UK Health Security Agency

Adverse Weather and Health Plan

Supporting evidence

2023 to 2024

Contents

1. Introduction

This document collates the activities and scientific evidence that underpin the UK Health Security Agency's (UKHSA) Adverse Weather and Health Plan (AWHP) on the impacts of adverse weather events and climate change on health.

This summary presents evidence from which best practice recommendations can be developed. The AWHP and shared documents (including this supporting evidence) will be updated on an annual basis to ensure that the plan and guidance are supported by a strong and reliable evidence base collected from academia and real-world examples.

Please note, the next iteration of the supporting evidence will contain information from the UKHSA Health Effects of Climate Change (HECC) report (to be published in 2023) as well as a chapter on the policy and legal commitments related to adverse weather and health.

1.1 Why is an adverse weather and health plan needed?

1.1.1 Policy context

Global temperatures are increasing in the UK and across the globe. With fluctuating temperatures and increasing numbers of adverse weather events, the UK government is acting to reduce the impact of the changing weather on the health of the population in England (1).

UKHSA is the UK government agency responsible for improving the health security of the public against various health threats, working in partnership at local and national levels, by providing intellectual, scientific and operational leadership, including in response to adverse weather events.

1.1.1.1 Climate Change Act (2008), Climate Change Risk Assessment (CCRA) and National Adaptation Programme (NAP) for the UK

Under the Climate Change Act (2008) the UK government has a statutory obligation to produce a national Climate Change Risk Assessment (CCRA) every 5 years. The first UK CCRA (CCRA1) was published in 2012 and informed the first National Adaptation Programme (NAP) in 2013. The NAP sets out the actions that the UK government and other agencies, public sector bodies or devolved governments will take to adapt to the challenges of climate change in the UK for the next 5 years.

Of the 6 highest priority risks identified by the second CCRA (CCRA2) (2) for the UK, published in 2017, 4 were related directly to public health and the broader health sector (see Figure 1).

Figure 1. The Adaptation Sub-Committee's assessment of the top 6 areas of inter-related climate change risks for the UK (2)

Accessible text equivalent of Figure 1. The Adaptation Sub-Committee's assessment of the top 6 areas of inter-related climate change risks for the UK (2)

More action needed:

Flooding and coastal change risks to communities, businesses and infrastructure – high risk.

Risks to health wellbeing and productivity form high temperatures – high risk.

Risk of shortages in the public water supply and for agriculture, energy generation and industry – medium risk, rising to high risk in future.

Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity – medium risk, rising to high risk in future.

Risks to domestic and international food production and trade – medium risk, rising to high risk in future.

Research priority:

New and emerging pests and diseases and invasive non-native species, affecting people, plants and animals – medium risk, rising to high risk in future.

End of text equivalent

The Technical Report for the third CCRA3 (CCRA3) (3) presented strong evidence that under warming scenarios of 1.5°C to 2°C, the UK will be subject to a range of significant and costly impacts unless significant further action is taken now. It identified 61 climate risks across multiple sectors of our society alongside a wide range of potential climate impacts on health and productivity, affecting households, businesses and public services. Impacts range from a deterioration in soil health and agricultural productivity to impacts on water availability and alternative energy supply. Eleven of these risks relate directly to public health and the broader health sector (Table 1) and 7 score the highest urgency (3).

Table 1. CCRA3 health-related risks and opportunities by urgency score (3)

Risk	Description of risks and opportunities	Urgency score
H1	Risks to health and wellbeing from high temperatures	More action needed
H3	Risks to people, communities and buildings from flooding	More action needed
H4	Risks to people, communities and buildings from sea level rise	More action needed
H6	Risks and opportunities from summer and winter household energy demand	More action needed
H8	Risks to health from vector-borne diseases	More action needed
H12	Risks to health and social care delivery	More action needed
ID9	Risks to public health from climate change overseas	More action needed
H2	Opportunities for health and wellbeing from higher temperatures	Further investigation
H7	Risks to health and wellbeing from changes in air quality	Further investigation
H9	Risks to food safety and food security	Further investigation
H10	Risks to health from poor water quality and household water supply interruptions	Further investigation

Evidence indicates that the costs of climate change to the UK are already high and increasing. For 8 of the 61 climate risks detailed by CCRA3, UK-wide economic damages are estimated to exceed £1 billion per annum by 2050 under a 2°C-warming scenario.

