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Cold homes in Wales: Is the satisfactory heating regime appropriate for health and well-being?

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Mae'r ddogfen hon ar gael yn Gymraeg / This document is available in Welsh.

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Executive summary

Living in a cold home is a modifiable risk factor for poor physical and mental health and well-being outcomes, including winter and cold related death.

Certain population groups are more likely to live in cold homes including, but not exclusively, those living in low income households. However, many interrelated factors affect vulnerability to living in a colder home such as fuel poverty and poor housing conditions. During the cost of living crisis, more households in Wales struggled with the increased cost of heating their home. The COVID-19 pandemic also led to more people working from home. Such circumstances may exacerbate existing vulnerabilities to living in a colder home, including financial resources.



In Tackling Fuel Poverty 2021 to 2035, Welsh Government set out a plan to support those struggling to meet the cost of their domestic energy needs. The plan included a satisfactory heating regime for a) households with older and disabled residents; and b) other households in Wales. The satisfactory heating regime advises warmer temperatures in the living room and longer heating hours for households with older or disabled residents. However, a minimum temperature of 18°C in other rooms is recommended for all households regardless of occupancy.

About this report

This report assesses the appropriateness of the satisfactory heating regime. It does so by exploring: the heating regimes used in homes in Wales during winter; who is at risk of living in colder homes; and the impacts of living in colder homes on health and well-being.

The report brings together evidence from multiple sources and findings from the Housing Warmth Survey, a household survey conducted in Wales from January to March 2022. Professionals with expertise in housing, indoor temperature and its associations with health and well-being, were involved in the development of this report. Recommendations on the satisfactory heating regime are made and are intended to inform the approach to tackling fuel poverty in Wales.

Chapter 1 sets out background information about heating regimes and vulnerability to cold homes and the Welsh policy context. The evolution of indoor temperature recommendations for homes including the Welsh Government satisfactory heating regime is described.

Chapter 2 presents the factors that influence vulnerability to living in, and experiencing worse outcomes from, cold homes.

Chapter 3 summarises findings from a 2022 systematic review of the evidence on cold homes and their associations with health and well-being.

Chapter 4 presents findings of the Housing Warmth Survey. The survey explored the heating

regimes implemented in households, and their associations with health and well-being. The final sample was 2,182 but sample sizes vary for each outcome due to missing data. Key findings include:

Heating practices during winter

- Of 2,182 participants, almost eight in ten (79%) reported that they had a working room thermostat or digital temperature controller in their home. Of those with a working room thermostat or digital temperature controller one in ten (13%) did not know the temperature their thermostat was set to or did not provide temperature data. Thus, of the full sample three in ten (31%) had no working thermostat or unknown thermostat temperature setting.
- Of those reporting a temperature (n=1,499), 11% lived in a colder home (room thermostat set to below 18°C); 89% lived in a warmer home (room thermostat set to 18°C or above).
- The mean thermostat temperature was 20.0°C.
- When controlling for other factors, only home ownership status was independently associated with living in a colder home; private renters were over two times more likely to report living in a colder home than individuals who owned their own home (compared with those living in a warmer home).
- Of 2,170 participants, three-quarters (75%) heated their whole home in winter.
- Those living in colder homes were 37% less likely to report heating the whole home than those living in warmer homes.
- Of those only heating selected rooms (n=539), the majority (92%) heated the living room, 60% heated selected bedrooms.

Thermal comfort and behavioural responses when feeling cold at home

- Of 2,176 participants, nine in ten (89%) reported thermal comfort in their main living area.
- Of those who reported thermal discomfort (n=238), 71% reported cost as the reason they were not able to keep comfortably warm.
- Of 2,165 participants, 44% reported that putting on extra clothes was their first response to feeling cold in the home.

Self-rated health and well-being

- There was no significant association between living in a colder home and self-rated health, low mental well-being or stress or anxiety in the last three months about the costs of heating the home, cutting or skipping meals due to the cost of heating the home, or reporting falls at home in the last 12 months.
- Those living in colder homes were 2.2 times more likely to be reluctant to invite guests into their home due to difficulties keeping it warm (versus those in warmer homes).

Societal factors

- Of 2,179 participants, 28% reported that the COVID-19 pandemic meant that they now heated their home for more hours and 5% reported they heated their homes for fewer hours.
- Of 2,178 participants, 53% reported concern for the impact of their heating use on climate change. 42% reported they were not concerned and 6% reported they didn't know. Of those that were concerned or didn't know (n=1,266), 44% reported that they had made changes to reduce their household heating use and 25% reported that they were beginning to think they should make changes to reduce their heating use.

Chapter 5 sets out evidence-based recommendations regarding the appropriateness of the satisfactory heating regime in Wales. The recommendations are based on careful consideration of the evidence presented in this report and expert consultation. The recommendations are that the satisfactory heating regime should:

- Advise that households heat to a temperature that is comfortable but to avoid temperatures falling below 18°C throughout the home and at a minimum in commonly used living areas; higher minimum temperatures might be required for vulnerable groups.
- Continue to refer to older people and disabled people as vulnerable in colder homes but also reference additional population groups that can be vulnerable.
- Be updated in line with emerging evidence and societal changes.
- Be regularly monitored and evaluated, informed by equality considerations that are kept under review, including assessment of how heating regimes might impact health inequalities.
- Use terminology and evidence that is meaningful and relevant to the public.
- Signpost to trusted, accessible and inclusive sources of information and advice on affordable warmth and keeping safe at home.

Intended audience and impact

The report findings and recommendations can be used to inform policy deliberations and policymaking in Wales. It could also be of wider relevance to stakeholders with an interest in housing warmth and health inequalities. The report contributes to the current evidence on vulnerability to cold homes and the health and well-being impacts of cold homes on different population groups. Finally, broader impacts of this work are intended by providing evidence to support better health, well-being, safety and comfort in homes in Wales.

1. Introduction

A growing and consistent body of evidence indicates that cold homes have negative and often severe consequences for residents' health and well-being [1,2]. People living in cold homes are at increased risk of winter/cold-related death [3,4], serious physical health conditions including circulatory and respiratory problems [2], and mental health distress [5]. In Wales, 30.9% more deaths occurred in the winter months of 2020 to 2021 than in non-winter months [6]. Furthermore, over 75% of excess winter deaths are in those aged 75 years and over and 30% of excess winter deaths are attributed to living in cold homes [4].



Welsh policy context – housing, cold homes and a satisfactory heating regime

Keeping warm and safe at home is a key policy priority in Wales [7,8]. Responsibility for housing in Wales is devolved to Senedd Cymru and Welsh Government [9]. Welsh Government has signalled its commitment to prevent or reduce the negative outcomes which are a consequence of living in a cold home. In 2021, Welsh Government published its Cold Weather Resilience Plan, also known as the 'Warm Homes' plan [8]. The plan sets out how Welsh Government will work with key partners to prioritise and protect vulnerable and lower income householders at risk of avoidable ill health caused by living in a cold home. Furthermore, in Tackling Fuel Poverty 2021 to 2035 [7], Welsh Government commit to ensuring that Welsh households can afford to maintain a sustainable, safe and comfortable home environment. As such, Welsh Government set out a definition of a 'satisfactory heating regime' (see Box 1).

Welsh Government commissioned advice to determine whether the current definition of a satisfactory heating regime (Box 1) is appropriate to ensure people can be kept comfortable and safe, particularly given changes to working patterns because of the COVID-19 pandemic.

Box 1: The Welsh Government satisfactory heating regime

The satisfactory heating regime specifies [7]:

- 23°C in the living room and 18°C in other rooms achieved for 16 hours in a 24-hour period in households with older adults (aged 60 years or over) or disabled residents.
- 21°C in the living room and 18°C in other rooms for nine hours in every 24-hour period on weekdays, and 16 hours in a 24-hour period on weekends for other households.

Indoor temperature recommendations for homes

Guidelines on satisfactory heating regimes have evolved over multiple reviews and policies. A report by the World Health Organization (WHO) published in 1984 established that there was minimal risk to the health of sedentary people in household temperatures of between 18 and 24°C [10,11]. Collins (1986) found that temperatures below 16°C increased risk of respiratory disorders and elevated blood pressure among older people [12].

The first upper temperature threshold recommendation for vulnerable groups was cited in a cross-sectional observational study of patients in Scotland with chronic obstructive pulmonary disease (COPD). The study found better respiratory health status when an indoor temperature of 21°C was maintained for at least nine hours per day [13].

Minimum indoor temperature recommendations for homes are generally considered beneficial for population health and well-being. In 2014, Public Health England (PHE) published a systematic literature review on the evidence for minimum home temperature thresholds and their impact on health [14]. The review identified 20 studies published between 1973 and 2014 and evidenced negative outcomes for cardiovascular and respiratory health and decreased thermal comfort in colder homes (i.e. below 18°C), with inconclusive evidence on Body Mass Index (BMI). Overall, the review found strong evidence that colder homes have a harmful effect on health [14]. The review identified a need for further research to understand the relationship between behaviour, vulnerability to cold, and potential health risks of exposure to cold homes in the short- and longer-term.

Since 2014, the UK Health Security Agency (UKHSA) has recommended a single minimum temperature in homes of 18°C [15]. A systematic review in 2018 found good evidence associating indoor temperatures of less than 18°C with poorer health outcomes [1]. Using these findings, the WHO recommends 18°C as a safe and well-balanced indoor temperature to protect the health of general populations during cold seasons [1] but also suggest that a higher



minimum indoor temperature may be necessary for vulnerable groups including older people, children and those with chronic illnesses [1,16]. The National Health Service website currently advises to 'heat your home to a temperature that's comfortable for you' [17]. A summary of indoor temperature recommendations is presented in Table 1.

Despite the current recommendations, it is unclear what temperatures people heat their homes to. In a study of English living rooms, the average temperature during heating-on periods was 19.5°C based on objective measurement [18], and in a national survey in England the observed mean indoor temperature of centrally-heated dwellings that had and used a thermostat was 20.4°C [19]. However, not all households have room thermostats or digital controllers. The same survey in England revealed that of households with central heating systems, 87% had a main thermostat to control the temperature [19].

Table 1: Indoor temperature recommendations

Source, year of publication [Reference]	Indoor temperature recommendation for homes	Target population for recommendation
WHO, 2018 [1]	A minimum of 18°C	General population
	A higher minimum (unspecified) may be necessary (see also WHO 2007 [20])	Vulnerable groups
WHO, 2007 [20]	From 1987 the temperatures of between 18°C and 24°C [16]	Non-vulnerable groups
	Between 20°C and 24°C	Vulnerable groups
Health and Social Care Public Health Agency for Northern Ireland, 2022 [21]	Heat the main living room to around 18 to 21°C and the rest of the house to at least 16°C. At night, keep the temperature above 18°C in your bedroom	All households
UKHSA, 2022 [15]	A minimum threshold of 18°C at all times	Healthy people (aged 1 to 64 years)
	Daytime temperatures above 18°C may be beneficial for health	Older people (aged 65+ years) or those with pre-existing medical conditions
Scottish Government, 2017 [22]	21°C in the living room and 18°C in all other occupied rooms	Non-vulnerable
	23°C in the living room and 20°C in all other occupied rooms	Vulnerable to the adverse health and well-being impacts of living in fuel poverty
Welsh Government, 2021 [7]	21°C in the living room and 18°C in other rooms for 9 hours in every 24-hour period on weekdays, and 16 hours in a 24-hour period on weekends	General households
	23°C in the living room and 18°C in other rooms achieved for 16 hours in a 24-hour period	Households with older (aged 60+ years) or disabled people

Note: The WHO definition of vulnerable groups includes children, the elderly (aged over 65 years), and people with cardiorespiratory disease and other chronic illnesses.

Expert consultation and advice



The satisfactory heating regime

- Satisfactory heating regimes are based on modelling (methods of predicting housing energy requirements) where temperature monitoring often takes place in a selected number of dwellings for a relatively brief period and can be affected by outdoor temperature/weather and household activities.
- There is a need to understand exposure levels over time, to inform guidelines on safe temperatures and heating hours.
- Emphasis on the use of 'safe' as opposed to 'satisfactory' and 'temperature' in place of 'heating' in the definition would reflect the threat to health outside the guidelines and the wide variation in heating patterns.
- The cost of attaining a satisfactory heating regime has increased with the rising cost of living.



Vulnerability to cold homes

The concept of vulnerability broadly refers to a person's susceptibility to harm. Vulnerability to cold homes can be seen as the likelihood of living in a cold home and the likelihood of experiencing negative health effects of cold homes (see Figure 1).

Importantly, vulnerability can be permanent or temporary. For example, people may have life-long health conditions which increase their vulnerability to cold homes, while others could experience transient financial instability which can affect the affordability of heating.

Figure 1: Populations susceptible to living in cold homes and/or to the health harms of cold conditions (groups may appear in more than one list)

Particularly at risk in the event of severe cold weather [15]

- older people
- children under the age of 5
- people with pre-existing chronic medical conditions
- people with mental ill-health that reduces the individual's ability to self-care (including dementia)
- people living in deprived circumstances
- other marginalised or socially isolated individuals or groups
- pregnant women (in view of potential impact of cold on foetus)
- people with learning difficulties
- people assessed as being at risk of, or having had, recurrent falls
- people who are housebound or otherwise low mobility
- people living in houses with mould
- people who are fuel poor
- homeless or people sleeping rough

Particularly vulnerable to the harmful effects of living in a cold home and/or having an above average likelihood of living in a cold home [25]

- older people
- children (including those aged less than 5 years)
- disabled people and people with long term health conditions
- people living with mental health conditions
- people paying for their fuel with a prepayment meter
- people living in energy inefficient housing

A higher proportion of these groups lived in cold homes [5]

- people with a long-standing illness or impairment
- other than white British ethnicity
- people living in low income households
- women
- single adults
- lone parents
- people who are unemployed or those who are long-term sick
- people who have family/home care as their employment status
- people in social or private rented sectors
- people living in flats

Research in Wales has identified a number of populations likely to be vulnerable to living in a cold home. In a snapshot of poverty in Wales, the Bevan Foundation identified that more than three in ten (31%) people reported going without heating in their home in the three months to January 2024 [23]. This represented over half (51%) of disabled people whose condition limits them a lot, four in ten (40%) people living in households with children under 18 years, and three in ten (30%) living in households with no children under 18. Furthermore, almost half (45%) of those reporting a household income under £20,000, four in ten (42%) private renters and almost half (47%) of those renting from a social landlord had gone without heating in their home in the period [23].

Data from an earlier snapshot of poverty in Wales in 2023 revealed that 43% of people whose physical health and 41% of people whose mental health had been negatively affected by difficulties in accessing essential goods and services, ascribed a lack of heating in their home as a contributory factor [24].

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Vulnerable population groups

The satisfactory heating regime recognises the vulnerability of older people and disabled people in cold homes but does not reflect the broader range of vulnerable populations such as children. The Tackling Fuel Poverty report [7] identifies specific groups who are at risk of fuel poverty but are not included in the definition of a satisfactory heating regime, for example children under 16 years of age.



2. Factors influencing living in a cold home and health and well-being

Key points:

This chapter describes key risk factors operating at the societal, property and personal level that influence the likelihood of living in a cold home, or of experiencing worse outcomes as a result of living in a cold home.

- At a societal level, factors including the rising cost of living and energy costs play a significant role in the affordability of heating.
- At a property level, property age and energy efficiency are important factors in how well people can adequately heat their homes.
- At a personal level, considerations such as perceptions of thermal comfort can influence feeling of warmth at home.

Housing warmth is influenced by a range of factors operating across **societal** (about social, economic and environmental circumstances), **property** (about the building) and **personal** (about the occupants) levels (Figure 2). Some of these factors are longstanding issues, such as fuel poverty and older, less energy efficient housing stock in Wales. Other factors are more recent influences, such as the increasing cost of living.

The factors influencing housing warmth do not always occur in isolation and may span societal, property and personal levels. Also, the factors do not always operate in deterministic ways. For example, there is no straightforward link between living in a cold home and low income. Many people living in low income households in Wales often live in some of the least energy efficient housing; other low income householders live in socially rented housing which tends to be more energy efficient than private housing but might still be unable to afford their energy bills [25].

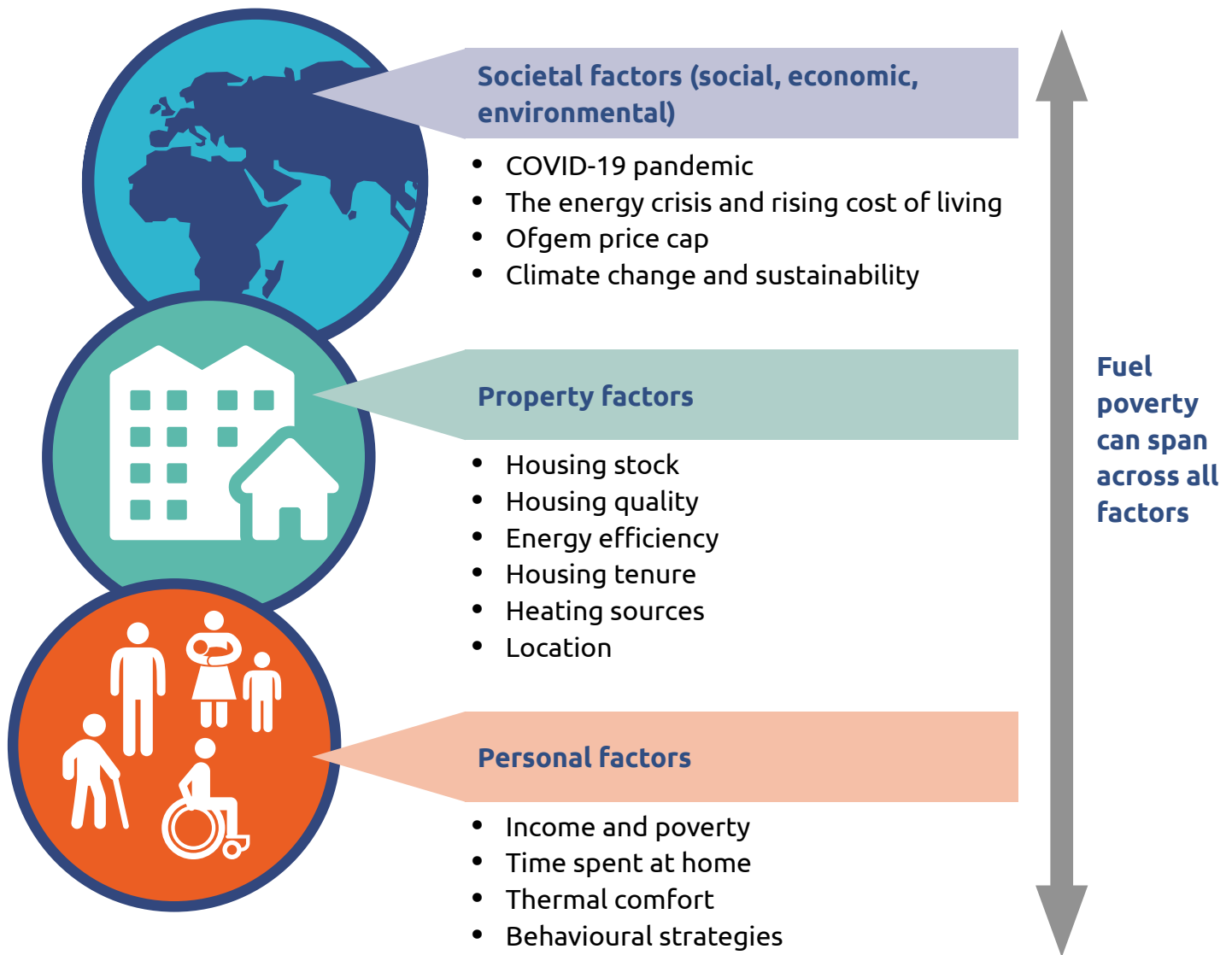
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Personal and property level factors

Consideration of cold homes should include a focus both on the 'property' (e.g. housing conditions and types) and the 'person' (e.g. income and perceived satisfaction with temperatures in the home). These factors can interact; an energy inefficient dwelling may be occupied by a household with sufficient income to afford to heat it to the minimum temperature threshold, while the same dwelling occupied by a low income household may not be able to afford to maintain a safe temperature regime.



Figure 2: Interrelated factors associated with housing warmth, health, and well-being



Fuel poverty

Fuel poverty relates to the ability to afford adequate heating [26]. The Tackling Fuel Poverty 2021 to 2035 plan defines fuel poverty as:

- Households needing to spend more than ten percent of their full household income to maintain a satisfactory heating regime [7].

Fuel poverty can also be considered as those [7]:

- At risk of fuel poverty (paying more than eight percent, but less than ten percent of full household income)
- Living in severe fuel poverty (paying more than 20% of full household income)
- Living with persistent fuel poverty (paying more than ten percent of full household income in two out of the three preceding years).

