it helps to...cool myself down and then just switching the [electric] fan on...is good enough.
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The heavy use of fans, which CRC10B seemed to render implicitly as necessary, made up a fundamental part of the discovery of his heat tolerant capacity from a young age. This occurred when he moved to a smaller room with just a standing fan and no AC unit while living in his previous flat in Commonwealth during his primary school years. From the social practice perspective, particularly from the framing of meanings/understandings, he came to have the experiential knowledge that cooling from one standing fan was “good enough”, and that his body’s “heat tolerance” was “quite high” as he was able to bear with the room’s conditions. This was something that extended to the present—he slept with the fan “90% of the time”, but this was qualified by his observations about the room’s “small” size, which allowed the fan’s wind flow to “reach almost every part of the room” (OH). The key point here is that heat tolerance was not seen as a practice that occurred apart from the electric fan; it was practiced in conjunction with the fan. Fans were an essential material in the social practice of heat tolerance as it allowed an individual like CRC10B to persist, withstand and live with heat.

CRC02A&B’s Account. We observe this similar relationship between fans and heat tolerance with CRC02A and CRC02B (b. early 1960s), a retired married couple living in a public flat in Sengkang (northeastern region). Right from the first interview, they declared their credentials as non-AC users who lived with and tolerated the heat at home. “I mean”, both CRC02A and CRC02B articulated, “we are being brought up without aircon. So as we marry, we also can...live without it. So we just carry on without it... We prefer fresh air” (ET). Fresh air, especially in the context of the public flat, did not mean mere natural ventilation. Fans were required to alleviate the heat and circulate the natural air. CRC02B recalled growing up in her family’s rental flat in Bendemeer during the 1960s, which housed 11 family members. Electric fans were used for sleeping (OH). In their household tour interview, it was also evident that fans were a fundamental part of supporting their “fresh air” lifestyle, which included other practices like drinking tea, cold water ingestion, light dressing, and natural ventilation. When discussing how fresh air and fans worked together, CRC02A commented, ‘Fresh air will come in and the ceiling fan can rotate’ (HT).

We conclude with the case of CRC37 (b. late 1980s), a computing professional who lives alone in a public flat in Bukit Panjang and grew up with a heat tolerance lifestyle, mostly relying on electric fans and natural ventilation in the different houses he stayed in (see OH for a full account of his experience). As he explained, “unless like the heat wave...then I’ll use the aircon... Yeah, because I don’t really like cold... Yeah, I prefer like warm... [Interviewer: The fan would be sufficient for you for most of the time, including when you are sleeping?] That’s right” (ET). CRC37’s preference for a warm home environment and a heat-tolerance lifestyle did not seem to be affected by his daily exposure of a cold AC office environment. Instead, to ensure that his body would continue to be used to warmer temperatures, he wore a winter jacket in the office to “keep...warm”, enabling him to transition back to his warmer fan-mediated home environment seamlessly, without needing to “reduce” his house’s temperature through AC space cooling to match his office’s low temperatures (ET). His insistence on a fan-mediated heat tolerance lifestyle also influenced his girlfriend, who would stay overnight at his place frequently. He observed that his girlfriend, who was used to sleeping in an AC room environment, started to “compromise” and “acclimatise” to his preference of sleeping in a “warm” fan-ventilated room environment. The electric fan was crucial in mediating CRC37’s girlfriend’s experience: the fan’s speed in the room had to be put to the highest whenever she stayed over with him, whereas when CRC37 was home alone on cool or normal temperature days, he would use a lower fan speed (HT). This suggests that (a) the fan eased his girlfriend’s transition to living in a warmer environment; and (b) CRC37’s preference for warm environments occurred in conjunction with the usage

of electric fans at lower speeds, and not apart from it. An exception was during the cooler periods, when CRC37 felt that it was cool enough to be at home without switching on the fans (ET and HT).

From the elements of skills and materials from the SPT framework, it is evident that electric fans emerged as an essential skill and technological tool (material) that constantly mediated the heat and humidity of household living conditions. The fan was mostly used in conjunction with different passive ventilation techniques, such as opening the doors and windows to make household living conditions more bearable. The fan also facilitated the continued practice of time-honoured practices, especially heat tolerance, where several participants continued to adopt a non-AC, warm-oriented lifestyle for the long-term. While we do observe situations where the electric fan was not needed due to particularly cool periods or surroundings (e.g., one of CRC37's previous houses faced a forest, making it very cool in the mornings and evenings, CRC37, OH), the fan was still heavily relied upon to mediate household environmental conditions most of the time. This crucial mediating role of the electric fan needs to be foregrounded and would be especially pertinent for understanding factors and circumstances that make the fan work over the AC as a key heat management strategy, and the potential implications of these reasons for a warming Singapore.