The CCRA also includes a review of costs and benefits of adaptation policies, and concludes that many early adaptation investments are highly effective and deliver high value for money. These include early weather warning systems, climate-resilient infrastructure and improving our evidence base for best practice. Adaptation also often leads to important co-benefits. As well as reducing potential losses from climate change, it often generates direct economic gains or leads to social or environmental benefits (3).

1.1.1.2. National Planning Policy Framework (NPPF)

The National Planning Policy Framework states that local plans should take a proactive approach to mitigating and adapting to climate change, considering the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures (4).

The Planning Practice Guidance provides detailed guidance for developers and planners regarding flood risk assessment (5), and the Environment Agency is a statutory consultee to all applications for development that could be at current risk of flooding from rivers and the sea or are in a critical drainage area. It is important to note that guidance regarding climate change allowances for new development includes sensitivity testing up to a + 2°C temperature scenario (6), (7).

Flooding and coastal erosion cannot be eliminated, and many landscapes have evolved based on regular flood and erosion patterns. The UK government's objective is to manage floods and coastal erosion to save lives, better protect communities and support economic growth. There is a need to prepare for climate change through timely action to manage flood and coastal risk. This can help reduce costly impacts later and manage the risks to people's homes and businesses across the country.

1.2 What is the AWHP?

The AWHP delivers our commitment under the National Adaptation Programme to develop a single plan that brings together and improves existing guidance on weather and health. It builds on existing measures taken by government, its agencies, the NHS and local authorities, to protect individuals and communities from the health effects of adverse weather and to build community resilience.

The plan outlines the key areas where the public sector, independent sector, voluntary sector, health and social care organisations and local communities can work together to maintain and improve integrated arrangements for planning and response to deliver the best outcomes possible during adverse weather. The plan brings together and builds on the previous Heatwave Plan for England, first published in 2004, and the Cold Weather Plan for England, first published in 2011.

The plan is underpinned by:

- an evidence collection, published in parallel, that underlines the activities and scientific evidence that support the plan
- guidance and support materials
- the weather-health alerts (heat and cold) developed in collaboration with the Met Office

The AWHP will address the various direct and indirect health risks identified in CCRA2 (2) and the CCRA3 published in 2021 (3). See Independent Assessment of UK Climate Risk for full list. Examples of risks to health include:

- risks to health and wellbeing from high temperatures
- impact on health from sea level rise and flood events, poor housing and insulation
- pressures on household energy demand

1.3 Methodology

This document draws on and incorporates qualitative and quantitative data from existing literature on the health effects of heatwaves, cold weather and flooding. This includes studies conducted by UKHSA and its partners (including systematic literature reviews; reviews of interventions, attitudes and behaviours; stakeholder engagement outputs) and previous national weather plans, associated evidence, evaluation and guidance documents. The documents that have been reviewed include:

- Cold Weather Plan for England (8)
- Cold Weather Plan – Making the Case: Why long-term strategic planning for cold weather is essential to health and wellbeing (9)
- Cold Weather Plan for England evaluation (10)
- Policy Innovation Research Unit (PIRU) Evaluation of the Cold Weather Plan (11)
- Cold Weather Plan Seminar (unpublished)
- Heatwave Plan for England (12)
- Heatwave Plan for England – Making the Case: The impact of heat on health – now and in the future (13)
- Policy Innovation Research Unit (PIRU) Evaluation of the Heatwave Plan for England (14)
- Flooding and Mental Health Guidance (15)

The AWHP is part of the government's response to ensure that the UK is resilient to climate change. Therefore, this evidence document also considers the changing risks and population responses as highlighted in the:

- second UK Climate Change Risk Assessment 2018 (2)

- third UK Climate Change Risk Assessment 2021 (3)
- second UK National Adaptation Programme 2018 (16)
- National Risk Register 2020 (17)

A number of studies have been commissioned to support this document and helped to close evidence gaps. These have been appropriately cited throughout this document.

2. Health effects of adverse weather

This chapter provides an overview of the health effects of adverse weather. Firstly, it is important to differentiate between the specific meanings of the terms ‘extreme weather’ and ‘adverse weather’ as they are used throughout this document.

‘Adverse weather’ describes weather events (that is, hot and cold weather, flooding from heavy rain, snowfall) that impact on public health. The conditions at which risks to health start to increase are not necessarily severe or extreme.

‘Extreme weather’ relates to exceptionally adverse and unexpected weather conditions for the season and location.

The health effects of adverse weather events are well documented, as these have become more intense and frequent due to climate change (1). Heatwaves in England have resulted in significant excess mortality in recent years, and evidence suggests a risk of acute mortality increases at high temperatures in all populations (18). Whilst temperatures are expected to rise, the risk from cold weather will continue to contribute to significant excess mortality across England for the foreseeable future.