Households are considered fuel poor when occupants are unable to afford to heat their homes to a reasonable temperature. People's inability to afford adequate heating can lead to physical and mental health impacts such as respiratory or circulatory problems and, in extreme cases, hypothermia [27].

Fuel poverty is influenced by three primary factors: household income, the current cost of energy, and the energy efficiency of a home [26]. It was estimated that from April 2022, up to 45% (614,000) of households in Wales could be living in fuel poverty; an increase from 14% (196,000) in 2021 [28]. Fuel poverty estimates do not include households living in unmetered, off-grid, or rural locations. Such dwellings are also more likely to be detached, with inadequate heating.



Case study 1: ECO 4

In the UK, the [Energy Company Obligation \(ECO\) 4](#) scheme (opens in new window) provides grants to fund energy-efficient upgrades to homes, with the aim of increasing energy efficiency and reducing fuel poverty and energy costs.

Societal factors

Societal factors are the broader social, economic and environmental conditions that influence the likelihood of living in a colder home, or of negative health and well-being outcomes as a result of living in a colder home.

Case study 2: Healthy Homes Initiative

Upon its establishment in 2013, the New Zealand Ministry of Health programme 'Healthy Homes Initiative' was aimed at increasing the number of children living in warm, dry and healthy homes and reducing hospitalisations and ill health associated with housing conditions. The initiative was expanded in 2016 to focus on warm, dry and healthy housing for low income families with 0 to 5 year-old children and pregnant women. An evaluation of the programme has been published [29].

Energy costs and the rising cost of living

The rising cost of living has had a wide-ranging and likely long-term impact on the day-to-day lives of people in Wales [30]. There have been significant rises in the cost of essentials that have outstripped increases in average wages and welfare payments [30]. The cost of energy has risen disproportionately compared to most other goods [31], with wholesale energy prices increasing rapidly from the second half of 2021 onwards [32].

In December 2022, a survey found 92% of consumers in Wales reported that energy prices were a worry. Further, due to the price in energy rising, almost eight in ten (78%) reported putting their heating on less due to cost [33].

Efforts to reduce the impacts of cold homes have been recommended as part of a wider package of short-term public health responses to the rising cost of living [30]. However, while the rising cost of living is expected to affect most households across Wales, it is disproportionately impacting and widening health inequalities for the most disadvantaged [30]. Housing and food account for a bigger share of expenditure for low income households than high income households [34].

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Fuel Poverty Monitor

The [National Energy Action Fuel Poverty Monitor](#) (opens in new window) is an important source of information regarding the Welsh context of the energy crisis and policy response [35].



Energy price cap

In 2019, the default tariff cap (also known as the energy price cap) was introduced by Ofgem to set a maximum price per unit of electricity and gas for customers on domestic default tariffs in Great Britain [36]. For the period 1 October 2022 to 31 March 2024 the default tariff cap was superseded by the Energy Price Guarantee (EPG).

Some households did not get support from the EPG due to their energy source (e.g. oil or liquefied petroleum gas (LPG)) or how they paid for their bills (e.g. prepayment meter). This is of particular relevance for rural households who often rely on oil or LPG as their main source of heating [37].

Climate change and sustainability

Domestic energy use is a significant contributor to carbon emissions. The residential sector emitted 68.1 MtCO₂ in 2021, accounting for 19.9% of all carbon dioxide emissions in the UK [38]. In 2021, almost a fifth (18%) of adults in Wales reported the cost of heating a home was their main concern about the impact of climate change [39].



The latest Intergovernmental Panel on Climate Change (IPCC) report predicts global increases in climate-related illnesses, premature deaths and threats to mental health and well-being due to rising temperatures and more severe weather events [40]. United Kingdom Climate Projections (UKCP18) show increases in average summer temperatures and the number of heatwave events in the UK [41]. Projections for Wales suggest that heat-related deaths could increase from a baseline of 2.4 per 100,000 people per year to 6.5 per 100,000 per year by the 2050's [42].

Higher winter temperatures resulting from climate change could lead to a reduction in cold-related mortality when temperature alone is considered [43], as well as falling heating demands [44,45] and in the long term, potentially, reduced heating costs [46]. However, this needs to be balanced against evidence of the health and broader impacts of heatwave events [46,47].

Property factors

The characteristics of a dwelling can influence heating patterns, and the quality of design and construction can determine how vulnerable people are, to cold and other extreme weather [48,49].

Housing stock

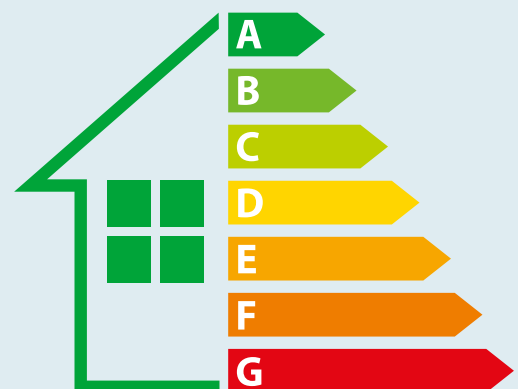
There has been consideration of the relationship between housing, safety, and well-being, in the context of Welsh housing stock [27]. Wales has the oldest housing stock in the UK, with over a quarter of houses (26%) built before 1919 [50]. Older properties are reported to be more likely to be poorly insulated and with inappropriate heating [51]. Also, many homes in Wales are detached, with higher space-heating energy demands [52].

Housing quality and energy efficiency

As of March 2023, the median Energy Performance Certificate (EPC) rating (see Box 2) for Welsh dwellings is 66, which falls within band D, where A is the most energy efficient [53]. Data on median energy efficiency scores in Wales and English regions in 2023 revealed that Wales had among the lowest median energy efficiency score [53].

Box 2: Energy efficiency ratings

An Energy Performance Certificate (EPC) provides an indication of the energy efficiency of a dwelling based on property features including insulation and building materials [53]. Following an assessment, an EPC score between 0 and 100 is generated, and the associated band provides information regarding energy efficiency: from band A, 92 and above (most efficient) to band G, 1 to 20 (least efficient), with interim bands reflecting a continuum of efficiency [53]. However, not all dwellings have been assessed and provided with an EPC rating.



Case study 3: Building fabric improvements

A study on energy-efficiency interventions with low income households in Wales suggested that building fabric improvement interventions improved living conditions and reduced energy use [54].

Housing tenure

The latest figures for Wales (published in 2022) reveal that people living in the private rented sector were more likely to be fuel poor; 23% of private rented households were living in fuel poverty compared with 13% of owner occupiers or those in social housing [28].

Data from 2018 suggest an improvement in the energy efficiency of private rented dwellings in Wales since 2010 [55]. The private rented sector in Wales has the largest proportion of pre-1919 dwellings (43% of all private rented dwellings) with over half of private rented dwellings in energy efficiency band D (54%), 24% in band C and 7% in band F; and are most likely to have one or more Housing Health and Safety Rating System (HHSRS) Category 1 hazards (24%) [55].



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Diversity of dwellings in Wales

The diversity of dwellings and household types should be considered, including non-traditional dwellings and households, such as Gypsy, Traveller, and other nomad communities. Evidence indicates that Traveller community members can face barriers to accessing energy schemes and often live in inadequate housing with poor heating conditions [56,57].



Heating sources

As of March 2023, mains gas was the most common source of central heating fuel in dwellings with an EPC analysed in England and Wales (80%) followed in joint second, in Wales only, by oil and electricity (both around 7%) [53].

Location

Dwellings in rural areas of Wales tend to be less energy efficient than dwellings in urban areas [50]. Rural homes tend to be older [58] and are more likely to use heating oil or LPG as their main heating fuel, which are more expensive than gas and electricity received through the national energy network [37].

Personal factors

As well as societal and property factors, personal factors are also important for influencing the likelihood of living in a cold home or of worse outcomes from living in a cold home.

Income and poverty

The likelihood of living in a cold home is often influenced by the affordability of heating. Low incomes often restrict people to living in older and colder homes [1] and people with lower disposable incomes may struggle to heat their homes or to adapt to rising energy prices [59]. Spending less on heating homes creates cold and damp conditions, which can compound existing poor quality or poorly insulated housing and negatively affect health [30].

Households in Wales may experience difficulties in coping with increased energy costs due to lower levels of employment and income [60]. UK polling by National Energy Action (NEA) in autumn 2022 reported that 81% of households said they would be rationing energy during that coming winter and that households classified as low income were most affected [35].

Statistics for Wales updated in 2022 showed that households where the participant was unemployed or on means tested benefits were more likely to be in fuel poverty than those who were not [28]. In Wales, almost six in ten (57%) people of working age are classed as living in poverty [61]. Living in a workless household increases the risk of poverty. However, many working households still experience poverty, and this has worsened during the last two decades [61].

Case study 4: Communities4Change Wales pilot

Communities4Change (C4C) Wales is an evidence-informed approach that brings together several agencies with a focus on changes to improve health and health equity. Public Health Wales worked with Cwm Taf Morgannwg Healthy Housing Partnership (CTMHHP) to test and evaluate the [Communities4Change \(C4C\) Wales](#) (opens in new window) approach [62].

Time spent at home

Time spent at home can influence vulnerability by increasing home heating demands or exposure to cold.

Over the COVID-19 pandemic, more people were spending longer at home, often using more energy while earning less, placing particular pressure on people on low incomes and in the least energy efficient homes [63].

The pandemic also transformed the way people work, with a shift towards homeworking. Figures for Wales suggested that 30% of the workforce were homeworking in the period January to March 2022 and that 11.5% of non-homeworkers reported working from home at least one day a week [64].

Data for Great Britain collected in November 2021 revealed that of those who said they were working from home at least once in the previous week because of the COVID-19 pandemic, more than four in five adults (82%) said they were spending more on utility bills [65]. This might be particularly important for the future of household heating, given Welsh Government's new 'Smarter working' remote working strategy for Wales, which sets out an aim for 30% of the Welsh workforce to work at or near to home [66].



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Vulnerable population groups

There are many reasons why some population groups are particularly vulnerable to cold homes. Time spent at home has an impact on population groups including older people and young children.

Spending a larger proportion of time at home can increase the demand for heating and potentially the length of exposure to cold where homes are hard to heat. Those vulnerable to this include retirees, older adults, children and disabled people. A large proportion of the workforce who work from home are also potentially vulnerable.

Thermal comfort

Thermal comfort is a state of mind which expresses satisfaction with the thermal environment and is influenced by a range of environmental, individual objective and subjective factors [11,67]. Thermal discomfort – where an individual perceives a lack of satisfaction with the ambient temperature – ranges from feeling uncomfortable to serious health impacts [59].

Thermal comfort is influenced by indoor environmental factors (e.g. air temperature, movement, and exchange, and humidity which are influenced by dwelling type and construction) and individual factors (e.g. gender, age, health status, duration of exposure to temperatures outside of the comfort range, and clothing worn [59]). These factors are often not stable but will vary within a given day and across time, and will have different impacts on different people, bringing about challenges in the measurement and assessment of thermal comfort [59].

Behavioural responses

People's behavioural responses can provide further insights on the likelihood of living in, or having worse outcomes from living in, a cold home. Behavioural responses can include rationing heating such as turning the heating down or off in some or all rooms [68,69]. In Great Britain during January 2022, almost a third (32%) of respondents to the Opinions and Lifestyle Survey whose cost of living had risen reported cutting back on their gas and/or electricity use [65].

Self-disconnection from prepayment meters is also a known behavioural response to home heating costs, and more so because of rising energy prices. Self-disconnection occurs when people with a prepayment meter do not have enough money to top-up their meter and their meter cuts out, or when they do not realise that credit on the meter is limited [70].

In addition, the "heat-or-eat" dilemma is a trade-off typically between heating and food consumption [58,71]. In Wales in winter 2024 (2023/24), a quarter of people (24%) reported that they either cut down on the size of a meal or missed a meal for themselves in the three months to January 2024 [23], although it is not known whether this is related to a trade-off between heating and food consumption. A Public Health Wales survey, conducted over winter 2023, revealed that almost a half (45%) of people had to cut down on the amount of food they bought in the preceding six months as a result of the rising cost of living [72].

3. Cold homes and health and well-being

Key points:

This chapter summarises the evidence presented in [Cold homes and their association with health and well-being: a systematic literature review](#) (opens in new window) published by Public Health Wales NHS Trust in 2022 [2].

Twenty studies were included in the systematic review. Overall, evidence suggests that living in cold homes (i.e. below 18°C) is associated with negative effects on health and well-being. Older adults and those living with long-term health conditions were more likely to experience worse health when living in cold homes. However, the evidence was insufficient to draw clear conclusions regarding health and well-being outcomes at specific temperature thresholds for different population groups.

What is known about cold homes and health and well-being?

A growing body of evidence suggests that cold homes contribute to a range of negative health and well-being outcomes [4,73,74] including:

- Respiratory problems [1,14,75,76]
- Poorer cardiovascular health [14,77]
- Mental health conditions such as depression and anxiety [74]
- Loneliness, social isolation, and a poorer sense of well-being [78,79]
- An increased risk of falls [78].

What is the evidence for specific temperature thresholds at which negative health and well-being effects start?

The included studies (n=20) examined the association between cold homes and health outcomes relating to the cardiovascular system; respiratory system; sleep; physical performance; and general health (Table 2).

Most studies (n=18) recorded temperatures inside participant homes, with measurements often taken in different rooms. The two remaining studies used controlled temperatures in laboratory settings under thermal test conditions [80,81]. The time interval of temperature measurement varied across studies from every ten minutes (n=10) to one time point only (n=3). Most studies also collected outdoor temperatures.

Seventeen of the twenty studies found exposure to cold indoor temperatures was associated with negative effects on health measures (Figure 3). More than half of these studies (n=11) investigated health effects at a specified temperature threshold below 18°C (in line with the WHO minimum temperature recommendation; see Table 1); these included a range of temperatures from 10°C to 17.9°C (see Figure 3).

Table 2: Distribution of main health outcomes in included studies


Health category	Number of studies	Detailed outcome explored
Cardiovascular	10	Blood pressure [80,82–87] Salt intake (linked to blood pressure) [88] Electrocardiogram (also known as ECG) abnormalities [89] Blood platelet count [90]
Respiratory	3	Chronic obstructive pulmonary disease (COPD) [91] Respiratory viral infection [92,93]
Sleep	2	Nocturia [94] Sleep onset latency [95]
Physical performance	2	Physical performance [81] Hand-grip strength [96]
General health	3	Perceived impact of cold on health [97] Self-rated health [98,99]









Note: Nocturia refers to needing to wake up more than once at night to urinate. Sleep onset latency refers to the time it takes to fall asleep after turning the lights off.



For patients with COPD, home temperatures at or below 18.2°C were associated with increased severity of symptoms [91]. For healthy adult and child populations, there was no significant relationship between exposure to cold homes and symptoms of viral infection [92,93]. There was also mixed evidence for associations between cold indoor temperatures and general self-rated health, with two studies reporting deteriorating health [97,99] and contrasting evidence observing an association between each 1°C increase in indoor temperature and poor self-rated health [98]. However, several explanations were speculated including that people with worse self-rated health may have chosen or been advised to maintain warmer temperatures.

This evidence is consistent with and builds upon the findings of the PHE systematic literature review in 2014 and the WHO systematic review in 2018 [1,14]. There is consistent evidence that temperatures of below 18°C are associated with negative effects on health measures. This suggests that the minimum temperature of 18°C to which the WHO and UKHSA currently recommend the general population heat their homes, is safe for health. However, there is insufficient evidence to draw clear conclusions regarding outcomes at specific temperature thresholds for different population groups. The available evidence also has several limitations including a lack of personal exposure measurements and the inability to clearly establish cause and effect between indoor temperatures achieved and health and well-being outcomes.

Figure 3: Summary of results by health and well-being outcome from individual studies published 2014 to 2022 included in the review

Outcome	Association identified	Temperature threshold below 18°C specified
 Cardiovascular		
In adults aged 20 years or older, a home thermal insulation intervention increased morning temperature by 1.4°C (14.5°C to 15.9°C) and reduced morning systolic blood pressure and diastolic blood pressure [85]	Studies found an association between colder temperature and poor health	
In adults aged 60 years or older, an intervention to heat living rooms to 24°C before waking increased temperature on average by 2.1°C (14.1°C to 16.2°C) four hours after rising, and reduced systolic blood pressure and diastolic blood pressure [82]		
In adults aged 20 years or older, morning systolic blood pressure showed a higher increase compared with evening systolic blood pressure per 10°C decrease (range 3.3°C [morning] to 27.5°C [evening]), particularly for older adults and women [86]		
In adults aged 60 years or older, nocturnal urinary sodium excretion rate in the coldest homes (10.1°C plus or minus 2.3°C) was 14.2% higher than in the warmest (19.3°C plus or minus 1.8°C) [88]		✓
In normotensive and pre-hypertensive males aged 23 to 26 years, higher morning blood pressure surge were recorded under cold conditions (16.67°C plus or minus 0.45°C) compared to warm conditions (24.40°C plus or minus 0.78°C), with higher trends observed in pre-hypertensives [80]		✓
In adults aged 50 years or older, systolic blood pressure and diastolic blood pressure was higher for people living in cold homes (below 18°C) compared with people living in warmer homes (18 °C or higher) [87]		✓
In adults aged 16 years or older, a 1°C decrease in temperature was associated with an increase in blood pressure [84]		
In adults aged 60 years or older, blood platelet count in the cold group (below 14.4°C) was significantly higher compared to intermediate (14.4°C to 17.9°C) and the warm (higher than 17.9°C) groups [90]		✓
In adults aged 20 years or older, electrocardiogram abnormalities were more likely in those living in cold houses (below 12°C) compared to warm houses (18°C or higher) [89]		✓
In adults aged 60 years or older, a 1°C decrease in temperature (range 0.3°C [night] to 33.6°C [morning]) was associated with an increase in daytime systolic blood pressure, nocturnal blood pressure fall, sleep-trough morning blood pressure surge [83]		

Outcome	Association identified	Temperature threshold below 18°C specified
 Respiratory		
In adults aged over 18 years, no association was observed between measured temperature (range approximately 1°C to approximately 38°C) and possible or probable viral infection or sleep quality in winter [92]	Studies found no association identified between temperature and health	
In children aged 15 years or under, there was no difference in the incidence of the common cold between coldest (below 16°C for 180 minutes per day or more) and least cold (below 16°C for less than 30 minutes per day) night-time temperature groups [93]		
In adults aged 45 to 85 years with chronic obstructive pulmonary disease, more severe symptoms occurred at 18.2°C or below [91]	Studies found an association between colder temperature and poor health	
 Sleep		
In adults aged 60 years or older, sleep onset latency decreased from 16.7 minutes to 12.4 minutes after increasing evening temperature from 10°C to 25°C [95]	Studies found an association between colder temperature and poor health	
In adults aged 60 years or older, nocturia was more likely in those living in colder houses (13.2°C plus or minus 3.0°C) compared to those in warmer houses (18.6°C plus or minus 2.4°C) [94]		
 Physical performance		
In women aged 70 years or older, physical performance (e.g. muscle power of lower limbs) decreased in a 15°C room compared with a 25°C room [81]	Studies found an association between colder temperature and poor health	
In older people (mean 81 years), worse hand-grip strength was associated with cold houses (below 18°C) compared to warm houses (18°C or higher) [96]		

Outcome	Association identified	Temperature threshold below 18°C specified
 General health		
<p>In adults aged 16 years or older, each 1°C increase in temperature (range 7.5°C to 36.8°C) was associated with a 1.7% higher likelihood of poor self-rated health; this was a linear relationship [98]</p>	<p>Study found an association between warmer temperature and poor health</p>	
<p>In adults aged 66 years or older living in homes below 18°C, existing chronic health problems including osteoarthritis and asthma appeared to worsen in the cold [97]</p>	<p>Studies found an association between colder temperature and poor health</p>	
<p>In adults aged 61 to 98 years, room temperatures below approximately 15°C were perceived to have a negative influence on health and well-being [99]</p>		

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Evidence on heating patterns

Heating to 18°C is supported by the evidence. However, there are difficulties relating to standard heating patterns due to dependencies such as the period of time that the house is occupied and the activities being undertaken by the household and limited evidence that associates heating patterns and behaviours with health and well-being.

In the UK, it is very common for homes to use heating intermittently, typically switching off the heating when occupants are asleep at night and when they are out during the day.

What population groups are vulnerable to the negative health and well-being outcomes of cold homes, and in what ways?

Children, older adults, and people living with long-term health conditions are known to be especially vulnerable to the negative outcomes of cold homes [1]. Figure 3 presents the findings of studies on the health and well-being outcomes of cold homes among different population groups identified within the review; individual studies were published 2014 to 2022.

