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How home temperatures affect health and well-being in low-income households: Evidence from temperature monitoring and lived experience

Briefing

Contents

Mae'r ddogfen yma ar gael yn y Gymraeg /
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Housing Warmth and Health Programme

This briefing is part of a wider programme of work and series of publications that can be found on the Public Health Wales website under the topic of Housing: Housing - Public Health Wales

How home temperatures affect health and well-being in low-income households: Executive summary

Why this work is important

- Living in a cold home below 18°C is linked to poorer health and well-being[1]. A low income can restrict people to living in older and harder to heat homes[2] and to spending disproportionately larger amounts of income on energy[3].
- Energy prices reached record highs over the winter 2022/2023 and remain above pre- 'energy-crisis' levels[4].
- There is a need to understand the lived experiences of low-income households to help inform effective policy responses.

Which evidence gaps we aimed to address

- What awareness do people have of safe and healthy indoor temperatures?
- What are the indoor temperatures in low-income households at a time of record high energy prices?
- What is the impact of indoor temperature on the physical and mental health and well-being of those living on a low income?

How we did this work

- We objectively measured indoor temperatures and conducted interviews with 15 participants from low-income households (less than £20,000) in March 2023.

What we found

- Average daytime (08:00 to 20:00) main living room temperature was 17.7°C, with a wide variation among the homes:
  - Just over half (n=8) had an average main living room temperature at or above the recommended minimum 18°C (range 18.3°C to 23.1°C)
  - Just under half (n=7) had an average main living room temperature below the recommended minimum 18°C (range 13.3°C to 16.9°C)
- Almost all (n=13) participants thought that temperatures between 18 and 24°C were safe and healthy; a minority regarded 16°C or under as safe. Many (n=7) based their views on personal comfort rather than awareness of official guidelines.
- When asked about the impact of experiencing cold in the home, most (n=12) described negative impacts on their health and well-being, with some experiencing negative economic and social impacts.

> ***"There's days where I won't eat so that we can have heat."*** (P9, 21.0°C)

> ***"I think it's depressing because you're cold every day and then it's that constant worry of overspending on your utility bill…my mental health suffers."*** (P11, 13.7°C)

> ***"If it's cold, I don't feel like I want to do anything. I feel like just tired and lethargic, there's no get up and go."*** (P13, 15. 9°C)

> ***"The worry over fuel prices is a constant" … "I use [essential] medical equipment each day and I'm sitting there thinking to myself, can I afford to actually use that?"*** (P3, 18.6°C)

What this means for people, policy and practice

Despite differences in indoor temperatures (above and below 18°C), most participants reported negative impacts of feeling cold in the home on their health and well-being. Notably, some of those living in a warmer home (18°C or above) spoke about the negative impacts of managing a warmer living area, including cutting back on eating and worrying about the affordability of energy bills. The study highlights the importance of lived experience in understanding the housing and health challenges faced by some low-income households, providing insights that may be useful for policy and service planning, and identifies opportunities to broaden understanding.

1 Janssen H, Ford K, Gascoyne B, Hill R, Roberts M, Bellis MA, et al. Cold indoor temperatures and their association with health and well-being: a systematic literature review. *Public Health*. 2023;224:185–94.
2 Ormandy D, Ezratty V. Thermal Discomfort and Health: Protecting the Susceptible from Excess Cold and Excess Heat in Housing. *Advances in Building Energy Research*. 2015;10:84–98.
3 Office for National Statistics. *Family spending in the UK: April 2023 to March 2024*. 2025.
4 Bolton P. *Gas and electricity prices during the 'energy crisis' and beyond*. 2025.

The evidence

Cold homes, health and well-being

Home temperatures below 18°C in winter have been linked to poorer health and well-being (1) and around 30% of excess winter deaths have been attributed to living in cold homes (2). Health agencies including the World Health Organization (WHO) (3), the United Kingdom Health Security Agency (UKHSA) (4) and Public Health Wales (5) recommend 18°C as a minimum home temperature during cold seasons for generally healthy adults (1). For vulnerable populations including those with long-term health conditions, children and older adults, temperatures higher than 18°C may be necessary for health and comfort (3,5).

The link between low income and cold homes

Having a low income is a risk factor for living in a cold home, as it can restrict individuals to living in older homes that are more likely to be thermally inefficient and poorly built (3,6). Having a low income can also result in spending disproportionately larger amounts of income on energy than those with higher incomes (7). In 2006, a study in England on low-income households reported a median standardised daytime living room temperature of 19.1°C (8). However, the study pre-dates the record-high energy prices and it did not address the link between indoor temperature and health.

Energy costs and cost of living pressures

UK households experienced record high energy costs over the winter of late 2022 and early 2023 and cost of living challenges (9). At the same time, there was a significant rise in the proportion of households setting their room thermostat below 18°C during winter 2022/2023 (from 6.7% in 2021/22 to 15.2% in 2022/23) (10). Also, in Wales, more people reported experiencing stress or anxiety in the previous three months due to the cost of heating their home (from 57.2% in 2022 to 66.5% in 2023) (11).

A study into the impact of the energy crisis on thermal conditions and comfort in England during winter (January to February) 2023 using indoor temperature monitoring found that six of nine households were unable to heat their homes to 18°C (12). Going without essentials like heating, food and showers has remained at 7 million (60%) of low-income households in the UK since October 2022 (figures for May 2025) (13).

Evidence gaps

- Lack of evidence on awareness of safe and healthy temperatures.
- Lack of objectively measured indoor temperatures in low-income households, with no known studies conducted during the record high energy prices.
- Lack of evidence of the impact of indoor temperature on the health and well-being of those living on a low income, with no known studies on the impact of objectively measured indoor temperature on mental health or conducted in Wales.

Aim of this work

The aim of this work was to understand the impact of home temperatures on the health and well-being of people living in low-income households in Wales.

Its objectives were:

- To objectively measure indoor temperatures and determine those that fall above or below the recommended minimum of 18°C.
- To use semi-structured interviews to explore participants' experiences of indoor temperature and how they feel it affects their health and well-being, and their awareness and understanding of healthy indoor temperature guidelines and the associated health risks of cold homes.

What this work adds

This briefing presents the experiences of 15 individuals living in low-income households (see definition in Box 1). It draws on objective indoor temperature monitoring and interviews exploring awareness and understanding of healthy indoor temperature guidelines and the impacts of home temperature on health and well-being.

While the focus of this work was specifically on the experiences of people living in low-income households, all the participants also self-reported a long-term health condition. Hence, the information provided in this briefing acknowledges that some factors (e.g. income and health) can overlap to shape people's lived experiences.

Box 1. A low income is defined here as 60% of the median UK household income (£32,500 at the time of study) before housing costs (Fiscal Year End 2023), which was a total income below £19,500 before housing costs (14). Due to the categorisation of income in this study, participants reporting £15,000-£19,999 or below per year were included (see Appendix Table A1).