As these events place greater pressure on the health and social care sector, it is necessary to ensure adequate preparations are in place for their services to reach those most vulnerable to adverse weather events.

2.1 Cold

Mortality is significantly higher during the winter months in the UK (December to March) when compared to other seasons. On average there are around 35,000 excess winter deaths (EWDs) each year in England and Wales, but this does tend to fluctuate, sometimes by a large amount. The CCRA3 stated that the burden of ill-health from cold weather and cold homes remains significant in the UK and is a priority for public health and local government action (3), (19). Whilst climate change is likely to reduce the level of cold-related mortality overall, numbers are predicted to remain high until the end of the century (20), (21).

As well as the significant rise in deaths, the winter period also sees a substantial increase in illnesses.

As will be detailed in the next section, the reasons more people die in winter relative to other times of the year are complex and interlinked, including:

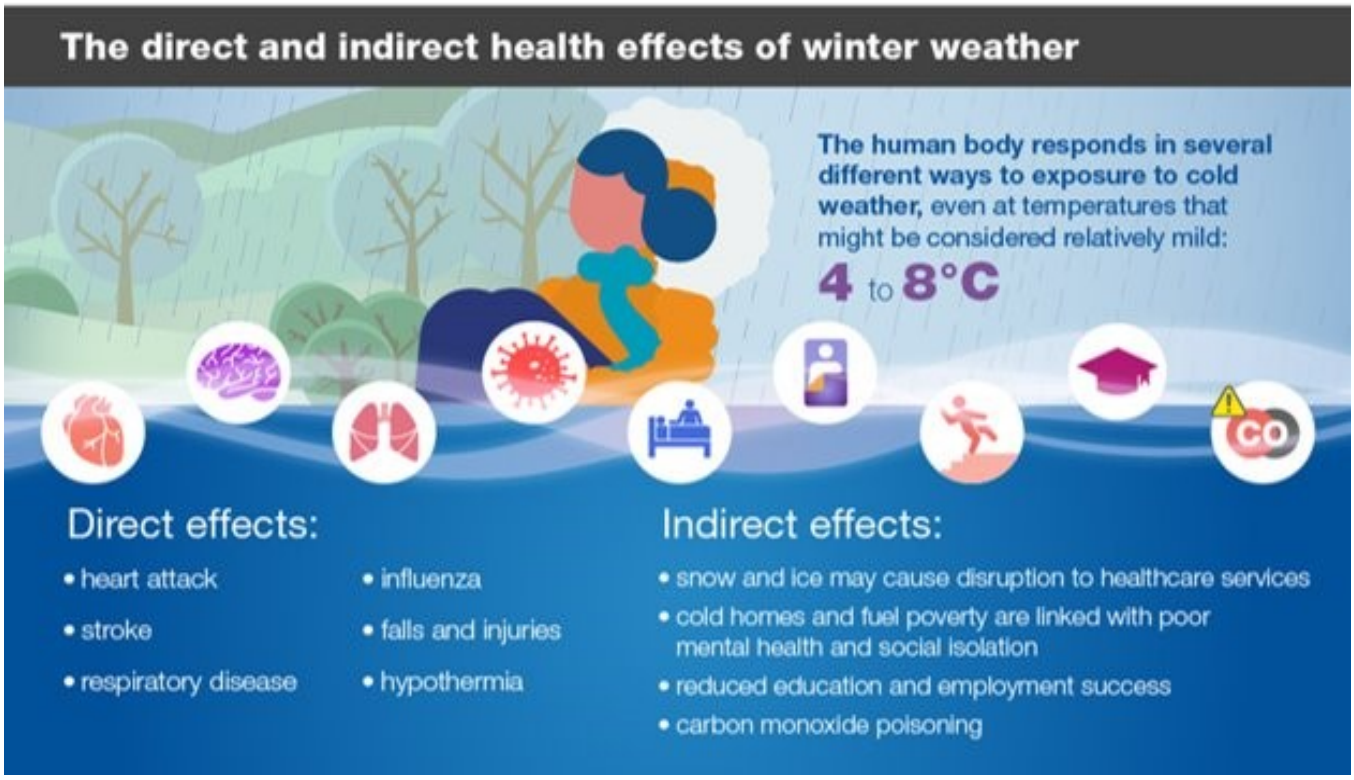
- poor quality housing, particularly cold homes
- circulating infectious diseases, particularly flu and norovirus
- physical hazards such as snow and ice
- health inequalities

2.1.1 Health effects from cold weather

There is a strong evidence-base on the risk to health from cold weather and about the effects of cold weather on health being predictable and mostly preventable.