Studies reported increased blood pressure from living in cold homes in different population groups [80,83–87]. Nevertheless, these physiological changes varied across studies. The potential health impacts of these changes require more research, including the association of indoor temperature with cardiovascular disease risk [100–102].

Older people and those with chronic health problems were found to be more vulnerable to negative impacts from cold homes [80,86,91]. Physical performance in older adults was shown to decrease following indoor cold exposure [81,96], which is an important risk factor for falls and fall-related injuries.

Sleep problems have also been shown to increase in older adults exposed to cold indoor temperatures [94,95]. Other research has reported that cold exposure does not affect sleep stages like heat exposure does, but that cold exposure nonetheless affects cardiac autonomic response during sleep; hence it is proposed that the impact of cold exposure may be greater than that of heat exposure in real-life situations [103].

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Physiology

Certain population groups might be vulnerable due to their physiology. For example, a study has reported that age-related decline in autonomic nervous function led to impairment of thermoregulatory capacity in a high proportion of old people [104]. A report on the characteristics of low income households most at risk of living in cold homes in Wales has summarised some of the physiological factors that increase susceptibility to cold and that increase risk in cold homes [25].

What are the gaps in understanding the relationship between cold homes and health and well-being?

There are gaps in the evidence on cold homes and health and well-being. In particular, additional evidence is needed on:

- The impacts of cold homes on mental health and well-being; isolation and loneliness; and the wider determinants of health, such as educational attainment;
- The impacts of cold homes on specific population groups such as children under five years old and those living in fuel poverty;
- The specific temperature thresholds at which health effects start among different population groups; and,
- The long-term health and well-being effects of exposure to cold homes among different population groups.

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Cold homes evidence

Limitations of existing research on cold homes

- There is no international temperature measurement regime and, in turn, no set guidelines for conducting research on temperatures in homes. The American Public Health Association and Centers for Disease Control and Prevention 1986 minimum housing standards outline a specific set of instructions for measuring temperature [105].
- There is extensive literature on heating patterns and behaviours, but the evidence is not always linked to health.
- There is also a gap in understanding exposure levels over time that could help inform required temperatures and number of heating hours.
- Evidence on cold homes should consider, for example, hot water use and its relationship with health and well-being; the relationship between housing, overheating and health; and any differences between heating the home and heating the person.

Interrelated factors relevant to cold homes

- Indoor temperature alone is just one aspect of healthy indoor conditions. Also relevant are ventilation, condensation, mould growth, particulate matter and damp.
- Indoor conditions are linked to the way people heat their home when it is very cold and their behaviours relating to ventilation, such as not opening windows in winter.

4. The Housing Warmth Survey (Wales, 2022)

Key points:

This chapter presents findings from the Housing Warmth Survey (Wales, winter 2022) on: heating regimes used during winter; thermal comfort and behavioural responses to feeling cold at home; health, well-being and colder homes; and societal factors and colder homes. The survey was conducted via telephone and online between January and March 2022. Data collection was undertaken by a commissioned market research company. The final sample was 2,182 but sample sizes vary for each outcome due to missing data. Key findings include:

Heating regimes used during winter

- Of 2,182 participants, almost eight in ten (79%) reported that they had a working room thermostat or digital temperature controller in their home. Of those with a working room thermostat or digital temperature controller, one in ten (13%) did not know the temperature their thermostat was set to or did not provide temperature data. Thus, of the full sample three in ten (31%) had no working thermostat or unknown thermostat temperature setting.
- Of those reporting a temperature (n=1,499), 11% lived in a colder home (room thermostat set to below 18°C); 89% lived in a warmer home (room thermostat set to 18°C or above).
- The mean thermostat temperature was 20.0°C.
- When controlling for confounding, only home ownership status was independently associated with living in a colder home; private renters were over two times more likely to report living in a colder home than individuals who owned their own home (compared with those living in a warmer home).
- Of 2,170 participants, three-quarters (75%) heated their whole home in winter.
- The odds of heating the whole home were 37% less likely in those living in colder homes (versus those in warmer homes).
- Of those only heating selected rooms (n=539), the majority (92%) heated the living room, 60% heated selected bedrooms.

Thermal comfort and behavioural responses when feeling cold at home

- Of 2,176 participants, nine in ten (89%) reported thermal comfort in their main living area.
- Of those who reported thermal discomfort (n=238), 71% reported cost as the reason they were not able to keep comfortably warm.
- Of 2,165 participants, 44% reported that putting on extra clothes was their first response to feeling cold in the home.

Health and well-being

- There was no significant association between living in a colder home and self-rated health, low mental well-being or stress or anxiety in the last three months about the costs of heating the home, cutting or skipping meals due to the cost of heating the home or reporting falls at home in the last 12 months.
- Those living in colder homes were 2.2 times more likely to be reluctant to invite guests into their home due to difficulties keeping it warm (versus those in warmer homes).

Societal factors

- Of 2,179 participants, 28% reported that the COVID-19 pandemic meant that they now heated their home for more hours and 5% reported they heated their homes for fewer hours.
- Of 2,178 participants, 53% reported concern for the impact of their heating use on climate change. 42% reported they were not concerned and 6% reported they didn't know. Of those that were concerned or didn't know (n=1,266), 44% reported that they had made changes to reduce their household heating use and 25% reported that they were beginning to think they should make changes to reduce their heating use.

Study methodology

The full study methodology is provided in the Appendix Section 1.2. The Housing Warmth Survey was conducted during January to March 2022. A quota sampling approach was used, with an oversample of 500 people aged 65 years or older to allow for analysis on those potentially more vulnerable to cold temperatures.

A professional market research company was commissioned to undertake data collection. Data were collected by telephone and online.

In total 2,290 adults aged 18 years and over, resident in Wales, took part in the survey. Survey responses considered too fast (n=17) and those with missing demographic data (n=91) were excluded. The final sample used for analysis was 2,182 adults. However, sample sizes vary across outcomes due to missing data.

Study questionnaire

The study questionnaire was developed by the research team. All measures were self-reported. Appendix Table A1 details the full questions for data analysed in this study. Survey questions explored in this report included: participant demographics (age, gender, ethnicity, employment, postcode of residence); household characteristics (household occupancy, household resident disability (those reporting their own disability and/or living with a household member who had a disability or long-term health condition), home ownership, income); home characteristics (main source of heating, year of home build); household heating (room thermostat temperature

settings; rooms heated); thermal comfort; behavioural responses (when feeling cold at home, cutting or skipping meals due to the cost of heating the home, reluctance to invite guests into the home); perceptions of minimum temperatures to keep people comfortable and safe; well-being and health (self-reported a health condition from a defined list, mental well-being [using the Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS)], overall self-reported health, stress or anxiety about the costs of heating the home, falls at home in the last 12 months); and influence of the COVID-19 pandemic and climate change on household heating behaviours.

Data analysis

Data are presented for the full analytical sample, or where sub-samples are presented due to missing data, the sample size for each outcome is presented. Data are unweighted.

Due to small numbers in minority ethnic populations, ethnicity was coded into 'white', and all other ethnic groups combined, termed here 'other than white'. However, due to only 2.2% of the sample reporting 'other than white' ethnicity (see Appendix Table A2), the variable was not included in the analyses.

Bivariate analyses (chi-squared) were used to examine relationships between outcomes, participant demographics and household characteristics. Independent relationships for each outcome of interest were then explored using logistic regression analysis, including multinomial logistic regression, controlling for socio-demographics and household characteristics (age, gender, Welsh Index of Multiple Deprivation (WIMD) quintile [106]) and survey method. Models also included potential confounders which may be linked to increased vulnerability to cold homes: self-reported a health condition, having a disabled resident, income, home ownership and household occupancy. Analysis used SPSS version 29.

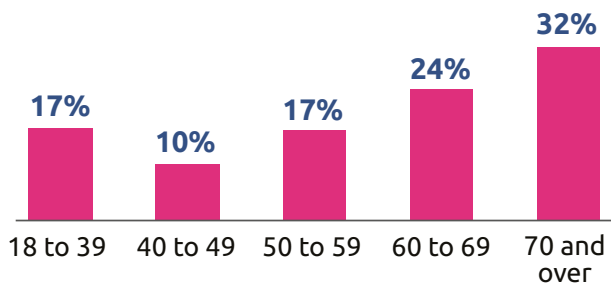
Who took part

The majority of the sample were female (60.2%) and aged 60 and over (56.1%). Over half of the sample reported a disabled household resident, with 64% self-reporting a health condition. Over four in ten (45.3%) of the sample were retired, and four in ten were employed (40.6%; full/part-time or self-employed).

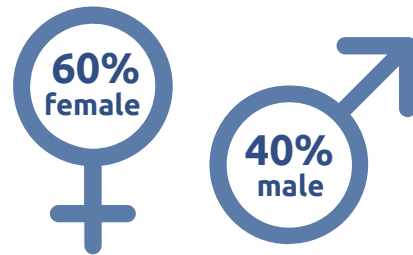
Figure 4 and Appendix Table A2 show the demographics and housing characteristics of the full sample.

Figure 4: Sample demographics and housing characteristics (N=2,182)

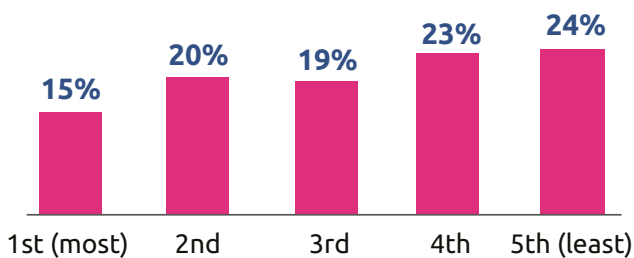
Age group (years)



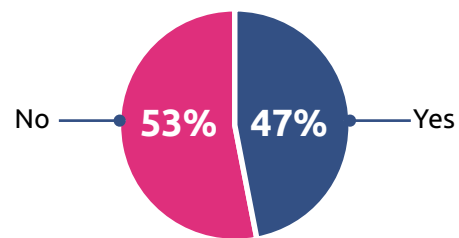
Gender



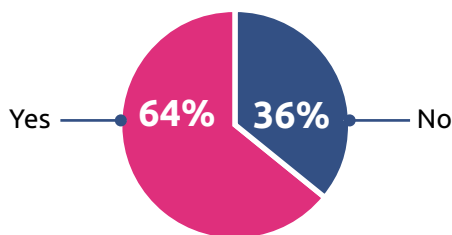
Deprivation quintile



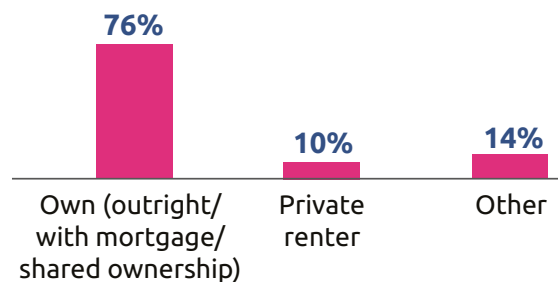
Disabled household resident



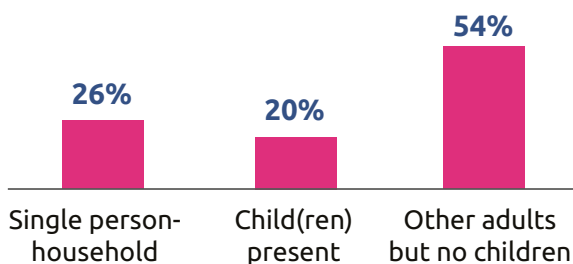
Self-reported a health condition



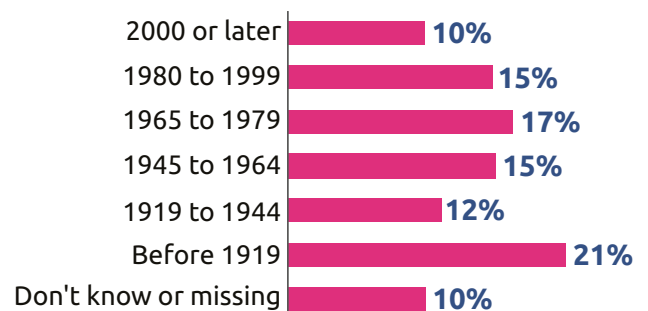
Home ownership



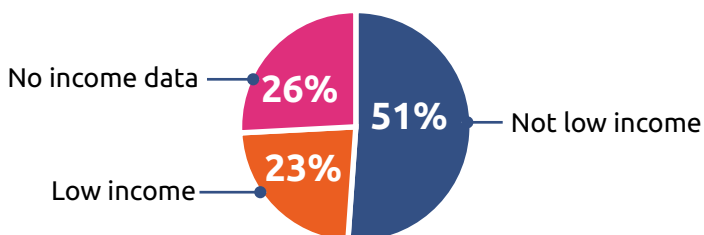
Household occupancy



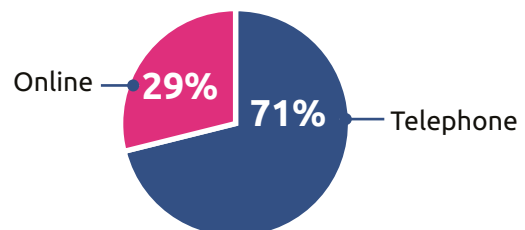
Year of home build



Low income



Survey method



Note: Other home ownership includes those who rent from local authority/housing association/ cooperative/ trust/ registered social landlord and those who didn't know/refused to answer. Figures may not add up to 100% due to rounding.

Room thermostat temperature settings

Participants were asked if they had a working room thermostat or digital temperature controller, and if so, at what temperature it was typically set to heat their home in winter. Temperatures in Fahrenheit were converted to Celsius and rounded to the nearest whole number (°C).

Of the full sample (N=2,182), 78.6% reported having a working room thermostat, 19.4% did not (1.9% missing). Of those with a room thermostat, 87.4% (n=1,499) reported the temperature at which they set their thermostat. Thermostat temperatures of less than 5°C or above 35°C were coded as missing (see Appendix and Table A1). In total, 31.3% of the full sample reported that they did not know the temperature at which the room thermostat was set or had missing data (herein termed no temperature data; see Box 3).

For the purpose of analyses in this report, room thermostat temperatures of less than 18°C have been used as a proxy measure for colder homes (see Box 3). Temperatures of 18°C and over are used to indicate warmer homes. This cut off was selected due to the common use of 18°C as a recommended minimum temperature threshold for homes (including the Welsh Government; see chapter 1, Table 1). However, it should be noted that the location of the room thermostat was not measured in the survey.

Box 3: Room thermostat temperature definitions used in this report

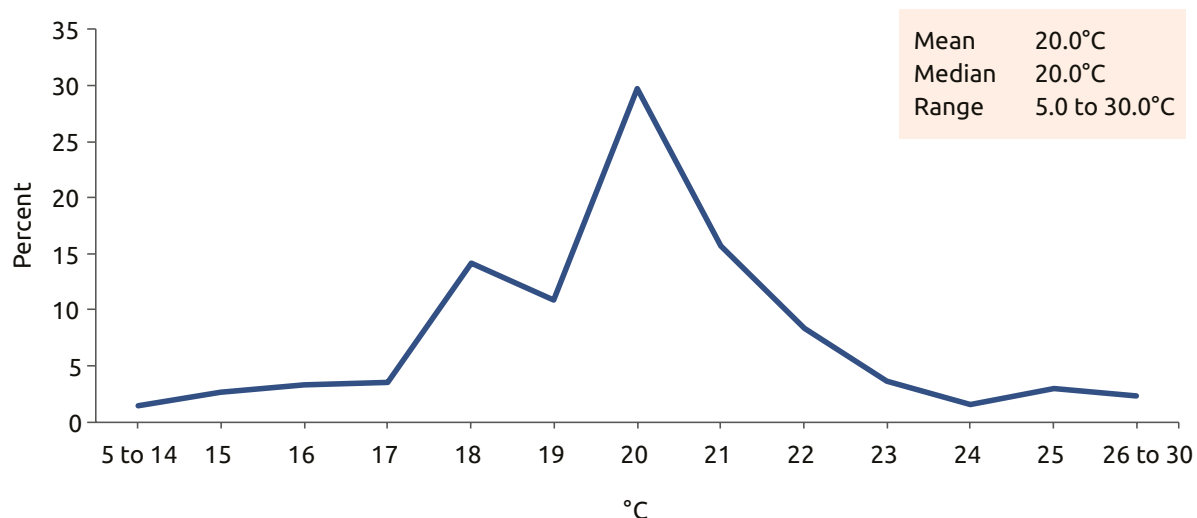
Colder home: working thermostat set at less than 18°C

Warmer home: working thermostat set at 18°C or above

No temperature data: no working thermostat or unknown thermostat temperature setting

Amongst those reporting a room thermostat temperature (n=1,499), the mean thermostat temperature was 20.0°C. The distribution of room thermostat temperatures is shown in Figure 5.

Figure 5: Distribution of reported room thermostat temperatures (n=1,499)



One in ten (10.7%) of those reporting a room thermostat temperature reported a colder home (thermostat set to below 18°C; 7.4% of the full sample) and 89.3% reported a warmer home (18°C or above; 61.3% of the full sample).

People living in colder homes

In bivariate analyses (see Appendix Table A3), room thermostat temperature reporting varied by age, deprivation, household occupancy and home ownership. There were no significant associations with gender, income, or reporting either a household resident disability or self-reporting a health condition (Table A3).

For age, the proportion reporting a colder home ranged from 5.6% of 50 to 59 year-olds to 8.9% of 18 to 39 year-olds. 18 to 39 year-olds were least likely to report a warmer home (47.3%) and most likely to have no temperature data (43.8%). Conversely, 60 to 69 year-olds were most likely to report a warmer home (67.4%) and least likely to have no temperature data (25.5%; Table A3).

There was no clear trend for deprivation, although people living in the least deprived quintile were most likely to report a colder home (8.7%, falling to 6.2% in the mid deprivation quintile). People living in the least deprived quintile were most likely to report a warmer home (67.0%, falling to 55.8% in the second most deprived quintile). They were also least likely to report no temperature data (24.3%, rising to 36.0% in the second most deprived quintile).

For household occupancy, the proportion reporting a colder home was highest in those with children present in the household (9.8%), reducing to 8.2% of those in single-person households and 6.1% of those living with other adults but no children. This latter group was most likely to report a warmer home (64.5%) with around a third of all groups having no temperature data.

For home ownership, 10.1% of private renters reported living in a colder home, compared with 7.0% of those who owned their own home (including those who reported they owned their home outright, with mortgage or via shared ownership) and 7.4% of those with other tenure status. Private renters were substantially less likely to report living in a warmer home (35.5%, compared with over 60% of other groups) and more likely to have no temperature data (54.4%, compared with around 30% of those in other groups).



When controlling for demographic and household confounders (see methods), compared with a warmer home, only home ownership status was independently associated with living in a colder home, while age, deprivation, household occupancy, home ownership and income were all independently associated with lack of temperature data being reported. Private renters were 2.1 times more likely than those who owned their own home to report living in a colder home and 2.2 times more likely to not report temperature data (Table A4).

Individuals living in single-person households were also 1.3 times more likely to have no temperature data than those living with other adults but no children (compared with those living in a warmer home). Participants who did not report their income were 1.3 times more likely to have no temperature data than those not on a low income (compared with those living in a warmer home). However, reporting a low income was not associated with temperature data. People living in the second most deprived and mid deprivation quintiles, were 1.6 times more likely to not report temperature data compared with the least deprived (Table A4).

Private renters were
2 times
more likely to report
living in a colder home
compared to those
who owned their own
home (compared with
those living in a warmer
home) when adjusting
for confounders

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Context of the Housing Warmth Survey findings

- Outdoor temperatures should be recorded as part of home temperature measurements. During the data collection period, outdoor air temperatures were warmer than average for the period in Wales [107].
- In considering the links between health and climate change, it is important to know the type of heating people are using and to recognise that 'all heat is not equivalent'. Some heating sources, in particular solid fuel heaters, increase exposure to indoor pollutants which may have subsequent health impacts. However, measuring indoor pollutants was outside the scope of this report.
- Future work on housing warmth could explore the feasibility of linking data on household heating to the Welsh Housing Conditions Survey or the Secure Anonymised Information Linkage (SAIL) Databank.



