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Impact of climate change and associated extreme weather events on primary care: A multi-perspective qualitative study in multimorbidity

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Abstract

Purpose:

People with multiple long-term conditions, most of whom are managed in primary care, are particularly vulnerable to the health impacts of climate change and extreme weather events. This study explored perceptions of climate change and extreme weather in relation to primary care in England, among people with multimorbidity, their carers, and health and social care professionals.

Methods:

We conducted semi-structured online interviews and focus groups with individuals living with multimorbidity (n = 11), informal carers (n = 4), health professionals (n = 8), and a climate–health expert (n = 1). Data were analysed using reflexive thematic analysis.

Results:

Four themes were identified: (1) Extreme weather was perceived as less relevant in England; (2) Primary care systems were described as overstretched and underprepared; (3) Weather events exacerbated chronic conditions, increased isolation, and strained carers and professionals—impacts were unequally distributed; (4) Participants called for climate resilience through awareness, standard operating procedures, outreach to vulnerable groups, and system-level adaptation.

Conclusions:

Climate change poses growing challenges for primary care, especially for people with multimorbidity. Adaptation strategies must be equity-focused, integrated into routine care, and supported by infrastructure, guidance, and cross-sector collaboration to safeguard health and reduce inequalities.

Clinical trial number: Not applicable

Background

Multimorbidity, the co-existence of two or more chronic physical and/or mental health conditions, is an increasingly prevalent global health challenge. More than half of adults aged 60 years and above live with multimorbidity, and prevalence is projected to rise further as populations age and the burden of long-term conditions grows (1–3). In England, 27.2% of the population are estimated to live with multimorbidity (4), rising to 54.0% among those aged 65 years and older (5). Women, people with learning disabilities and individuals experiencing socioeconomic disadvantage are disproportionately affected (6, 7, 8). The rising prevalence of multimorbidity has profound implications for individuals. families as well as health and care systems that are already under strain. Primary care is the cornerstone of multimorbidity management. In England, most cases are diagnosed, treated, and managed in primary care (9). More than half of GP appointments and three-quarters of prescriptions relate to people living

with multimorbidity (4). Management typically involves long-term medication use, regular monitoring, and ongoing support for self-care, all of which depend on sustained access to primary care. However, primary care is under intense pressure, with unprecedented demand, workforce shortages, and financial constraints (8). The growing burden of multimorbidity threatens to amplify these challenges, raising questions about the resilience of primary care in the face of additional external stressors.

One such stressor is climate change. Projections for England indicate hotter, drier summers with more frequent and prolonged heatwaves and droughts (10, 11), as well as warmer, wetter winters with increased flooding and storm events. Rising air pollution, greater humidity, wildfires, sea-level rise, and coastal flooding are also anticipated (11). These changes are expected to disrupt public infrastructure, including health services, while directly influencing health outcomes. People with multimorbidity are especially vulnerable: physiological frailty, polypharmacy, and reduced adaptive capacity increase their risk of adverse outcomes during extreme weather events (12, 13). Evidence from epidemiological studies demonstrates that temperature extremes are associated with higher mortality and hospital admissions in people with multimorbidity (14–20). For example, excess winter mortality has been partly attributed to the cumulative burden of chronic conditions, while during extreme heat events the risk of death rises with the number of comorbidities present. Social factors compound these risks. Older adults with multimorbidity may have limited mobility, rely on carers, or live in housing ill-suited to temperature extremes, further heightening vulnerability. Social disadvantage, poverty, and disability also interact with environmental stressors to exacerbate health inequities (8, 17).

Despite these known risks, research on climate change, health, and multimorbidity remains limited. Much of the existing literature has focused on the effects of extreme weather on single conditions such as cardiovascular disease, respiratory illness, or diabetes (14–16), or on acute outcomes such as hospitalisation and mortality. Studies specifically considering multimorbidity as a distinct construct are limited, and there is a paucity of evidence about how climate change may interact with the complex care needs of this population. Furthermore, although primary care is the frontline for managing multimorbidity, evidence on how general practice and community-based services can prepare for and adapt to climate-related pressures is lacking. Where climate and health research has engaged with primary care, the focus has primarily been around environmental sustainability, particularly reducing carbon emissions in line with the UK's 2050 net-zero target (21). While important, this emphasis does not address adaptation and resilience in service delivery. Key aspects remain to be elucidated as to how primary care systems can maintain continuity of care, safeguard vulnerable populations, and respond effectively to climate-related disruptions. Addressing this gap is crucial to protect those at greatest risk, particularly people with multimorbidity, whose health depends on sustained and coordinated primary care support. This study aimed to explore perceptions of climate change and extreme weather on primary care in England, with a focus on people living with multimorbidity, their carers, and health and social care professionals.

Methods

Study design

A qualitative study using with online focus groups and semi-structured interviews. Participants included individuals living with multimorbidity, informal carers, and professionals working in primary and allied health care settings. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist was followed to guide the transparency and completeness of reporting (see Supplementary Table 1).

Recruitment and sampling

An iterative recruitment strategy was used. Purposive sampling was used and recruitment was facilitated through social media, the university website (Supplementary Fig. 1), and word-of-mouth referrals (snowball sampling). Participants were recruited via an online registration form (Qualtrics). This included a brief demographic and eligibility survey (age, sex, ethnicity using UK Census categories, education, professional role where applicable, and geographical location) which was developed for this study (See Appendix 1). Screening questions ensured alignment with predefined inclusion and exclusion criteria as follows:

Inclusion criteria:

- Adults (≥ 18 years), able to provide informed consent.
- English speaking.
- Either: (i) living with multimorbidity, (ii) an informal unpaid carer of someone with multimorbidity, (iii) a primary care or allied health professional, or (iv) an expert or researcher in health and climate change.

Exclusion criteria:

- Lacking capacity to provide informed consent.
- Unable to speak English.

Eligible participants received a study information sheet and consent form by email. All 24 participants met inclusion criteria.

