13 Too Cool or Too Hot

Thermal Comfort in Low-Income Homes and Lived Experiences of Energy Poverty in India and Austria

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13.1 Introduction

A substantial body of literature already explores the planning and design of housing for the urban poor in the Global South. However, this scholarly discourse primarily focuses on questions of affordability (Manna, 2018; Mukhija, 2001; Nastar, 2020). So far, little work has been done on heat stress and adaptation to the heat in these socioeconomic groups. In the Global North, particularly in Europe, research on energy poverty has concentrated chiefly on heating requirements[1] (Brunner et al., 2012; Dubois, 2012; Hernández & Bird, 2010). The need to adapt to extreme summer heat is only now appearing as a concern to reckon with, given that heat-related deaths are rising even in more temperate climates.

13.1.1 Energy poverty and thermal comfort[2]: in the Global North (mostly) concerned with heating

Energy poverty is generally understood as an interplay of high energy prices, low household incomes, and low energy efficiency homes (Boardman, 2010, p. 32). When looking at energy efficiency, it has to be noted that low-income households need to reside in comparably cheap accommodations to be able to cover all their living costs, including housing costs and energy bills. In the case of Austria, cheap accommodation is predominantly found in rentals[3] built before 1960. Low-income households are, on average, more frequently found to live in privately rented apartments in this era (Statistik Austria, 2022). These apartments are more cheaply available than recently constructed rentals (Global Alliance for Buildings and Construction, 2018). With the first legal requirement on the insulation of buildings enacted in Austria only in 1974[4], most buildings in this age bracket display relatively poor energy efficiency standards. Buildings built before 1960 therefore have lower energy efficiency values than more recently constructed ones.

Households residing in poorly insulated buildings will need to consume more energy to keep their home at a specific threshold temperature (e.g., 20–21°C as recommended by the World Health Organization; ; WHO, 1987) than households in well-insulated buildings with an efficient heating system. This low energy efficiency of the buildings concerned means tenants must consume more energy to satisfy their basic needs in terms of keeping warm during cold winters. This higher energy consumption rate will generally tend to effectuate higher energy bills for the household concerned. Households with low budgets at their disposal are at risk of spending a considerable proportion of this budget on energy if they live in such buildings (which, as shown above, they tend to do above average). This proportion thentends to be well above the average household expenditure on energy. Households affected by this mismatch between disposable income and energy bills are considered energy poor.

DOI: 10.4324/9781003408536-16

Costs of real estate – either in sale or rent – do not necessarily reflect a property's energy efficiency in the first place; features such as location, infrastructure provision, and equipment may play a more decisive role. In a bid to tip real estate markets towards valorizing more energy efficient buildings, the European Parliament first enacted the Energy Performance of Buildings Directive (EPBD) in 2002. This directive required the issuing of a standardized energy certificate in the event of the sale or rent of a building or apartment to inform consumers about the energy efficiency of the building they are about to inhabit. Notably, such certificates cannot predict customers' future energy bills in the specified unit, as these bills are determined by residents' actual energy consumption rather than the standardized demand forming the basis of the certificates' calculation. These certificates, however, render comparable different properties on offer in regard to their respective energy efficiency. Current research, however, tends to indicate that the introduction of EPBD's energy certificates has not yet succeeded in raising consumers' awareness of energy efficiency and thereby increasing the value of more efficient buildings (Ayala et al., 2016; Mutter & Sterk, 2016+02:00).

Energy poor households residing in homes with low energy efficiency standards struggle to afford thermal comfort – besides covering other basic energy needs such as cooking warm food regularly, bathing, etc. Lack of thermal comfort is therefore one prominent consequence of energy poverty. However, maintaining healthy lifestyles below certain heating, cooking, and bathing thresholds is impossible. If low-income households restrict their energy consumption for heating below certain thresholds to avoid high energy bills, they risk jeopardizing their long-term health. Thermal comfort is thus closely linked to health (; Santillán Cabeza, 2010).

