Exploring futures of summer comfort in Dutch households

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Abstract. Due to climate change, the outdoor temperatures, frequencies, and durations of heatwaves and levels of solar gain in the Netherlands are expected to increase. Based on the European Energy Performance of Building Directive (EPBD) new standards are introduced. However, it is still uncertain how Dutch culture might adapt to this change in climate. The qualitative study underlying this paper addressed this question by focusing on the future of summer comfort in Dutch households. It comprised 21 interviews with diverse households and 10 expert interviews. Results show that while summer night ventilation and shading can prevent or reduce overheating through low-energy means, several cultural and practical barriers stand in the way of their full potential. Practices of shading and summer night ventilation require the active involvement of residents, but clash with their historically formed relation with the sun. A cultural shift is needed to better integrate these practices into household responses to hot weather. Moreover, the study identifies potential for technologies, policies and procedures to support acclimatisation of residents to higher temperatures. This could save energy as well as promote healthy living during hot weather.

Keywords. Summer comfort, Netherlands, cultural change, qualitative study, dwellings, energy.
DOI: https://doi.org/10.34641/clima.2022.388

1. Introduction

The climate in the Netherlands is getting warmer [1]. Due to climate change, the likeliness, severity, and duration of heatwaves is increasing. Dutch dwellings have long been built with a focus on keeping warm during winter, resulting in high levels of insulation and airtightness, which increases the risk of overheating. Other factors contributing to overheating issues are urbanisation and urban heat islands, and an ageing society.

Dutch households are beginning to experience the consequences of climate change in their everyday lives and starting to adjust their lives and homes to these new circumstances. For those who can afford it, mitigating discomforts and health risks of hot weather are within reach, but tend to require high amounts of energy. Essent, one of the main energy providers in the Netherlands reported a 30% increase in energy demand during the August 2020 heatwave [2]. This growth was attributed to the rising use of ventilators and air conditioners in households. While penetration rates for active cooling are relatively low in the Netherlands, this trend is worrying because it could jeopardize achieving national and international CO_2 reduction targets, and further contribute to climate change. Moreover, for those not able to take required measures, overheating is expected to pose increasingly severe health threats [3].

At this point in time, Dutch responses to global warming can still go in many directions, some of which are undesirable from health, inclusivity, and environmental points of view. This paper, which is based on a publicly available stakeholder report [4] presents a qualitative exploration of the future of domestic summer comfort in the Netherlands. By identifying and extrapolating current cultural, demographic and technological trends in domestic summer comfort, it identifies relevant questions, challenges, and points of friction.

While the focus of the study is on the Netherlands, its outcomes may be relevant beyond this context, particularly in countries where active cooling is currently on the rise due to global warming.

2. Background

The Dutch Meteorological Institute (KNMI) defines a heatwave as a period of at least five consecutive days with daily maximum temperatures exceeding 25°C, with at least three of the five days reaching maximum temperatures above 30°C. In the Dutch context, heatwaves of this kind are still considered extreme weather events; local governments put heat plans in action to protect vulnerable groups and people experience disruptions to their everyday lives such as more difficulty with sleeping, focusing and getting around. These heatwaves are expected to become longer, warmer, and more frequent [1].

The Netherlands is at a crossroad when it comes to summer comfort. Permanently adopting highly energy-intensive, cooling-dependent practices of summer comfort that exist in countries like Australia [5, 6] could still be prevented if well-informed decisions are taken today. 'Solving' overheating in dwellings with active cooling is not the only possible way forward; summer comfort in the Netherlands could still go in a variety of directions. Actions in the present regarding new building policies, proposing standards (e.g. the NTA 8800), designing infrastructure, building technologies, and passing on instructions have an effect on shaping futures of summer comfort in Dutch households. These actions, in turn, are informed by visions, assumptions and expectations of what futures are possible, desirable and likely to come about. Insight into these futures from a Dutch household perspective is so far limited.