Cold temperatures and winter weather have direct and indirect effects on health (see Figure 2).

Figure 2. The direct and indirect health effects of winter weather (22)



Accessible text equivalent of Figure 2. The direct and indirect health effects of winter weather (22)

The human body responds in several different ways to exposure to cold weather, even at temperatures that might be considered relatively mild: 4°C to 8°C.

Direct effects are:

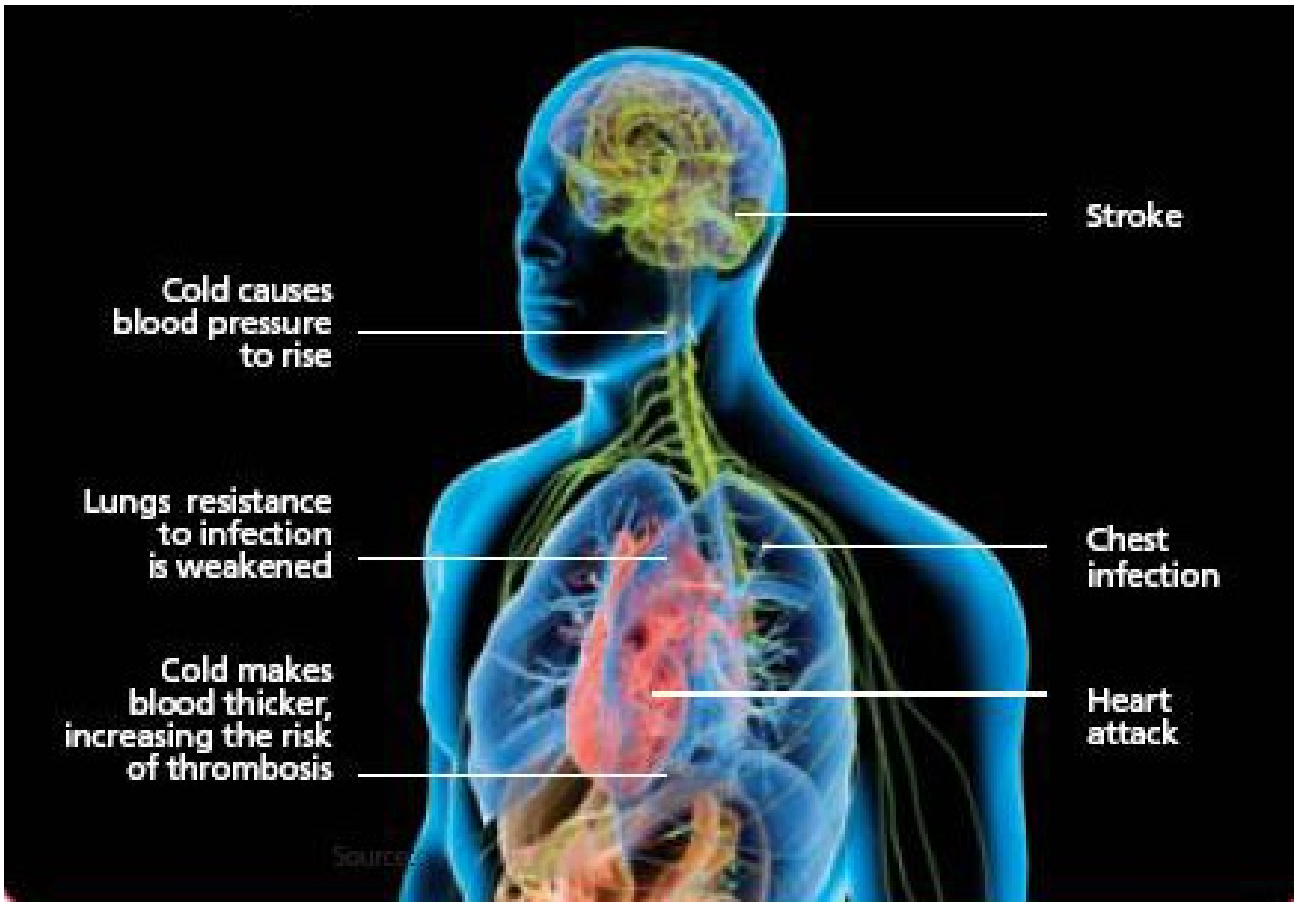
- heart attack
- stroke
- respiratory disease
- influenza
- falls and injuries
- hypothermia

Indirect effects are:

- snow and ice causing disruption to healthcare services
- cold homes and fuel poverty which are linked with poor mental health and social isolation
- reduced education and employment success
- carbon-monoxide poisoning

End of text equivalent

Figure 3. Direct health impacts of cold weather



Accessible text equivalent of Figure 3. Direct health impacts of cold weather

Heart attack.
Stroke.
Chest infection.
Cold causes blood pressure to rise.
Lungs resistance to infection is weakened.
Cold makes blood thicker, increasing the risk of thrombosis.