13.1.2 … and with heat (mostly) in the Global South

India comprises a significant proportion of the global population that is energy poor. The country houses 700 million people primarily using solid fuels for cooking (Tripathi et al., 2015) and 244 million without access to electricity who use lower-rung fuels such as kerosene for lighting purposes (International Energy Agency, 2016). There is also an unaccounted portion of households that do have electricity connections but have unreliable and sporadic access to electricity (Kumar et al., 2019). Finally, there are those who do have stable access to electricity, mostly in urban areas, yet are struggling to afford it, especially when it comes to high energy-consuming appliances such as air conditioners to safeguard thermal comfort in times of high temperatures (Gupta et al., 2020).

Due to climate change, prolonged heat waves with elevated temperatures are expected for most of the globe in the decades to come. In its latest report, the International Panel on Climate Change states that extreme weather events, including heat waves, have intensified in cities and globally (IPCC, 2022). Population exposure to heat waves will continue to increase with additional warming. The IPCC links the increased occurrence of extreme heat to impacts on human health, mentioning that extreme heat events already result in human mortality and morbidity today as observed results of climate change. It acknowledges significant geographical differences in heat-related mortality without additional adaptation. Overall, outdoor temperatures will increase in both the Global South as well as the Global North. This heat stress will further amplify these cities' existing urban heat islands (UHIs). Therefore, cities will be most affected by heat events, and their populations will generally be most exposed to heat. Adaptation to heat is therefore a task of global scale (ibid).

UHIs significantly impact buildings in urban areas (Akbari et al., 1992) because increased urban temperatures exacerbate the energy demand for cooling buildings. Urban heat islands are one of the best-documented examples of anthropogenic climate change (Santamouris, 2007).

Put simply, these phenomena consist of the fact that air temperatures are often higher in cities than in their surrounding countryside (Asimakopoulus & Santamouris, 2011; Oke, 1982; Oke, 1988). At the same time, high urban temperatures considerably decrease the cooling potential of natural and night ventilation (Santamouris, 2007). If the surrounding outdoor areas in cities are hardly cooler than the indoor spaces in buildings, opening windows at night will only slightly help to cool these spaces.

While UHIs are the result of a combination of several physical phenomena[5], not per se specific to neither the North nor the South, more research has been conducted on UHIs in Northern cities (Oke, 1982). Already, heat-related concerns are fast gaining attention in the more temperate climates of the North in light of rising average temperatures due to global climate change. Also, energy demands related to cooling are foreseen to rise at the global level (Davis & Gertler, 2015). With the additional impact of UHIs, urban areas even in temperate climates will have to adapt to heat. Those groups in society who are already struggling to afford energy for heating will most probably face difficulties covering their cooling demands too (ibid).

In 2022, India was the highest ranked among 54 high-impact countries, in which the rural and urban poor are at high heat-related risk because they lack access to cooling; roughly 190 million urban residents were assumed to fall within this group nationwide (Sustainable Energy For All, 2022). Ownership of air conditioning appliances in 2016 amounted to 30 million units in India, corresponding to just 4% of all households (as compared to 570 million in China). The International Energy Agency points out that AC ownership rises very steeply with income and predicts that sales of AC units in India will continue to grow rapidly (International Energy Agency, 2018), with a current annual increase of 8% in electricity demand for cooling in the residential sector (International Energy Agency, 2016: p. 92).

There are well-documented links between excessive heat and increased morbidity and mortality globally (Vicedo-Cabrera et al., 2021). To counteract heat stress, electrically powered air conditioning systems are being installed to provide respite. Low-income households, however, often lack the financial resources to afford electricity for such devices to keep themselves cool (if, at all, they have the resources to buy the devices). For these groups, again, lack of thermal comfort is a prominent consequence of energy poverty. And as in the case of cold homes, prolonged periods of thermal discomfort in hot environments likewise carry health risks (Vicedo-Cabrera et al., 2018).

This chapter presents the findings of two research projects that examined the diverse lived experiences of energy poverty resulting in frequent lack of thermal comfort in Global South and North contexts. It found similarities despite the apparent discrepancies in overall framework conditions such as climate, living standards, welfare regimes, or housing provisions.

13.2 Methods

Two research projects conducted independently and at different points in time form the basis of this chapter. Their approaches, methods, and results are presented hereafter separately at first before drawing joint conclusions.