This raises questions like: To what extent are mainstream Dutch households equipped and able to equip themselves to deal with longer, warmer, and more frequent heatwaves? Which strategies do households apply and aspire to achieve comfort in times of hot weather, and which currently not? What are possible consequences of these strategies for levels and patterns of energy demand, and general well-being? What are developments outside of these households that may affect these strategies?

Since they pertain to the future and therefore cannot be directly studied, these questions are challenging to answer. To come to answers, this study draws on theories and methods from social practice theory, which is a group of theories from sociology that approach everyday life as a collection of practices [7, 8]. Practice theories are useful for the challenge at hand because they are particularly good at studying larger scale societal changes while still considering the details of everyday life [9].

Summer comfort is a so-called dispersed practice [10], a practice that is part of many integrative practices. Examples of integrative practices are cooking, bathing, and sleeping. Part of the challenge is to identify the relevant integrative practices. Within social practice theory, the study builds on earlier work that explored dispersed practices (of winter comfort) historically [11]. What this earlier work highlighted, besides the importance of including a range of integrative practices, is the importance of including broader changes outside the household in the analysis: i.e. practices of domestic winter comfort co-evolve with changing indoor climate technologies and were affected by government policies such as the increased age of compulsory education and reduced work hours [11]. Inspired by Dahlgren et al. [12], these contextual trends were divided into three categories: (1) Climate changes, (2) Demographic changes, (3) Technological changes.

In line with current trends towards more 'smart', interactive technologies in the home, the study draws on the concept of co-performance. Co-performance is a modification of social practice theories that places automated technologies—such as thermostats—next to people as co-performers of practices [13]. The idea behind this shift is that automated technologies increasingly take over tasks from people. Sensors, processing power (matching sensor values to pre-set thresholds), connectivity (to weather predictions, mobile phones) and actuators (connected to power sources, usually the electricity network) allow these devices to act relatively independent of the inhabitants. Their 'behaviour', alongside that of humans, affects the development of everyday practices. For example, the actions of an automated sunscreen are based on a judgment—'*it is too sunny now, this sunshine should be prevented from entering the home, wind speeds are low enough: go down*'. As such, it, and by implication the designers who designed the judgment into the device, become performers of this judgment in everyday life. The actions of the sunscreen, reflecting judgments about 'good' and 'bad' sunshine, 'strong' and 'mild' winds, are experienced by inhabitants and passers-by who see and experience the action. This in turn influences their ideas of appropriate shading behaviour. A co-performance perspective therefore considers the combined behaviour of people and automated devices when considering practices and how they change.

These theoretic starting points: (1) summer comfort as a dispersed practice, (2) social change as a co-evolution of practices and contextual developments, and (3) automated technologies and their designers as co-performers of practices alongside people, form the basis for the methodology that was used to answer the main research question: where are Dutch households currently heading in terms of summer comfort?

3. Method

The study consisted of a set of interrelated research activities. These included a research visit to Australia, trade fair visits, internet scoping, expert interviews, household interviews, field observations, and a media analysis. Ethics approval for the studies involving human participants (household interviews and expert interviews) was obtained through the

Eindhoven University of Technology Ethics Board under reference ERB2020ID18 and ERB2020ID140 respectively.

To design the household interviews in a way that they would capture all relevant practices, background research was conducted to identify which practices are affected by and involved in summer comfort. Since dealing with hot weather is relatively new for the Netherlands, a research visit to Australia was used to gain more insight into living in hot weather. This resulted in the following list of seven focal integrative practices: (1) cooking and eating, (2) personal care and clothing, (3) laundering and cleaning, (4) home working, (5) free time, (6) sleeping, and (7) ventilating, shading and cooling.