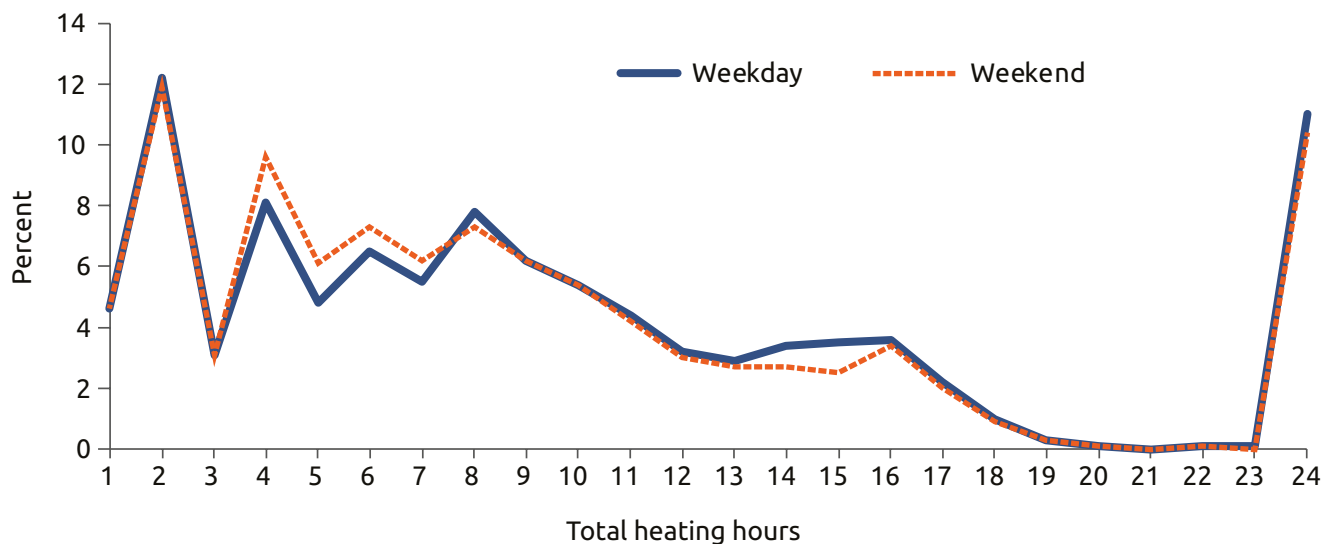
Total heating hours

Participants were asked on a typical weekday/weekend in winter what times of day they or their household had their heating on.

Of 2,033 participants, the mean number of total heating hours during weekdays was 9 (median 8), range 1 to 24. One in ten (10.4%) reported that during weekdays they had their heating on for 24 hours (Figure 6).

Of 2,019 participants, the mean number of total heating hours during weekends was 10 (median 8), range 1 to 24. Over one in ten (11.0%) reported that during weekends they had their heating on for 24 hours (Figure 6).

Figure 6: Distribution (percentage) of the reported total weekday (n=2,033) and weekend (n=2,019) heating hours

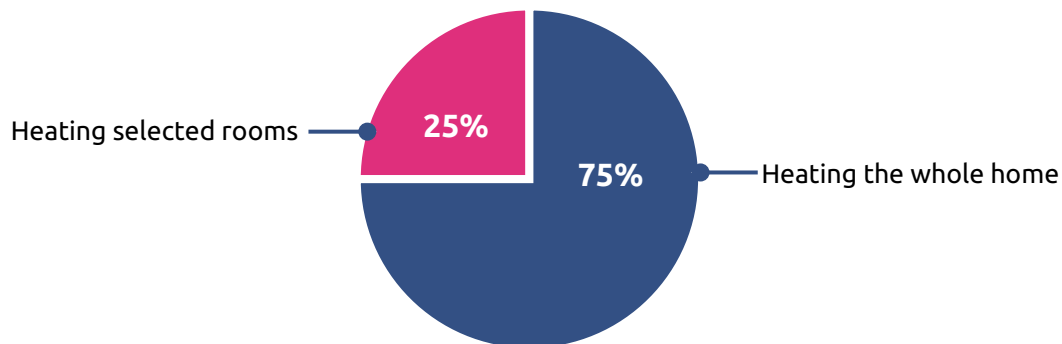


Heating the whole home

Participants were asked if during winter they or their household heat their whole home.

Of 2,170 participants, 75.0% reported heating the whole home during winter (Figure 7).

Figure 7: Proportion of participants heating their whole home (n=2,170)



The prevalence of heating the whole home was 72.0% in those in colder homes, 79.2% in those with warmer homes, and 67.5% in those with no thermostat data (Table A5).

In logistic regression analysis, controlling for demographic and household confounders (see methods), individuals with colder homes and those not reporting thermostat data were significantly less likely to report heating the whole home than individuals in warmer homes (Table A6).

Heating the whole home was also significantly associated with having children in the household, whilst single-person households were significantly less likely to heat the whole home (versus those reporting living in households with other adults but no children).

Those aged 60 years and over were significantly less likely to report heating the whole home than those aged 18 to 39 (Table A6).

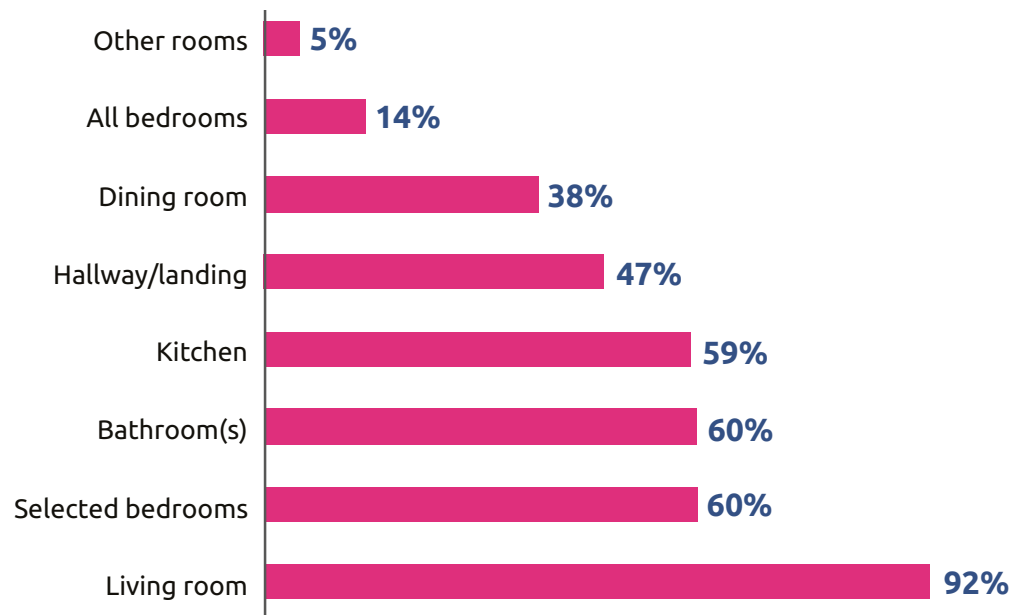
The odds of reporting heating the whole home were 37% less likely in those living in colder homes (versus those in warmer homes)

Heating selected rooms

Participants who did not heat the whole home were asked which rooms they heated in winter.

Of those who did not heat their whole home in winter (n=539), 91.8% reported heating their living room. Other commonly heated rooms were selected bedrooms (59.9%), bathroom(s) (59.6%), and the kitchen (58.6%; Figure 8).

Figure 8: Proportion of participants heating selected rooms in the home during winter (n=539)



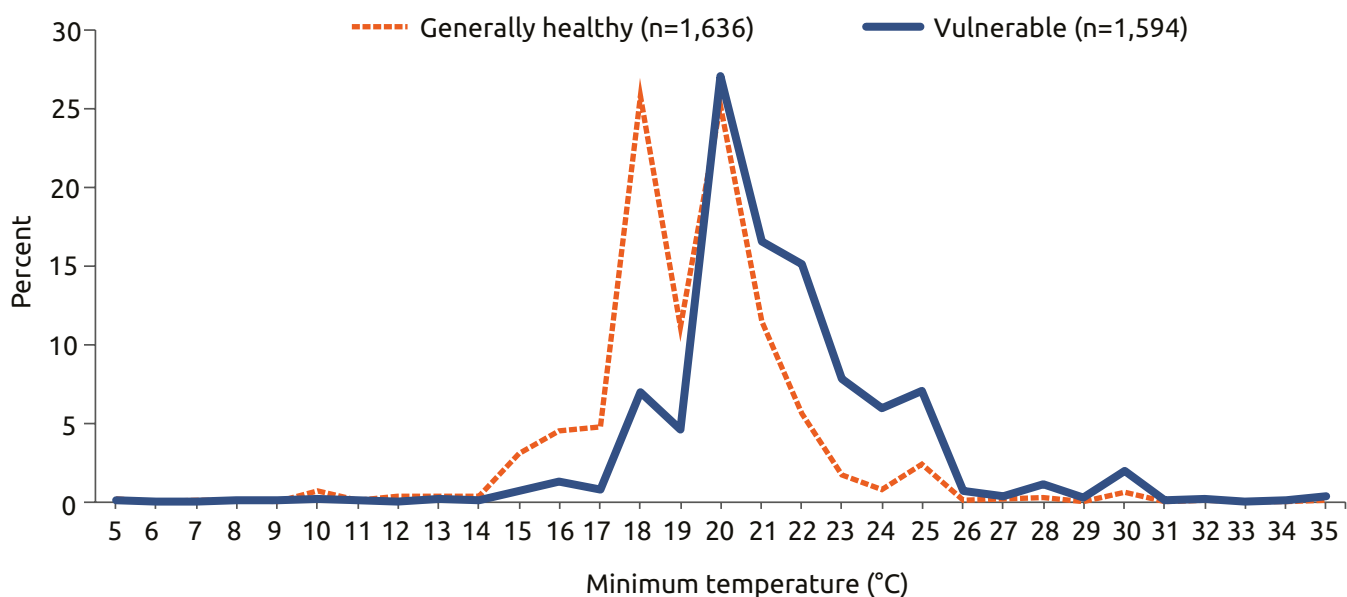
Minimum temperatures for comfort and safety in generally healthy and vulnerable people

Participants were asked what minimum temperature they thought homes should be heated to in winter to keep generally healthy people and more vulnerable people (e.g. older people or people with long-term health conditions) comfortable and safe at home. Temperatures in Fahrenheit were converted to Celsius and rounded to the nearest whole number (°C). Thermostat temperatures of less than 5°C or above 35°C were coded as missing (see Appendix and Table A1).

Of 2,174 participants, 24.7% reported that they did not know what minimum temperature homes should be heated to in winter to keep generally healthy populations comfortable and safe. The mean reported minimum temperature for generally healthy populations was 19.2°C (median 19°C, range 5 to 35°C; Figure 9).

Of 2,167 participants, 26.4% reported that they did not know what minimum temperature homes should be heated to in winter to keep more vulnerable populations comfortable and safe. The mean reported minimum temperature for more vulnerable populations was 21.3°C (median 21°C, range 5 to 35°C; Figure 9).

Figure 9: Minimum reported temperatures for comfort and safety in generally healthy and more vulnerable people



Thermal comfort in the main living area

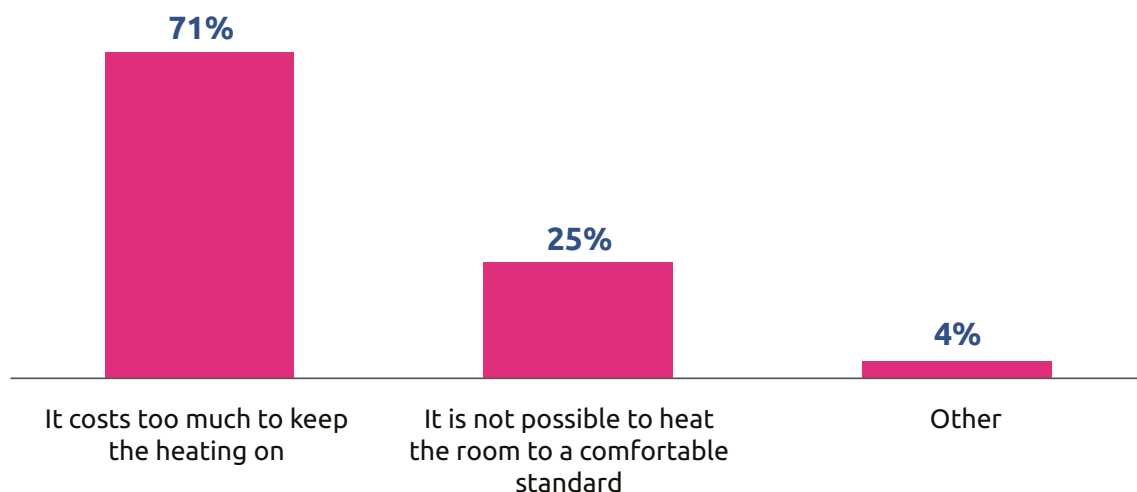
Participants were asked if in winter they were able to keep comfortably warm in their main living area (the room in which they spend the most time).

Of 2,176 participants, 89.1% reported thermal comfort in their main living area, with 10.9% reporting thermal discomfort.

Of those reporting thermal discomfort (n=238), 71.0% reported cost as the reason they were not able to keep comfortably warm. A quarter (25.2%) reported that it was not possible to heat the room to a comfortable standard and 3.8% reported other reasons (including those reporting no heating source; Figure 10).

9 in 10 respondents reported thermal comfort in their main living area in winter

Figure 10: Reported reasons for not feeling comfortably warm (thermal discomfort) in the main living area (n=238)



Note: Other includes those reporting no heat source.

The prevalence of thermal discomfort was 14.9% in those in colder homes, 9.0% in those with warmer homes, and 13.8% in those with no thermostat data (Table A7). In logistic regression analysis, controlling for demographic and household confounders, there were no significant relationships between thermal discomfort and room thermostat temperature (Table A8).

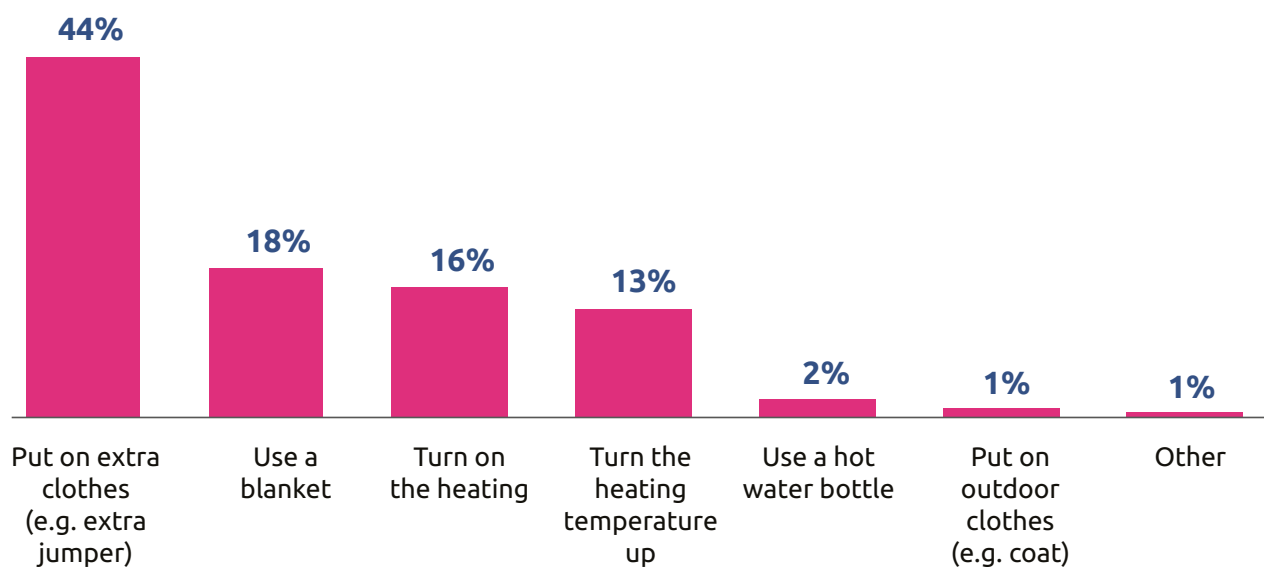
Reporting thermal discomfort was significantly associated with being female, having a disabled household resident and completing the survey online. Those reporting a low income were two times more likely to report thermal discomfort than those who reported not having a low income. Private renters were 1.8 times more likely to report thermal discomfort than those who owned their home. Finally, single-person households and households with children were significantly associated with experiencing thermal discomfort, compared to households with other adults but no children. Thermal discomfort was associated with age, with those aged 70 years and over significantly less likely to report thermal discomfort than those aged 18 to 39 (Table A8).

Initial behavioural responses when feeling cold at home

Participants were asked which warming behaviour they usually do first when they feel cold in their home.

Of 2,165 participants, putting on extra clothes was the most common first response to feeling cold (44.3%); followed by using a blanket (18.3%); turning on the heating (16.0%); and turning the heating temperature up (13.3%; Figure 11). Less than one in twenty (4.3%) participants reported that they rarely or never feel cold at home.

Figure 11: Proportion of participants reporting this action as the first they take when feeling cold at home (n=2,165)



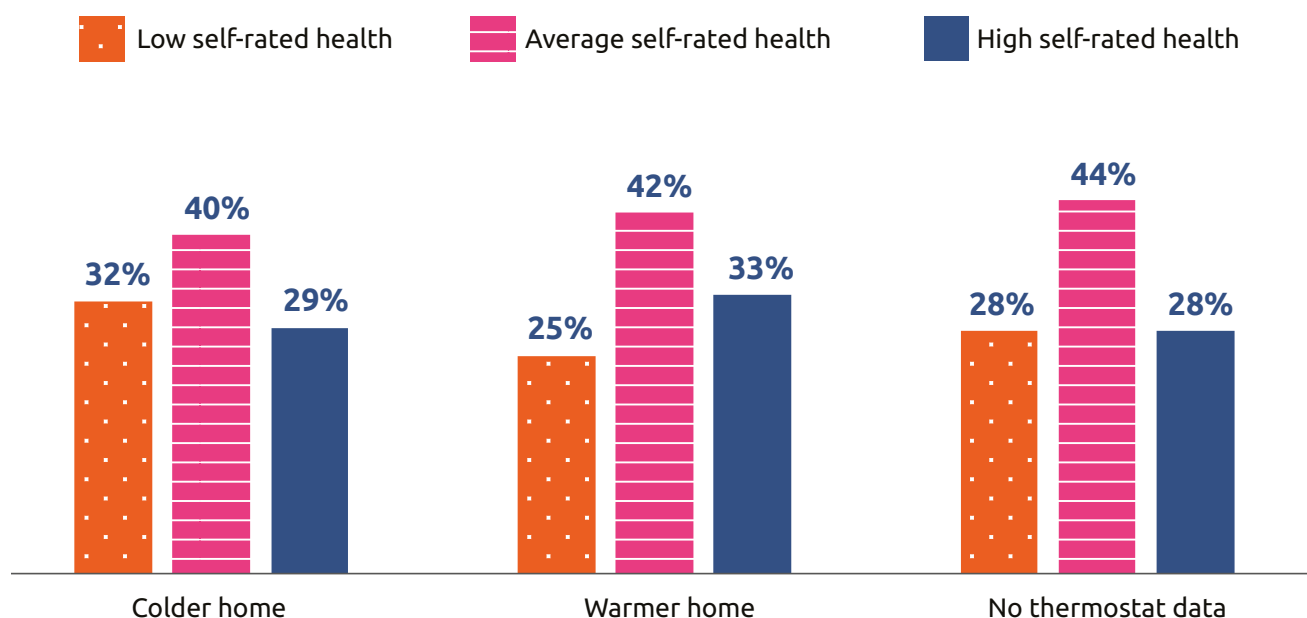
Self-rated health

Using an adapted version of the EQ-VAS [108], participants were asked to rate their own health on a scale of 0 (the worst state of health they could imagine) to 100 (the best state of health they could imagine). Scores were categorised into low (less than or equal to the 25th percentile, 0 to 60), moderate (more than the 25th percentile to less than the 75th percentile, 61 to 89) and high (more than or equal to the 75th percentile, 90 to 100; see Appendix Table A1).

Of 2,133 participants, 26.8% had low self-rated health, 30.9% rated their health as high, whilst 42.3% rated their health as average.

The prevalence of low self-rated health was 31.8% in those in colder homes, 25.4% in those with warmer homes, and 28.3% in those with no thermostat data. Whilst these figures were 28.7%, 32.5% and 28.3% respectively for high self-rated health (Figure 12, Table A9).

Figure 12: Prevalence of self-rated health by room thermostat temperature



When controlling for demographic and household confounders (see methods), there was no significant relationship between home thermostat data and self-rated health. Those reporting a disability in the household were 10.3 times and 2.3 times more likely than those with no disability to report low or average self-rated health, respectively (compared to those with high self-rated health). Those who self-reported a health condition were 4.8 times and 2.1 times more likely than those with no health conditions to report low or average self-rated health, respectively (compared to those with high self-rated health). Compared with those with high self-rated health, those reporting a low income and those who did not provide income data were 1.8 times and 2.2 times more likely to have low self-rated health than those with non-low household income. Finally, those who completed the survey online were 2.1 times more likely to report low self-rated health than those completing by telephone (compared to those with high self-rated health).