Intended audience and impact

The findings from this exploratory study offer indicative insights that may be useful to inform work underway at both local and national levels and would be relevant to policymakers, practitioners, researchers and others working with low-income or otherwise vulnerable households. By highlighting real-world experiences of home temperatures and the physical and mental challenges of living in cold conditions, the work provides understanding of how housing warmth relates to health and how these experiences are shaped by overlapping social and economic factors. The study also reinforces the importance of inclusive engagement with people who have lived experience, as their perspectives are essential for informing policies and approaches that better meet the needs of households in Wales.

How we did this work

The research took place between 3rd March and 6th April 2023. It followed household surveys in winters 2021/22 and 2022/23 on home heating regimes during winter, which identified health and well-being impacts of the cost of heating the home (11) including impacts experienced by low-income households (5).

Who was eligible to take part?

- Respondents to the 2023 survey (11) who were willing to be contacted for follow-up research (see Recruitment in Appendix 1).
- Aged 18 or older and living in Wales.
- From households with an annual income under £20,000 (see Box 1) with those aged 65 years or older also receiving the Warm Home Discount (15).
- Out of 42 eligible people, 15 took part.

What did we do?

1. Surveys:

- Participant demographics and housing characteristics were drawn from survey questions in the 2022 and 2023 Housing Warmth surveys (see Appendix Table A1).
- We used Met Office weather data to report outdoor temperature for the time of study (16) because of the link between outdoor and indoor temperature (12).

2. Temperature monitoring:

- We placed one data logger in the main living room (the room they spend most time in) to record indoor temperature every hour for 1 to 3 weeks to capture a set period (14th to 20th March 2023) for all participants (see Temperature Monitoring in Appendix 1).
- We looked at the average (mean) daytime temperature (08:00 to 20:00 [8]) and identified households falling above or below the recommended minimum of 18°C.
- Average temperature was presented for each participant alongside corresponding quotes.

3. Interviews:

- After temperature monitoring, we spoke to all 15 participants by telephone between 21st March and 6th April 2023.
- We used semi-structured questions (see Appendix Table A2) relating to a typical winter day at home during the most recent winter to ask about:
  - How comfortable they feel at home including time spent at home
  - How affordable their heating is
  - What they do when they feel cold and why, including any support needs
  - Their awareness of healthy home temperatures
  - How being cold affects their health
- Interviews lasted about 17 minutes on average.
- We used thematic analysis to develop key themes in the interview data (see Appendix 3).

A detailed description of the methodology can be found in Appendix 1 at the end of this document.

What we found

Who took part?

Participants were recruited from across Wales. Everyone who took part was over 40 years old, and more than half were aged 60 or older. All had at least one long-term health condition, such as heart disease, arthritis, or mental health problems. Most (11 of 15) said their health or disability affected their daily life (Table 1).

Table 1: Individual and household characteristics

Gender	10 female, 5 male
Age	All 15 were aged 40-79 years with 8 (53%) aged 60 years or over (classified as an older adult [17])
Ethnicity	All 15 reported White ethnicity
Employment	11 were non-working (retired, disabled, carer, unemployed), 4 were working (part time and full time)
Long-term health condition	All 15 reported a long-term health condition e.g. cardiovascular, respiratory, mental health, memory, musculoskeletal, diabetes, and some reported multiple conditions
Daily life limited	11 said that their day-to-day activities were limited because of a health problem or disability
Household composition	9 were single-person households and 6 lived with others
Tenure	10 owned their own home and 5 rented from a local authority or housing association

What were their homes like?

Almost half the homes (6 of 15) were terraced, with almost all (14 of 15) built before 1979. Many participants (n=10) reported damp, condensation or mould and used mostly mains gas central heating. Most households (n=11) were in urban areas across Wales (Table 2).

Table 2: Housing characteristics

Housing type	6 houses were terraced and other housing types included detached, semi-detached and flats
Year built	7 homes were built before 1919 and 7 homes were built between 1919 and 1979
Housing condition	12 reported having damp, condensation, mould, or a combination of these in their home
Main heating system	10 participants used central heating (mains gas). Other main heating systems included central heating (oil), electric storage heaters, gas fire and air/ground source heat pump
Urban or rural	11 homes were in an urban area and 4 in a rural area, with diverse geographical coverage across Wales

What were the recorded indoor temperatures?

On average, main living rooms were 17.7°C (SD 3.2) during the day (08:00 to 20:00; Figure 1; Appendix Table A3). Five participants had much colder main living rooms, with temperatures between 13.3°C and 15.9°C.

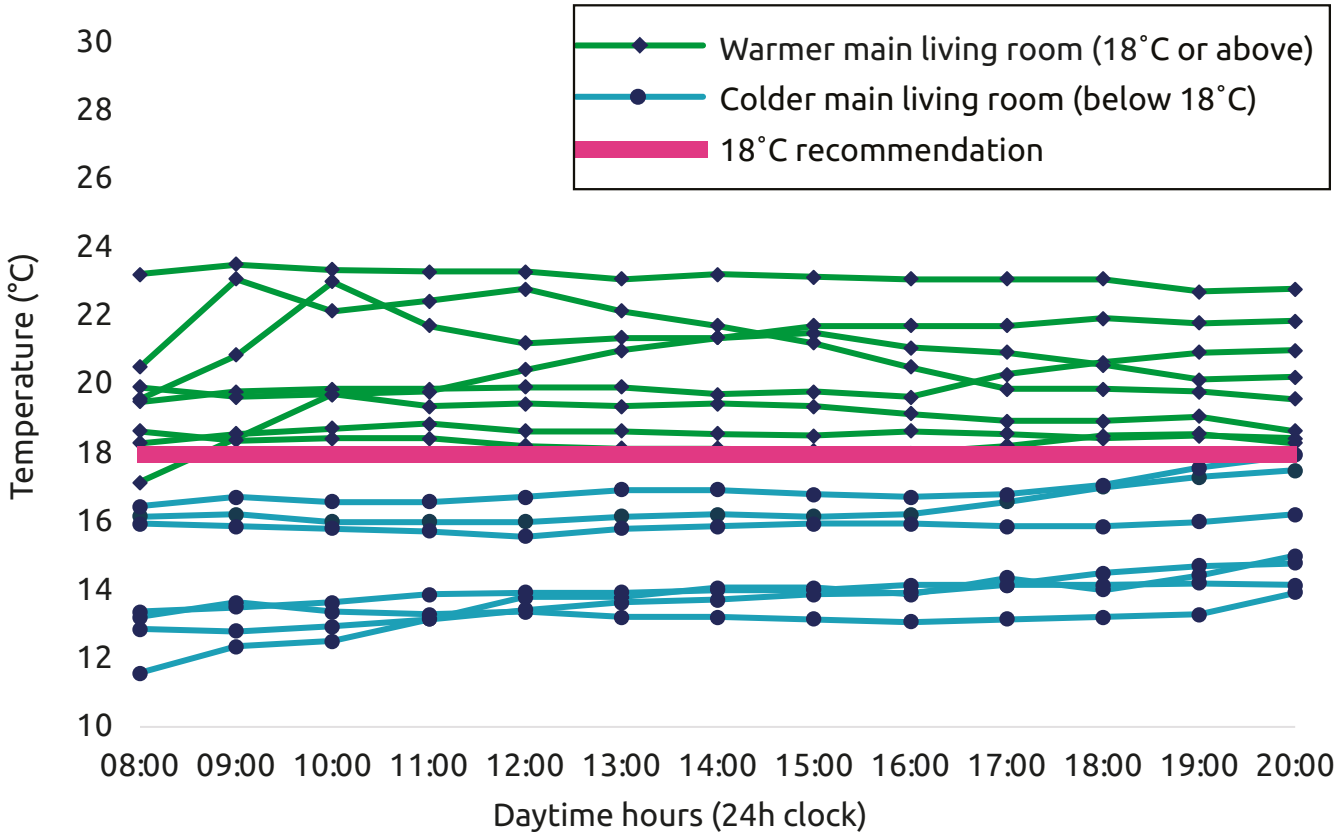
8 participants had a warmer main living room with average temperatures of 18°C or above (range 18.3°C to 23.1°C)