6.6 Points for Consideration

First, the findings from this section establish that in Singapore's household context, the historical relationship between AC ownership and AC reliance is not inevitable. Through a social practice lens, these findings provide a solid evidence base which corrects current interpretations about the inevitability of AC reliance as outlined at the beginning of the section. Household thermal histories, contexts and know-how of AC usage and other heat management measures shaped and continue to shape domestic AC cooling practices. Significantly, we suggest that the lack of contingency in this historical relationship between ownership and reliance implies a gap in which various interventions can be introduced. For instance, targeted campaigns focusing on various reasons or specific pathways leading to AC reliance can be introduced to encourage a shift away from energy-intensive cooling practices, without the need to discourage AC ownership. On another view, this gap can be seen as a time allowance that allows policymakers and stakeholders to enact prophylactic measures that focus on transforming consumer habits and practices about AC ownership towards a sustainable and/or low-energy orientation, thereby potentially forestalling the development of interlinkages between the relationship between ownership and reliance. Finally, we also observe unevenness in teleological thinking about household AC futures amongst CRC households; that is, while some households, such as CRC03A&B, imagined a future of continued high AC reliance, this was not the case for others like CRC14B, who perceived that living in her future high-floor unit with unblocked views would be a panacea to high AC reliance. This suggests potential for reshaping societal and community narratives about desirable thermal futures towards a sustainable direction, and the revaluation of what mechanical cooling devices should be prioritised in light of this direction.

A second consideration pertains to the possibility of adopting a whole-of-nation approach towards the promotion of Singapore's mixed heat management and high electrical fan usage culture in the domestic settings. Currently, household heat management is mainly left up to the choices and circumstances of households and individuals. This means that such a heat management culture is ground-up and largely uncoordinated, thereby making it susceptible to structural or environmental factors that may tilt the balance away from the continued adoption of such a thermal culture. A whole-of-nation approach could help to

protect and augment this thermal culture and shift it towards a more sustainable orientation. For instance, one potential whole-of-nation measure could be the consideration of setting national design and building standards that seriously account for and elevate mixed heat management practices and electrical fan usage over AC space cooling in residential settings, and the possibility of extending such standards to non-residential settings. This could include the need to consider universal electric fan access and provision in Singapore, given its fundamental role as a basic mechanical cooling device across all households. While such an approach should still retain consumer freedom to purchase high-energy cooling devices like the AC, it would serve as a means to prioritise an existing and widely-adopted thermal culture that could put Singapore on a long-term sustainable path in a culturally-acceptable manner.



Chapter 7

Conclusion

7. Conclusion

7.1 Summary of Main Findings

Our analysis of WG2 data through the disciplinary lenses of ethnography, physiology and history uncovered useful insights into how Singapore households experienced and managed urban heat. For instance, both the ethnography and physiology sections underscored the remarkably individual nature of heat experiences, while the ethnography and history sections highlighted the diversity of heat management practices in Singapore households. Before we outline some implications for policy, we briefly summarise how each of the sections address RQ1 and RQ2.

RQ1: How do Singapore households experience urban heat, and enact practices in relation to these experiences?

Ethnography:

- Heat experiences are unique, contingent on multiple physiological, material and psychological factors operating on and across individual, household and societal scales.
- Participants primarily cooled down at home and relied on mechanical strategies for their daily cooling needs. These strategies were usually supplemented with non-mechanical strategies that are woven into everyday routines such as eating or drinking. On a societal scale, the prevalence of certain heat management practices over others can be explained by examining the meanings, materials and competencies constituting a practice.
- Participants' thermal preferences and heat management strategies were strongly influenced by their upbringing. Though stable, these preferences and strategies can still be changed at certain points.

Physiology:

- How households managed heat at night shaped clear differences in bedroom temperature and humidity, with fan-reliant households sleeping in consistently warmer and more humid environments than Fan+AC users in the first few hours of sleep and AC users throughout the entire night.
- Despite clear environmental differences between cooling strategies, thermoregulatory and cardiovascular responses during sleep were broadly similar across all three groups. Wrist skin temperature followed the same pattern across all archetypes, rising sharply at sleep onset before gradually declining through the remainder of the sleep period. Heart rate showed a tendency to be higher among AC users compared to fan-only users, through the overall sleep-period pattern. A gradual rise in heart rate following sleep onset, before stabilising through the night was consistent across all three groups.
- Participants tolerated rather than resolved their nocturnal heat experience, with thermal perception reflecting habituation and cost-driven resignation across all groups, and a persistent preference for cooler conditions remaining unmet even among AC users.