While households are experts on their own current ways of dealing with hot weather, they are less able to predict their future options. Working from the range of everyday practices identified in the background research, a set of domain experts was consulted to gain an overview of near-future trends and developments related to these practices. These domains included HVAC, sleep, physiology, fashion, architecture, building standards, social housing and domestic shading. The ten expert interviews were conducted between March and December 2020. The expert interviews were tailored to the expertise of each interviewee and included preliminary results of the study where possible. The interviews lasted 30 minutes to 1,5 hours. All experts were offered the chance to read and comment on a concept version of the stakeholder report [4].

2030 and 2050 were taken as milestones for these futures. One nearer-future and one further-future. These are timeframes that are often mentioned in strategy documents by government and industries and are therefore expected to match decision-making practices among these important stakeholders.

Details on the data collected during household study – the core element of the research – are included below, followed by an overview of the data analysis approach and a discussion of the limitations of the data for the goals of the study.

3.1 Household study

The set-up for the household study consisted of a workbook and an interview. The workbook was designed to prime participants on the topics to be discussed in the interview and collected systematic data that is difficult to collect in an interview, such as the number of times the household does their grocery shopping or how often different categories of laundry are washed.

Interviews were semi-structured and conducted in the participating households. A flyer and application form were made to recruit participants. The recruitment message was spread through the social media accounts of the project partners, via Twitter, LinkedIn, and via email.

To recruit more participants from lower-income groups with practical education levels and migration backgrounds, a partnership was made with a social housing association in Rotterdam. This eventually resulted in the desired balance of owner and tenant participation.

While planning the study, it was uncertain whether there would be a heatwave. 'Luckily', a major heatwave occurred from 5 to 18 August 2020, well in-sync with the planned study. According to KNMI, August 2020 was the second warmest August since 1901. Exceptional to this heatwave was the high minimum temperature, with three tropical nights (minimum temperature above 20°C), which, on average have occurred less than once a year, and nine tropical days (max 30°C or above) which historically occur once a year on average.

Eventually, 15 of the 21 participating households completed the workbook and interview, while six were only interviewed. A total of 21 hours of interview material was collected, representing a total of 60 residents. The ages of interviewees varied from early 20s to early 70s. The study covered a variety of types of dwellings with buildings years ranging from 1909 to 2019 that roughly reflect the national figures, including both urban and rural locations.

3.2 Data analysis

Analysis of the household interview data used the following main steps:

a) Theoretic framework and approach to topic, also embedded in workbook and interview set-up, leads to initial coding frame (activities)
b) Coding I: Transcripts are all coded according to these nodes > additional nodes emerge from the first coding process, transcripts are scanned
c) Coding II: Nodes are analysed more in-depth and tables per participant are made that summarize subthemes per node, some additional coding is done, transcripts are read carefully
d) Counts are made where possible and relevant
e) Table overview is used to write aggregate text for each node/theme into report
f) Questions that arise are noted down
g) Additional information is gathered through literature, internet search, and expert interviews
h) Findings per practice are summarized in an overview table including current situation, prognosis and risks/opportunities.

This process is not fully linear. For example, in the case of cooking and eating, the report text was roughly written before the Coding II process and then gradually revised after Coding II and additional information gathering.

3.3 Limitations

No actual measurements of indoor temperatures were made, so conclusions regarding temperatures are based on self-reported values, which tend to be less reliable. The use of workbooks with daily exercises, which primed participants to notice their indoor temperature values in the week before the interview, partly compensated for this.

The interview focused on a selection of practices. Other possibly relevant practices that were not included specifically were pet care, parenting, and do-it-yourself activities.

The sample is not fully representative of the Dutch population. Relevant caveats are lower-income households, households with a migration background, and age groups above 70. These representation issues were addressed where possible through expert interviews and studies conducted by others.

4. Findings

This section brings together the findings and extrapolates trends and developments identified into speculations on probable futures of summer comfort in Dutch households. The detailed results of the data analysis with rich data on each practice can be found in [4].