7 participants had a colder main living room with average temperatures below 18°C (range 13.3°C to 16.9°C)

What was the outdoor weather like?

The average outdoor temperature in Wales in March 2023 was 6.2°C, which was slightly warmer (0.3°C) than the long-term average for that time of year (1991 to 2020). From the 8th of March onwards (temperature data collected 14th to 20th March) it was predominantly unsettled with moist, milder air pushing up from the south. Wales had 200% of average rainfall for the month making it one of the wettest and dullest months on record (16).

Figure 1: Average (mean) hourly daytime (08:00 to 20:00) temperatures in the main living room against minimum 18°C recommendation



Produced by Public Health Wales. Source: Public Health Wales.

Figure 1 note:

Weekday and weekend day temperatures were initially analysed separately as heating patterns often vary depending on time of the week:

- Average (mean) weekday temperature was 17.6°C (SD 3.2) for the 15 participants.
- Average weekend day temperature was 18.0°C (SD 2.4) for the 15 participants.

As the variation was less than 0.5°C outside of the mean, a 7-day week is presented in Figure 1.

What did participants tell us during interviews?

Reflecting on the most recent winter, participants expressed concerns about the impact of the cold at home and high energy costs on their behaviours, comfort, health, food, housing and social connection.

Average living room temperature (°C) from **14th to 20th March 2023** is presented for each participant alongside their quotes. For this reason, quotes may not directly reflect recorded temperatures but provide further insight into the lived experience of indoor temperatures.

Feeling cold at home

Spend most time at home

Most participants (n=11) said they spend most, if not all their time, at home and in the room the temperature monitoring took place (either a living room or kitchen). Two participants were out most of the day and left their heating off. Another two said they were out for a couple of hours, three days per week but lived with others who stayed in.

Feeling cold

Most participants (n=12) described feeling cold, but this varied from feeling *"very cold"* (P8, 23.1°C; P11, 13.7°C; P12, 18.3°C) to *"barely warm"* (P3, 18.6°C"). One expressed that they had been cold for many winters:

> ***"This winter's no different to last. The house is still freezing. It was last year, and it was the year before that." … "I can go up there [upstairs which is unheated] for an hour, but after that, it's just the same as going out the back."*** (P2, 19.0°C)

Some participants said they felt colder in certain areas of the home due to minimising heating use in selected rooms, whilst others said they felt colder at certain times of day:

> ***"Depending on whereabouts you are in the house depends on the temperature really. If we're upstairs, [we] can get quite cold. But the general living area stays at just a nice temperature."*** (P13, 15.9°C)

> ***"It's cold when I get up, but I get dressed, put a hot water bottle up my jumper, get a cup of tea and then I'm alright."*** (P1, 13.6°C)

A minority said they were comfortably warm at home; notably, one of these had a main living room temperature below the recommended minimum (P5, 20.1°C; P7, 16.4°C; P10, 21.0°C).

Energy is unaffordable

Struggling with energy affordability and cutting back

Almost all participants (n=14) said that their household energy costs were more expensive than in previous winters, with many participants *"struggling"* (P9, 21.0°C) to afford them:

> ***"We just couldn't afford to put the heating on. It was just ridiculous." … "I've had to use my credit card to fill the tank up again."*** (P12, 18.3°C)

> ***"Well, the bills they're going to pile up and that, that's what I'm worried about. It's all right putting it on, but you know, can you pay for it when the bill comes?"*** (P14, 16.9°C)

Spending on energy was usually reduced by cutting heating use:

> ***"I have to keep them [heating bills] affordable, let's put it like that, by just not having heating like I would normally any other winter."*** (P6,13.3°C)

Heat the person, not the home

Heating self, not the home

When asked what they do when they feel cold at home, all fifteen participants described behaviours focused on heating themselves first rather than heating the room or the home. This involved wearing additional layers or warm clothes including some wearing outdoor clothes indoors:

> ***"I'm sitting here now, and I've got a bodywarmer and a fleece on, so we're still sort of reasonably frugal with it [the heating]."*** (P15, 13.9°C)

> ***"We all wear coats and hats and scarfs"*** (P12, 18.3°C)

One person reflected:

> ***"I try and warm myself up rather than warm my house up because of the expense of it."*** (P1, 13.6°C)

Some participants also said they used a blanket, a hot water bottle, movement or a hot drink to keep warm:

> ***"Marching on the spot warms me up a bit. Gets me through the afternoons."*** (P4, 21.2°C)

> ***"To treat myself, I got a heated throw, and I put that around me…just to warm my body up a bit"*** (P14, 16.9°C)

One participant recognised the health risk of limiting their heating use and just heating themselves due to the associated damp and mould problems:

> ***"I can keep warm with a blanket, you know, a hot water bottle, as I said, I'm warming me rather than the house, but then I have to deal with the house because there are health issues relating to mould and damp and that sort of thing."*** (P6, 13.3°C)

Able to heat the home as needed

Four participants described buffers that enabled them to heat their home as needed including:

- Being in receipt of a welfare payment/government grant;
- access to a private pension; and
- fixed or lower energy payments.