Data collection

A topic guide was co-developed by the research team with input from a public and patient involvement contributor (JL) and piloted in early interviews. It covered: (i) perceived impact of extreme weather on the health of people with multimorbidity; (ii) effects on informal carers; (iii) implications for primary care and health professionals; and (iv) views on models of care, prevention, and adaptation (Table 1). Data were

collected between September 2024 and March 2025 through semi-structured interviews and online focus groups conducted via Microsoft Teams. Sessions, led by members of the research team (RT, GS, LS), lasted 25–90 minutes. The semi-structured format ensured consistency while allowing participants to raise additional perspectives. Both interviews and focus groups were used to balance depth of individual experience with breadth of views. All sessions were audio-recorded, transcribed verbatim, and anonymised prior to analysis.

Table 1
Topic guide used for all interviews and focus groups with patients, health care professionals and informal carers

Main Questions	Prompts Questions	Probes
Understanding the Impact of Extreme Weather on Health i. Tell me about your background and expertise ii. What comes to mind when you think of extreme weather? iii. Can you talk about your experiences or observations of extreme weather events (such as extreme heat, flooding or extreme cold weather) on the health of **individuals with multiple long term conditions**? iv. What key issues do you think about or have come up during extreme weather conditions? v. How can some extreme weather conditions more difficult for this population than others? vi. How might extreme weather affect **caregivers** supporting individuals with MULTIMORBIDITY?	v1) How might caregivers be affected physically? v2) How might caregivers be affected mentally?	
Identifying Key Challenges and Strains on Primary Care Services from Extreme Weather i. From your perspective, what specific challenges can extreme weather events pose to **primary care services** in delivering healthcare to individuals with multiple long term conditions? ii. How can primary care providers possibly **adapt their approach** to meet the increased demand for services and address the unique needs of individuals with multiple long term conditions during and after extreme weather events?	What are the main challenges faced by primary care services during extreme weather events in terms of **resources**, and **service delivery, etc**?	Can you provide **examples or situations** illustrating gaps or limitations in primary care services' ability to respond effectively to the healthcare needs arising from extreme weather events?
Exploring Interventions and Preventative Measures	From your perspective, what **preventative measures** could be put in place to minimise the adverse effects of	

Main Questions	Prompts Questions	Probes
i. What possible interventions or strategies do you believe could **mitigate the health impacts** of extreme weather on individuals with multiple long term conditions and their caregivers? ii. What **role can primary care services play** in implementing interventions to address the specific needs of this population during extreme weather events?	extreme weather on health outcomes for individuals with multiple long term conditions and their caregivers?	
Responding to Extreme Weather i. How **important is collaboration** between healthcare providers, local authorities, social care, community organisations, and individuals with multiple long term conditions and their caregivers, in preparing for and responding to extreme weather events?	What **strategies** do you think could improve communication and coordination between primary care services and other stakeholders during extreme weather events?	Can you share examples of other professionals and services to address health impacts of extreme weather on those with MULTIMORBIDITYs?

Main Questions	Prompts Questions	Probes
Future Planning and Adaptation i. What do you see as the **key priorities** for policymakers, health and social care providers, and community leaders in preparing for future extreme weather events and their impact on health? ii. Reflecting on the importance of education, awareness-raising and long-term planning, how can we build a **more resilient** primary care system capable of addressing the health needs of vulnerable populations amidst changing climate conditions? iii. How can **technological advances and innovation** be used to better support people with multiple long-term conditions during extreme weather events? a. How can it be used to better support caregivers during extreme weather events? b. How can it be used to better support primary care services during extreme weather events?	ii a) How could we raise awareness of the health needs of people with MULTIMORBIDITY during climate change? ii b) How would a well prepared primary care service look when it comes to planning for future extreme climate events?	
Is there anything else that you would like to say that we haven't discussed so far in this interview?	Possibly **follow up** on an interesting point(s) raised by the interviextreme weather eventse, which may have come into your mind, or you think is worth revisiting to delve deeper. **Stop the recording**	
Do you have any questions for us?	Do you wish to receive results of the study? • Ask the participant if they can **recommend anyone else** who we could interview? • Thank participant. Ensure they have **study contact information** for any future enquiries. (Note: prepared some contacts if participants are upset by the interview,	

Main Questions	Prompts Questions	Probes
	such as GP, charity helpline, etc).	

Data analysis Data were analysed using Reflexive Thematic Analysis, guided by Braun and Clarke's six-phase methodology (22). This approach was selected for its flexibility in exploring shared meanings and variations in experience, while recognising the active role of researchers in theme generation rather than treating themes as emerging passively from the data. The analysis was underpinned by a broadly constructivist orientation, which assumes that knowledge is co-constructed between participants and researchers and shaped by social context. QSR NVivo (Version 12) was used to organise transcripts and support systematic coding. A constant comparative approach was applied throughout, enabling the team to identify patterns as well as divergences across accounts of people living with multimorbidity, carers, and professionals. Initial familiarisation involved repeated reading of transcripts and note-taking on potential analytic directions. Four qualitative researchers trained in the Reflexive Thematic Analysis members of the team (RT, GS, LS,) and JL, a PPI contributor who has lived experience of multimorbidity, received training from the team, independently coded a subset of the same transcripts line by line, generating inductive codes close to the data. These coding outputs were then compared and discussed to develop a preliminary coding framework. Rather than seeking consensus on a single "correct" interpretation, differences in coding were treated as a source of analytic richness, ensuring that multiple perspectives were integrated. The coding framework was iteratively refined as further transcripts were coded, with regular team meetings to review developing patterns, question assumptions, and consider alternative interpretations. Themes were generated through an interpretive process of grouping related codes, interrogating their boundaries, and exploring how they captured latent as well as semantic meanings. Draft themes and subthemes were refined through discussion with study collaborators to ensure credibility and relevance to the study aims. To enhance trustworthiness, reflexive practices were embedded throughout. Team members maintained reflexive notes to consider how their disciplinary backgrounds and experiences shaped interpretation. Emerging themes were also presented at a public engagement activity, providing an opportunity for feedback and sense-checking with wider stakeholders. This process informed the refinement of the final thematic structure and helped ensure that the findings resonated with those most affected by the study topic.