Overall, the study confirms the expectation that the use of active cooling in Dutch dwellings is likely to increase in the future. This is reflected in growing sales figures of cooling systems, but also in actual and experienced overheating in dwellings and frictions with emerging practices of shading and ventilation. The latter, along with embodied acclimatisation, have potential to contribute to summer comfort in a low-energy manner. However, their establishment is hampered by existing infrastructures, and historically shaped cultural values and habits, as well as competition between practices. The sections below elaborate on these points.

4.1. Actual and experienced overheating

Overheating is already an issue in Dutch households. From the perspective of the NZEB (Net Zero Energy Buildings) standards, several dwellings in the study (all apartments) exceed the threshold of 450 WHOs (the Weighted Overheating Hours) above 27°C. Overall, reported indoor daytime temperatures during the heat wave ranged from 24°C to 45°C for dwellings without cooling. The dwellings that reported temperatures over 30°C in their main living areas were all rented city apartments.

Stories of residents confirm that these dwellings become practically unliveable during a heat wave. Moreover, most households in the study considered their dwelling to be overheated well below the formal overheating threshold. Indoor temperatures above 25°C were considered too high by all but four participants, particularly for working and sleeping. These higher temperatures inhibited their freedom of movement and capability to go about their daily business, such as focusing on work, sleeping well, and performing housework.

These issues were absent for households with active cooling, but they were inhibited in other ways, particularly, in being outdoors. The data indicated that households with active cooling have a stronger tendency to take the car instead of walk or cycle, because stepping outside from a cooled space felt like 'hitting a wall'. In other words, spending time in cooled spaces reduced their willingness and ability to tolerate the higher outdoor temperatures.

With climate change, these overheating issues are expected to grow. The next sections go deeper into the strategies that households currently apply and aspire to deal with these issues.

4.2 Acclimatizing

Participants that were able to enjoy or accept the heat and modify their daily schedules around it were most capable of getting through the heatwave without too much discomfort. For example, families that had their summer holidays during the heat wave or a student practicing mindfulness. However, the freedom to adjust one's daily schedule is not accessible for everyone, especially if heatwaves are to occur more often outside of summer holidays. Moreover, freedom to adjust one's schedule is not a guarantee for getting through the heatwave well, as illustrated by the participating retired couple. As known from physiological research, not all bodies are equally capable of dealing with heat and these capabilities decrease with age [14, 15].

However, the study shows that common knowledge among the general public on bodily responses to heat show a gap with state-of-the-art research, particularly regarding the role of sweat in dealing with heat (it is mostly seen as something negative) and the capability of bodies to adjust to higher temperatures over time. While research shows that people can adapt to heat by as much as 1°C per day as confirmed by the physiology expert, none of the participants referred to acclimatisation or related concepts of bodily adjustment to heat over time. This finding indicates that adjustments in knowledge, available products, skills, and attitudes to acclimatize could reduce people's experiences of being locked into their homes and bodies and contribute to well-being in a low-energy manner. Put more strongly, the adverse mental and physical effects of reduced physical activity in hot weather might be partly mitigated if people (are facilitated to) acclimatize.

4.3 Cultural frictions with shading, ventilation and cooling

Emerging practices often compete with existing ones. As Shove et al. [8] explain, when practices change, new links must be made and old ones broken.

A seemingly embedded friction that arose from the interviews is the relationship that 'the Dutch' have with warm weather. Warm and sunny weather is associated with being outdoors and enjoying the light and warmth of the sun. In the spring, when days get longer and warmer, people open doors and windows to let fresh air in, extending their living spaces onto balconies and into gardens. Fluctuating temperatures mean that Dutch summers can have relatively cool spells that precede heatwaves. When temperatures go up, the sun is initially welcomed into the home. But when temperatures rise, this behaviour leads to overheating, which is then difficult to correct.