History:

- Participants compartmentalised their experiences of heat in the workplace and at home, applying different standards of thermal comfort.
- Regardless of how much they relied on air-conditioning, participants consistently employed a mix of strategies, including fans and other time-honoured practices, to manage heat based on their households' specific needs and circumstances.

RQ2: How do these experiences and practices relate to climate-change mitigation actions/choices?

Ethnography:

- Most participants observed that climate change was impacting their daily lives to varying levels.
- However, most did not frame heat as a problem in the context of climate change mitigation. Participants were generally more concerned with their personal ability to adapt to the effects climate change, rather than their capacity to effect change.
- While only a few participants raised environmental concerns about air-conditioning, most expressed a willingness to reduce their use, provided their personal comfort was not sacrificed. This leaves some room for optimism, as individuals' thermal preference and somatic experience of heat can change over the course of a lifetime.

Physiology:

- Current physiological coping capacity may not hold as temperatures rise. This may put fan-reliant households at greater thermal risk in an extreme warming climate.
- A persistent preference for cooler conditions across all groups signals growing cooling demand, suggesting further AC adoption is likely without targeted intervention.
- The Fan+AC approach shows that comfort can be maintained with less AC runtime, offering a practical model for reducing household cooling energy demand.

History:

- The historical relationship between AC ownership and AC reliance is not inevitable.
- Participants have historically relied on fans to supplement and substitute natural ventilation when natural ventilation proved lacking. Electric fans should thus serve as a logical starting point for climate change adaptation in urban households.

7.2 Recommendations and Implications

Taken together, the findings of this technical report yield broad implications for the promotion of sustainable cooling strategies and heat-health in a warming world. The history section showed us that AC reliance was not an inevitable outcome of Singapore's development trajectory. However, the ethnography section reminded us that to effectively reduce AC's hold on households and society, we must attend to the meanings, competencies, and materials that drive its widespread use. In this section, we draw on findings from all three sections to lay out some implications and considerations for policy, dividing them into measures addressing AC reliance and those addressing heat health in general.

Measures to Address AC Reliance

- *Meanings*: Dispelling myths and reshaping long-standing meanings underlying AC use

We observed that many participants are not consciously aware that excessive AC dependence might impair their heat resilience. AC usage is also left up to individual households' discretion, deployed according to household needs.

Recommendations:

- o Disseminate learning materials on how excessive AC dependence might exacerbate sensations of heat, as well as ways to manage conditions like eczema and maintain sleep quality without AC use.
- o Work with communities to create and promote a nation-wide low-energy thermal culture that is congenial with Singapore's household heat management culture and practices.

- *Competencies*: Addressing skill gaps in AC and fan usage

Among the population we sampled, we observed that most participants were unfamiliar with the more advanced features of their air-conditioners and ceiling fans.

Recommendations:

- o Work with retailers, contractors and other relevant stakeholders to educate the public on more energy efficient ways to use their AC (e.g., how and when to use the dehumidifying function) and ceiling fans (e.g., advising customers if a particular model has a counterclockwise direction, and when they should use it).
- o Encourage more creative ways of using the AC (e.g., shifting from usage throughout the night to pre-cooling for a few hours).

- *Materials*: Redesigning spaces to support alternative ways of cooling down

We observed that many participants engaged in mixed heat management strategies, but ultimately turned to AC due to structural or household-level circumstances.

Recommendations:

- o Redesign high-rise residences to prioritise mixed heat management practices and electric fan usage, thereby reducing reliance on AC space cooling. Ensuring that homes are well-ventilated from the start is crucial given that culturally, cooling has shifted from being a communal activity to a private endeavour. Measures could involve pre-installing mesh screens to keep out insects and dust, or installing blinds for privacy. Developers should also implement additional defensive measures if their buildings are structurally prone to heat.
- o Make electric fans, particularly permanently installed ceiling and wall fans, a public good. This means universal fan access for all households, particularly for low-income rental flats.

- *Intervention demographics and timeframes*

We observed that participants tended to change their heat management practices at particular points of discontinuity.