Results

A total of 24 participants took part in the study, comprising five online focus groups (Table 2) and nine individual interviews (Table 3). The sample included ten men and fourteen women. Focus groups ranged in size from two to four participants and were organised to maximise shared experiences. Interviews reflected a range of individual roles and perspectives relevant to the study focus. Eighteen participants self-identified as White, with the remaining participants self-identifying as Black African, Black Caribbean, Black British, Asian/Asian British, or of mixed/multiple ethnic backgrounds. The sample included eleven individuals living with multimorbidity (two of whom were also informal carers), four

general practitioners (one of whom lived with multimorbidity), four informal carers, one social worker, one pharmacist, one physiotherapist, one thermal physiologist, and one senior health and well-being coach. Participants represented a range of Index of Multiple Deprivation (IMD) deciles (1–10) (identified by postcode), levels of educational attainment, and geographic regions across England (Table 4).

Table 2
Sample characteristics for patients, healthcare professionals and informal carers included in the study, by focus group

Interview Type	ID	Sex	Ethnicity	Region	IMD	Education	Role
Focus Group 1	54232	M	White	South West	9	Degree	Individual with multimorbidity
Focus Group 1	75492	W	White	Scotland	6	Degree	Individual with multimorbidity
Focus Group 1	85546	M	White	South East	4	A-levels or similar or ONC / OND	Individual with multimorbidity
Focus Group 1	92312	W	White	Scotland	8	Higher degree	Individual with multimorbidity
Focus Group 2	36572	M	White	West Midlands	7	Postgraduate degree	Individual with multimorbidity
Focus Group 2	55189	W	Mixed / Multiple ethnic groups	South East	2	Postgraduate degree	Individual with multimorbidity
Focus Group 2	23682	W	Black / African / Caribbean / Black British	South West	1	GCSEs / O levels or similar	Individual with multimorbidity & a carer
Focus Group 2	75109	M	Asian / Asian British	North West	9	Postgraduate degree	Individual with multimorbidity & a carer
Focus Group 3	80165	M	Asian / Asian British	South East	4	Postgraduate degree	GP
Focus Group 3	31789	M	White	South West	7	Higher degree	GP
Focus Group 4	23890	W	White	South West	7	GCSEs / O levels or similar	Carer
Focus Group 4	37120	W	Asian / Asian British	South West	8	A levels or similar or ONC / OND	Carer
Focus Group 4	94460	W	Black / African / Caribbean / Black British	South East	10	Postgraduate degree	Clinical Pharmacist
Focus Group 5	68712	W	White	South West	10	Degree	Carer

Interview Type	ID	Sex	Ethnicity	Region	IMD	Education	Role
Focus Group 5	69521	W	White	South West	5	A levels or similar or ONC / OND	Carer

Table 3
Sample characteristics for patients, healthcare professionals and informal care-givers included in the study, by interview

Interview Type	ID	Sex	Ethnicity	Region	IMD	Education	Role
Interview	72335	W	White	South East	9	Degree	Individual with multimorbidity
Interview	44129	W	White	Yorkshire	10	Degree	Individual with multimorbidity
Interview	29104	M	White	South East	10	Postgraduate degree	GP
Interview	10365	M	White	South East	7	HNC / HND Degree	Individual with multimorbidity
Interview	31024	W	White	East Midlands	3	Degree	GP
Interview	43695	M	White	South West	10	Higher degree	Physiotherapist
Interview	65012	W	White	South East	10	Postgraduate degree	Social worker
Interview	33310	M	White	South East	10	Postgraduate degree	Thermal Physiologist/Climate change expert
Interview	99681	W	White	South East	5	Postgraduate degree	Senior Health and Wellbeing Coach

Table 4
Demographic breakdown of participant characteristics for all patients, healthcare professionals and informal carers by percentage proportion of total sample

Characteristics	Percentage
Gender	
Women, n (%)	59%
Men, n (%)	41%
Ethnicity	
White	75%
Asian	12%
Black	8%
Mixed	4%
IMD quintile	
Most Deprived (1)	4%
IMD 2	4%
IMD 3	4%
IMD 4	8%
IMD 5	8%
IMD 6	4%
IMD 7	16%
IMD 8	8%
IMD 9	12%
Least deprived 10	29%
Region	
South East	41%
South West	37%
East Midlands	4%
Yorkshire	4%
North West	4%

Characteristics	Percentage
Gender	
West Midlands	4%
Scotland	8%
Highest level of education	
Post graduate degree/Higher Degree	45%
Degree/ HND/HNC	33%
A levels/ GCSEs or similar	20%

Four overarching themes were identified through thematic analysis, each illustrating how participants perceived, understood, experienced, and responded to the challenges of extreme weather events in the context of primary care in England, as depicted by Fig. 1. These are presented in detail below, with illustrative quotations from patients, carers, and care professionals used to support these findings.

Theme 1: Perceptions of extreme weather in the context of England

This theme explores patient, informal carer and professional perceptions of extreme weather events and climate change in England.

1.1. Impacts of extreme weather events are less relevant in England compared with elsewhere in the world: "The UK Doesn't Experience Extreme Weather"

A key reason for the lack of awareness of the health impacts of climate change may stem from the belief that England does not experience extreme weather to the extent and intensity as other regions of the world. Participants often questioned the relevance of extreme weather to the context of England, with many suggesting that the temperate climate protected the country from the worst impacts of climate change compared with elsewhere in the world. A care professional observed:

"*The weather isn't really a huge, a subject I spend an awful lot of time thinking about because we live in quite a temperate climate, especially in the South of England, so we don't tend to get extreme weather…" (Physiotherapist 43695).*

Similarly, others also framed extreme weather events as a problem "abroad", with one participant referencing the example wildfires in Spain or Greece: *"We've seen a lot of fires, like in Spain and Greece… where the weather's really changed."* (*Focus Group 2, Patients and Informal Carers).*

Cultural differences were also noted, contrasting how other countries adapt to extreme heat compared with UK practices. A climate change expert observed:

“In Spain… people don’t go out at midday…it’s too hot during that time. It’s dangerous. …Whereas in the UK, it’s still very much this culture of we don’t get the sun very often, so when it is a hot day… let’s go outside and make the most of it.” *(Climate Change Expert 33310).*

1.2. Salience and prominence of extreme weather events in primary care

The effects of extreme weather events on healthcare and service provision were generally not regarded as salient concerns in primary care. Further, there was a perception that the issue of extreme weather events did not feature in the routine day-to-day activities in the health service:

‘I'm not aware of anything in particular. And at meetings I've been to, it's never come up as an item about climate, so consequently I don't think they're particularly… In the health service anyway, it's not something they consider at this moment in time, the effects of weather as a specific item” (Patient 10365).