Females were less likely to report average self-rated health than males (compared to those reporting high self-rated health; Table A10).

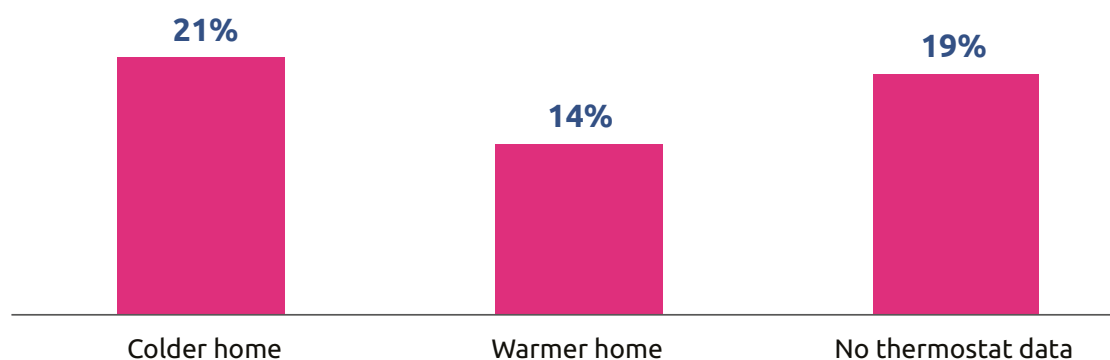
Low mental well-being (SWEMWBS)

Participants were asked about their mental well-being using the 7-item Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS, see Box 4) [109].

Of 2,072 participants who completed the SWEMWBS scale, 15.9% were categorised as having low mental well-being.

The prevalence of low mental well-being was 20.6% in those in colder homes, 13.7% in those with warmer homes, and 19.3% in those with no thermostat data (Figure 13, Table A11).

Figure 13: Prevalence of low mental well-being by room thermostat temperature



When controlling for demographic and household confounders (see methods), there was no significant association between living in a colder home and mental well-being. However, having a low mental well-being was significantly associated with age (highest in those aged 18 to 39 years), having a disabled household resident, self-reporting a health condition and completing the survey online. Adjusted odds of reporting low mental well-being were highest in the fourth least deprived quintile (quintile 4), compared to the least deprived (quintile 5). Low mental well-being was also significantly associated with reporting a low income or not providing income data (versus those on high income). Finally, individuals in single-person households were significantly more likely to have low mental well-being, compared to those living with other adults but no children (see Appendix Table A12).

Box 4: Scoring the Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS)

SWEMWBS comprises 7 items, of which responses to each item are scored from 1 (none of the time) to 5 (all of the time; see Appendix Table A1). These scores are summed to provide an overall raw score, which is then transformed according to established guidelines [109]. Scores can range from 7 to 35 with lower scores indicating lower mental well-being.

Here, low mental well-being was classified as more than 1 standard deviation below the mean overall mental well-being SWEMWBS score of all participants (mean 23.34, SD 4.68, low less than 18.7).

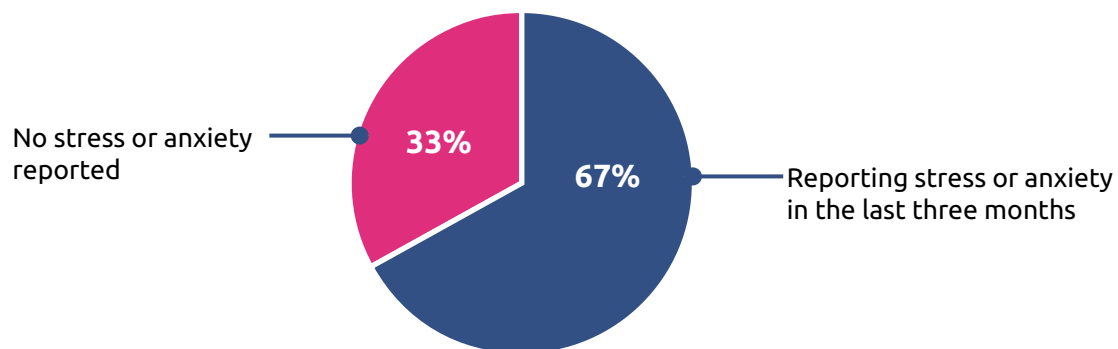
SWEMWBS© NHS Health Scotland, University of Warwick and University of Edinburgh, 2008, all rights reserved.

Stress or anxiety about the cost of heating the home

Participants were asked about their feelings of stress or anxiety over the cost of heating their home in the past three months. Those who reported any frequency of stress or anxiety were categorised as having stress or anxiety. Those reporting stress or anxiety were then asked if they were a little or very stressed, or anxious, or somewhere in-between.

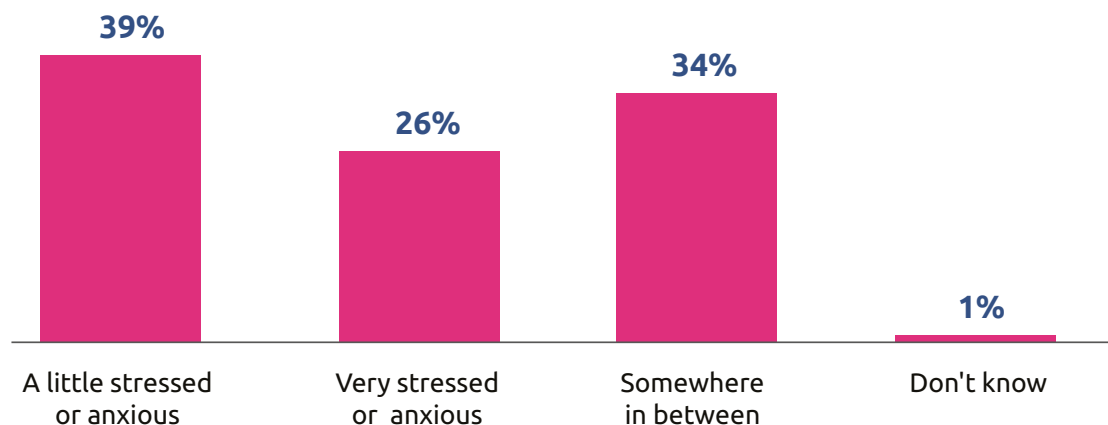
Of 2,151 participants, two-thirds (67.3%) reported any stress or anxiety in the last three months about the cost of heating the home (Figure 14).

Figure 14: The prevalence of participants reporting stress or anxiety in the last three months about the cost of heating the home (n=2,151)



Of those reporting stress or anxiety in the last three months, the majority (38.8%) reported they had been a little stressed or anxious, with 25.9% reporting they had been very stressed or anxious and 33.9% reporting somewhere in between (1% didn't know, 0.4% missing; Figure 15). It is important to note that the data was recorded at a time of a rapid increase in wholesale energy costs that began in the second half of 2021 and does not reflect any subsequent fluctuation in energy prices.

Figure 15: Level of reported stress or anxiety in the last three months about the cost of heating the home



The prevalence of stress or anxiety about the cost of heating the home was 69.8% in those in colder homes, 66.0% in those with warmer homes, and 69.2% in those with no thermostat data (Table A13).

When controlling for demographic and household confounders (see methods), there was no significant association between living in a colder home and reporting experiencing stress or anxiety about the cost of heating the home. Reporting experiencing stress or anxiety about the cost of heating the home was significantly associated with being aged 18 to 39 years (versus being aged 60 and over), being female, having a disabled household resident, self-reporting a health condition and completing the survey online.

Experiencing stress or anxiety about heating costs was also significantly associated with reporting a low income or no income data (versus those on high income). Finally, participants with children in the home were significantly more likely to report stress or anxiety about the cost of heating the home, compared to those living with other adults but no children (see Appendix Table A14).

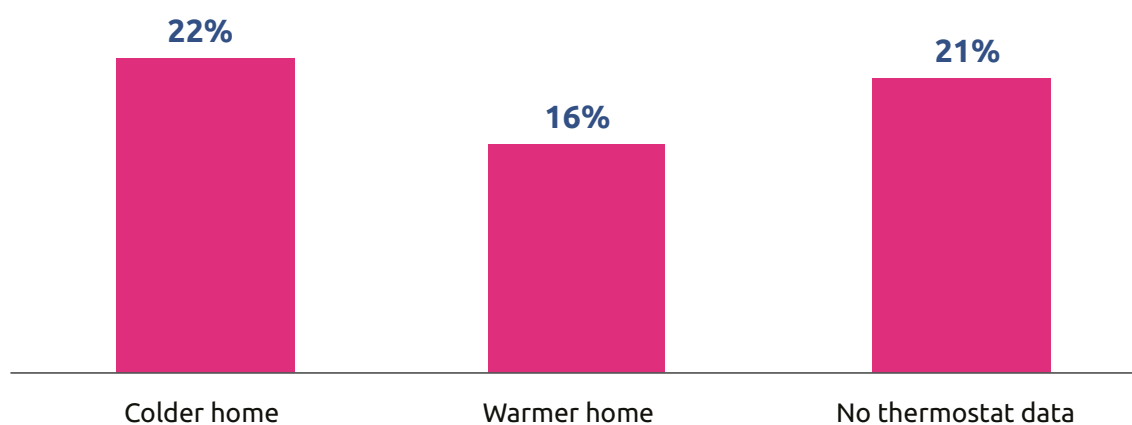
Cutting or skipping meals due to the cost of heating the home

Participants were asked if in the last three months, they had ever cut the size of their meals or skipped meals because of the cost of heating their home.

Of 2,162 participants, 18.2% reported cutting or skipping meals due to the cost of heating the home.

The prevalence of cutting or skipping meals due to the cost of heating the home was 22.4% in those in colder homes, 16.3% in those with warmer homes, and 21.0% in those with no thermostat data (Figure 16, Table A15).

Figure 16: Prevalence of cutting or skipping meals due to the cost of heating the home by room thermostat temperature



When controlling for demographic and household confounders (see methods), there was no significant association between living in a colder home and cutting or skipping meals due to the cost of heating the home.

Cutting or skipping meals due to the cost of heating the home was significantly associated with being aged 18 to 39 years (versus those aged 50 and over), having a disabled household resident, self-reporting a health condition and completing the survey online. People who reported a low income were significantly more likely to cut or skip meals due to the cost of heating the home compared to those who reported having a non-low income. Private renters and those reporting other home ownership statuses were also at increased risk of reporting cutting or skipping meals due to the costs of heating the home (versus those reporting home ownership). Finally, individuals in single-person households and those with child residents were both significantly more likely to report cutting or skipping meals due to the cost of heating the home, compared to those living with other adults but no children (see Appendix Table A16).

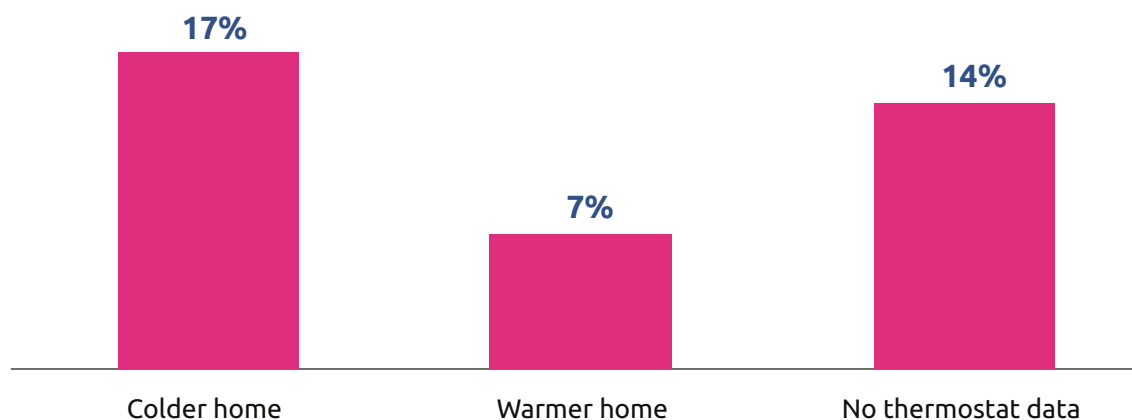
Reluctance to invite guests into the home because of difficulties keeping it warm

Participants were asked if they ever felt reluctant to invite friends or family into their home because of difficulties keeping it warm.

Of 2,159 participants, 10.1% reported reluctance to invite guests into the home due to difficulties keeping it warm.

The prevalence of reporting reluctance to invite guests into the home due to difficulties keeping it warm was 16.9% in those in colder homes, 7.2% in those with warmer homes, and 14.2% in those with no thermostat data (Figure 17; Table A17).

Figure 17: Prevalence of reluctance to invite guests into the home due to difficulties keeping it warm by room thermostat temperature



When controlling for demographic and household confounders (see methods), individuals with colder homes and individuals with no temperature data were 2.2 times and 1.5 times respectively, significantly more likely to report reluctance to invite guests into the home compared to those with warmer homes.

Reluctance to invite guests into their home was also significantly associated with living in more deprived quintiles (quintiles 1 to 3 versus the least deprived quintile), having a disabled household resident, self-reporting a health condition, reporting a low income, and completing the survey online. Single-person households and households with children were also significantly associated with reporting reluctance to invite guests into the home, compared to households with other adults but no children. Finally, private renters were 1.7 times more likely to report reluctance to invite guests into the home (versus those who owned their home).

Those living in colder homes were 2.2 times more likely to be reluctant to invite guests into their home due to difficulties keeping it warm compared to those in warmer homes

Those aged 60 and over were significantly less likely to report reluctance to invite guests into their home than those aged 18 to 39 (see Appendix Table A18).

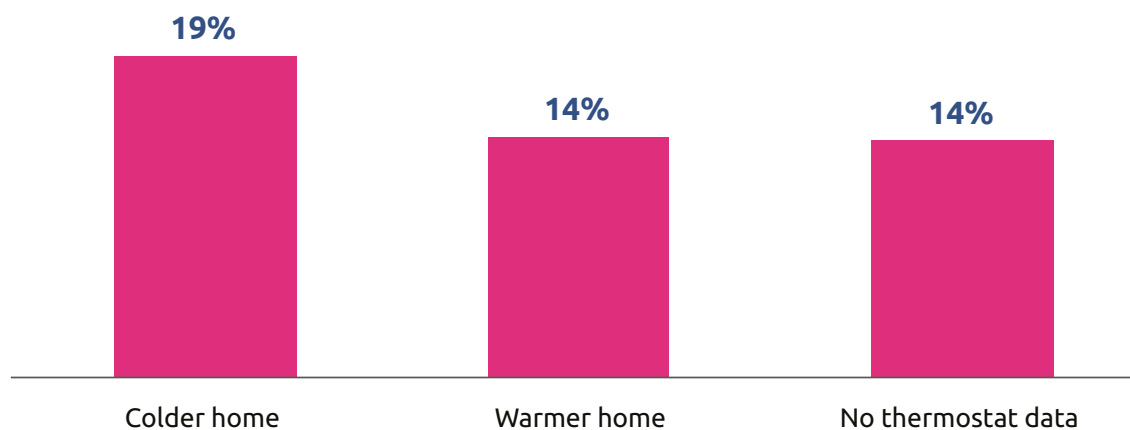
Falls at home in the last 12 months

Participants were asked if they had fallen at home in the last 12 months.

Of 2,180 participants, 14.7% reported having had a fall at home in the last 12 months.

The prevalence of falls at home in the last 12 months was 19.3% in those with colder homes, 14.4% in those with warmer homes, and 14.2% in those with no thermostat data (Figure 18; Table A19).

Figure 18: Prevalence of falls at home in the last 12 months by room thermostat temperature



When controlling for demographic and household confounders (see methods), there was no significant association between living in a colder home and reporting having had a fall at home in the last 12 months.

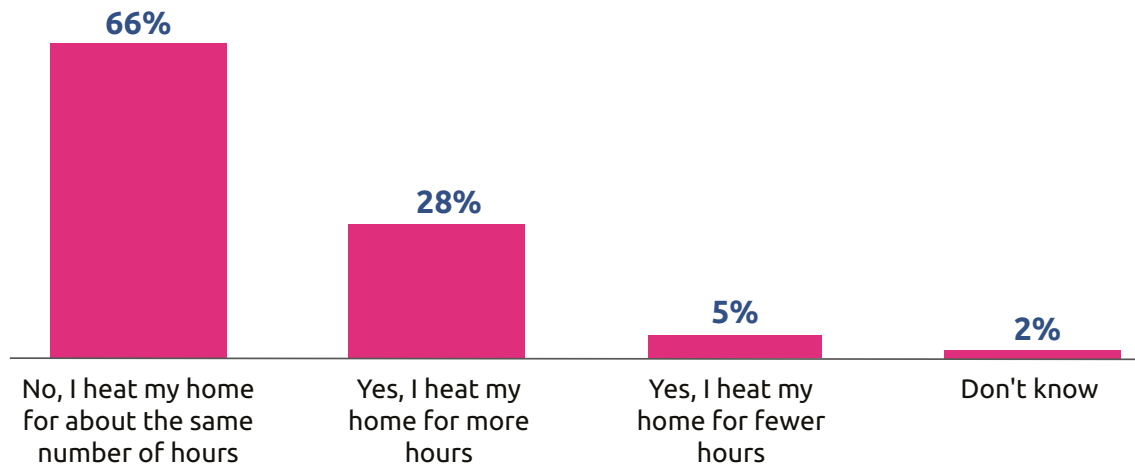
Individuals aged 70 years and over were significantly more likely to report having fallen at home in the last 12 months than 18 to 39 year-olds. Individuals who reported a disabled household resident and those self-reporting a health condition were more likely to report having experienced a fall in the last 12 months. Reporting a fall at home in the last 12 months was also significantly associated with single-person household occupancy (versus those living with other adults but no children; Appendix Table A20).

Influence of the COVID-19 pandemic on household heating

Participants were asked if the COVID-19 pandemic had changed the number of hours their household typically heat their home during winter.

Of 2,179 participants, 65.6% reported that they heated their home for about the same number of hours, with 27.9% reporting that they now heated their home for more hours and 4.8% reported they heated their homes for fewer hours (Figure 19).

Figure 19: Influence of the COVID-19 pandemic on household heating hours



Impact of climate change

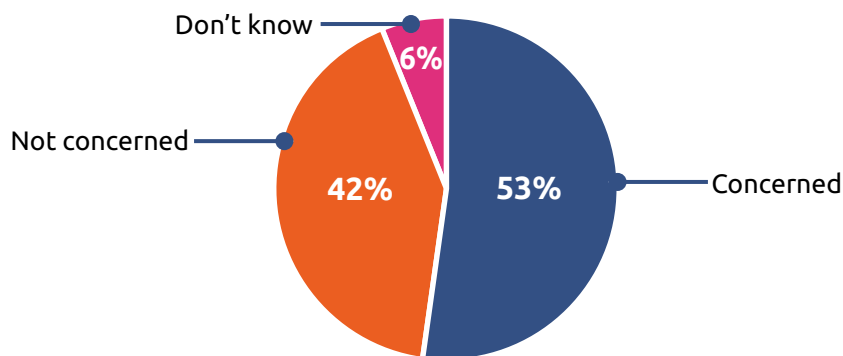
Participants were asked if they were concerned about the impact of their household heating use on climate change. Those who responded yes or don't know, were asked if climate change concerns influence their household heating use.

Of 2,178 participants, 52.6% reported concern for the impact of their heating use on climate change. 41.9% reported they were not concerned and 5.6% reported they didn't know (Figure 20).

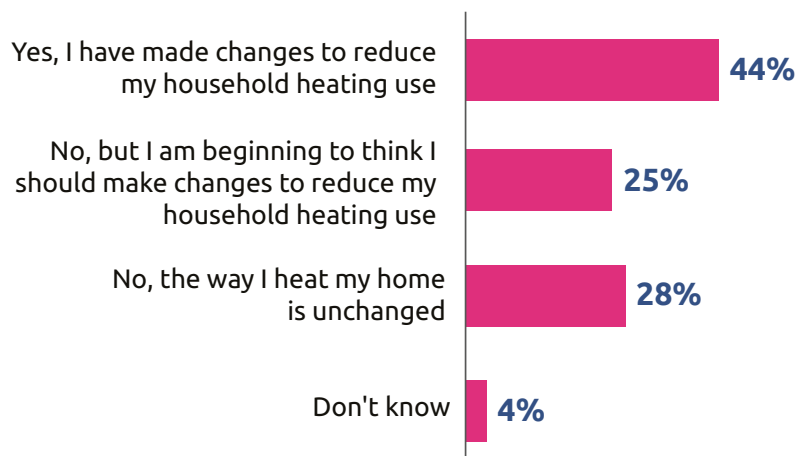
53% were concerned about the impact of their heating use on climate change

Of those that were concerned or didn't know (n=1,266), 43.5% reported that they had made changes to reduce their household heating use. A further 25.2% reported that they were beginning to think they should make changes to reduce their heating use and 27.6% reported that there was no influence and the way they heated their home was unchanged (Figure 20).