End of text equivalent

Indirect effects include mental health effects from depression, reduced educational and employment attainment as well as risk of carbon monoxide poisoning from poorly maintained or poorly ventilated boilers, and cooking and heating appliances with combustion sources.

Although exposure to extreme cold can kill directly through hypothermia, respiratory and circulatory (lung and heart) conditions, dementia and Alzheimer's are the leading causes of cold-related illness and death. People with dementia and Alzheimer's do not readily recognise that they are feeling cold.

An increase in cold weather-related deaths is observed very soon after the onset of cold weather. These mortality rates can remain raised for up to 4 weeks after the initial cold snap. Deaths caused by cardiovascular conditions are observed first, followed by deaths from stroke and then respiratory conditions. It is important to note that negative health effects start at relatively moderate outdoor mean temperatures of 4°C to 8°C. Although the risk of death increases as temperatures fall, the higher number of days at moderate temperatures in an average winter means that it is at these more moderate temperatures that the greatest health burden occurs. Therefore, although action to protect health on the coldest days remains important, shifting the emphasis to year-round planning and all-winter action is essential to protect those most vulnerable to the impacts of cold weather-related health risks and to address winter pressures in the NHS and social care. This aligns closely with the NICE guidance on 'Excess winter deaths and morbidity andthe health risks associated with cold homes'.

2.1.1.1 Cardiovascular disease

Exposure to cold temperatures increases blood pressure and risk of blood clotting in healthy people who are sedentary and wearing minimal clothing. Evidence suggests the threshold at which these effects start to occur is 18 (+/-0.5)°C; effects include increases in erythrocyte count and fibrinogen, both of which are important for thrombus (blood clot) formation and rises in blood pressure (23). If clots occur in the heart and brain vessels, they can lead to heart attack and stroke. High blood pressure increases the risk of heart attack, heart failure, kidney disease, stroke or dementia.

2.1.1.2 Respiratory illnesses

When the weather is cold, people tend to spend more time indoors where they are more likely to be in close proximity to one another. This can aid the spread of infection.

Exposure to low indoor or outdoor temperatures suppresses the immune system, diminishes the lungs' capacity to fight off infection and increases constriction of the airways which stimulates mucus production. These factors are associated with an increased risk of bronchitis and pneumonia.

It is estimated that GP visits for respiratory illness increase by up to 19% for every 1°C drop below 5°C of the mean temperature (24).

When a house is damp as well as cold, mould is likely to occur. This increases the risk of respiratory illness, particularly asthma. Home energy efficiency measures have been shown to significantly reduce absence from school in children due to asthma, and recurrent respiratory infections (25).

A recent study found that older people who were living in fuel-poor households, or who did not own their home, had significantly worse respiratory health (measured by peak expiratory flow rates) (26).

2.1.1.3 Influenza ('flu')

Most cases of flu in the UK tend to occur during an 8 to 10 week period during the winter. For most healthy people, seasonal flu is an unpleasant but self-limiting disease that they recover from within a week. Flu in an older person, a pregnant woman or someone with an underlying condition (particularly chronic respiratory or cardiac disease or those who are immunosuppressed) may be more severe. Seasonal flu vaccinations can provide protection and are offered, free of charge, to those at risk. To see the full list, please visit the Annual flu programme.

2.1.1.4 Other infectious diseases

As well as influenza, cold weather is associated with an increase in the prevalence of other respiratory infections, such as respiratory syncytial virus. Other infectious diseases, such as bacterial infections and viral gastroenteritis (winter vomiting disease), also have a seasonal pattern and may increase in winter.

2.1.1.5 Pregnancy

Pregnant women at risk of high blood pressure may be affected by temperature extremes. Low temperatures are known to raise blood pressure and may exacerbate maternal hypertension. There is some evidence for an association with low temperatures in late pregnancy and pre-eclampsia (27).

Several reviews have assessed the evidence regarding the impact of ambient temperature and birth outcomes. There is some evidence that low temperatures increase the risk of pre-term birth and stillbirth (28 to 31).