Proper, disciplined outdoor shading and summer night ventilation routines could reduce the extent to which indoor spaces heat up [16], but adopting these routines requires more than new equipment and behaviours. Viewing the sun as an 'enemy' instead of a 'friend' for part of the year requires a cultural shift. The Dutch friendship with the sun is deeply embedded in customs (opening doors, curtains and windows to enjoy light, views and fresh air), the built environment (ample, sun facing windows) and related professional practices such as architecture (disliking and sometimes prohibiting outdoor shading). For most of the year, the sun is and will remain a friend, helping to light and warm dwellings, and keep people healthy and cheerful. Learning to occasionally 'cool' this friendship may be difficult to achieve and implicitly seems to hamper the potential of shading and ventilation practices to develop.

Active cooling is more explicitly approached with reservation. Participants without active cooling are familiar with air conditioning, but find it too energy-consuming, noisy, expensive, and uncomfortable. However, even highly committed, knowledgeable residents in modern homes, equipped with the latest shading and ventilation technologies, had trouble maintaining a comfortable indoor climate without the use of active cooling. Many anticipated getting some form of active cooling in the future. Those who already had cooling were mostly content with their systems (except for mobile air conditioners). Although there are cultural and practical frictions to integrate active cooling into Dutch households, they seem easier to overcome than those related to shading and ventilating. Added to this lower barrier to uptake is the risk that active cooling creates a further threat for shading and ventilation practices to reach their potential because they compete.

4.4 Shading, ventilation and cooling compete

Shading and active cooling can complement each other in dwellings, but the study illustrates how they compete in the market. Both active cooling and outdoor shading require considerable investment. If households have an opportunity to only invest in one, then cooling has the better position in terms of low-effort comfort. This competition is also visible in the current NZEB requirements, where adding a form of active cooling eliminates incentives for other, low-energy measures against overheating such as shading.

Cooling and summer night ventilation compete directly in the dwelling. While the cooling system is on, windows and doors need to be closed to retain the microclimate. This effect is even stronger for mobile air conditioners, used in three participating households, because securing the hose in the window can further hamper the opening of windows when the device is not in use.

In general, active cooling, when properly designed and installed, can secure comfortable temperatures in the dwelling regardless of other measures such as shading or ventilation. Shading and ventilation require the active involvement of residents. With active cooling in place, the incentive to invest money, time, and effort in them is reduced. Mobile air conditioners have a particularly problematic position in this respect because of their relatively low threshold, and energy-efficiency. While they can be life-savers on the scale of individual users, in the broader picture these appliances form undesirable symptoms of overheating in Dutch dwellings that contribute to the problem of climate change and heat islands [17].

4.5 Entry points for active cooling

The attraction of active cooling is strong. The study shows that this temptation varies for different practices, rooms, dwelling types, and types of residents. Sleeping and working are practices that seem to be most receptive to air conditioning. Working occurs in different spaces in the home, but bedrooms form an appealing entry point. They can be cooled relatively efficiently and can be used for the two activities that require cooling most. The study did not find many bedroom/offices, but the architect consulted mentioned that they get frequent requests for workspaces in bedrooms because it is an efficient use of space.

When installed in living rooms first, work might move to the living room—although in multi-person households this is hampered by privacy issues. Sleeping then remains an issue, as people do not seem eager to sleep downstairs during heatwaves as a rule. This may stimulate installing multiple units in the living room and bedrooms.

Mobile air conditioners seem like an obvious solution to cover multiple activities, but on closer observation, they come with a range of challenges. Besides the issue of their relatively low efficiency, their capacity tends to be too small for most living rooms. When used in other rooms, they hamper ventilation practices, and their noise levels interfere with sleeping and working. Although mobile, they cannot be easily moved up or down the stairs. As argued above though, they can play a role in a growing habituation of and appetite for active cooling at the cost of ventilation and shading.

The type of households that seem most receptive to air conditioning are higher income households that spend more time at home, for example, when habitually working from home, during a pandemic, or when in retirement. Active cooling can also spread between homes. Neighbours, friends, or family are more likely to get it installed after experiencing the cool escape during a heatwave.