Figure 20: Proportion of participants reporting concern about the impact of their household heating use on climate change and the influence on household heating use



Of those concerned or didn't know:



Note: Figures may not add up to 100% due to rounding.

5. Recommendations and conclusions

Key points:

This chapter presents recommendations intended to inform Welsh Government policy deliberations and decision-making on the satisfactory heating regime in Wales. Recommendations are contextualised by the evidence presented throughout this report. Potential impacts on health inequalities are drawn out and high-priority recommendations to improve the public health evidence base are made. Important caveats to the recommendations, areas requiring further research and the limitations to the data in the report are also presented.

Recommendations

The satisfactory heating regime should advise that households heat to a temperature that is comfortable but to avoid temperatures falling below 18°C throughout the home and at a minimum in commonly used living areas. Higher minimum temperatures might be required for vulnerable groups.

Evidence linking cold home exposure to poor health and well-being outcomes indicates the suitability for a minimum temperature threshold of 18°C in the home. However, there is not currently enough evidence to support other temperature thresholds [2]. A limited number of studies have linked better health outcomes with home temperatures higher than 23°C when compared to temperatures below 18°C (Figure 3) but these studies only compared warmer temperatures (higher than 23°C) with colder temperatures (below 18°C) and not temperatures between 18°C to 23°C. As such, it is not possible to determine the temperature at which health benefits start. Further research is required on the impact of exposure to different temperatures and the impacts of such thresholds for different population groups. This would be in line with the WHO and UKHSA guidelines which specify a minimum temperature of 18°C with a higher, but unspecified, minimum temperature possibly needed for vulnerable groups (Table 1).



Findings from the Housing Warmth Survey showed that most participants in Wales who had a room thermostat were setting it to a minimum of 18°C in winter. In line with other research in the UK [19], the mean temperature at which thermostats were set was 20.0°C. Furthermore, nine in ten participants reported thermal comfort in their main living area, although participants living in colder homes were most likely to report a lack of thermal comfort. The recommendation to heat homes to a temperature that is comfortable for residents aligns with NHS advice on ['Winter vaccinations and winter health'](#) (opens in new window).

This recommendation does not specify temperature ranges or warmer temperatures in the living room. The majority of Housing Warmth Survey participants reported heating their whole homes (75%). However, participants living in colder homes were less likely than those in warmer homes to heat their whole home. As such, reference to 'living areas' rather than living rooms recognises how other rooms in the home might be commonly used.

This recommendation does not specify number of heating hours. The Housing Warmth Survey findings revealed that the mean number of total heating hours during weekdays and weekend days were nine hours and ten hours respectively. However, it was not possible given lack of objective temperature measurement to determine the temperature attained during the heating periods.

Issues around climate change and fuel poverty are also of relevance to this recommendation. Heating for thermal comfort could offset any additional heating demands of warming the home for a set number of hours that might be longer than is necessary for thermal comfort and could in turn help to reduce greenhouse gas emissions and contribute to Net Zero commitments.

The satisfactory heating regime should continue to refer to older people and disabled people as vulnerable in colder homes, but also reference additional population groups that can be vulnerable.

Although evidence has linked older and disabled people to risk of harm from cold homes, additional population groups may also be vulnerable. For example, people living with long-term conditions, particularly cardiorespiratory disease, are reported to be particularly vulnerable to the negative outcomes of cold homes [1,2]. Furthermore, despite older people being vulnerable to the negative impacts of cold homes [1,15,22], the age range at which the negative health effects of cold homes occur is unclear.



Vulnerability is highly complex; it can be a permanent or transitory state and different vulnerabilities can intersect to influence risk and outcome. A broader definition of vulnerability would include those who might not be seen as vulnerable on the basis of age (e.g. older people) or health, but who nonetheless experience important impacts on their health and well-being.

The Housing Warmth Survey revealed that private renters were two times more likely to report living in a colder home than those who owned their own home. Also, cutting or skipping meals due to the cost of heating the home was significantly associated with having a disabled household resident and self-reporting a health condition but also with younger age (18 to 39 years versus those aged 50 and over), low household income, and household occupancy. People who reported a low income were significantly more likely to cut or skip meals due to the cost of heating the home compared to those who reported having a non-low income.

Other evidence describes impacts on social well-being and quality of life among older people who are reluctant to invite people to a cold home [110]. In the Housing Warmth Survey,

reluctance to invite people into the home due to difficulties keeping it warm was 2.2 times more likely among participants living in colder homes than those in warmer homes. Having a disabled resident, self-reporting a health condition, reporting a low income, single-person households, households with children and private renters were at risk of being more reluctant to invite guests into their home due to difficulties keeping it warm.

Reference to vulnerable groups should also include those who do not have or cannot use a temperature thermostat or digital controller in their home. In the Housing Warmth Survey, experience of thermal discomfort was more likely among those living in colder homes, and in those who reported not having a thermostat or not reporting temperature data. Lack of thermostat or temperature controller ownership, or difficulties of use, could plausibly limit the ability of householders to understand, monitor and control the temperatures and heating patterns in their homes.

The satisfactory heating regime should be updated in line with emerging evidence and societal changes.

It is advised that research and evaluation on home temperatures include a focus on gathering evidence on vulnerability, to inform more effective policy responses. The evidence base could be strengthened by including data on lived experience, using objective temperature measurements, and leveraging existing data such as EPC ratings, and other existing survey data. As the granularity of data improves over time, it would be important to build evidence-based insights into policy and practice, including insight on intersecting, or overlapping, drivers of vulnerability.



Evidence on the effects of broader societal factors should also be captured, to determine changes in who is vulnerable and in what ways. For example, the impact of climate change. Over half of the Housing Warmth Survey participants (53%) reported concern for the impact of their heating use on climate change. Of those who were concerned or did not know, 44% reported having made changes to reduce their household heating use and 25% reported beginning to think they should make changes to reduce their heating use. Results of a climate change and health survey in 2021 revealed that 44% of people in Wales said they always minimise energy use in the home to help reduce climate change [39]. Welsh Government has set a 'Net Zero' target for reducing carbon emissions by 2050 in line with the Well-being of Future Generations (Wales) Act (2015) [111].

Energy use is, to an extent, influenced by time spent at home. Over a quarter of Housing Warmth Survey participants (28%) reported that the COVID-19 pandemic meant that they heated their home for more hours; 5% reported they heated their home for fewer hours. With Welsh Government's ambition for 30% of the Welsh workforce to work at or near to home [66], changing trends in home and agile working following the COVID-19 pandemic may bring about increased household heating demands.

Since the pandemic, the interrelated challenges posed by the rising cost of living have been expected to worsen the historical challenges related to fuel poverty [30]. Rising energy costs have had an impact on households, shown in evidence that heating was the household essential that the largest proportion of people in Wales had gone without in the three months to January 2023 [24]. Results of the Housing Warmth Survey reveal that, of those reporting thermal discomfort in their main living area, 71% reported cost as the reason they were not able to keep comfortably warm.

As well as these broader social changes, any updates to the definition of the satisfactory heating regime should also take account of changes in housing conditions (e.g. energy efficiency) and advancements in thermostat regulation (e.g. smart home technology), including trends in uptake and use.

The satisfactory heating regime should be regularly monitored and evaluated, informed by equality considerations that are kept under review including assessment of how heating regimes might impact health inequalities.

Regular monitoring and evaluation of the satisfactory heating regime should include an identification of compliance with the guidance and related drivers of and barriers to compliance. It should also include an assessment of heating patterns in households throughout Wales, and their impacts on outcomes including health, well-being, safety and comfort.



Limitations of the current evidence preclude specific recommendations for particular vulnerable population groups. As a result, it is recommended that monitoring and evaluation of the satisfactory heating regime should seek to identify any unintended consequences and potential harms, particularly where they might disproportionately accrue among those who are already disadvantaged. This should include seeking to identify any impacts on inequalities that might widen health gaps.

Any unintended effects should inform a refresh of the satisfactory heating regime, informed by latest evidence and data. This is of particular importance given that it is often the same population groups that are disproportionately represented in poor-quality homes that also experience health inequalities, including older adults, people with long-term conditions and disabled people, ethnic minority groups and low income groups [112].

The satisfactory heating regime should use terminology and evidence that is meaningful and relevant to the public.

It is vital that the public understand the recommendations set out in the satisfactory heating regime and its relevance to health, well-being, safety and comfort. As such, work should be conducted to explore population understanding of the recommendations. Such knowledge can help shape policy which supports individuals in making informed decisions about heating their homes.

The language used in the satisfactory heating regime is important. For example, referring to a 'safe' (rather than satisfactory) regime and to 'temperatures' (rather than heating) could provide greater clarity. Furthermore, the addition of terms such as 'winter', 'warmth' and 'recommendations' could reinforce the purpose and relevance of the satisfactory heating regime. Public consultation or engagement could also be used to help define suitable terminology.



The satisfactory heating regime should signpost to trusted, accessible and inclusive sources of information and advice on affordable warmth and keeping safe at home.

Whether temperature recommendations are accepted or adopted by members of the public will depend to a large extent on affordability and household budgets. Findings from the Housing Warmth Survey indicated that those reporting a low income were more likely to report thermal discomfort than those reporting household incomes of £20,000 or more per year. Evidence has identified that households under financial constraint might ration their energy use or adopt responses such as self-disconnection [70]. Furthermore, other individuals might live in hard-to-heat homes where attaining 18°C might require longer, and more costly, energy usage.



Signposting to trusted, accessible and inclusive information could help the public to feel in better control of heating their homes. This could include information on saving energy at home, on how to be safe and comfortable in hard-to-heat homes, and on heating the home during periods when it is not occupied.

Where signposting is used, it should be available via different sources (including physical locations, online, via the telephone, and via post), in multiple languages including Welsh, and in formats suitable for people with different physical or learning disabilities or impairments.

Caveats to the recommendations

The following caveats should be considered in the interpretation and application of the recommendations:

- The recommendations are based on multi-source evidence, including the Housing Warmth Survey; a survey conducted during a time of economic fall-out from the COVID-19 pandemic and at the start of the rising cost of living. During data collection, more people in Wales would have been facing increasing energy costs and pressures on household budgets which might have affected their reported heating practices at home.
- The recommendations do not specify a maximum or higher temperature threshold. The short- to long-term health impacts of fuel poverty, sustainability and climate change should be considered in developing any upper temperature recommendations.
- The recommendations are for heating regimes in homes during winter. Regimes to stay safe at home during hot weather or during cold weather (outside of winter) were beyond the scope of this report.
- The recommendations do not advise on minimum temperatures when the home is unoccupied for a prolonged period during winter; for example, during holidays away from home.
- The recommendations do not reflect the diversity of household types, including Gypsy, Traveller, and other nomad communities.
- The recommendations provide a guideline for household heating only. Indoor air quality, humidity or the presence of mould were outside the scope of this report.
- The recommendations are informed by available evidence. There is a lack of evidence on certain population groups such as children or ethnic minority groups to inform whether tailored recommendations are required for individual populations.
- The recommendations do not advise on night-time temperatures.
- The recommendations are not intended to replace or contradict the recommended room temperatures of 16 to 20°C set out in the [‘the safest room temperature for babies’](#) (opens in a new window) by the Lullaby Trust.

Strengths and limitations of the Housing Warmth Survey data

There are a number of limitations to the Housing Warmth Survey (Wales, winter 2022) which should be considered in interpreting the study findings. Due to restrictions around COVID-19 and the potential for new variants, it was decided that a face-to-face household survey could not be administered. As a result of difficulties in recruiting younger age groups via telephone, data collection had to be extended to recruit online. However, analysis has adjusted for the confounder of study methodology.

It was not possible to record reasons for declining to participate, which may have resulted in study bias.

In recognition of the known vulnerability of older people to the effects associated with colder homes, purposeful over-sampling was used to increase the number of older adults responding to the survey. The study population is not representative of the Welsh population, and individuals reporting 'other than white' ethnicity were under-represented in the survey.

The cross-sectional design of the survey means that causality cannot be measured between home temperatures and outcomes studied. Furthermore, all survey measures were self-reported and subject to recall and reporting bias. The measure of temperature in the home was based on measurement of the room thermostat temperature and not the room temperature achieved. Furthermore, it was not known where in the home the room thermostat or digital temperature controller was located. This has limited the exploration of the appropriateness of the satisfactory heating regime, which specifies set durations of warmer temperatures for living rooms as opposed to other rooms in the home.

The survey did not explore other thermal environmental conditions (e.g. humidity) within the home [113]. The survey also did not ask about home energy efficiency, which may limit understanding of the number of heating hours required to maintain satisfaction with the thermal environment.

The survey findings reflect the rapid rise in wholesale energy costs that began in the second half of 2021 [32]. A follow-up survey of those who consented to take part in future research was conducted January to March 2023. The follow-up survey aimed to explore differences between survey years, during a period of increasing energy and living costs. Differences in heating behaviours, coping strategies, and well-being across survey years have been explored in the ['Keeping warm at home during winter in Wales' report](#) (opens in new window [114]).

Areas requiring further research

Recommendations for research and evidence have been made throughout the report. High-priority areas for further research should seek to:

- Recruit people living in colder homes to studies, to enable investigation of the relationship between living in colder homes and outcomes relevant to health and well-being and the wider determinants of health (e.g. education).
- Explore the feasibility of linking data on household heating to other available data sources.
- Determine if there are health and well-being impacts of home temperatures above 18°C.
- Identify whether there are specific lower and upper temperature thresholds at which health benefits and health effects occur among different population groups.
- Explore levels of vulnerability to colder homes among marginalised population groups, including those with intersecting vulnerabilities.
- Reveal any disproportionate impacts of indoor heating recommendations and practices on under-researched population groups including young children and ethnic minority groups.

- Gather the insights of vulnerable population groups on heating practices and health and well-being using lived experience methods of data collection.
- Investigate any long-term effects of colder homes on mental health and well-being.
- Consider night-time temperatures and the effect of colder homes on sleep.

The above high-priority research recommendations should include consideration of broader contextual factors relevant to health and well-being, such as fuel poverty, climate change and sustainability.

Conclusions

Experience of cold homes is socially patterned and can create and worsen health

inequalities. The likelihood of living in a cold home is unevenly distributed. Certain groups are at increased risk, including (but not exclusively) disabled people.

There are many factors that can act alone or in combination to affect vulnerability to cold

homes. These include broader societal trends and events (e.g. the rising cost of energy), the property (e.g. energy efficiency) or the person (e.g. their heating patterns). These factors do not always occur in isolation but often co-occur and can intersect to influence exposure and vulnerability.

The evidence-based recommendations emphasise the importance of addressing

vulnerability and of advancing equality. This has included a recommendation for accessible, inclusive communication on the satisfactory heating regime and advice on staying warm and well in the home in winter. A recommendation is made for the monitoring and evaluation of heating regimes in homes across Wales, including the monitoring of impacts on health inequalities and any unintended effects that might widen inequalities. Areas for further research are also suggested, with a focus on high-priority evidence on vulnerability in the context of cold homes and home heating regimes.

Cold homes matter and many people are affected. Affordable housing warmth is an important determinant of health and well-being. In turn, housing warmth can affect other, broader determinants of health and well-being outcomes. Attention to housing warmth provides a strong rationale for investment in health and well-being as a driver and enabler of health for all, across present and future generations.

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Appendix 1: Study methodology

1.1. Expert consultation workshop and subject expert involvement

An online expert consultation workshop was held in February 2023. The workshop was facilitated by Public Health Wales and conducted on Microsoft Teams. A diverse group of eight academics and professionals attended, who had subject expertise in housing and its associations with health and well-being.

Attendees provided feedback on the draft report structure, the emerging findings from the Housing Warmth Survey (Wales, winter 2022), and the emerging recommendations. Attendees also shared additional evidence to inform the report. Feedback and action points were transcribed and summarised during the workshop to aid discussions, with comments provided through the online chat function.

Following the workshop, attendees were provided with a written summary of the workshop to check for accuracy of interpretation and provide additional feedback. Subject experts were also invited to share case studies to inform the report (see Expert consultation and evidence boxes throughout report).

A Housing Warmth Expert Advisory Group provided advice on technical aspects of the project, some of whom attended the expert consultation workshop and peer reviewed the written report.

1.2. The Housing Warmth Survey (Wales, 2022)

Sampling and recruitment

The Housing Warmth Survey (Wales) was a cross-sectional study conducted between January and March 2022. The survey was designed to understand how people in Wales heated their home in winter including levels of thermal comfort.

The survey had a target sample size of approximately 1,500 adults representative of the Welsh population. An additional boost sample of 500 adults aged 65 years and over was included because of the vulnerability of this population to the health harms associated with cold homes (see chapter 3). The study inclusion criteria were adults aged over 18 years, residing in Wales and able to consent to participation. Only one individual per household was eligible to participate.

Data collection and sampling was undertaken by a professional commissioned market research company (MRC; M.E.L Research). A quota sampling approach was used with sample selection stratified by health board area, urban-rural location and deprivation quintile (at the Lower Super Output Area [LSOA] using the Welsh Index of Multiple Deprivation [WIMD] 2019;[106]). Quotas within sampled areas were based on age and sex, excluding the boost sample.

In line with other national surveys [39] potential participants were contacted by telephone (using Random Digit Dialling for landline and a consumer/lifestyle data sample to include mobile phone numbers). Due to the underrepresentation of participants in younger age groups,

sampling was extended during data collection to include an online sample. Online participants were recruited from panel providers (Dynata and Respondi); individuals registered to take part in paid research studies.

Procedure

On contact, all participants were provided with a study overview. This included its aims and objectives, voluntary nature and contact details for the MRC, the research team and an independent contact for complaints. It was made clear to all participants that they were able to withdraw at any time.

All study materials were available in Welsh or English language. Calls were made all days of the week within reasonable hours, with up to five call attempts made.

Individuals were asked if they would be willing to be contacted for follow-up research. Those who consented were allocated a unique personal identifier code and their personal contact data (name, email, telephone) were recorded. Personal contact data were held separately to the survey data. However, survey responses were linked to the personal identifier code. After study completion all participants regardless of their responses were provided with information on appropriate national support services.

Questionnaires were completed over the telephone, using Computer Assisted Telephone Interviewing (CATI) technology, or online. The survey was piloted by M.E.L Research to allow for any clarifications and amendments if required.

Ethical approval for the study was granted by Bangor University Healthcare and Medical Sciences Academic Ethics Committee (reference: 2021-17050).

Questionnaire

Where possible, the questionnaire used validated instruments and questions from previous surveys conducted by Public Health Wales. The questionnaire covered: housing characteristics, household heating and thermal comfort, health and well-being, and individual and household characteristics. All questions were self-reported. Table A1 outlines the survey questions used for analysis in this report and qualifying responses or variable categorisation for each outcome where appropriate.