During consultations, there was a perception that health concerns related to the effects of extreme weather were not seriously considered. A patient commented:

”If I went to my doctor and said, 'Oh, the weather'. Then he might just say to me: 'Well, get an electric blanket.' You know what I mean?” (Patient 10365).

A participant explained that preparedness in primary care for weather-related events is largely shaped by established seasonal funding and programmes designed to mitigate seasonal illnesses during winter (e.g., setting up winter hubs and vaccination programmes), rather than by a recognition of extreme weather events as a distinct health risk:

“… it's very much, there's funding there for winter hubs and winter vaccination schedules and plans and things like that. I suppose the GP surgeries go chasing the funding and, so I suppose there's …is a recognition that these illnesses happen more in the winter because extra funding is released for them, but that's not really from an extreme weather perspective. It's just from a ‘we're going into winter’, and we expect more of these illnesses at that time.“ (GP 29104).

Although heat and heatwaves may feature more in public discourse, extreme cold events remain the most significant in terms of their impact on health and wellbeing:

“Yes, I'm not sure if the heat is so much of an issue, certainly in my role, it's more the cold, I would say. We don't get extreme heat. We certainly have hot days, but I think most people with the conditions obviously can deal with that.” (Physiotherapist)

Another care professional commented on the impact of cold on increased workload:

“When we say extreme weather, if I start off with the cold and things … so when we see extreme cold, with the frail cohort then, yes, we get more callouts to their houses and things like that” (*Clinical Pharmacist,*

Focus Group Four 94460).

Theme 2: Perceptions of the impacts and implications of extreme weather events on the primary care system

A second theme illustrated how primary care was perceived as ill-prepared for many of the potential challenges of weather extreme. Participants described a system already under strain from existing demand, lacking resilient infrastructure as well a clinical or institutional guidance.

2.1 Infrastructure limitations in Primary Care

Climate-resilient infrastructure limitations were identified such as poorly ventilated or non-air-conditioned buildings, to ensure safe and sustainable service delivery during extreme weather events. Some healthcare facilities, such as older hospitals, were considered outdated and poorly designed to cope with extreme heat. A participant explained:

"I've spoken to some people … during those hot periods, it is extremely hot, because parts of the hospital don't have air conditioning, and then they have certain strict regulations on opening windows, depending on what floor you're on, for health and safety reasons, because of patient safety. …Then, depending, which side they face, they might have the sun beaming in … and the infrastructure's not great, and it does sometimes feel like you're in a glasshouse just cooking".(Climate Change Expert 33310).

Another participant added:

"… Extreme heat - which, it's not that frequent in the UK… but there are periods where it happens. I don't think that there is always the infrastructure to deal with it, in the surgeries that I have at least worked" (GP, Focus Group Three).

A care professional outlined the practical limitations of managing high temperatures in the primary care setting:

"In primary care, the patients aren't really in the building for a large majority of time… So, we do what we can … If it was really hot, the risk of fire is minimal. There's nothing left around that's going to be super-heated to the point that it's going to cause issue … It's just a building like a normal building, so ventilated as much as it can be. I don't know that there's… Even winds and stuff like that, there's not really anything that you can do for someone's health by putting something in place with the weather." (Clinical Pharmacist, Focus Group Four 94460).

The infrastructure limitations also have impacts on staff during extreme weather, as one participant described:

"I don't think that there is the infrastructure, for it, unfortunately, in primary care. …in extreme weather conditions, there should be reasonable adjustments for the clinicians as well, to be able to deliver their

service, for example, by working from home on some occasions, because at least in primary care we can offer that." (Focus Group Three, healthcare professionals)

2.2 Procedural and Care Guidance Challenges in Primary Care

Participants emphasised the need for better frameworks (e.g., clinical guidance) to support practitioners in clinically managing climate-related health impacts on patients, as well as mitigating potential effects on staff. A participant highlighted the lack of clarity regarding the provision of appropriate support to patients during weather extremes:

"To be honest, I don't think the guidance is that great … we get told there's a Met Office warning for this weather: 'can you please do a welfare check on the people you're supporting?' There's not really any guidance around what that welfare check should involve" (Social Worker 5012).

Another participant highlighted a gap in national health communications, specifically a lack of guidance on weather extremes and possible health impacts, particularly for people with multimorbidity:

"Not that I've seen really, no. Every year we get updates on the flu burden or the flu vaccination policy and things like that, but it's not from an extreme weather perspective" (GP 29104).

Further, from a patient perspective, limitations were highlighted in the information available to care staff to offer better support during these periods:

"…when I've talked to the medics and things like that, there doesn't seem as though there's much information available to them about the effects of climate on people's health in a way that makes them aware of what impact it might have on the person's individual problems. I think it's a case of education." (Patient)

Lastly, one patient noted the differences in standard operating procedures during weather extremes based on locality and subsequent disruption in services:

*I live in the [*] area, or on the outskirts of the area but in the [*] area, and the next borough to us have completely different facilities available to them, and yet they're in the same cohort for the NHS. You've got the [*] team that looks after the ** boroughs in [*], but they don't all operate under the same system. How can that be? (Patient 10365)*

2.3 Capacity Constraints and Challenges in Managing the Impacts of extreme weather events

Participants anticipated increase in demand during weather extremes in an already overstretched primary care services, exacerbating existing system capacity pressures:

"It stretches our capacities hugely. We've already got really long wait lists, but we would see those wait lists increase even more, so that patients would be waiting longer for their appointments, be waiting longer to be

signposted to external services, or have referrals done, because our capacities will be stretched" (Senior Health and Wellbeing Coach 99681).