13.2.1 Methods of Study I on lack of heating in Austria

A study on energy poverty (hereafter Study I), concentrating on households experiencing difficulties keeping their homes warm in Austria, was conducted in 2014 in the small town of Krems (approximately 25,000 inhabitants), about 80 km to the west of the capital city of Vienna. Based on group discussions with experts from a local social housing provider and a local NGO, six buildings in Krems were selected for further investigation with *Wachaustrasse*, the case study area later selected, being among them right from the beginning.

A standardized questionnaire was developed to investigate residents' housing and living conditions. It contained 38 questions in 7 blocks relating to the building/apartment, heating and hot water generation, rental and energy costs, household income, health, and demographic data. Thus, the survey not only investigated households' housing and living conditions but also gave a clear indication of whether or not the particular household could be regarded as energy poor. This identification was especially relevant in the case of the residential building block *Wachaustrasse,* which became the focus for developing renovation concepts. The block comprises three floors each, accessed via eight staircases, and houses 85 apartments. The net habitable areas of these apartments vary between 37 and 65 m^2. Ten semi-structured telephone interviews, 25 questionnaires manually filled in and sent by mail, and nine interviews done on the spot were conducted in six buildings between January and June 2014 in Krems. Out of these, two telephone interviews and eight in-person interviews were conducted in *Wachaustrasse* alone. Draft reports were presented to respondents during three residents' meetings to determine whether the raw data was correctly interpreted. During the third occasion, municipal and local social service representatives were present and invited to give feedback to residents and researchers alike.

13.2.2 Methods of Study II to assess heat-related thermal comfort in India and Austria

A second study (hereafter Study II) was conducted in 2019 in the Indian cities of Vijayawada and Jodhpur (with a population of approximately 1 million inhabitants) and the Austrian capital Vienna (1,8 million inhabitants). It looked at how heat affects the daily lives of low-income households. The dwellings of low-income respondents investigated in Vijayawada are characterized by poor thermal standards of buildings and poor ventilation. The government-built rehabilitation colony[6], in which respondents live, was selected for field measurements of indoor temperatures and qualitative interviews. Most interviewees in Jodhpur reside in self-built, one-storey units while all Viennese respondents are tenants in multi-storey apartment blocks that were built before the advent of building by-laws on energy efficiency.

For this research, interview questions were developed for semi-structured qualitative questionnaires. Fourteen semi-structured qualitative interviews were conducted in low-income households not only in the colony in Vijayawada (six interviews) but also in Jodhpur (five interviews) in India and Vienna (three interviews) in Austria, Europe. It is worth pointing out that, contrary to Study I, this study explored one aspect of thermal comfort – namely heat – in both South and North contexts. Not least due to its limited sample size, Study II did not seek to outrightly compare the very different situations in India vs Austria. Rather, it aimed at exploring potential common concerns regarding thermal comfort in the interviewed, low-income households in both countries.

Interviews in India were translated and transcribed from the local Telugu language. Local translators translated Hindi/Marwari into English, and interviews in Vienna were done in German. In this chapter, the results obtained from qualitative interviews are presented.

13.3 Results

13.3.1 Too cold … (Study I)

Survey results revealed considerable levels of poverty and, as a consequence, self-restrictions in energy consumption for many of the interviewed households in *Wachaustrasse*. The household income for 45% of the interviewees was less than 901 EUR per month, while the income of a further 27% of the interviewees ranged between 901 and 1,500 EUR monthly. Residents' average income ranges far below the national average of around 3,400 EUR per month and the median income for Austrian households (Statistik Austria, 2016). The living and heating costs of 45% of the interviewed households amount to between 5 and 7 EUR/m^2 per month. These expenses were below the Austrian average of 8 to 9 EUR per month (Höltl et al., 2015) at the time of the study. This demonstrates that the interviewees are restricting their expenditure on energy. This reduced expenditure is reflected in reduced thermal comfort in their homes.