2.1.1.6 Low weight gain in infants

Studies demonstrate that there is a relationship between living in cold homes and poor infant weight gain, attributed to the fact that children living in colder homes need greater calorific intake to fulfil growth potential (32).

2.1.1.7 Hypothermia

Deaths directly caused by hypothermia represent only a small proportion of the total amount of excess winter deaths. Hypothermia is a potentially fatal lowering of core body temperature caused by exposure to cold. One study looking at patients over 65 years attending emergency departments found peaks in incidence of hypothermia coinciding with periods of cold weather. More than one third of the 5% of patients with core body temperature below 35ºC died. The majority of patients lived in relatively deprived postcodes (33).

2.1.1.8 Falls and injuries

Winter weather and cold homes affect mobility and increase the likelihood of falls and injuries – especially in frail and elderly people – because:

- symptoms of arthritis worsen in cold, damp houses
- strength and dexterity decrease as temperatures drop, increasing the risk of non-intentional injuries
- snow and icy conditions increase the risk of trips and falls outdoors (34)

In England, the number of emergency hospital admissions – due to falls on snow and ice – varies considerably from one winter to another. A recent study showed that the weekly rate of emergency hospital admissions for falls on snow and ice is inversely related to the mean weekly temperature (35).

2.1.1.9 Mental and social health and wellbeing

Damp, cold housing is associated with an increase in mental health problems, such as depression and anxiety (9). Living in these homes can affect people's ability to go about their daily lives. Some become socially isolated as they are reluctant to invite friends or family to a cold house, while others seek refuge elsewhere as an alternative to staying in.

Cold housing can also negatively affect children's emotional wellbeing and resilience. It can be difficult for children to study or do homework in a cold house, which affects educational and long-term health and work opportunities. Studies have suggested that more than 1 in 4 adolescents living in cold housing are at risk of developing mental health problems, compared with one in 20 adolescents who have always lived in warm housing (36).

It is difficult to measure a direct increase in demand on mental health services due to cold weather. However, there is an established association between common mental disorder (CMD) – including depression and anxiety – and cold, damp homes.

A questionnaire linking proxies for fuel poverty to CMD showed that 10% of those with CMD reported not being able to keep their home warm enough in winter, compared with just 3%

without CMD. Of those with CMD, 15% said they had mould in their home, compared with 8% with no CMD (37).

2.1.1.10 Indoor air quality and cold weather

Emissions to air occur from all aspects of lives lived indoors. These include emissions from the fabric of buildings themselves, through to sporadic emissions from activities such as cooking, cleaning, the use of heating systems, fires and solid fuel stoves. The weather can also play a role in the composition of indoor air quality. For example, the increased use of a wood-burning fireplace in the winter combined with infrequent ventilation (opening of windows for air circulation) can lead to higher concentrations of carbon monoxide (CO), NOx (both nitrogen oxide and dioxide) when compared to the same houses in the summer. There are concentration thresholds for many air pollutants that can impact human health when exceeded.

Cases of CO poisoning increase in winter months (38), (39). During cold weather, people may use malfunctioning or inappropriate appliances to heat their homes or may also try to reduce ventilation. While the number of hospitalisations and deaths from unintentional non-fire related CO poisoning have declined over time, over the past 5 years (2017 to 2021) there were still around 20 deaths a year in England and Wales (40).

Heating and cooking appliances (such as those using oil, gas, coal or wood), especially gas boilers, that are incorrectly installed, poorly maintained, malfunctioning, poorly ventilated, unflued or with blocked flues are the major sources of carbon monoxide exposure and poisoning in the home (39), (41).

The Smoke and Carbon Monoxide Alarm (England) (Amendment) Regulations 2022 (42) require private sector landlords and registered providers of social housing to install at least one smoke alarm on every floor of a premises used as living accommodation, and a carbon monoxide alarm should be installed in any room which is used as living accommodation containing a fixed combustion appliance (excluding gas cookers). The landlord must make sure the alarms are in working order at the start of each new tenancy and that they are repaired or replaced once they are found to be faulty.

Exposure to CO may be acute or chronic (43). It can have effects on the cardiovascular and neurological systems and may lead to death (44). Symptoms of CO poisoning include:

- headache
- dizziness
- confusion
- disorientation
- memory loss
- fainting
- coma
- death

It can also cause harm to an unborn child.