> ***"I was fortunate enough, before all the energy prices went up, I locked in with [Energy provider] on an 18-month contract."*** (P5, 20.1°C)

> ***"I have to be honest and say that the government grant that we received has helped."*** (P10, 21.0°C)

Using personal preference to determine healthy temperatures

Almost all participants (n=13) thought that temperatures between 18 and 24°C were safe and healthy. The remaining two said temperatures of 16°C or under were safe and healthy. Around half the group (n=7) based their idea of a safe temperature on personal preference and only three participants referred to official guidance (e.g. NHS, Government website, free thermometer card) (Table 3).

Comfortable temperature for self

When participants spoke about their idea of safe and healthy temperatures, seven referred to what they found as a comfortable temperature, this was regardless of whether they felt warm at home or were maintaining such temperatures:

> ***"Well, I feel that it should be at least 20°C. I'm comfortable at 20°C."*** (P4, 21.2°C)

> ***"I would like my house to be between 20 and 22°C, which me, as a cold person, would be comfortable in."*** (P6, 13.3°C)

> ***"Well, we've set the controls for the heating at 18°C, which we thought was a reasonable level."*** (P15, 13.9°C)

One participant noted the importance of maintaining a minimum temperature to reduce the risk of housing problems linked to health:

> ***"Around the 14°C and 16°C mark." … "A minimum temperature to keep damp at bay and keep the general temperature in the room. It's the damp and everything, isn't great for health"*** (P13, 15.9°C)

Table 3: Awareness of safe and healthy temperatures

ID	Home temperature (°C)	Idea of safe and healthy temperature (°C)	Source of knowledge
1	13.6	16	Personal preference
2	19.0	21	Family
3	18.6	24 (for elderly)	Family
4	21.2	20	Personal preference
5	20.1	18.5	Personal preference
6	13.3	20 to 22	Personal preference
7	16.4	20	Unsure, maybe TV
8	23.1	16 to 24 (health dependent)	Guidance, NHS
9	21.0	18 healthy, 20 older	Government website
10	21.0	19 to 20	Personal preference
11	13.7	18 to 20	Personal preference
12	18.3	18 to 19	Do not recall
13	15.9	14 to 16	Do not recall
14	16.9	18	Free thermometer card
15	13.9	18	Personal preference

Vulnerable groups need warmer temperatures

A few participants (n=3) identified certain population groups, such as older adults and those with existing health conditions, as needing slightly higher indoor temperatures than the general population:

> *"I think the national standard minimum, I believe, for the elderly, is 24 degrees."* (P3, 18.6°C)

> *"Especially the older generation, and those that have got physical disabilities, then 18°C isn't enough for them."* (P9, 21.0°C)

> *"Particularly elderly people and young children and the disabled"* (P4, 21.2°C)

Negative impact of the cold at home on health and well-being

Most participants (n=12) perceived harmful effects of the cold at home on their health and/or well-being (Table 4).

Table 4: Perceived impact of cold at home on health and well-being

Health and well-being impact sub-themes	Examples from interviews
Cold at home negatively impacts well-being (including economic and social outcomes)	Feeling down or miserable, low mood, frustration, lack of motivation, guilt, worry and concern about cost of heating, concern for others in the home, limiting hobbies in the home, limiting visitors, financial difficulties, cutting back on essentials (skipping meals)
Cold at home worsens existing long-term health conditions	Worsened: anxiety, chronic obstructive pulmonary disease (COPD) symptoms, asthma symptoms, pain from peripheral neuropathy (damaged nerves in hands and feet), pain from damaged spinal cord, and pain from arthritis
Cold at home negatively impacts mental health	Constant worry including worry about cost of powering essential medical equipment
Cold at home negatively impacts physical health	Respiratory infection, loss of movement or mobility issues and health issues relating to mould and damp
No impact from the cold at home	Not affected, do not feel cold

Cold at home negatively impacts well-being (including economic and social outcomes)

Twelve participants provided examples of how the cold at home was negatively impacting their well-being. This included feelings of low mood, lack of energy and motivation, and frustration, including many worrying about the cost of energy:

> ***"It's more frustrating than anything."*** (P2, 19.0°C)

> ***"It just makes me feel pretty down. I've got no energy" … "I don't like being at home when it's cold. I stay [in work] longer. Even though I don't get paid for it"*** (P8, 23.1°C)

> ***"If it's cold, I don't feel like I want to do anything. I feel like just tired and lethargic, there's no get up and go."*** (P13, 15.9°C)

Many participants described going without essentials (such as hot meals), not bathing, limiting hobbies in the home and being less likely to invite visitors over due to unaffordable heating costs:

> ***"We don't have many over anymore because it is nippier. You just feel if you're bringing people over, you've got to turn the heaters up and it's just not cost effective, then."*** (P13, 15.9°C)

> ***"I'm sitting huddling up rather than being able to sit at the sewing machine or sit sewing because I'm just too cold" … "I hate it. I wish I could get out of this house" … "I don't bath anymore. I only shower every other day instead of every morning, yes, so that's things I used to enjoy"*** (P6, 13.3°C)

> ***"It makes it hard because I don't eat hot meals, I live on cereal, so - you're already cold and then you're eating cold stuff."*** (P14, 16.9°C)

For one participant, they described skipping meals to afford heating:

> ***"I mean you have to do certain things yourself, to try and keep yourself not getting depressed, or not feeling rundown, and at the minute, with the cost of everything, it just has a knock-on effect." … "There's days where I won't eat so that we can have heat."*** (P9, 21.0°C)

Another individual who said that the cold was negatively impacting how they felt about spending time in the home found themselves thinking about others in warmer climates:

> ***"I find myself thinking, oh, wouldn't it be lovely to live in a nice, hot, warm country. I just think how other people are living."*** (P15, 13.9°C)

Cold at home worsens existing long-term health conditions

Five participants felt that the cold worsened an existing health condition; four of these were related to physical conditions (peripheral neuropathy, a damaged spinal cord, asthma, arthritis and COPD) and one to their mental health (anxiety):

"I suffer from peripheral neuropathy where you have damaged nerves in your feet and hands and arthritis in my fingers as well" … "Yesterday morning for example something went wrong with my boiler" … "I ached so much all day yesterday. My hands and feet were cold." (P4, 21.2°C)

"The surgery was quite concerned a few weeks ago when the sudden onset of snow came and the really cold snap. I just couldn't stop coughing, that is one of my asthma symptoms, which is the dangerous kind where I have an asthma attack, I start expelling air from my body by coughing and I can't breathe." (P8, 23.1°C)

For one participant, who identified themselves as vulnerable to the cold due to having COPD, they said that the cold triggered respiratory infections:

"I've had two chest infections with the [cold] because I've got COPD, which is like emphysema, yes? So you're prone to the cold." (P14, 16.9°C)

Cold at home negatively impacts mental health

Some (n=4) participants described the negative impact of being cold at home to their mental health. A few of these participants reported constantly worrying about fuel prices:

"The worry over fuel prices is a constant, especially as I'm home all day and don't have a warm office to go to or stuff like that, you know."… "I have a condition called obstructive sleep apnoea so I use [essential] medical equipment each day when I sleep and I'm sitting there thinking to myself, can I afford to actually use that?" (P3, 18.6°C)

A few others said that being cold at home was depressing and for one, this was worsened by constantly worrying about overspending on their energy bill:

"I've never had to live like this before, you know, where part of my being in the house all the time is trying to be warm. I've never felt as though I need to wear a hat in my house, wear fingerless gloves in my house or walk around with a hot water bottle in my jumper. You know, it's quite depressing really." (P6, 13.3°C)

"I think it's depressing because you're cold every day and then, you know, it's that constant worry of overspending on your utility bill. So, you know, your mental health suffers. Yes, my mental health suffers." (P11, 13.7°C)

Cold at home negatively impacts physical health

Four participants described the physical health impacts (unrelated to existing conditions) of the cold at home. A few said that the cold at home reduced their mobility, whilst a few others suggested that the cold at home might have caused recent respiratory illness:

> ***"I had a stinking cold this week and is it because my house is too cold? I don't know. You know. But I'm not going to put the heating on thinking oh I've been ill this week because the house is cold, you know." … "It is only my money that comes in and financially I'm not happy to put the heating on just for me"*** (P11, 13.7°C)

> ***"I'm always alright downstairs [but]" … "I find it really unpleasant to go upstairs [due to no heating source], so it affects me that way. Working up there, hoovering and changing beds and all that, that slows me down. That's not really a health thing. That's just movement."*** (P2, 19.0°C)

> ***"We all couldn't tell whether we'd got Covid, or whether we were bloody ill from cold. We couldn't tell. We all kept taking Covid tests. It was just cold."*** (P12, 18.3°C)

No impact from the cold at home

Despite most participants describing how the cold was negatively impacting their health and well-being, three said that they were completely unaffected.

For two of the participants, this was due to maintaining a warm home environment and using additional behaviours to warm themselves:

> ***"I don't like being cold, I hate being cold. But I can't say it's affected me as such." … "I'm usually wrapped up in a jumper and scarf, and sometimes a hot water bottle for warmth."*** (P5, 20.1°C)

> ***"I wouldn't know because I don't feel cold. I also have quite a tolerance to the cold from the various jobs I've done in the past over my working life. I've always worked a lot outside. So, you know putting on an extra jumper or putting on some thermals."*** (P10, 21.0°C)

One participant reported no impact from the cold at home on their household but shared concern for their disabled husband:

> ***"No, it doesn't affect us at all." … "I wouldn't let him get cold, cold. I've got to look after him, poor man. But yes, I think he's comfortable. He would tell me if he's cold."*** (P7, 16.4°C)

Support is important

Some participants had received support to help keep warm. Five noted property related support including new doors and windows, dry lining of walls, internal insulation, installation of storage heaters, solar panels, and an air source heat pump:

"It's more affordable now than before, because we've had internal insulation and storage heaters just put in. Before we ran off oil.' (P13, 15.9°C)

"This winter we have been a lot warmer. Last year we were fortunate to get a grant to - or some work done in the house, to do the dry lining of the walls." (P15, 13.9°C)

Barriers to support

Three participants discussed gaps in the support available:

"I don't think there is any [support available] for me." (P11, 13.7°C)

"Because we're still of working age, so there isn't a lot of government [financial] help" (P9, 21.0°C)

For one participant this included speaking with the council about up-grading their property to central heating which had felt challenging:

"They [the council] would say, "Yes, you should be entitled to that. You should be okay." … but nothing ever happens. And you always think you're talking to the right person but actually you're not, because it doesn't go any further" (P2, 19.0°C)

Some participants felt they had exhausted interventions for their property or that such interventions would be inappropriate. Three participants expressed that not much could be done in their home to improve its heat retention.

Support needed to attain warmth at home

Some participants provided ideas about support that could help to improve their housing warmth. This included more affordable energy, solar panels and structural improvements for improved energy efficiency.

The importance of financial help to ensure homes could be heated as needed was highlighted:

"As I said the windows and doors were replaced, it's insulated as much as it can be. So the only help that would be sensible would be some sort of financial help." (P3, 18.6°C)

"More affordable heating." (P6, 13.3°C)

One participant also highlighted the importance of supporting others in the community:

"We need to be working from the ground up in communities like mine. It's quite a deprived community really" (P1, 13.6°C)

What we learned and why it matters

In this section, we look at what participants told us and what the data shows. We explore the challenges households face, how they cope, and what this means for health and well-being. We also highlight what support could make a difference and recommendations for future work.

Who took part and why they're at risk

Everyone in the study lived in low-income households (as set by the study design) but they also had long-term health conditions, with some requiring medical equipment. Many were older adults and spent much of their time at home, which can make them more vulnerable to the effects of cold indoor temperatures (18). Previous research has shown that people with health conditions often heat their homes to higher temperatures (19) and older adults in low-income households are less likely to ration energy or go cold compared to working-age adults (20). Research and health guidelines recommend warmer homes for older people and people with health conditions (3,21,22). Further studies could help us understand how cold affects adults in good health and adults who are younger.

What participants thought was a safe temperature

Most participants said a healthy home should be at least 18°C, though a few thought that 16°C was acceptable. Most based their views on personal comfort rather than awareness of official guidelines. Some also considered the needs of vulnerable groups like older adults or those with health problems, including worrying about their loved ones needing extra warmth. This highlights a gap between public understanding and public health recommendations, signalling a need to communicate temperature safety advice more clearly.

How warm were homes?

With the weather in March being slightly milder and wetter than average (see outdoor weather on page 8), just over half of the homes had main living rooms above the recommended 18°C, with an average of 17.7°C during the day but with a wide variation among homes. Some homes were much colder, with average temperatures as low as 13.3°C, which can lead to cold and damp conditions that harm health (12,23). Behavioural factors such as frugality may have led some participants to maintain colder temperatures (24). However, rising energy costs have made it harder for many people, not just those on low incomes, to keep their homes warm (12).

Evidence on the ideal indoor temperature for chronically ill or older adults is inconclusive. WHO advises that a higher minimum than 18°C may be necessary for vulnerable groups (3). Welsh Government currently recommends 21°C in living rooms and 18°C in other rooms for most households, and 23°C in living rooms for vulnerable individuals (21). These higher temperatures reflect the needs of older adults and those with chronic illness, who often require warmer environments for health and comfort (1,5).