Seven out of ten interviewed households reported that they could not afford to sufficiently heat their home. They all had lived experiences of diminished thermal comfort while residing in cold homes. Out of the seven affected households, six reported mould growth in their apartment[7], with five of these mould-affected households indicating that at least one household member was suffering from chronic health constraints. In contrast, all three households in the building that indicated they were able to keep their home warms were free of mould. Several reasons were mentioned for being unable to heat some rooms. These included leaky windows and doors, insufficient or lacking insulation, old and inefficient heating systems, and the technical impossibility of heating some rooms (e.g., due to a lack of connection to the chimney), in addition to the economic reasons that applied to all affected households. Some households reported multiple reasons for not being able to heat all rooms.

Given respondents' limited energy consumption, installing thermal insulation in their building does not hold the potential to further decrease their consumption. However, it could significantly increase thermal comfort for them. Nevertheless, several respondents voiced considerable concern over and fear of a future where such refurbishment is implemented as they expect associated rental costs to increase as a result. Their building was constructed and owned by a limited-profit-housing-association[8] obliged to offer affordable rents. Rents are therefore legally prohibited from being increased beyond the national? inflation rate. The associations, however, can still increase those components of rent that are dedicated to savings for maintenance and future refurbishments. Several respondents stated that they would have to look for alternative housing should these rent components increase after thermal insulation has been applied to the building.

13.3.2 … or too hot (Study II)

Most male respondents interviewed in the Indian cases of Study II are engaged in manual labour, which they carry out outdoors. Therefore, men are more exposed bodily to direct sunlight and heat during the day due to their work. Working less or not at all due to heat-induced strains on their bodies during the day or outright heat-related illnesses represents a significant problem for daily workers and self-employed alike. Being unable to sleep sufficiently due to a lack of thermal comfort in hot homes over prolonged periods of time was cited as contributing to such health concerns. If, as a consequence, they are unable to work, then heat has a negative impact on the incomes of poor households engaged in the informal economy. Not working at all or working less diminishes their earnings during days of extreme heat.

In eight of the 11 interviewed households in India, women try to stay inside their homes during hot days and take care of their children. For most of the day, they regard these homes as a means of protection against hot, direct sunlight. Staying inside is perceived as advantageous during the morning and midday hours. The picture starts to change during and after the day's hottest hours. Indian interviewees indicated heat to be most prevalent between 11 a.m. and 4 p.m. Four households in Vijayawada – both in single-family units and apartment blocks– reported that they would start sitting outside in the shade (of trees or buildings) around this time.

They partly do this because their houses and flats become overheated, turning uncomfortably hot in the afternoon. However, respondents stressed that they mostly sit outside to chat with neighbours.

Buildings cannot fully satisfy the protective properties ascribed to and expected of them by residents: temperature recordings in interviewees' homes in Vijayawada revealed that indoor temperatures were higher than outdoors for the entire recording period, including nights and mornings. Due to their limited resources, most households—especially those in the resettlement colony in Vijayawada—had no choice in selecting their homes, whether these were row houses or units in multi-storey buildings. They also had no say in the design of their homes to cater for expected climatic conditions, for example, in terms of shutters, shades, and openings to enable ventilation. Seemingly unrelated issues likewise impact the thermal comfort of residents. For example, with drains clogged by uncollected garbage, water gets stagnant close to the homes, mosquitoes breed, and consequently residents need to block windows to keep out mosquitoes even during the night when the admission of cooler outside air could potentially improve indoor thermal comfort.

Even though many interviewees conceded that they perceive heat to be intense at times, they mostly put it into perspective with other difficulties they face in their day-to-day lives (such as water and electricity shortages or the lack of proper sanitation). They stated that, compared with these, the heat was one of their lesser concerns. In a similar vein, Austrian interviewees were more concerned with being able to afford their daily necessities (covering bills for energy in general, rent, medicine, food supplies, expenses for children's schooling, etc.) than with heat and felt that heat was something they simply had to endure. Prioritizing their daily problems also contributed to paying less attention to the lack of thermal comfort in their homes. Heat tolerance can thus be understood as a low-cost coping strategy applied by many of the interviewees. However, this strategy bears the risk of not paying attention to health-related heat risks.