Table A1: Survey questions, and variable categorisation or qualifying response

Participant and household socio-demographics		
Outcome	Question asked <i>(response options)</i>	Categorisation or qualifying response
Age group (years)	How old are you? <i>(18 to 19; 20 to 24; 25 to 29; 30 to 34; 35 to 39; 40 to 44; 45 to 49; 50 to 54; 55 to 59; 60 to 64; 65 to 69; 70 to 74; 75 to 79; 80 to 84; 85 and over)</i>	18 to 39; 40 to 49; 50 to 59; 60 to 69; 70 and over
Gender	Do you identify as...? <i>(Male; Female; Transgender; Other; Prefer not to say)</i>	Male; Female
Ethnicity	What is your ethnic group? Choose one option that best describes your ethnic group or background. <i>(White: White: Welsh/English/Scottish/Northern Irish/British; White: Eastern European; White: Irish; White: Gypsy or Irish Traveller; Other White. Asian or Asian British: Bangladeshi; Chinese; Indian; Pakistani; Other Asian or Asian British. Black/African/Caribbean/Black British: African; Caribbean; Other Black/African/Caribbean/Black British background. Mixed: White and Asian; White and Black Caribbean; White and Black African; Other mixed. Other: Arab. Other [please specify]; Prefer not to say)</i>	White; Other than white
Household resident disability	Are your day-to-day activities limited because of a health problem or disability which has lasted or is expected to last for at least 12 months? Select one [115] <i>(Yes, limited a lot; Yes, limited a little; No)</i> Does anyone with a disability or long-term health condition live in your household...? <i>(Yes; No)</i>	Yes, limited a lot; Yes, limited a little and/or Yes respectively to the two questions

Participant and household socio-demographics		
Outcome	Question asked <i>(response options)</i>	Categorisation or qualifying response
Self-reported health condition	<p>Have you ever been told by a doctor or nurse that you have any of the following conditions? Select all that apply</p> <p>Heart disease or circulation problems e.g. angina or heart attack, high blood pressure, stroke</p> <p>Lung disease e.g. chronic bronchitis, emphysema, COPD, asthma</p> <p>Mental health problems e.g. depression, anxiety</p> <p>Memory problems e.g. dementia (Alzheimer's disease, Parkinson's disease)</p> <p>Joint problems e.g. arthritis</p> <p>Diabetes (Type 1 or Type 2)</p>	One or more of the conditions listed
Household occupancy	<p>How many people currently live in your household, who are:</p> <p>Adults?</p> <p>Children?</p>	<p>Single household: no other adults or children reported</p> <p>Child(ren) present: reported at least one child in the household</p> <p>Other occupancy: other adults but not children reported</p>
Home ownership	<p>Do you and your household own or rent this accommodation...?</p> <p><i>(I/we own it [outright; with a mortgage; shared ownership]; I/we rent it from private landlord/agent; I/we rent it from local authority; I/we rent it from housing association/cooperative/trust/registered social landlord; Other; I don't know)</i></p>	<p>Own (outright/with mortgage/shared ownership)</p> <p>Private renter</p> <p>Other (includes those who rent from local authority/housing association/cooperative/trust/registered social landlord; I don't know; missing/refused)</p>

Participant and household socio-demographics

Outcome	Question asked (response options)	Categorisation or qualifying response
Low income	<p>Approximately what would you say is the total annual income of your household (including all benefits) before tax and deductions...?</p> <p><i>(£0 to £4,999 per year [0 to £96 per week]; £5,000 to £7,499 per year [£97 to £144 per week]; £7,500 to £9,999 per year [£145 to £192 per week]; £10,000 to £14,999 per year [£193 to £288 per week]; £15,000 to £19,999 per year [£289 to £385 per week]; £20,000 to £29,999 per year [£386 to £577 per week]; £30,000 to £39,999 per year [£578 to £769 per week]; £40,000 to £49,999 per year [£770 to £961 per week]; £50,000 to £59,999 per year [£962 to £1,153 per week]; £60,000 to £69,999 per year [£1,154 to £1,346 per week]; £70,000 to £79,999 per year [£1,347 to £1,538 per week]; £80,000 to £89,999 per year [£1,539 to £1,730 per week]; £90,000 to £99,999 per year [£1,731 to £1,923 per week]; £100,000 or more per year [£1,924 or more per week])</i></p>	<p>Low income: less than £20,000 per year</p> <p>Not low income: Reported £20,000 per year or more</p> <p>No income data</p>
Main source of heating	<p>Which of the following do you and your household use to heat your home? Select the main source</p> <p><i>(Electric central heating (e.g. storage heater); Mains gas (central heating); Oil (central heating); Coal/wood/smokeless fuel fires or stoves; LPG (liquid petroleum gas); Electric fire; Gas fire; Portable heater (gas, electric or oil); Solar panels; Air/ground source heat pumps; I have no source of heating; Other (please specify); I don't know)</i></p>	
Year of home build	<p>Approximately, when was your home built?</p> <p><i>(Before 1919; 1919-1944; 1945-1964; 1965-1979; 1980 -1999; 2000 or later; I don't know)</i></p>	
Employment	<p>Which of the following best describes your current employment status?</p> <p><i>(Employed full-time [35 or more hours per week]; Employed part-time [up to 34 hours per week]; Self-employed; Student; Unemployed; Long-term sick or disabled; Retired; Carer, including those not working for domestic reasons [e.g. at-home parent]; Other [please specify]; Prefer not to say)</i></p>	

Study outcomes		
Outcome	Question asked <i>(response options)</i>	Categorisation or qualifying response
Room thermostat temperature settings	Do you have a working room thermostat or digital temperature controller? <i>(Yes; No; I don't know)</i> In winter, what temperature is your room thermostat or digital temperature controller typically set to heat your home to? <i>(Temperature in °C or °F)</i>	Temperatures in Fahrenheit converted to Celsius. Individuals reporting temperatures less than 5°C or above 35 °C were coded as missing
Total Heating hours	On a typical weekday (Monday-Friday) in winter, what times of day do you and your household have your heating on? Select all the times that apply... <i>(12am to 11pm; Heating is on all the time; I don't know)</i> On a typical weekend (Saturday-Sunday) in winter what times of day do you and your household have your heating on? Select all the times that apply... <i>(12am to 11pm; Heating is on all the time; I don't know)</i>	Total hours summed
Heating the whole home	Do you and your household heat your whole home in winter...? <i>(Yes; no)</i>	Yes
Heating selected rooms	Which rooms do you heat in winter? Select all that apply: <i>(Living room; Kitchen; Dining room; All bedrooms; Selected bedrooms; Bathroom(s); Hallway/landing; Other)</i>	
Minimum temperatures for comfort and safety	What minimum temperature do you think homes should be heated to in winter, to keep the following groups comfortable and safe? Generally healthy people More vulnerable people, for example, some older people or people with long-term health conditions <i>(°C or °F; I don't know)</i>	Temperatures in Fahrenheit converted to Celsius. Individuals reporting temperatures less than 5°C or above 35 °C were coded as missing

Study outcomes		
Outcome	Question asked <i>(response options)</i>	Categorisation or qualifying response
Thermal comfort in the main living area (adapted from the National Energy Action [NEA] survey [116])	In winter, are you able to keep comfortably warm in your main living area (the room in which you spend the most time)...? <i>(Yes; no; I don't know)</i> Where the response was no, why are you not able to keep comfortably warm? <i>(It costs too much to keep your heating on; it is not possible to heat the room to a comfortable standard; I have no source of heating; Other [please specify])</i>	No
Initial behavioural responses when feeling cold at home	When you feel cold in your home, which of the following do you usually do first? Select one: <i>(Turn on the heating; Turn the heating temperature up; Put on extra clothes e.g. extra jumper; Put on outdoor clothing e.g. coat, gloves, hat; Use a hot water bottle; Use a blanket; I rarely or never feel cold at home; Other [please specify]; I don't know)</i>	
Self-rated health (adapted from the EQ-VAS [114])	If 100 is the best state of health you could possibly imagine and 0 is the worst state of health you can imagine, how good or bad is your own health today? <i>(0 to 100)</i>	Scores categorised into low (less than or equal to the 25th percentile, 0 to 60), moderate (more than the 25th percentile to less than the 75th percentile, 61 to 89) and high (more than or equal to the 75th percentile, 90 to 100)

Study outcomes		
Outcome	Question asked <i>(response options)</i>	Categorisation or qualifying response
Low mental well-being (SWEMWBS)	<p>The following are statements about feelings and thoughts. Please tell me which best describes your experience of each over the last 2 weeks.</p> <p>I've been feeling optimistic about the future I've been feeling useful I've been feeling relaxed I've been dealing with problems well I've been thinking clearly I've been feeling close to other people I've been able to make up my own mind about things</p> <p><i>(None of the time; Rarely; Some of the time; Often; All of the time)</i></p>	Items scored and scores converted from raw to metric in line with guidance [109]. Low mental well-being cut off was more than 1 standard deviation below the mean (Mean 23.3381, SD 4.6812; Cut off scores less than 18.6)
Stress or anxiety about the cost of heating the home	<p>In the last 3 months, how often have you felt stressed or anxious about the cost of heating your home? <i>(Not at all; Not often; Quite often; Very often)</i></p> <p>Those reporting any level of stress were then asked... Thinking about the most recent time you felt stressed or anxious about the cost of heating your home, how would you describe the level of these feelings? <i>(A little stressed or anxious; Very stressed or anxious; Somewhere in between)</i></p>	Not often; Quite often; Very often
Cutting or reducing meals due to the cost of heating the home	<p>In the last 3 months, have you ever cut the size of your meals or skipped meals because of the cost of heating your home? [Select one] <i>(Never; Only occasionally; Quite often; Very often)</i></p>	Only occasionally; Quite often; Very often

Study outcomes		
Outcome	Question asked <i>(response options)</i>	Categorisation or qualifying response
Reluctance to invite guests into the home because of difficulties keeping it warm	Have you ever felt reluctant to invite friends or family to your home because of difficulties keeping it warm? <i>(Yes; no)</i>	Yes
Falls at home in the last 12 months	Have you fallen at home in the last 12 months? <i>(Yes; no)</i>	Yes
Influence of the COVID-19 pandemic on household heating	Has the COVID-19 pandemic changed the number of hours you and your household typically heat your home for in winter? Select one <i>(Yes, I heat my home for more hours; Yes, I heat my home for fewer hours; No, I heat my home for about the same number of hours)</i>	
Climate change	Are you concerned about the impact of your household heating use on climate change? <i>(Yes; no; don't know)</i> Those responding yes or don't know were then asked... Do climate change concerns influence how you and your household keep your home warm? <i>(Yes, I have made changes; No, the way I heat my home is unchanged; No, but I am beginning to think I should make changes; Don't know)</i>	

Data analysis

In total 2,290 participants completed the survey (1,577 telephone, 713 online). During data collection, 49,968 telephone numbers were called at least once (a conversion rate of 3.2%). A compliance rate for the online sample was not able to be calculated for this survey method.

Seventeen online responses considered too fast (the fastest 1%; less than 3.5 minutes in length) and responses missing key demographics (adjusted for in models, see below; n=91) were excluded. The final sample for analysis was 2,182. However, the sample size across outcomes explored in the report varies due to missing data.

Postcode of residence was converted to Lower Super Output Area (LSOA; geographical areas with approximately 1,600 residents) for categorisation to WIMD quintiles [106]. The WIMD is a standardised measure for comparing deprivation between small localities.

Data analysis was conducted using IBM SPSS Statistics (Version 29). Descriptive statistics were conducted to calculate sample characteristics (Appendix Table A2) and the prevalence of study outcomes (see Table A1). Chi-squared tests were used to explore relationships between participant and household socio-demographics and study outcomes. Binary and multinomial logistic regression models (Enter method) were then used to explore the associations between each study outcome and participant and household socio-demographics adjusting for: participant gender, age, self-reported health condition, and household disability, low income, ownership, occupancy, temperature, residential deprivation quintile and study method (online or telephone). Results are presented in Tables A3 to A20. All data is unweighted.

Appendix 2. Data tables

Table A2: Full sample participant and household socio-demographics (N=2,182)

		n	Percent
Age group (years)	18 to 39	370	17.0
	40 to 49	228	10.4
	50 to 59	360	16.5
	60 to 69	530	24.3
	70 and over	694	31.8
Gender	Male	868	39.8
	Female	1314	60.2
Deprivation quintile	1st (most)	318	14.6
	2nd	428	19.6
	3rd	417	19.1
	4th	501	23.0
	5th (least)	518	23.7
Survey method	Telephone	1544	70.8
	Online	638	29.2
Disability in the household	No	1026	47.0
	Yes	1156	53.0
Self-reported health condition	No	785	36.0
	Yes	1397	64.0
Household occupancy	Single household	573	26.3
	Child(ren) present	441	20.2
	Other structure	1168	53.5
Home ownership	Own	1667	76.4
	Private rent	217	9.9
	Other	298	13.7
Low income	Not low income	1105	50.6
	Low income	511	23.4
	No income data	566	25.9
Employment	Employed (full/part-time/self-employed)	886	40.6
	Student	22	1.0
	Unemployed	72	3.3
	Long-term sick or disabled	123	5.6
	Retired	988	45.3
	Carer	69	3.2
	Other	13	0.6
	Missing	9	0.4

		n	Percent
Urban or rural	Urban	1367	62.6
	Rural	815	37.4
Ethnicity	White	2133	97.8
	Other than white	49	2.2
Main heating source	Electric central heating	149	6.8
	Mains gas central heating	1552	71.1
	Oil central heating	238	10.9
	Other including no heat source	222	10.2
	Missing	21	1.0
Year of home build	Before 1919	452	20.7
	1919 to 1944	252	11.5
	1945 to 1964	335	15.4
	1965 to 1979	364	16.7
	1980 to 1999	332	15.2
	2000 or later	223	10.2
	Don't know or missing	223	10.3

Note: Other household occupancy structure is those with other adults but no child residents; Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer; Carer includes those not working for domestic reasons (e.g. at-home parent).

Table A3: Room thermostat data by participant and household socio-demographics

		Room thermostat data						
		n	Colder home	Warmer home	No data	χ^2	P	
Age group (years)	18 to 39	370	8.9	47.3	43.8			
	40 to 49	228	8.8	54.8	36.4			
	50 to 59	360	5.6	62.5	31.9			
	60 to 69	530	7.2	67.4	25.5			
	70 and over	694	7.2	65.7	27.1	52.364	<0.001	
Gender	Male	868	7.4	62.3	30.3			
	Female	1314	7.4	60.7	32.0	0.701	0.704	
Deprivation quintile	1 (most)	318	7.2	59.1	33.6			
	2	428	8.0	55.8	36.0			
	3	417	6.2	58.3	35.5			
	4	501	6.4	64.1	29.5			
	5 (least)	518	8.7	67.0	24.3	23.744	0.003	
Disability in the household	No	1026	6.9	60.3	32.7			
	Yes	1156	7.8	62.2	30.0	2.156	0.340	
Self-reported health condition	No	785	6.6	59.0	34.4			
	Yes	1397	7.8	62.6	29.6	5.788	0.055	
Household occupancy	Single household	573	8.2	58.1	33.7			
	Child(ren) present	441	9.8	57.1	33.1			
	Other structure	1168	6.1	64.5	29.5	13.441	0.009	
Home ownership	Own	1667	7.0	64.5	28.5			
	Private rent	217	10.1	35.5	54.4			
	Other	298	7.4	62.4	30.2	70.169	<0.001	
Income	Not low income	1105	7.4	62.5	30.0			
	Low income	511	8.6	56.9	34.4			
	No income data	566	6.2	62.9	30.9	6.432	0.169	
Survey method	Telephone	1544	7.6	66.8	25.5			
	Online	638	6.7	48.0	45.3	83.160	<0.001	

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A4: Adjusted odds ratio (AOR) of living in a colder home (with a room thermostat set to below 18°C) or having no thermostat temperature data versus living in a warmer home (with a room thermostat set to 18°C or above) by participant and household socio-demographics

	Ref category		Colder home				No temperature data			
			AOR	LCI	UCI	P	AOR	LCI	UCI	P
Age group (years)	18 to 39	0.336	Ref				Ref			
	40 to 49		0.877	0.472	1.629	0.679	0.939	0.647	1.362	0.740
	50 to 59		0.548	0.285	1.054	0.071	0.758	0.531	1.082	0.127
	60 to 69		0.660	0.347	1.255	0.206	0.629	0.434	0.914	0.015
	70 and over		0.634	0.324	1.242	0.184	0.736	0.496	1.091	0.127
Gender	Female	0.925	0.980	0.696	1.380	0.909	1.036	0.849	1.264	0.728
Deprivation quintile	1 (most)		0.793	0.456	1.378	0.410	1.241	0.889	1.732	0.205
	2		0.974	0.600	1.581	0.914	1.566	1.159	2.117	0.004
	3		0.774	0.462	1.296	0.330	1.580	1.171	2.130	0.003
	4		0.721	0.445	1.168	0.184	1.255	0.938	1.679	0.126
	5 (least)	0.040	Ref				Ref			
Disability in the household		0.763	1.099	0.757	1.596	0.620	0.953	0.767	1.184	0.662
Self-reported health condition		0.121	1.101	0.746	1.625	0.630	0.810	0.649	1.010	0.061
Household occupancy	Single household		1.402	0.918	2.141	0.118	1.346	1.054	1.720	0.017
	Child(ren) present		1.406	0.855	2.310	0.179	0.740	0.550	0.995	0.046
	Other structure	0.003	Ref				Ref			
Home ownership	Own	<0.001	Ref				Ref			
	Private rent		2.094	1.189	3.688	0.011	2.214	1.577	3.109	<0.001
	Other		0.885	0.523	1.499	0.650	0.791	0.583	1.075	0.134
Low income	Not low income	0.102	Ref				Ref			
	Low income		1.215	0.781	1.892	0.387	1.244	0.954	1.623	0.107
	No income data		0.891	0.568	1.399	0.616	1.344	1.045	1.729	0.021
Survey method	Online	<0.001	0.854	0.535	1.363	0.509	2.216	1.699	2.889	<0.001

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A5: Proportion of those who reported heating the whole home by participant and household socio-demographics

		Heating the whole home			
		n	Yes	χ^2	P
Age group (years)	18 to 39	363	81.3		
	40 to 49	225	85.3		
	50 to 59	359	75.5		
	60 to 69	530	70.9		
	70 and over	693	71.3	30.236	<0.001
Gender	Male	864	74.0		
	Female	1306	75.7	0.868	0.351
Deprivation quintile	1 (most)	316	76.9		
	2	422	78.9		
	3	415	75.2		
	4	500	70.4		
	5 (least)	517	75.0	9.704	0.046
Disability in the household	No	1018	74.2		
	Yes	1152	75.8	0.753	0.385
Self-reported health condition	No	778	75.8		
	Yes	1392	74.6	0.427	0.513
Household occupancy	Single household	570	67.5		
	Child(ren) present	438	85.4		
	Other structure	1162	74.8	42.163	<0.001
Home ownership	Own	1658	75.0		
	Private rent	214	74.3		
	Other	298	75.8	0.168	0.919
Low income	No	1099	76.5		
	Yes	509	70.7		
	No income data	562	76.0	6.609	0.037
Thermostat data	Colder home	161	72.0		
	Warmer home	1335	79.2		
	No data reported	674	67.5	33.364	<0.001
Survey method	Telephone	1542	73.9		
	Online	628	77.7	3.397	0.065

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A6: Adjusted odds ratio (AOR) of heating the whole home versus heating selected rooms in the home by participant and household socio-demographics

		Heating the whole home			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			0.011
	40 to 49	1.205	0.753	1.928	0.436
	50 to 59	0.702	0.470	1.048	0.084
	60 to 69	0.559	0.371	0.842	0.005
	70 and over	0.576	0.373	0.889	0.013
Gender	Female	1.050	0.855	1.291	0.640
Deprivation quintile	1 (most)	1.071	0.758	1.514	0.698
	2	1.251	0.908	1.722	0.170
	3	1.051	0.772	1.430	0.753
	4	0.773	0.581	1.028	0.076
	5 (least)	Ref			0.039
Disability in the household		1.185	0.948	1.482	0.136
Self-reported health condition		0.990	0.785	1.248	0.931
Household occupancy	Single household	0.764	0.598	0.975	0.031
	Child(ren) present	1.575	1.118	2.221	0.009
	Other structure	Ref			0.001
Home ownership	Own	Ref			0.681
	Private rent	0.870	0.599	1.264	0.465
	Other	0.899	0.651	1.242	0.519
Low income	Not low income	Ref			0.084
	Low income	0.910	0.694	1.194	0.497
	No income data	1.251	0.961	1.629	0.095
Thermostat data	Colder home	0.632	0.432	0.924	0.018
	No data reported	0.504	0.403	0.629	<0.001
	Warmer home	Ref			<0.001
Survey method	Online	0.937	0.697	1.260	0.666

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A7: Proportion of those who reported thermal discomfort (not being able to keep comfortably warm) by participant and household socio-demographics

		Thermal discomfort in the main living area			
		n	Yes	χ^2	P
Age group (years)	18 to 39	369	17.9		
	40 to 49	228	19.3		
	50 to 59	360	13.9		
	60 to 69	529	9.3		
	70 and over	690	4.2	71.520	<0.001
Gender	Male	867	8.3		
	Female	1309	12.7	10.257	0.001
Deprivation quintile	1 (most)	316	15.8		
	2	427	15.2		
	3	417	8.6		
	4	500	9.0		
	5 (least)	526	8.1	24.137	<0.001
Disability in the household	No	1022	8.0		
	Yes	1154	13.5	16.799	<0.001
Self-reported health condition	No	784	8.5		
	Yes	1392	12.3	7.196	0.007
Household occupancy	Single household	569	12.7		
	Child(ren) present	440	18.2		
	Other structure	1167	7.4	40.678	<0.001
Home ownership	Own	1662	7.7		
	Private rent	217	24.4		
	Other	297	19.2	79.157	<0.001
Low income	No	1105	9.1		
	Yes	509	19.8		
	No income data	562	6.4	56.951	<0.001
Thermostat data	Colder home	161	14.9		
	Warmer home	1334	9.0		
	No data reported	681	13.8	13.510	0.001
Survey method	Telephone	1538	7.3		
	Online	638	19.6	69.413	<0.001

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A8: Adjusted odds ratio (AOR) of thermal discomfort in the main living area (not being able to keep comfortably warm) versus thermal comfort by participant and household socio-demographics