These insights can be used to accelerate the spreading of active cooling, but also to design measures that might slow down or prevent Dutch households from becoming dependent on energy intensive cooling equipment that could hamper the development of other strategies to deal with a warming climate.

Automation can play a role here, when shading responds automatically to levels of solar gain, rain and wind, and ventilation to temperature and humidity differences inside and outside the dwelling. However, the role of residents cannot be ignored. Not only their autonomy in deciding whether to have these systems at all, but also in the ways they are used. The study revealed a wide array of circumstances in which people might disable automated shading, such as feeling locked-in, wanting more light, annoyance with repeated movement, wanting to open windows, etc. For ventilation systems, it became clear that their automated responses to CO_2 or humidity levels can conflict with summer comfort by drawing in hot outside air during the day, while summer night ventilation, in most homes, requires residents to open and close windows while they are sleeping.

4.6 Pathways for active cooling

So far, active cooling is discussed as one practice, but in fact, different forms of active cooling are currently developing in parallel. Main pathways are radiant cooling and air-conditioning. Radiant cooling, mainly in underfloor settings powered by heat pumps or district cooling are relatively slow systems that cool the building mass. Such systems are likely to run continuously during hot weather. An advantage of these systems is that for ground source heat pumps, cooling can be provided on low-energy demand, or even energy-positive manners when heat is stored for use in winter. Air-conditioners work more quickly by directly cooling the indoor air and are more likely to be used based on occupancy and direct demand. Spaces also heat up again relatively quickly when they are off. Mobile air-conditioners allow for even more directed, person-oriented, albeit fleeting forms of cooling. Apart from their efficiency, these different patterns of use are likely to affect their overall energy demand.

Moreover, levels of energy demand for active cooling do not only depend on the type of systems and when it is used, but also on the set-temperature. At present, the temperatures to which households will set their cooling systems has not been settled or stabilised, but it is likely that norms around acceptable and normal temperature ranges will develop in the coming years and decades. With heating, for example, Dutch households presently tend to set their thermostat somewhere between 18 and 22°C. This normalised temperature range has formed and changed over a long time period [21], and varies per cultural context [22] .

As illustrated in the introduction, building norms, standards and system design can play an important role in shaping these norms. Considering that technologies co-shape practices, it makes a huge difference for the way in which Dutch summer comfort practices will develop whether default settings, promotion materials, media and installer instructions for cooling systems recommend setting the system to 18°C or 27°C, introduce some other metric like a combined humidity/temperature value, or are designed to offer a variable temperature that moves with the outdoor temperature and slowly increases over time to support acclimatisation.

4.7 Cooling <> heating

When considering longer term consequences of a proliferation of active cooling in Dutch households, effects on heating practices should also be taken into account. Most cooling systems can also heat. Compared to the gas-fired, high-temperature central heating system still dominant in the Netherlands, air-conditioners are quicker and support more on-demand use patterns. Their proliferation might therefore lead to partial replacement of gas-fired central heating systems, which, next to electrification, could have a positive effect on overall household energy demand. Research has shown that on-demand forms of heating tend to be less energy-intensive than central heating [18, 19]. However, if air-conditioning is used in addition to—and not as a replacement of—central heating systems, then additional energy demand for indoor climate could arise. As shown in one of the participating households, air-conditioning is easy to use as a quick form of 'top-up heating' on cooler moments outside of the regular heating season. It might therefore replace existing, low-energy strategies for these moments such as sweaters. Further research is needed to investigate how these patterns may develop.

4.8 Additional effects of warming on everyday life

The use of active cooling in the home seems to lead to a dependence on cooled spaces that extends beyond the dwelling. The examples in the study indicate a trend towards spending more time indoors, and the car becoming preferred over other means of transportation. Beside increases in CO_2 emissions and energy costs that accompany the increased use of most forms of active cooling, these trends indicate undesirable health effects resulting from lower activity levels and lower natural vitamin D intake.