How people felt and stayed warm

Most participants said they felt cold including when, for some, objective temperature monitoring showed their main living rooms were heated above the recommended minimum temperature. However, some of the participants said that other parts of their home (e.g. upstairs) were colder than their main living room. To cope with the cold, all participants reported wearing extra layers, and some used heated blankets, hot water bottles, or kept moving to stay warm. Similar strategies have previously been used in low-income UK households (20). It is possible that the difficulties participants reported in feeling comfortable with the temperature at home could have been due to the health problems reported and because most of the participants were older age (25).

How cold homes affected health and well-being

Regardless of home temperature, participants described feeling tired, low in mood, and stressed about energy costs, with some skipping meals or avoiding visitors to save money. Several felt the cold made health problems like asthma or arthritis worse, and some reported impacts on mental health such as constant worry about the cost to adequately heat the home, including worry about cost of powering essential medical equipment. A few suspected recent illnesses were due to cold homes, showing how both physical and mental health can suffer when it's hard to keep warm. Exposure to indoor cold is linked to many poor health outcomes (1), including poor respiratory (3,26) and cardiovascular health (3,27), mental disorders (e.g. depression) (28) and severe mental distress (29), loneliness and social isolation, and a greater prevalence of falls (30). Only a few participants felt they were unaffected by the cold due to savings or financial support.

Money worries and tough choices

Many participants worried about the cost of heating, with some going into debt or skipping meals to pay their bills. When heating becomes unaffordable, some households can face hard decisions like falling behind on payments or cutting back on essentials. Some 3.2 million low-income UK households (27%) have been unable to adequately heat their home since the start of 2022. Rather than having to choose between heating or eating, 2.3 million households (21%) have gone without both (13).

What support is needed to attain warmth at home

Some participants shared examples of support received to improve their housing warmth, but others described barriers to support. Often where support was received it was felt that this was not enough to heat homes adequately.

With energy and living costs at record highs, targeted help is needed for those most at risk from cold homes. Improving housing to reduce excess cold and associated ill health offers excellent value for money (31). Improving energy efficiency in homes at risk of fuel poverty has been shown to significantly enhance people's well-being and quality of life, reducing financial strain while increasing thermal comfort, social connection, and how effectively indoor spaces can be used (32). Low-income households can especially benefit from energy efficiency interventions (33) but even small heating costs can be a heavy burden for the lowest-income households (20).

Study limitations

This exploratory study involved a small sample size, meaning the findings cannot be extrapolated to the population but do provide insight. The sub-sampling process resulted in a sample of adults aged 40 to 79 years with long-term health conditions, which may reflect self-selection bias. To reduce this risk, the study invitation focused on heating practices in Wales rather than income. Younger adults and adults from minoritised ethnic backgrounds were underrepresented, so experiences of these groups warrant further investigation.

Because the household survey took place in January to February 2023 and sub-sampling required additional time, temperature monitoring occurred in March 2023, when outdoor temperatures were milder and wetter than winter. This reduced the likelihood of capturing colder indoor conditions, which may have been experienced in winter. However, interviews did reflect experiences across the most recent winter to provide further insight into the lived experience of indoor temperatures. Future studies should consider longer monitoring periods with a larger sample size.

Telephone interviews averaged under 20 minutes, which may have limited the depth of responses. However, researchers followed a semi-structured script to ensure consistency. Interviews focused on the most recent winter, which may not align directly with the recorded temperatures. But the interviews aimed to capture lived experience rather than provide precise triangulation with temperature data. A thematic approach was agreed when considering the data collected; however, this was retrospective.

Recommendations for future work

- **Recruit a representative sample** in national indoor temperature and health monitoring programmes.
- **Include diverse demographic representation and household structures** (e.g. a range of ages, ethnicity, cultural context, households with children, specifically under five years) and **conduct intersectional analysis.**
- **Require full winter-season monitoring** with minimum sample sizes for accurate indoor temperature exposure data, including accurate local outdoor weather monitoring and accurate exposure data via household behaviour diaries or personal exposure monitors.
- **Evaluate the impact of indoor temperatures** above and below the minimum 18°C recommendation on health and well-being using a representative sample.
- **Ensure qualitative depth** by incorporating extended or follow-up interviews and applying a predefined methodological approach, such as reflexive thematic analysis or interpretative phenomenological analysis (IPA).

Conclusions

This briefing provides insight into indoor temperatures and health and well-being among 15 adults with long-term health conditions living in low-income households, at a time of record high energy and living costs in March 2023.

During a slightly milder and wetter than average March, just over half of participants maintained a daytime living room above 18°C, while others experienced colder conditions, including average temperatures as low as 13.3°C. Regardless of temperature, most reported that feeling the cold at home had negative impacts on health and well-being, including financial strain, feeling cold and uncomfortable, and worsening of existing health conditions. Some avoided heating parts of their home entirely, such as upstairs, posing potential health risks if these areas are used regularly. Although guidance suggests 18°C as a minimum, evidence for older adults and people with chronic conditions is inconclusive, and higher temperatures may be needed to ensure their health and comfort.

Adaptive behaviours were common, often focused on heating the person first rather than the home. Most participants viewed temperatures of somewhere between 18°C to 24°C as comfortable and safe, however, almost all based this on consideration of personal comfort, highlighting the importance of communication of temperature safety guidance. For some, concerns about energy costs often led to lower maintained temperatures, reinforcing affordability as a key issue affecting housing warmth.

While the temperature data alone provides valuable understanding of the indoor temperatures in participants' main living rooms, the qualitative findings help us to understand their exposure to the temperatures (how much time spent in the home and in which rooms), their experience of heating the home and impact on their health and well-being.

This study underscores the importance of lived experience in understanding the housing and health challenges faced by low-income households, providing insights that may be useful for policy and service planning. Further research with other understudied populations, such as younger adults and children, would help to broaden understanding of the link between housing and health and contribute to future policy and practice developments.

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Appendix 1: Methodology

Ethical approval

Ethical approval for the research was granted by the Bangor University Healthcare Sciences Ethics and Research Committee (reference: 2023-17292) on February 6th, 2023. All participants provided verbal opt-in informed consent to participate.

Information Governance approval was granted by Public Health Wales (PHW).

Study design

This was a mixed-methods study involving in-home temperature monitoring and semi-structured interviews conducted by PHW and Bangor University. The study was conducted from 3rd March to 6th April 2023 as part of a wider research project on household heating regimes and their associations with health and well-being (5,11).

Eligibility

Those who were eligible to participate in the study were residents in Wales aged 18 years or over who had consented to contact for follow-up research when taking part in The Housing Warmth Survey 2023 (11), and lived in a low-income household (see definition in Box 1). Using the 2023 survey responses households were classified as low-income if:

- the respondent was aged 18 to 64 years and was in the bottom quartile of self-reported household income (less than £20,000 per year).
- the survey respondent was aged 65 years and over and was in the bottom quartile of self-reported household income (less than £20,000 per year) and in receipt of means-tested state benefits (Warm Home Discount scheme) (15).