13.3.3 Comparative heat stress assessment in India and Austria

Study II mainly conducted interviews in Austria as a control group mechanism. There are, of course, apparent differences between these two countries. The hot, arid climate of Jodhpur and the hot and humid one of Vijayawada are distinctively different from Vienna's more temperate conditions, not least in terms of absolute daily temperatures. Furthermore, housing structures are different. All interviewed Viennese households live in multi-storey buildings, and all of them are tenants (as are nearly 80% of the city's total population). By contrast, homeownership was more prevalent in both Indian samples[9]. However, interviewees in both India and Austria belong to low-income groups. Due to their limited resources, the interviewed households had little or no choice in selecting their homes, whether single, mostly owned houses, or rented apartments in multi-storey buildings. Consequently, they hardly had any agency over the design of their homes with regard to climatic conditions, especially when it comes to ventilation, shutters, and shades to keep out solar radiation or thermal mass to dampen temperature peaks.

Examples of this lack of agency include – besides the above-mentioned issue of mosquito breeding – residents in India being unable to sleep on cool rooftops due to a lack of ladders to get there. In Austrian households, they often cannot – in the absence of shutters – shield their rooms from hot sunlight during the daytime or open windows for ventilation during the night because of the noise of heavy traffic on nearby roads. For the case of winter cold, respondents in Study I had pointed out that some of their rooms did not even have access to chimneys (so even if they would be able to afford both a heater and fuel, they still could not heat these rooms).

This lack of agency influences how residents can handle thermal discomfort in their homes. While low incomes force them to live in poorly planned and built buildings that constitute sources of thermal discomfort rather than comfort, this lack of resources keeps them from affording any but the most basic remedies A lack of thermal comfort can even lead to a loss of income for Indian informal workers, which makes it even harder for them to change anything about their situation.

In contrast to the heat-related situation found in the Austrian sample of Study II, heat in India threatens to impact interviewees' household incomes more negatively. Those working outside – primarily men – may see themselves incapacitated by the heat, so they will not be able to work for several days or weeks. In the context of primarily informal working relationships, they cannot fall back on sick leave payments in such cases and consequently earn less than during cooler months. While these findings may not be surprising, they are a stark reminder that people's socioeconomic limitations can play out similarly even under very distinct geographical circumstances.

13.4 Discussion and conclusion

The two studies presented here showcase how low-income households in both India and Austria struggle to afford thermal comfort in their homes. Interviewees restricted their energy consumption to be able to pay their energy bills. Consequently, they cannot either sufficiently heat their homes or not mechanically cool them at all and therefore suffer from thermal discomfort.

Mould growth is the most apparent consequence of a lack of heating in the Austrian cases. While in the Indian cases, buildings constitute the single most important and effective means of protection against heat stress for the interviewees. However, design restrictions and appliances of cheap building materials limit the effectiveness of this protection, especially during the evening and night. Building design and materials are difficult to change or improve after their original construction. Therefore, people must remain with what was provided by local authorities. Buildings thus play an ambivalent role: they can constitute a source of thermal discomfort or comfort – the former in case they are poorly planned and built, the latter in case they are constructed with sufficient thermal mass, equipped with shading, and provide suitable openings for ventilation.

The most low-profile measures for alleviating heat stress in existing settlements in Indian cases can only indirectly target related problems. Safeguarding regular and sufficiently frequent garbage removal, mostly from open drains near homes, represents such an indirect approach to increasing household thermal comfort. In Austria, by contrast, low-profile measures could include funding schemes for tenants to install external shading on windows.

The research findings presented here highlight deficiencies in thermal comfort in the studied homes. Thermal discomfort, as a prominent consequence of energy poverty, is the common denominator linking the lived experiences of energy-vulnerable households in both India and Austria (which, as is exemplary demonstrated, links, at least partly, to health and sometimes even to livelihood issues). On this common denominator, the dialogue over energy poverty can hinge in these distinctively different countries.