Other areas in which increases in energy demand are likely to arise according to our finding are in increased capacity for cold food storage, showering and laundering. Several households reported that fruits and vegetables that are normally kept in dry storage are moved to refrigerators during hot weather, where they compete for space with more cooled drinks. This leads to an increased demand for (larger) fridges and freezers—appliances which, in turn, directly contribute to overheating in dwellings due to the heat they produce. The study also indicated that shower frequencies increase during hot spells. The main reason for more showers within the sample was not to cool down, but to rinse off sweat. This requires water, as well as energy to heat it. Finally, natural fluctuations in daily temperature patterns mean that morning time, as the coolest time of day, becomes populated with many activities: sports, work, cleaning, etc. This has consequences for energy demand for laundering. Hanging out laundry is physically intense. Doing it in the morning requires the washing machine to run during the night, which is out of sync with solar energy production. Moreover, a tendency to minimize physical activity may increase the use of dryers, which also generate heat inside the home. With a trend towards better insulated homes, these secondary effects could become significant.

4.9 Different consequences for different types of households and dwellings

While it is difficult to draw a strict line, some of the dwellings in the study were clearly overheated. These examples represent a larger group of households for which homes become unliveable for part of the year. Smaller, well-insulated dwellings, with higher window-to-content ratios, high sun exposure (e.g. in high-rise), little shading and ventilation opportunities, located in cities (heat islands) heat up quickly. Such dwellings are more likely to be occupied by lower-income households and are more often rented than owned. This might also mean that the potentially higher amount of time spent at home by the residents due to lower levels of employment could add to the overheating issues.

Also judging from recently introduced building standards in the Netherlands and elsewhere [20], overheating is slowly starting to be acknowledged as an issue, and social housing providers and landlords are beginning to contemplate on how to intervene. The study indicates that the costs of installing and maintaining outdoor shading on non-ground floor windows plays a role in hampering tenants and owners to act. Moreover, explicit demand for shading and cooling seems low among social housing tenants. This could have all kinds of causes such as other more pressing issues on the tenants' minds, a fear of unmanageable rises in rent, unfamiliarity with the effects of shading and ventilation on overheating, or better skills of acclimatizing. Despite various efforts to involve low-incomes households, they were only present indirectly in the study through stories of higher income tenants, experts and observations during fieldwork. More research is needed into the specific issues, wishes and strategies of this group.

5. Conclusions

This study set out to gain more in-depth insight into the ways in which Dutch households are likely to deal with the growing problem of overheating in their dwellings. Several opportunities were identified that might direct Dutch domestic practices of summer comfort onto more inclusive, healthy, and less energy-intensive pathways.

A range of opportunities present themselves around acclimatisation, i.e., modifying bodily relations with hot weather. There seems to be a gap between state-of-the-art physiological research on how bodies deal with heat and everyday knowledge among the households. The benefits of sweating (when combined with drinking enough water) as an effective way to deal with heat is not fully acknowledged. Moreover, none of the participants talked about bodily adjustment to heat over time, while research shows that this effect can be as strong as 1°C per day.

Outdoor shading during the day and ventilation during the night can reduce or prevent overheating. The study shows that barriers exist for these practices to develop to their full potential in Dutch households. Cooling might reduce residents' acceptance of the experienced downsides of shading (including the costs) and lowers incentives and opportunities to utilise cooler night air.

6. Acknowledgements

Thanks to the members of the User Committee and all experts and participants in the study. This research was funded by the Dutch Research Council (NWO) under grant number VENI17343.

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Data Statement

The datasets generated and analysed during the current study are not publicly available because they are still in the process of preparation to be submitted to a database. They will be made available in a repository, probably DANS Easy.

Moreover, a detailed overview of the results of the study is available in the open access stakeholder report of the study through: https://research.tue.nl/en/publications/exploring-probable-futures-of-summer-comfort-in-dutch-households-