Recruitment

A commissioned market research company (MRC; used for data collection as part of the wider study) reapproached eligible participants via telephone to invite them to participate in an additional phase. In total, 42 respondents met the eligibility criteria. Of these, 15 were recruited, agreeing to have a temperature logger installed in their main living room and complete an interview with a PHW researcher.

Consenting individuals were visited at home by a researcher from the MRC for data logger installation, during which they were provided with a participant information sheet, data logger information sheet and signposting and support debrief sheet. All study materials were provided in English and Welsh languages. All participants were verbally informed of the study aim and methodology and provided opt-in verbal consent. Participants were offered a gift voucher as a thank you for their study participation. At least two weeks after the data loggers were installed, participants were re-contacted by the MRC to book a telephone interview with a member of the study research team.

Surveys

In two previous studies undertaken by PHW in 2022 and 2023, validated self-reporting style questions were used. All questions were self-reported. To reduce participant burden, some questions were not repeated in wave two (2023), hence why data has been extracted from different survey waves. Where possible, participant demographic and property data are drawn from the wave two of the Housing Warmth Survey (5). Gender and ethnicity were only recorded during wave one (Table A1).

Table A1: Survey questions and variable categorisation used for this briefing – participant demographics and housing characteristics

Outcome (Year of extracted data)	Question asked (response options)	Categorisation
Gender (2022)	**Do you identify as…?** Male; Female; Transgender; Other; Prefer not to say	Male; Female
Age (2023)	**How old are you?** 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	18 to 59; 60 and over (older adult)
Ethnicity (2022)	**What is your ethnic group? Choose one option that best describes your ethnic group or background.** 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	White; Other than white
Employment (2023)	**Which of the following best describes your current employment status?** 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	Working; Non-working
Self-reported health condition (2023)	**Have you ever been told by a doctor or nurse that you have any of the following conditions? Select all that apply** Heart disease or circulation problems e.g. angina or heart attack, high blood pressure, stroke; lung disease e.g. chronic bronchitis, emphysema, COPD, asthma; mental health problems e.g. depression, anxiety; memory problems e.g. dementia (Alzheimer's disease, Parkinson's disease); joint problems e.g. arthritis; diabetes (Type 1 or Type 2)	One or more of the conditions listed

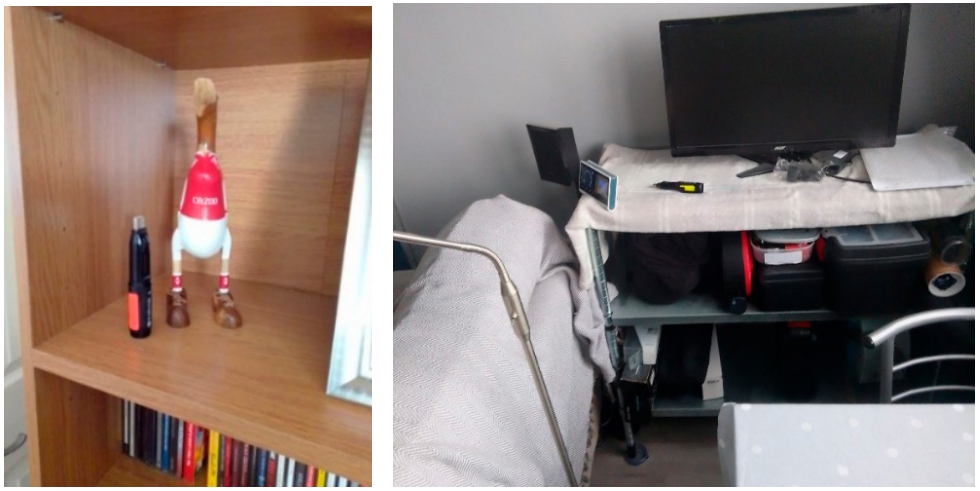
Outcome (Year of extracted data)	Question asked (response options)	Categorisation
Day-to-day activities limited (2023)	**Are your day-to-day activities limited because of a health problem or disability which has lasted or is expected to last for at least 12 months? Select one** (34) Yes, limited a lot; Yes, limited a little; No	Yes limited; No
Household composition (2023)	**How many people currently live in your household, who are:** Adults?; Children?	Single person household; living with others
Tenure (2023)	**Do you and your household own or rent this accommodation…?** 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	Owner-occupied; Private rent; Social rent
Housing condition (2023)	**Do you currently experience any of the following problems anywhere in your home?** Damp (walls and/or floors); Condensation; Mould; Rot in windows or door frames; Draught; Poorly fitting doors/windows	Housing problems; No housing problems
Rurality (2023)	**What is your postcode?**	Urban; Rural
Income (2023)	**Approximately what would you say is the total annual income of your household (including all benefits) before tax and deductions?** £0-£4,999 per year; £5,000-£7,499 per year; £7,500-£9,999 per year; £10,000-£14,999 per year; £15,000-£19,999 per year; £20,000-£29,999 per year; £30,000-£39,999 per year; £40,000-£49,999 per year; £50,000-£59,999 per year; £60,000-£69,999 per year; £70,000-£79,999 per year; £80,000-£89,999 per year; £90,000-£99,999 per year; £100,000 or more per year	Low income is below £20,000

Temperature monitoring

Lascar Temperature and Humidity Data Loggers (EL-21CFR-2-LCD) recorded indoor temperature at 1-hour intervals using internal memory. Before deployment, all loggers were calibrated and validated by placing them together in a domestic-like environment for 24-hours. Loggers with recorded temperatures ±1°C from the group mean were not used.

During the in-home installation, an MRC researcher positioned one logger in each participant's main living room such as the living room or kitchen (i.e. the room they spent most of their time). The logger was positioned approximately 1 metre above the floor, in a dry location away from any direct heat or cold sources, such as heaters and external windows (Figure A1).

Figure A1: Examples of recorded installation details



Due to resource constraints, logger installation was staggered, resulting in varied start and end dates. Each logger collected temperature data for 1 to 3 weeks to ensure at least one full week of measurements per participant. All 15 participants returned their loggers to the MRC using prepaid postage.

Average outdoor temperature for March 2023 is drawn from Met Office data (16). Outdoor temperature is a determinant of indoor temperature with evidence showing that residents counteract colder conditions by increasing their energy consumption (12).

Analysis of temperature data

Data from loggers were exported into Microsoft Excel for analysis. Data from 14th to 21st March (7-days) are presented; the 1-week with complete data for all participants. Hourly temperatures are averaged (mean) for the 7-day period, with daytime hours presented (08:00 to 20:00) (8). The daytime daily average is compared with the 18°C indoor temperature recommendation to identify households falling above or below the recommended minimum of 18°C, as was reported previously for self-reported temperatures (11).