2.1.2 Effects on healthcare services

The impact of cold weather on the health sector includes effects on:

- hospital and emergency services
- primary, community and social care

2.1.2.1 Impact on hospitals and emergency services

Evidence shows that there is an increase in hospital admissions from cold-related illnesses as temperatures fall. Admissions for chronic obstructive pulmonary disease increase as temperatures fall, particularly in those most socio-economically deprived (45).

Hospitals and social care commonly face winter pressures. These often result from a high demand for beds and difficulties in discharging patients. This may be compounded by staff shortages due to illness.

Cardiovascular, respiratory and infectious diseases with a seasonal increase, as well as weather-related accidents, contribute to raising the number of admissions. Prolonged in-patient episodes can occur, either due to medical complications or a delay in discharging patients because of lack of suitable accommodation.

Extreme weather can also have an impact on the number of ambulance call outs and response times. It has been suggested that for every reduction of air temperature by 1°C there is a reduction of 1.3% in performance (measured by response rate and response times). This may be related to the increase in volume of emergency calls and potentially adverse road conditions (46).

2.1.2.2 Impact on primary, community and social care

Increased levels of illness due to cold weather can put a strain on local NHS services such as general practices and hospitals. There is evidence that cold weather may prevent people from accessing these services.

In 2018, the English Housing Survey found that 2.6 million (11%) homes in England have at least one category 1 hazard (that is, the most serious harm outcome as defined by the health and safety rating system (HHSRS) for England and Wales) for excess cold (47). The total repair cost to bring all these dwellings to an acceptable level is estimated to be around £9.8bn wherein the cost to the NHS per year to treat people that are affected by poor housing is estimated at £1.4bn (47). The costs to the NHS in the report are based on first-year treatment costs only and do not include additional spending by social services, or economic losses through absences from work (48). Total costs to the NHS and the country are unknown.

Although average temperatures are expected to increase, cold is likely to remain a significant public health problem. Hard-to-heat homes are the major determinant of the burden of cold-related mortality and morbidity. There is only a minor opportunity from a warming climate in reducing cold-related deaths. This is because pre-existing issues such as poor housing, fuel poverty and an ageing population will continue to generate a significant vulnerable population to cold-weather harms in the future (16).

2.1.3 Excess winter mortality

The Office for National Statistics (ONS) estimated that 28,300 EWDs occurred in England and Wales in winter 2019 to 2020 (49). EWDs are the observed total number of deaths in winter (December to March) compared to the average of the number of deaths over the rest of the year. EWDs are not just deaths of those who would have died anyway in the next few weeks or months due to illness or old age. There is strong evidence that some of these winter deaths are indeed ‘extra’ and are related to cold temperatures and living in cold homes (23) as well as infectious diseases such as influenza. In the recent past, the rate of winter deaths in England was twice the rate observed in some northern European countries, such as Finland (50). Even with climate change, cold-related deaths will continue to represent the biggest weather-related cause of mortality (26).

2.1.3.1 Methodology and findings

The ONS calculates excess winter mortality each year. This is calculated as winter deaths (deaths occurring in December to March) minus the average of non-winter deaths (deaths occurring in the preceding August to November plus deaths occurring in the following April to July divided by 2). This estimate is published on an annual basis in November each year and is available by region and age-group.

The number of extra deaths occurring in winter depends on temperatures, levels of disease (particularly influenza) in the population and other factors.

An extension of this calculation is the Excess Winter Deaths Index. This takes the number of EWDs as calculated by ONS and divides it by the average of non-winter deaths on a 3-year rolling basis. This is published by age-group at local authority level, allowing comparison between local authorities and examination of trends over time.

Both methods use all-cause mortality to estimate the impact of winter or seasonal mortality. With these methods it is difficult to determine the relative impacts of underlying causes such as influenza or extremes of temperature. Researchers have developed methods to quantify the explicit effect of weather factors (mainly ambient temperature) by assessing changes in the daily number of health events in relation to day-to-day fluctuations in the weather and adjusting for other potential explanations for changes in mortality (such as circulating infections or air pollution). These time series studies indicate that there were around 41,000 cold-related deaths in 2000 (51).

2.1.3.2 NICE guidelines on excess winter mortality

NICE guideline (NG6) makes recommendations on how to reduce the risk of death and ill health associated with living in a cold home. The aim is to help meet a range of public health and other goals which include:

- reducing preventable excess winter death rates
- improving health and wellbeing among vulnerable groups
- reducing pressure on health and social care services
- reducing 'fuel poverty' and the risk of fuel debt or being disconnected from gas and electricity supplies (including self-disconnection)
- improving the energy efficiency of homes

Improvements to make homes warmer may also help reduce unnecessary fuel consumption (although where people are living in cold homes because of fuel poverty their fuel use may increase). In addition, such improvements may reduce absences from work and school that result from illnesses caused by living in a cold home.