		Thermal discomfort in the main living area			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			<0.001
	40 to 49	1.264	0.800	1.999	0.316
	50 to 59	1.042	0.652	1.664	0.863
	60 to 69	0.781	0.465	1.312	0.350
	70 and over	0.305	0.164	0.566	<0.001
Gender	Female	1.547	1.133	2.114	0.006
Deprivation quintile	1 (most)	1.163	0.725	1.867	0.530
	2	1.316	0.847	2.047	0.222
	3	0.801	0.490	1.309	0.376
	4	0.946	0.596	1.501	0.812
	5 (least)	Ref			0.246
Disability in the household		1.586	1.129	2.227	0.008
Self-reported health condition		1.240	0.871	1.766	0.233
Household occupancy	Single household	1.825	1.251	2.663	0.002
	Child(ren) present	1.564	1.063	2.300	0.023
	Other structure	Ref			0.003
Home ownership	Own	Ref			0.020
	Private rent	1.779	1.170	2.706	0.007
	Other	1.390	0.940	2.054	0.099
Low income	Not low income	Ref			<0.001
	Low income	1.972	1.382	2.815	<0.001
	No income data	0.941	0.608	1.458	0.786
Thermostat data	Colder home	1.440	0.868	2.389	0.158
	No data reported	1.239	0.903	1.701	0.185
	Warmer home	Ref			0.224
Survey method	Online	1.531	1.065	2.199	0.021

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A9: Self-rated health by participant and household socio-demographics

		Self-rated health				χ^2	P
		n	Low	Average	High		
Age group (years)	18 to 39	350	26.3	42.0	31.7	18.746	0.016
	40 to 49	223	31.8	42.6	25.6		
	50 to 59	355	27.3	43.4	29.3		
	60 to 69	526	24.7	37.8	37.5		
	70 and over	679	26.7	45.4	28.0		
Gender	Male	853	26.1	44.9	29.0	4.148	0.126
	Female	1280	27.2	40.6	32.2		
Deprivation quintile	1 (most)	308	32.5	42.5	25.0	28.911	<0.001
	2	415	33.5	39.3	27.2		
	3	410	24.6	43.7	31.7		
	4	493	25.4	42.6	32.0		
	5 (least)	507	20.9	43.4	35.7		
LTHC or disability in the household	No	1008	8.4	43.9	47.6	414.244	<0.001
	Yes	1125	43.2	40.9	15.9		
Health condition reported	No	763	9.6	41.0	49.4	263.608	<0.001
	Yes	1370	36.4	43.1	20.6		
Household occupancy	Single household	560	30.5	40.2	29.3	6.640	0.156
	Child(ren) present	424	26.7	43.9	29.5		
	Other structure	1149	25.0	42.8	32.2		
Home ownership	Own	1636	22.4	43.8	33.8	82.067	<0.001
	Private rent	211	34.6	42.2	23.2		
	Other	286	46.2	33.9	19.9		
Low income	No	1090	19.4	44.4	36.2	79.818	<0.001
	Yes	500	39.2	38.4	22.4		
	No income data	543	30.2	41.8	28.0		
Thermostat data	Colder home	157	31.8	39.5	28.7	6.205	0.184
	Warmer home	1325	25.4	42.1	32.5		
	No data reported	651	28.3	43.5	28.3		
Survey method	Telephone	1524	24.3	43.0	32.7	18.498	<0.001
	Online	609	33.0	40.6	26.4		

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A10: Adjusted odds ratio (AOR) of low and average self-rated health versus high self-rated health by participant and household socio-demographics

		Ref cat	Low self-rated health				Average self-rated health			
			AOR	LCI	UCI	P	AOR	LCI	UCI	P
Age group (years)	18 to 39	0.027	Ref				Ref			
	40 to 49		1.610	0.934	2.778	0.087	1.296	0.838	2.004	0.243
	50 to 59		0.863	0.515	1.446	0.576	1.014	0.673	1.527	0.947
	60 to 69		0.650	0.383	1.101	0.109	0.674	0.445	1.023	0.064
	70 and over		0.792	0.454	1.382	0.412	1.001	0.645	1.554	0.996
Gender	Female	0.053	0.792	0.602	1.042	0.095	0.766	0.615	0.954	0.017
Deprivation quintile	1 (most)		1.203	0.762	1.898	0.428	1.177	0.814	1.703	0.386
	2		1.438	0.958	2.159	0.080	1.024	0.737	1.422	0.888
	3		0.974	0.645	1.470	0.900	1.016	0.740	1.394	0.924
	4		1.214	0.821	1.795	0.331	1.077	0.798	1.454	0.626
	5 (least)	0.525	Ref				Ref			
Disability in the household		<0.001	10.3	7.522	14.184	<0.001	2.345	1.851	2.971	<0.001
Self-reported health condition		<0.001	4.8	3.429	6.623	<0.001	2.118	1.690	2.655	<0.001
Household occupancy	Single household		1.116	0.798	1.562	0.521	0.949	0.718	1.253	0.710
	Child(ren) present		1.216	0.802	1.843	0.358	1.185	0.852	1.649	0.314
	Other structure	0.644	Ref				Ref			
Home ownership	Own	0.234	Ref				Ref			
	Private rent		1.117	0.681	1.834	0.661	1.076	0.707	1.637	0.732
	Other		1.295	0.852	1.969	0.226	0.878	0.597	1.290	0.507
Low income	Not low income	<0.001	Ref				Ref			
	Low income		1.807	1.257	2.597	0.001	1.198	0.877	1.635	0.256
	No income data		2.164	1.530	3.062	<0.001	1.305	0.989	1.722	0.060
Thermostat data	Colder home		1.347	0.806	2.249	0.256	1.080	0.705	1.655	0.724
	No data reported		1.287	0.952	1.741	0.101	1.208	0.948	1.540	0.126
	Warmer home	0.380	Ref				Ref			
Survey method	Online	<0.001	2.125	1.457	3.101	<0.001	1.261	0.930	1.709	0.135

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A11: Proportion of those who reported low mental well-being by participant and household socio-demographics

		Low mental well-being			
		n	Yes	χ^2	P
Age group (years)	18 to 39	352	31.5		
	40 to 49	220	30.5		
	50 to 59	350	15.7		
	60 to 69	509	11.0		
	70 and over	641	6.4	151.425	<0.001
Gender	Male	825	13.5		
	Female	1247	17.6	6.256	0.012
Deprivation quintile	1 (most)	304	24.0		
	2	409	20.3		
	3	395	11.9		
	4	476	16.2		
	5 (least)	488	10.2	37.240	<0.001
Disability in the household	No	982	9.6		
	Yes	1090	21.7	56.290	<0.001
Self-reported health condition	No	759	9.5		
	Yes	1313	19.6	37.104	<0.001
Household occupancy	Single household	526	16.7		
	Child(ren) present	425	23.5		
	Other structure	1121	12.7	27.494	<0.001
Home ownership	Own	1585	11.4		
	Private rent	208	27.4		
	Other	279	33.0	105.067	<0.001
Low income	No	1072	13.2		
	Yes	483	25.9		
	No income data	517	12.4	46.753	<0.001
Thermostat data	Colder home	155	20.6		
	Warmer home	1281	13.7		
	No data reported	636	19.3	13.020	0.001
Survey method	Telephone	1459	9.3		
	Online	613	31.6	16.068	<0.001

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A12: Adjusted odds ratio (AOR) of low mental well-being versus not low mental-being by participant and household socio-demographics

		Low mental well-being			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			<0.001
	40 to 49	0.991	0.652	1.506	0.966
	50 to 59	0.316	0.203	0.493	<0.001
	60 to 69	0.253	0.158	0.406	<0.001
	70 and over	0.129	0.074	0.223	<0.001
Gender	Female	1.210	0.914	1.602	0.183
Deprivation quintile	1 (most)	1.398	0.897	2.178	0.139
	2	1.417	0.929	2.162	0.106
	3	0.835	0.523	1.333	0.450
	4	1.567	1.033	2.377	0.035
	5 (least)	Ref			0.024
Disability in the household		2.527	1.833	3.484	<0.001
Self-reported health condition		2.121	1.511	2.978	<0.001
Household occupancy	Single household	1.627	1.146	2.310	0.007
	Child(ren) present	0.877	0.611	1.258	0.476
	Other structure	Ref			0.009
Home ownership	Own	Ref			0.049
	Private rent	0.824	0.545	1.245	0.357
	Other	1.409	0.987	2.011	0.059
Low income	Not low income	Ref			0.001
	Low income	1.929	1.372	2.711	<0.001
	No income data	1.563	1.067	2.289	0.022
Thermostat data	Colder home	1.356	0.839	2.192	0.213
	No data reported	1.035	0.768	1.394	0.821
	Warmer home	Ref			0.460
Survey method	Online	2.733	1.951	3.829	<0.001

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A13: Proportion of those who reported stress or anxiety about the cost of heating the home by participant and household socio-demographics

		Stress or anxiety about the cost of heating the home			
		n	Yes	χ^2	P
Age group (years)	18 to 39	359	85.0		
	40 to 49	227	81.1		
	50 to 59	355	74.6		
	60 to 69	525	64.2		
	70 and over	685	52.0	154.475	<0.001
Gender	Male	852	61.9		
	Female	1299	70.8	18.800	<0.001
Deprivation quintile	1 (most)	310	73.5		
	2	419	72.6		
	3	413	68.3		
	4	496	62.7		
	5 (least)	513	62.8	20.479	<0.001
Disability in the household	No	1015	60.5		
	Yes	1136	73.3	40.107	<0.001
Self-reported health condition	No	774	62.1		
	Yes	1377	70.2	14.431	<0.001
Household occupancy	Single household	565	62.1		
	Child(ren) present	439	82.9		
	Other structure	1147	63.8	61.810	<0.001
Home ownership	Own	1648	63.2		
	Private rent	211	83.4		
	Other	292	78.4	53.702	<0.001
Low income	No	1096	66.0		
	Yes	502	74.9		
	No income data	553	62.9	18.852	<0.001
Thermostat data	Colder home	159	69.8		
	Warmer home	1327	66.0		
	No data reported	665	69.2	2.512	0.285
Survey method	Telephone	1527	59.3		
	Online	624	86.9	153.180	<0.001

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A14: Adjusted odds ratio (AOR) of stress or anxiety about the cost of heating the home versus no stress or anxiety about the cost of heating the home by participant and household socio-demographics

		Stress or anxiety about the cost of heating the home			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			<0.001
	40 to 49	0.813	0.509	1.297	0.385
	50 to 59	0.733	0.476	1.129	0.159
	60 to 69	0.533	0.348	0.816	0.004
	70 and over	0.320	0.205	0.499	<0.001
Gender	Female	1.442	1.180	1.763	<0.001
Deprivation quintile	1 (most)	0.998	0.708	1.405	0.989
	2	1.183	0.871	1.606	0.282
	3	1.103	0.820	1.484	0.517
	4	0.911	0.692	1.200	0.509
	5 (least)	Ref			0.508
Disability in the household		1.917	1.543	2.383	<0.001
Self-reported health condition		1.405	1.126	1.753	0.003
Household occupancy	Single household	0.998	0.783	1.273	0.989
	Child(ren) present	1.506	1.069	2.123	0.019
	Other structure	Ref			0.059
Home ownership	Own	Ref			0.610
	Private rent	1.238	0.803	1.907	0.333
	Other	1.067	0.761	1.497	0.706
Low income	Not low income	Ref			0.002
	Low income	1.601	1.205	2.128	0.001
	No income data	1.381	1.078	1.769	0.011
Thermostat data	Colder home	1.049	0.711	1.550	0.808
	No data reported	0.863	0.690	1.081	0.200
	Warmer home	Ref			0.392
Survey method	Online	2.873	2.099	3.931	<0.001

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A15: Proportion of those who reported cutting or skipping meals due to the cost of heating the home by participant and household socio-demographics

		Cutting or skipping meals due to the cost of heating the home			
		n	Yes	χ^2	P
Age group (years)	18 to 39	361	38.0		
	40 to 49	226	28.8		
	50 to 59	356	22.2		
	60 to 69	528	12.3		
	70 and over	691	6.9	186.217	<0.001
Gender	Male	859	16.9		
	Female	1303	19.1	1.727	0.189
Deprivation quintile	1 (most)	315	27.6		
	2	421	21.9		
	3	413	17.9		
	4	496	16.7		
	5 (least)	517	11.2	40.167	<0.001
Disability in the household	No	1020	10.7		
	Yes	1142	25.0	73.619	<0.0001
Self-reported health condition	No	777	12.2		
	Yes	1385	21.6	29.274	<0.001
Household occupancy	Single household	561	18.5		
	Child(ren) present	440	30.9		
	Other structure	1161	13.3	66.708	<0.001
Home ownership	Own	1656	11.7		
	Private rent	211	44.1		
	Other	295	36.3	206.174	<0.001
Low income	No	1099	15.4		
	Yes	504	30.4		
	No income data	559	12.9	66.473	<0.001
Thermostat data	Colder home	161	22.4		
	Warmer home	1330	16.3		
	No data reported	671	21.0	8.601	0.014
Survey method	Telephone	1534	10.6		
	Online	628	36.9	208.103	<0.001

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A16: Adjusted odds ratio (AOR) of cutting or skipping meals due to the cost of heating the home versus not cutting or skipping meals due to the cost of heating the home by participant and household socio-demographics

		Cutting or skipping meals due to the cost of heating the home			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			<0.001
	40 to 49	0.727	0.482	1.097	0.129
	50 to 59	0.550	0.365	0.829	0.004
	60 to 69	0.319	0.203	0.502	<0.001
	70 and over	0.167	0.099	0.280	<0.001
Gender	Female	1.046	0.805	1.359	0.737
Deprivation quintile	1 (most)	1.346	0.882	2.054	0.169
	2	1.295	0.862	1.947	0.213
	3	1.313	0.864	1.996	0.203
	4	1.419	0.949	2.122	0.089
	5 (least)	Ref			0.513
Disability in the household			2.886	2.127	3.916
Self-reported health condition			1.622	1.183	2.226
Household occupancy	Single household	1.814	1.297	2.538	0.001
	Child(ren) present	1.468	1.046	2.060	0.026
	Other structure	Ref			0.001
Home ownership	Own	Ref			<0.001
	Private rent	2.095	1.445	3.039	<0.001
	Other	1.701	1.220	2.372	0.002
Low income	Not low income	Ref			<0.001
	Low income	1.911	1.384	2.637	<0.001
	No income data	1.399	0.976	2.006	0.068
Thermostat data	Colder home	1.130	0.707	1.807	0.610
	No data reported	0.880	0.663	1.167	0.374
	Warmer home	Ref			0.520
Survey method	Online	2.639	1.923	3.620	<0.001

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A17: Proportion of those who reported reluctance to invite guests into the home because of difficulties keeping it warm by participant and household socio-demographics

		Reluctance to invite guests into the home			
		n	Yes	χ^2	P
Age group (years)	18 to 39	363	19.3	86.996	<0.001
	40 to 49	223	17.9		
	50 to 59	356	11.8		
	60 to 69	526	8.2		
	70 and over	691	3.3		
Gender	Male	858	9.7	0.281	0.596
	Female	1301	10.4		
Deprivation quintile	1 (most)	316	17.1	39.428	<0.001
	2	424	12.0		
	3	411	12.2		
	4	492	7.7		
	5 (least)	516	4.8		
Disability in the household	No	1017	5.9	37.319	<0.001
	Yes	1142	13.8		
Self-reported health condition	No	781	6.3	19.704	<0.001
	Yes	1378	12.3		
Household occupancy	Single household	567	13.1	24.213	<0.001
	Child(ren) present	432	14.4		
	Other structure	1160	7.2		
Home ownership	Own	1653	6.5	107.840	<0.001
	Private rent	214	25.7		
	Other	292	19.2		
Low income	No	1095	7.8	56.552	<0.001
	Yes	502	18.9		
	No income data	562	6.8		
Thermostat data	Colder home	160	16.9	32.649	<0.001
	Warmer home	1330	7.2		
	No data reported	669	14.2		
Survey method	Telephone	1533	6.0	97.714	<0.001
	Online	626	20.1		

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A18: Adjusted odds ratio (AOR) of reluctance to invite guests into the home because of difficulties keeping it warm versus no reluctance to invite guests into the home because of difficulties keeping it warm by participant and household socio-demographics

		Reluctance to invite guests into the home			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			<0.001
	40 to 49	1.123	0.691	1.823	0.640
	50 to 59	0.632	0.386	1.035	0.068
	60 to 69	0.472	0.276	0.806	0.006
	70 and over	0.158	0.082	0.304	<0.001
Gender	Female	0.969	0.703	1.337	0.849
Deprivation quintile	1 (most)	2.114	1.230	3.632	0.007
	2	1.712	1.002	2.927	0.049
	3	2.174	1.272	3.714	0.004
	4	1.492	0.858	2.594	0.156
	5 (least)	Ref			0.036
Disability in the household		2.151	1.479	3.126	<0.001
Self-reported health condition		1.689	1.134	2.515	0.010
Household occupancy	Single household	2.212	1.496	3.270	<0.001
	Child(ren) present	1.041	0.687	1.579	0.848
	Other structure	Ref			<0.001
Home ownership	Own	Ref			0.035
	Private rent	1.739	1.133	2.668	0.011
	Other	1.350	0.895	2.036	0.153
Low income	Not low income	Ref			0.003
	Low income	1.922	1.316	2.809	0.001
	No income data	1.300	0.823	2.054	0.261
Thermostat data	Colder home	2.218	1.325	3.713	0.002
	No data reported	1.533	1.095	2.146	0.013
	Warmer home	Ref			0.002
Survey method	Online	1.862	1.266	2.740	0.002

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A19: Proportion of those who reported a fall at home in the last 12 months by participant and household socio-demographics

		A fall at home in the last 12 months			
		n	Yes	χ^2	P
Age group (years)	18 to 39	370	10.8	26.289	<0.001
	40 to 49	227	12.3		
	50 to 59	360	10.6		
	60 to 69	530	14.3		
	70 and over	693	20.1		
Gender	Male	867	14.2	0.332	0.565
	Female	1313	15.1		
Deprivation quintile	1 (most)	318	17.9	10.700	0.030
	2	428	16.6		
	3	417	15.3		
	4	501	14.8		
	5 (least)	516	10.7		
Disability in the household	No	1025	5.8	123.932	<0.001
	Yes	1155	22.7		
Self-reported health condition	No	784	6.6	63.847	<0.001
	Yes	1396	19.3		
Household occupancy	Single household	573	20.2	18.891	<0.001
	Child(ren) present	440	12.5		
	Other structure	1167	12.9		
Home ownership	Own	1665	13.5	14.064	0.001
	Private rent	217	14.7		
	Other	298	21.8		
Low income	No	1104	10.9	29.178	<0.001
	Yes	511	20.5		
	No income data	565	17.0		
Thermostat data	Colder home	161	19.3	2.862	0.239
	Warmer home	1336	14.4		
	No data reported	683	14.2		
Survey method	Telephone	1543	15.5	2.458	0.117
	Online	637	12.9		

Note: Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.

Table A20: Adjusted odds ratio (AOR) of a fall at home in the last 12 months versus no fall at home in the last 12 months by participant and household socio-demographics

		A fall at home in the last 12 months			
		AOR	LCI	UCI	P
Age group (years)	18 to 39	Ref			0.023
	40 to 49	1.074	0.622	1.853	0.797
	50 to 59	0.914	0.537	1.553	0.739
	60 to 69	1.418	0.835	2.411	0.196
	70 and over	1.889	1.087	3.282	0.024
Gender	Female	1.034	0.798	1.340	0.799
Deprivation quintile	1 (most)	1.515	0.986	2.326	0.058
	2	1.419	0.951	2.117	0.087
	3	1.383	0.923	2.073	0.116
	4	1.421	0.962	2.098	0.077
	5 (least)	Ref			0.309
Disability in the household		3.618	2.619	4.998	<0.001
Self-reported health condition		1.780	1.265	2.506	0.001
Household occupancy	Single household	1.455	1.077	1.966	0.014
	Child(ren) present	1.381	0.915	2.085	0.125
	Other structure	Ref			0.030
Home ownership	Own	Ref			0.523
	Private rent	0.991	0.625	1.570	0.968
	Other	1.216	0.854	1.731	0.278
Low income	Not low income	Ref			0.601
	Low income	1.152	0.831	1.597	0.395
	No income data	1.159	0.835	1.610	0.378
Thermostat data	Colder home	1.349	0.862	2.111	0.190
	No data reported	1.023	0.770	1.360	0.875
	Warmer home	Ref			0.419
Survey method	Online	1.198	0.821	1.748	0.348

Note: AOR: Adjusted odds ratio; LCI: Lower confidence interval; UCI: Upper confidence interval; Ref: Reference category; Reference categories for gender, disability in the household, self-reported health condition and survey method were male, no disability, no health condition, and telephone respectively. Other household occupancy structure is those with other adults but no child residents. Home ownership includes those owning outright/with mortgage/shared ownership and other home ownership includes those who rent from local authority/housing association/cooperative/trust/registered social landlord and those who didn't know/refused to answer.



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