Semi-structured interviews

Semi-structured interviews were conducted via telephone at the end of the temperature monitoring period; between 21st March and 6th April 2023. The interview involved open-ended questions developed by the research team based on gaps in the evidence and explored thermal comfort; affordability of heating; behaviours when cold at home; awareness of healthy temperatures and impacts of being cold at home on health and well-being (Table A2). Interviews lasted on average 17 minutes (range 12 minutes to 45 minutes). With consent from the interviewee, all interviews were audio-recorded, transcribed and pseudo-anonymised.

Table A2: Semi-structured interview questions used in analysis for this briefing

Topic	Guiding questions	Follow-up questions
Housing warmth and thermal comfort	Can you tell me about a typical winter day at home? (Prompt: time spent at home, activities, comfort in terms of warmth, who else is usually at home)	Are there times when the feeling is better or worse? Why? What would need to change for you to feel comfortably warm at home?
Cost of living	How affordable is your heating bill?	Is it more or less affordable than last winter? Do you do anything to try and make your heating bill more affordable? If yes, what do you do?
Behaviours and factors influencing behaviour	What do you do when you feel cold?	Why do you do [*insert behaviour*]? Do you always do the same thing? What kind of help would you benefit from e.g. support from your local authority or community?
Awareness of healthy temperatures	What are your thoughts about the temperature your home should be heated to? (Prompt: safe/healthy temperatures and/or existing public health guidance) How do you think living in a cold home in winter affects a person's health and well-being?	Why do you think homes should be heated to [insert answer]? Do you know where you can find guidance on safe and healthy temperatures? How do you think it affects different people differently e.g. older people, children, healthy adults etc?
Impacts of cold on health and well-being	How do you think the cold affects [has affected] your health and well-being?	Does the cold ever affect how you feel about spending time at home? Does the cold ever affect what you do at home?

Analysis of interview data

Two researchers conducted thematic analysis (35) using ATLAS.Ti 8 software to identify patterns in the qualitative data. The researchers familiarised themselves with the data before undertaking analysis and independently freely coded two transcripts before engaging in peer discussion. The remainder of transcripts were coded independently, resulting in the generation of additional codes, which continued to be refined between researchers in an iterative process. Analysis included developing themes and sub-themes. All results were quality assured. Key themes relating to the study aim are presented.

Appendix 2: Temperature data

Table A3: Mean daytime temperatures (from 08:00 to 20:00) in the main living room for 7 days in March 2023

ID	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	Overall mean °C	Standard deviation
P06	13.2	13.6	13.4	13.3	13.4	13.2	13.2	13.1	13.1	13.1	13.2	13.3	13.9	**13.3**	**1.0**
P01	11.6	12.4	12.5	13.1	13.8	13.8	14.1	14.1	13.9	14.4	14.0	14.4	15.0	**13.6**	**0.6**
P11	12.9	12.8	12.9	13.1	13.4	13.6	13.7	13.9	13.9	14.1	14.5	14.7	14.8	**13.7**	**0.1**
P15	13.4	13.5	13.6	13.9	13.9	13.9	14.0	14.0	14.1	14.1	14.1	14.2	14.1	**13.9**	**1.4**
P13	15.9	15.9	15.8	15.7	15.6	15.8	15.9	15.9	15.9	15.9	15.9	16.0	16.2	**15.9**	**0.5**
P07	16.1	16.2	16.0	16.0	16.0	16.1	16.2	16.1	16.2	16.6	17.0	17.3	17.5	**16.4**	**0.4**
P14	16.4	16.7	16.6	16.6	16.7	16.9	16.9	16.8	16.7	16.8	17.1	17.6	17.9	**16.9**	**0.6**
P12	18.6	18.4	18.4	18.4	18.2	18.1	18.1	18.1	18.0	18.2	18.5	18.6	18.3	**18.3**	**0.4**
P03	18.3	18.6	18.7	18.9	18.6	18.6	18.6	18.5	18.6	18.6	18.4	18.5	18.4	**18.6**	**0.9**
P02	17.1	18.4	19.7	19.4	19.4	19.4	19.4	19.4	19.1	18.9	18.9	19.1	18.6	**19.0**	**0.8**
P05	19.5	19.8	19.9	19.9	19.9	19.9	19.7	19.8	19.6	20.3	20.6	20.9	21.0	**20.1**	**0.7**
P10	19.6	20.9	23.0	21.7	21.2	21.4	21.4	21.5	21.1	20.9	20.6	20.1	20.2	**21.0**	**0.3**
P09	19.9	19.6	19.7	19.8	20.4	21.0	21.4	21.7	21.7	21.7	21.9	21.8	21.9	**21.0**	**0.2**
P04	20.5	23.1	22.1	22.4	22.8	22.1	21.7	21.2	20.5	19.9	19.9	19.8	19.6	**21.2**	**0.6**
P08	23.2	23.5	23.4	23.3	23.3	23.1	23.2	23.1	23.1	23.1	23.1	22.7	22.8	**23.1**	**0.3**

Below 16°C | 16°C to 17.9°C | 18°C to 20.9°C | 21°C or above

Appendix 3: Theme development

Table A3. Theme development including the sub-themes presented in this briefing and example quotes

Theme	Sub-theme	Example quotes
Feeling cold at home	Spending most time at home	*"I'm housebound, so all day."*
	Feeling cold	*"This winter's no different to last. The house is still freezing."*
Energy is unaffordable	Struggling and cutting back	*"I have to keep them [heating bills] affordable, let's put it like that, by just not having heating like I would normally any other winter."*
Heating the person, not the home	Heating self, not the home	*"I try and warm myself up rather than warm my house up because of the expense of it."*
	Able to heat the home as needed	*"I have to be honest and say that the government grant that we received has helped."*
Using personal preference to determine healthy temperatures	Comfortable temperature for self	*"I'm comfortable at 20°C."*
	Vulnerable groups need warmer temperatures	*"Especially the older generation, and those that have got physical disabilities."*
Negative impact of the cold at home on health and well-being	Cold at home negatively impacts well-being (including economic and social outcomes)	*"If it's cold, I don't feel like I want to do anything."*
	Cold at home worsens existing long-term health conditions	*"I've had two chest infections with the [cold] because I've got COPD."*
	Cold at home negatively impacts mental health	*"it's depressing because you're cold every day and then, you know, it's that constant worry of overspending on your utility bill."*
	Cold at home negatively impacts physical health	*"I had a stinking cold this week and is it because my house is too cold?"*
	No impact from the cold at home	*"I wouldn't know because I don't feel cold."*
Support is important	Barriers to support	*"Because we're still of working age, so there isn't a lot of government [financial] help."*
	Support needed to attain warmth at home	*"More affordable heating."*

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