Insufficient funding and transportation limitations affecting patients' access to services were identified as key barriers hindering the adaptation of the primary care during extreme weather events:

"*I'm sure this comes up all the time, but funding. Funding is always something that we're struggling for at the moment, but funding and transport are the two barriers that we always see when we see patients" (Senior Health and Wellbeing Coach 99681).*

Another care professional participant highlighted transport challenges:

"I think the main things…that would be impacted are whether people can get into or get to the patient. So, if that's the home visiting service, if there was extreme weather going on, how do we get to the patient and manage them? Then vice-versa; how does the patient get to us, because it's mainly transport." (Clinical Pharmacist, Focus Group Four 94460).

One participant highlighted problems associated with financial cutbacks, noting that reductions in community support services could mitigate impacts:

"So you've got to set up the support systems as well. Support systems don't come from nowhere. They need personnel and money. For example, my local area, the day centres have closed for older people because they're not getting the money from the local authority because of cutbacks. That day centre for some people could have been a lifeline in these emergency situations, if their home isn't suitable, but they're not there now." (Patient).

Additionally, a care practitioner highlighted potential lengthening of waiting times and reduced access to essential services, resulting from extreme weather:

"We've already got really long wait lists, but we would see those wait lists increase even more, so that patients would be waiting longer for their appointments, be waiting longer to be signposted to external services, or have referrals done, because our capacities will be stretched, numbers will increase." (Senior Health and Wellbeing Coach 99681).

Theme 3. Extreme weather events: impacts on patients, carers and healthcare professionals

Experiences reflected deterioration, restricted mobility and social activity, psychosocial impacts, and heightened vulnerabilities due to structural inequities.

3.1 Effects on health and wellbeing

Patients, professionals and informal carers spoke about the impact of extreme weather on existing health conditions including exacerbations in cardiovascular, respiratory, renal, and musculoskeletal symptoms. A health professional observed that:

"…definitely in the summer, we see heat-related illnesses, heat stroke, possibly affecting kidney disease as well. If people are more dehydrated then their kidney function and heart function can reduce as well in the winter. Yes, the respiratory illnesses that come in as well." (GP 99681).

Another care professional highlighted the effect on daily routines and social engagement in those with multimorbidity:

'…access to things they might do physically, going away, going shopping, going to classes… any extreme weather has an effect on their functionality, and also their pain symptoms and their motivation to do physical things, I suppose, so I see that every day.' (Senior Health and Wellbeing Coach 99681)

Others described how the management of long-term conditions is more challenging due to disruption in access to healthcare services through weather events, either through missed appointments or lack of medication:

'I've definitely seen people with long-term conditions being impacted, not just with their health … so if there's flooding, can they get to their appointments? It might bring along other comorbidities that then impact their long-term health conditions and cause acute problems that basically mean it's harder to manage their long-term health conditions' (GP 99681).

Patients also described restricted routines and increased anxiety;

"To me, worry and fear…'Shall I go out of the house?'...So, you defer going out because you're concerned that cold, damp, miserable weather might have an adverse effect on your back pain, knee pain"(Focus Group 2, Patient).

Another participant with multimorbidity described the impact on their mental health, due to concerns over trips and falls, or exacerbating symptoms leaving them feeling more isolated and in need of social connection:

"It affects your mental health as well, …because you know you're limited in what you can do, it does affect your mood. I feel a bit trapped sometimes, because you like to go out, you see other people going out and doing things, but I know if I go out, my lung capacity will fall, and it's just too risky." (Focus Group 1, Patient).

Informal carers and healthcare professionals described stress, extended hours, and emotional fatigue. For carers, the demands of caregiving were intensified:

"It's not only the person who's ill. It puts a lot of strain and everything else and stress on the carers, and that in turn can lead to them ending up being ill. You know what I mean? I just think it's so counterproductive."

(Carer)

Healthcare staff also faced environmental challenges in their workplaces, especially from overheating due to a lack of effective climate control:

“Some surgeries have AC [air conditioning], and some rooms don't have AC. Sometimes you are fighting for a fan, and the fan gets displaced and the next day somebody else has taken it”. (Focus Group 3)

System failures during flooding also had lasting operational consequences:

“We've had flooding that's affected… Our building wasn't actually flooded, but the areas around, and so then you might have people not being able to come into work, you might have patients not able to come in.” (GP 31024)

3.2 Unequal Impacts of extreme weather events

The impacts of weather extremes appeared unequally distributed among population groups, with deprivation and limited resources intensifying vulnerability, for example, financial hardship prevented some from adequately heating their homes during cold spells:

“I've been in a property very recently where we have had quite cold weather and there was no heating on at all, and it was freezing. I just talked to them about why did they not have the heating on? I did find out it was around costs” (Social Worker 5012).

Further, financial hardship also restricted travel options for some if they needed to access alternative healthcare provision:

‘So, I think poverty also plays a part, because in the past also I've seen people who are living in poverty and they can't get a taxi or come to a different well site’. (Focus group 3)

Deprivation was also considered to be a predictor of the type and severity of conditions presenting at primary care and likely to worsen due to extreme weather events due to poor living conditions:

“If you're a GP who works in an area of high deprivation where more of your patients have poor housing, damp housing, then you are probably more likely to be seeing respiratory illnesses, possibly childhood asthmas, asthma exacerbations and things like that, than you would be if you were working in an area of low deprivation.” *(29104 GP)*

Theme 4: Climate Resilience in Primary Care

Participants highlighted the need for earlier identification and wider awareness of the risks of climate change to health, and ensuring adaptive strategies are in place to enable planning and preparations at individual, community, and system scales.

4.1 More awareness and information on extreme weather events

There was a general call amongst participants for information about how to be safe during extreme weather events, how to manage conditions and where to access help. With a desire to be kept in the loop, the emphasis here was on empowering the patient to feel prepared for extreme weather events:

"It might be looking at coping mechanisms for them to be able to self-manage with the heat, rather than focusing on what the initial goal was that they came to us with" (Social Worker 5012).

Signposting through technology was also suggested as a useful way for patients to independently access information suitable to their needs. Providing targeted support based on patient feedback was seen as being incredibly important – in one session it was identified that some patients felt anxious going out in cold or damp conditions in case they fell. Following this feedback, patients were taught how to manage their balance and strengthen their muscles:

"Something that we worked on with them during the session was being able to help them to stand back up if they were able to fall, and helping them with their balance, and standing up from a chair…All of those strength and conditioning things, we were able to boost their confidence, because they were able to do it in the session with each other, so they felt that they could go outside" (Senior Health and Wellbeing Coach 99681).