Recommendations:

- o Time interventions to engage individuals undergoing major life transitions (e.g., family formation and moving house) as people are the most amenable to change during those points.
- o Prioritise engaging families, since the formation of cooling strategies begins in domestic contexts.

Measures to Address Heat Health Amidst Climate Change

- *Moving from a generic to personalised approach to heat stress*

We found that behavioural cooling practices, rather than ambient conditions, were the primary drivers of personal heat experiences. Heat stress advisories should therefore aim to provide more personalised recommendations that consider individual risk factors.

Recommendations:

- o Integrate individual risk factors like age, health status, attire, and activity levels into heat stress models. Although the current Heat Stress Advisory acknowledges personal factors, the myENV application only takes macro-climatic data such as WBGT into account when monitoring heat stress. Agencies can reference existing examples implemented elsewhere (e.g., the AIHA Heat Stress Mobile Application) to develop a Singapore-specific model.
- *Creating and increasing awareness of communal spaces for cooling*

We observed that most participants rarely used communal facilities to cool down and hydrate, leading to their underutilisation. While it would be challenging to reverse impressions that cooling should be done at home, individuals should still be made aware of communal cooling facilities in their vicinity as a form of emergency preparedness.

Recommendations:

- o Create maps informing the public on nearby cooling facilities and integrate these with existing infrastructure (e.g., a layer on OneMap).
- o Engage communities to design and take ownership over communal cooling and hydration facilities that prioritise comfort and hygiene (e.g., installing water dispensers rather than water coolers)

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Appendix

Supplemental Analysis for Section 4: Ethnography

Ageing and changing bodies as a discontinuity factor

As heat is a sensorial experience mediated by the body, it stands to reason that physical changes to one's body can catalyse shifts in heat management practices. Several participants reported shifts in their heat management practices in response to bodily changes such as weight loss (CRC24), heart surgery (CRC02A), or the onset of age-related issues such hot flushes (CRC01B), a condition characterised by a sudden sensation of heat accompanied by perspiration that is typically experienced by women undergoing menopause and perimenopause.

Across participants, shifts in heat management practices that were induced by aging and changes to one's physicality tended to be more enduring. This was because, unlike changes arising from major life milestones, bodily changes often result in permanent or semi-permanent changes to one's thermal perception. For instance, once CRC24 picked up recreational running, at one point losing 20kg over three months, CRC24 began to feel more sensitive to the cold, reasoning that he no longer had "fats to protect [himself]" (Closing Interview). Though CRC24 ultimately attributed his shift away from air-conditioning to his propensity to adapt to the preferences of his romantic partners, CRC24 admitted that his weight loss played a significant role in shifting his preference in favour of the fan, such that fans were now his primary cooling mode throughout the day. CRC24's shift in preference was especially drastic considering that CRC24 almost exclusively relied on air-conditioning for everyday cooling across his youth and working years. Switching on the air-conditioner was so routine in CRC24's youth that its use had become detached from its original purpose of removing heat:

CRC24 (OH)	It's more of- not to fight the heat. I think it was more like I got used to it... Yeah, we don't actually. I think most people don't switch it on because it's hot. They will switch it on earlier it is hot. But they are so used to switching the air con on when they reach home, when they go home immediately. So they using. Yeah.
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CRC24's gradual shift in cooling practices—from turning on the air-conditioner on reflex, to largely foregoing it except during periods of extreme heat—thus challenges the notion that as incomes rise and standards of living increase, demand for cooling inexorably rises in an ever more energy-intensive direction. Instead, individuals can come to reject energy-intensive modes of cooling when their bodies no longer require it, even if they were previously accustomed to air-conditioning and still have access to the appliances at home—an argument we will expound on in greater detail in Section 6.

Another explanation supplied by participants was that aging and reaching maturity often conferred them with more autonomy and agency to form and act on their own preferences. Though—as established in the previous section on continuity—the formation of preferences cannot totally be disentangled from one's upbringing and family circumstances, some participants such as CRC22 and CRC34 did develop divergent

thermal preferences from their parents. Growing older, gaining financial independence and moving out of the family home afforded these participants the space to realise these thermal preferences.