Lessons learned from these findings should not only be applied to the planning of future housing, especially in the Indian context, but dedicated efforts are also necessary to ameliorate people's sufferings in existing structures despite their constrained resources (Mahadevia et al., 2020). More research is required to assess the effectiveness of small-scale and low-cost interventions in these buildings. Future extreme heat events induced by global climate change will impact low-income residents' lives and livelihoods, especially in densely built urban areas such as resettlement and rehabilitation colonies in India. Residents' health and livelihood in times of heat waves hinge on the heat-protective qualities of their homes. These interdependencies would have remained unclear when only looking at health, housing, or livelihood separately. By contrast, an integrated approach to the topic reveals how improvements in housing can foster resilience to heat regarding both health and livelihood. Considering the well-established link between poverty and ill health (Vaid & Evans, 2017), the critical role played by housing in promoting health and well-being under climate change becomes apparent.

Retrofitting the homes of low-income households increases residents' thermal comfort and well-being in both the Global South and North. The scholarly discourse in the South has yet to shift from focusing on more sustainable, new construction projects towards improving and invigorating existing building structures. In the North, retrofitting and refurbishment are already on the agenda. However, socioeconomic consequences, such as the displacement of poor residents, due to unaffordable rent increases after refurbishment, are still partly overlooked. Additionally, heat in housing is only now starting to become an issue of concern, even in more temperate climates, despite the fact that climate predictions for the coming decades clearly indicate an increased frequency of prolonged heat waves in these regions. In conclusion, awareness of the unfavourable thermal conditions in low-income households must be raised to initiate positive change in both contexts presented here.

Notes

1 Notwithstanding the fact that the broad term "Global South" encompasses many regions in which heating is also a necessity for parts of the year.

2 Thermal comfort is defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 55-2020) and the Austrian Standards Institute (ÖNORM EN ISO, 7730:2005) Klicken oder tippen Sie hier, um Text einzugeben.) as "that condition of mind which expresses satisfaction with the thermal environment" (Benton et al., 1990). Thermal comfort herein is understood as a desirable state according to social norms. People's practices linked to thermal comfort have to be seen as activities that they undertake to heat and cool their bodies and homes. These are not tendencies of luxury (Madsen & Gram-Hanssen, 2017). Habits, meanings, and knowledge are the main components of collectively shared practice. Comfort practices, then, are habitual actions that vary with different ideas of identity and social histories (Gram-Hanssen, 2010). Thermal comfort is thus understood as a socio-technical issue, as a negotiable socio-cultural construct that is both an idea and a material reality (Chappells & Shove, 2005).

3 In urban housing markets with a prominent rental sector – such as in Germany and Austria – renting will mostly be low income households' choice (Reinprecht, 2014; Statista, 2022; Whitehead & Scanlon, 2014) as they may not be able to afford the upfront costs for buying a home. To put this into perspective with India: here, the share of rentals in the overall housing market varies greatly between different union states, ranging from roughly 15% to 40%. Of all rented households, 80% are located in urban areas (Knight Frank India PVT LTD & Khaitan & Co, 2019).

4 ÖNORM B 8110/Beiblatt "Erläuterungen zu Abschnitt 6 der ÖNPRM B 8110 Hochbau-Wärmeschutz", Dezember 1974.

5 The following factors are contributing to UHI formation (Santamouris et al., 2001):

- Complex geometry of the built environment decreases heat loss from within streets.
- Thermal properties of construction materials increase the storage of heat in the fabric of the city.
- Anthropogenic heat is released from the combustion of fuels (e.g., cars).
- Removal of heat by wind from within streets is reduced.

6 The term "rehabilitation colony" in the Indian context broadly refers to residential estates of considerable size (often housing several hundred families) built to accommodate previously informal settlers affected by eviction from and removal of their makeshift homes.

7 Mould can cause many health effects, such as a stuffy nose, sore throat, coughing or wheezing, burning eyes, or a skin rash. People with asthma or who are allergic to mould may have severe reactions. Immune-compromised people and people with chronic lung disease may get infections in their lungs from mould (Mudarri & Fisk, 2007).

8 Limit-profit housing associations in Austria are legal entities under a dedicated Act. Their main goal is to construct and run affordable housing for which purpose they receive public subsidies (e.g., favourable loans). Any profit generated on a particular residential building has to be reinvested in the same.

9 Further gross differences, of course, exist regarding, for example, standard of living and welfare systems, which are, however, not explored in more detail here.

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