The importance of building social connections during extreme weather events was highlighted and some practical examples of this included a 'My Time to Chat Group' which offered a space to come build relationships with others:

'*Also, it gave them an opportunity to meet other people, form their social connections, which we know are really important for that age group' (Senior Health and Wellbeing Coach 99681).*

This also gave a place to come and get warm, especially for those who may not be able to afford to put the heating on at home, which may also help to reduce cold-related flare-ups of their conditions:

'Quite a lot of the patients that we see, especially in [*], may be struggling with their energy prices right now, so actually it's a really nice opportunity for them to find somewhere to be warm. Also, if they've got long-term health conditions, sometimes they feel flare ups from that cold weather, so giving them an opportunity to find somewhere that's a warm space is really great for them.' (Senior Health and Wellbeing Coach 99681).

To tackle the problem of missed appointments from patients not wanting to leave the house, the importance of following up was emphasised, to reduce patient anxiety about losing access to services:

'We would always communicate with them if they have missed a session via text or phone call, and then communicate with them when they come back in for that session around whether they're okay, just check in…' (Senior Health and Wellbeing Coach *99681*).

4.2 Supporting adaptation to climate change in Primary Care

There was consensus amongst participants that change was needed in the approach that primary care was taking towards protecting patients and staff from the impacts of climate change: *“I think the main one is being able to have a plan about this, recognise our vulnerable populations.” (Focus Group 3).* Many advocated for the need of a specific protocol that is actioned during extreme weather events:

“*Let's say in primary care you are in an area that really gets affected by flooding, or by something extreme, it would be nice if there is a contingency plan, some kind of organisational scheme within the practice, of what you have to do, how you have to approach it as a clinician. I think that this is also lacking” (Focus group 3).*

One suggestion was to have a standard operating procedure for prescribing to ensure patients were not missing vital medication due to extreme weather events:

“If they say all the power in village X has been wiped out and there are ten people in that village who are reliant on electricity just… I mean, we're all reliant on electricity, but there are, say, ten people who need it just to stay alive, then there needs to be provision for those ten people. Either to be transported to somewhere else where they can receive the right treatment, or have the back-up treatment to hand already” (Patient)

In relation to how this might look in practice, as part of a primary care consultation, a multilayered approach was advocated:

“I think there's different levels of it. You can have it down to the patient levels, so potentially checking on the patient more often, so you could have certain things that when we exceed this, there could be more water checks, where we're encouraging patients to drink more, take on more fluids. It could be basic things of asking people how they are, making sure layers are appropriate, taking body temperatures, etc., more often throughout that period, just to mitigate, or to be able to see if there's an issue with patients” (Climate Change Expert 33310).

It was noted several services already exist outside of the primary care settings that could support patients during extreme weather events. Taking a collaborative approach and sharing resources across the care networks was seen as helping to build capacity, which could help to bolster an overstretched service:

“I think a lot of the time we think that it sits with primary care, when actually there are a lot of things out in the community that we can signpost patients to that are going to help them just as much as coming into primary care and seeing a doctor” (Senior Health and Wellbeing Coach 99681).

One practitioner spoke about recruiting volunteers to drop goodwill packages round to patients who may be trapped at home, do a general welfare check or even training to lead a peer support programme following completion of the course themselves:

“We've almost got that eight-week behaviour programme that they go on, they meet peers, and then there's the opportunity afterwards to become a volunteer and to lead a programme afterwards, or to continue to offer a drop-in session” (Senior Health and Wellbeing Coach 99681).

Other practical suggestions to build capacity included the use of technology, in particular, telemedicine:

“The first one that I wanted to mention is maybe improvement of telemedicine. Of course, it will never replace a face-to-face consultation, but I think that if there was the ability to offer more video consultations, for example, they would offer more than a telephone one” (Focus group 3).

The data indicated that some groups will be more vulnerable due to socio-economic factors -*“We also don't take account of literacy problems because particularly the diseases, like head and neck cancer, that are very much related to poverty and social deprivation” (Focus Group 1).* A way to tackle this was through more outreach work with vulnerable groups with multimorbidities, to understand what their specific needs are during extreme weather events:

“… you can't just sit here and talk about how you're going to do it, you need to physically go into those groups and communities and immerse yourself in there. There are various groups for disabilities, for ethnic groups in different places, and it's just a case of finding them, going in there and saying what do we need to do to communicate to you? Are there cultural things? Are there things where women aren't able to do things because the hierarchy of the family, is there things where language is a barrier? Is there things where accessibility is a barrier? So, I think you've just got to go into them and find out and be open and see what do they need, and then try and do it.“ (Patient).

A recommendation was the need for a vulnerability ‘list’ which identifies those that will need targeted support during extreme weather events:

I was going to say have a list of the people you need to be at the top, but then extreme conditions can cause even the healthiest of people to have a major problem. It's going to be the ones who have, who already have, are vulnerable, considered vulnerable who need to be prioritised. There needs to be some sort of list of scale of priority so people are dealt with. (Focus group 1)

Discussion

This study explored perceptions of climate change and extreme weather events the context of primary care from people with multimorbidity, their informal carers, and health and social care professionals. Four themes were identified: (1) Perceptions of extreme weather in the context of England; (2) Perceptions of the impacts and implications of extreme weather events on the primary care system (3) Extreme weather events: impacts on patients, informal carers, and healthcare professionals and (4) Climate Resilience in Primary Care. Figure 2 provides a conceptual diagram which illustrates the key findings from this analysis. Together, these findings highlight a system already under strain, facing

additional risks from climate change, calling for a cultural shift in how climate change is framed in primary care, including outlining of conditions and processes for adaptation, improved climate–health literacy for the most vulnerable patients, clear operational guidance, an at risk register which triages need during extreme weather events, interdisciplinary collaboration, and equitable resource allocation.