CRC22 (OH)	No, no, actually not a sudden change. It's just that when you get older, you know what you want. When you were young, everything depended on family. So you've got no choice. Yeah, there's no choice for you. So the cooling strategy is to drink more cold water, eat more ice cream, have more showers, standing where the fan is, blowing directly at you, things like that. So when you got older, you have a choice. So your preference is holidays. Get out of the hot.
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As with the arrival of children, participants also made special accommodations for their pets. For instance, CRC15's family purchased a personal fan to ensure the thermal comfort of their family dog, Snowy. Adopting two dachshunds from SPCA led to more significant changes in CRC29AB's lifestyle. The mother and daughter pair purchased a king-sized low bed to allow the dogs to easily climb up and sleep with them, and despite facing financial constraints, CRC29B used the air-conditioner at night to cool the shared bedroom, prioritising the dogs' thermal comfort. Once their dogs passed away, CRC29B's air-conditioner usage significantly decreased, only turning it on once or twice the past year. Owning pets does not necessarily entail an increase in energy-intensive cooling methods. For instance, CRC31 significantly reduced his use of air-conditioning after acquiring a dog, as he was concerned that his air-conditioner would circulate pet dander throughout his home. Like CRC29AB, CRC31's air-conditioner habits reverted to his usual pattern once his dog passed away. This suggests that while pet owners often make significant accommodations for their beloved animals, these lifestyle changes may not be sustained once their pets pass away.

Relation of Heat to Climate Action

In previous sections, we established that heat management can be conceived of as a social practice, and that a more holistic understanding requires considering heat management both on the practice and individual level. One question that remains unaddressed, however, is whether Singaporeans associated heat management with climate change—the overarching motivation behind this research project.

Interview data demonstrates that CRC participants have noticed the effects of climate change in their daily lives. Most CRC participants reported experiencing unprecedentedly hot or erratic bouts of weather that broke away from established patterns in their living memory and connected these incidents to climate change. Participants differed in their accounts of how climate change manifests. Some held that climate change is characterised by increasing temperatures; others felt that climate change deepens extremes. Though climate change has begun to infiltrate daily life, most participants did not problematise heat in the context of climate change enough to galvanise significant changes to the way they manage heat. CRC32 was one of the few exceptions, however, she had a more personal connection to climate change than most as she witnessed a glacier melting firsthand during her travels in Latin America.

Reasons for this disconnect between heat and climate change vary. As established in earlier sections, many CRC households are well resourced with enough fans, air conditioners and other accessories that they can

still cope even when day-time temperatures perceptibly rise. As CRC03B puts it: "...of course I feel the changes, but it's really not that big to let me be so strong on [climate change]" (ET).

Many households also shared sentiments that echoed the "dragons of inaction" identified by Gifford (2011). Participants frequently characterised climate change as a problem that is too massive to comprehend, let alone resolve, while deeming individual action as futile, inconsequential or not their responsibility to undertake. Even among households that were more climate conscious, more emphasis was placed on climate adaptation rather than climate mitigation. CRC37, for instance, took to wearing a heat vest and running on a treadmill to 'acclimatise' his body to the heat, acknowledging a "mindset shift of global warming" (ET). However, his skepticism regarding the rate of climate change meant he did not perceive it as an issue influencing his personal heat management practices.

There was also a sense among most participants that their current configuration of cooling practices had already been pared down to the minimum level needed to achieve and maintain thermal comfort. Regardless of the appliance they used, the contexts in which they use them and their levels of usage, participants generally perceived their own usage patterns as economical, necessary and defensible. CRC04, for instance, characterised his usage pattern of the air conditioner for sleep and leisure as neither "[wanton]" nor "[wasteful]", but on a "need to basis" (ET). CRC09 also defended their nightly use of the air conditioner for sleeping despite their self-identification as someone who is more environmentally conscious, arguing that he had "no choice" but to use the air conditioner to guarantee quality sleep due to the noise pollution in his neighbourhood at night (ET).

Consequently, suggestions to further minimise their use of fans or air-conditioning had little resonance. When asked what conditions might prompt them to reduce their use of heat-management appliances such as air-conditioners and electric fans, CRC participants generally responded they would do so only if ambient temperatures matched their preferred ranges, or if advances in technology produced lower-energy devices that could rival the coolth of an air conditioner. Participants' reluctance to compromise on their thermal comfort also suggests that to some extent, Singaporeans have internalised thermal comfort standards that were developed in more temperate climates. Nevertheless, the finding that participants are open to reducing their use of heat management appliances, provided certain conditions are met, still offers some room for optimism. Given that thermal experiences and preferences can change over a lifetime, redesigning spaces to maximise natural ventilation and expose people to warmer temperatures can nudge individuals toward more sustainable cooling choices.