Comparisons with existing literature

To our knowledge, this is the first study to examine the perceived impact of climate change and extreme weather events on multimorbidity within the context of primary care in England. The findings align with wider evidence that climate change exacerbates chronic disease burden. For example, Kjellstrom et al. (2010) showed that climate change affects cardiovascular and renal function (11), and other studies report higher mortality among people with diabetes in hot weather, and greater hospitalisation and death from chronic obstructive pulmonary disease during cold spells (14, 15, 16). Research consistently links temperature extremes to excess mortality and increased health service use (12, 17). Typically, climate-health research focuses on the impacts of extreme heat (23, 24) our participants, however, emphasised cold weather as a greater immediate concern than heat; we found unmet social care needs, travel disruption, and isolation during winter restrict service access and impact mental health, suggesting that adaptation strategies must be seasonally sensitive.

Our findings showing that extreme may not only worsen underlying conditions but also act as barriers to accessing care—leading to missed appointments, delayed treatment, and deteriorating condition management are in line with previous research which focuses on people with intellectual, sensory or physical disabilities (25). Cultural unawareness of climate–health links was evident with primary care, consistent with Safarty et al. (2016) (26), who found that many physicians lacked confidence in discussing climate change with patients, and a third were unaware of institutional strategies to address it. The present study shows that systemic challenges faced during extreme weather events impact the broader population, highlighting the need wider climate adaption planning, issues which have been also identified in the recent introduction of the 2025 Climate Adaptation framework for NHS operations in England (27).

Our findings also resonate with research on health inequalities. Chronic illness is disproportionately concentrated in socioeconomically deprived communities and climate change may amplify these inequities by compounding vulnerabilities such as fuel poverty, poor housing, digital exclusion, and limited mobility (4, 5). We found problems with affording heating bills for the most vulnerable leads to a potential for worse health outcomes, an issue which is becoming increasingly more common (28). We also found that people with multimorbidity are more likely to feel socially isolated during extreme weather events, due to practical restrictions in being able to leave the house and fear of trips of falls. To date, very little research has examined this, and it is not clear whether there is causal link between climate change and loneliness, or whether both have overlapping moderators which increases the risk of both, such as having pre-existing health conditions (29). Previous research has found differences in climate adaptation between gender, ethnicity and age, particularly in relation to experiences of loneliness

(30, 31, 32) yet we did not find any references to this within our data, despite a broad range of gender and ages included. More research is needed to elucidate the relationship between climate change, loneliness and individual level factors, especially as loneliness has been found to worsen chronic conditions, which puts those with multimorbidity at even more risk during extreme weather events (33, 34). Lastly, while participants described promising adaptation strategies, many were dependent on individual patient initiative, which may be unrealistic for those facing structural barriers (35). This reflects evidence that climate-related disruptions can worsen disparities by reducing access to both clinical and social care (6, 7). Further research should examine how climate change affects marginalised groups such as people experiencing homelessness or severe mental illness, who were underrepresented in this study.

Strengths and limitations

We used a diverse sample encompassing patients, carers, and professionals, and the embedding of public and patient involvement throughout, which enhanced the authenticity and relevance of the findings. The use of reflexive thematic analysis enabled multiple perspectives to enrich interpretation. However, limitations should be acknowledged. Few participants were from the most socioeconomically deprived backgrounds, and highly marginalised groups were underrepresented, despite likely heightened vulnerability to climate impacts. Limited cultural salience of climate change may also have constrained engagement, excluding individuals less able or willing to discuss the topic. Future studies should adopt tailored recruitment strategies to capture these perspectives and ensure equity in adaptation planning.

Implications for practice

Most existing literature on climate change and primary care has centred on reducing healthcare-related carbon emissions in pursuit of the UK's 2050 net zero goal. While vital, this emphasis has overshadowed the equally urgent need to adapt primary care to protect health from climate risks. Our findings show that climate change is not yet seen as a salient issue in primary care, yet it is already shaping the health and care experiences of people with multimorbidity and their carers. To build resilience, climate change must be recognised as a health systems challenge. Primary care requires proactive adaptation through clear guidance, improved infrastructure, vulnerability registers, outreach to disadvantaged groups, and cross-sector collaboration with community services. Crucially, adaptation must be equity-focused, co-designed with patients and communities, and embedded in everyday planning to safeguard continuity of care while preventing further widening of health inequalities.

Abbreviations

AIM: Artificial Intelligence for Multiple Long-Term Conditions

AI: Artificial Intelligence

CNC: Cross NIHR Collaboration

COREQ: Consolidated Criteria for Reporting Qualitative Research

GP: General Practitioner

IMD: Index of Multiple Deprivation

MLTC: Multiple Long-Term Conditions

NHS: National Health Service

NIHR: National Institute for Health and Care Research

NVivo: QSR NVivo qualitative data analysis software

SPRC: School for Primary Care Research

UK: United Kingdom

Declarations

Ethics approval and consent to participate: This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the University of Southampton Research Integrity and Governance Team and Faculty of Medicine Ethics Committee (ERGO94370.A3). All participants received a detailed study information sheet and provided informed consent prior to participation. Participation was voluntary, and participants were informed of their right to withdraw at any time without giving a reason. Interviews and focus groups were conducted online, audio-recorded with permission, transcribed verbatim, and anonymised. All data were handled confidentially and stored securely in accordance with data protection regulations.

Consent for publication: Not applicable

Availability of data and materials: The qualitative data generated and analysed during this study (interview and focus group transcripts) are not publicly available due to their sensitive nature and the risk of participant identification. Data contain detailed personal accounts from individuals living with multimorbidity, informal carers, and health and social care professionals, and sharing these data would not be consistent with the terms of ethical approval or participants' consent. Anonymised extracts supporting the findings are included in the article. Further information about the data may be available from the corresponding author on reasonable request, subject to ethical approval and data governance requirements.

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Author contributions

HDM, PL and MS conceived the idea, GS, RT and LS prepared all study materials and collected data. JL provided lived experience expertise and supported recruitment. LS analysed the data and prepared the first version of draft. All authors contributing to the final version of the manuscript.

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36. Supplementary Table. 1 The Consolidated Criteria for Reporting Qualitative Research (COREQ).
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Figures

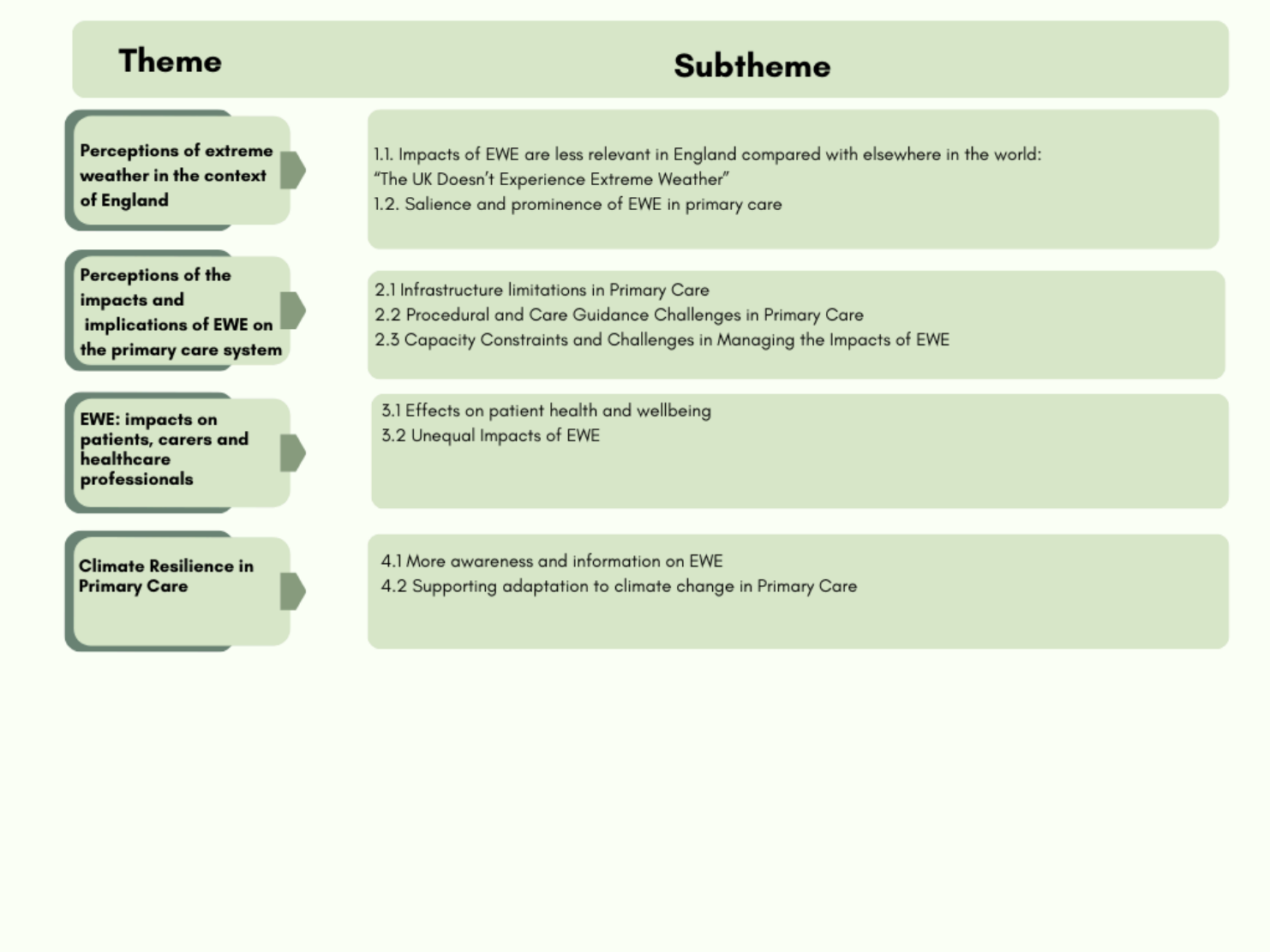

Figure 1

Themes and subthemes for all analysis focused on the impact of extreme weather events on primary care for people with chronic illness, healthcare professionals and informal carers

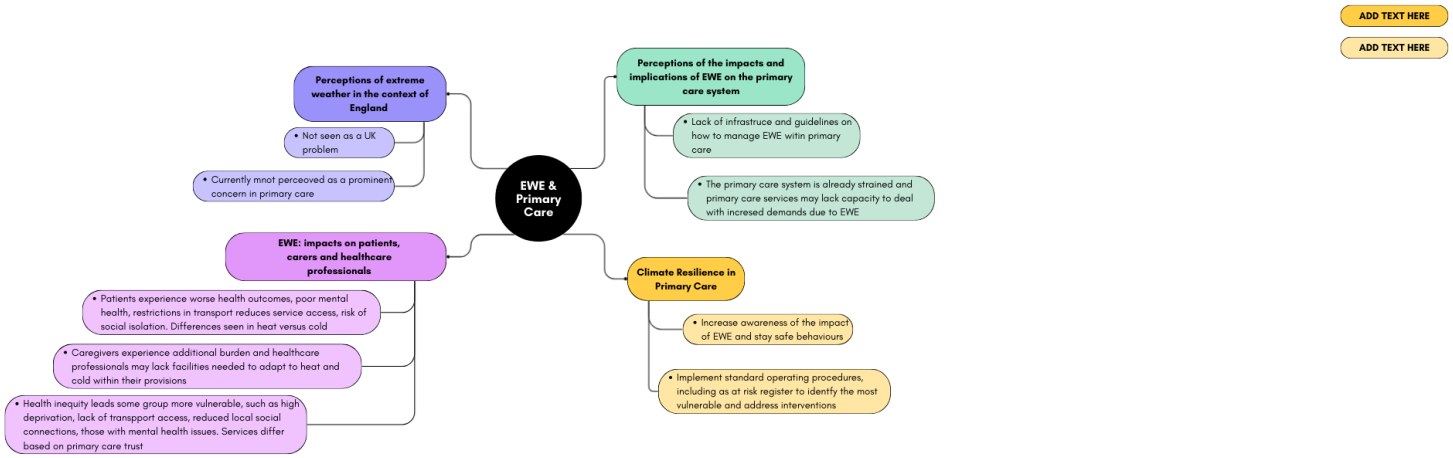

Figure 2

Conceptual diagram of all four themes in relation to perceptions of extreme weather events and primary care

Supplementary Files

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