The health problems associated with cold homes are experienced during 'normal' winter temperatures, not just during extremely cold weather. An increase in death rates due to a drop in temperature varies across England but can happen when temperatures drop below about 6°C.

Year-round planning and action by many sectors is needed to combat these problems. The guideline outlines a role for health and other practitioners in:

- prioritising which homes are tackled first
- shaping and influencing decisions about how homes are improved
- highlighting the importance of research, implementation and evaluation

A wide range of people are vulnerable to the cold. This is because of:

- a medical condition, such as heart disease
- a disability that, for instance, stops people moving around to keep warm, or makes them more likely to develop chest infections
- personal circumstances, such as being unable to afford to keep warm enough

In this guideline, the term "vulnerable" refers to a number of groups including:

- people with cardiovascular conditions
- people with respiratory conditions (in particular, chronic obstructive pulmonary disease and childhood asthma)
- people with mental health conditions
- people with disabilities

- older people (65 and older)
- households with young children (from new-born to school age)
- pregnant women
- people on a low income

The guideline is for commissioners, managers and health, social care and voluntary sector practitioners who deal with vulnerable people who may have health problems caused, or exacerbated, by living in a cold home. It will also be of interest to clinicians and others involved with at-risk groups, housing and energy suppliers. In addition, it may be of interest to members of the public.

NICE has also published a quality standard that covers reducing the health risks (including preventable deaths) associated with cold homes. It includes identifying people at risk who are particularly vulnerable to the cold, such as young children, older people and people with cardiovascular disease or mental health problems. It describes high-quality care in priority areas for improvement. It also describes high-quality care in priority areas for improvement helping to prevent excess winter deaths and illness associated with cold weather.

2.2 Heat

Extreme heat is increasing worldwide at an unprecedented rate (52), with a 6-fold increase of concurrent heatwaves since the 1980s compounding the impacts of other natural hazards, such as drought, wildfire and flash flooding (53).

The Intergovernmental Panel on Climate Change (IPCC) assessed with very high confidence that “globally, population exposure to heatwaves will continue to increase with additional warming, with strong geographical differences in heat-related mortality” unless further action is taken (54). Increasing temperature extremes are a growing health risk due to rapid urbanisation and demographic changes in countries with ageing populations. Therefore, actions are needed to adapt urban infrastructure – particularly housing – and to ensure that planning for such events takes account of those groups of people especially vulnerable to the health impacts of hot weather.

Climate change is already causing warmer temperatures in the UK. All of the warmest years on record in the UK have occurred since 2002. In July 2022 temperatures exceeded 40°C for the first time on record, and UKHSA and the Met Office issued the first Level 4 Heat-Health Alert.

This chapter presents the strong evidence base on the risks to health from excess heat. Evidence from the UK CCRA3 suggests that heatwaves remain an under-managed risk and will impact population health and health system delivery. Thus, heat is a priority risk for urgent action for England (3).

2.2.1 Health effects from hot weather

Summertime can be an enjoyable time of year; however, hot weather can be associated with an increased risk to health. Hot weather increases the risk of heart attacks, strokes, lung illnesses and other diseases. There are some groups, such as older people, young children and people with some long-term medical conditions who can be particularly vulnerable to the effects of hot weather. Many of the harms linked to heat exposure are preventable if a few simple actions are taken.

The body normally cools itself using 4 different physiological mechanisms:

- radiation in the form of infrared rays
- convection via water or air crossing the skin
- conduction by a cooler object being in contact with the skin
- evaporation of sweat

Increasing temperatures in excess of 25ºC are associated with excess heat-related deaths, with higher temperatures associated with greater numbers of excess deaths; at 27ºC or over, those with impaired sweating mechanisms find it especially difficult to keep their bodies cool.

When the ambient temperature is higher than skin temperature, the only effective heat-loss mechanism is sweating. Therefore, any factor that reduces sweating such as dehydration, lack of breeze, tight-fitting clothes or certain medications can cause the body to overheat.

Thermoregulation, which is controlled by the hypothalamus, can be impaired in the elderly and the chronically ill, and potentially in those taking certain medications, rendering the body more vulnerable to overheating. Young children produce more metabolic heat, have a decreased ability to sweat and have core temperatures that rise faster during dehydration

Babies and children will sweat less than healthy adults, and this will reduce their ability to cool down during hot weather, particularly if they are exercising or being active. This puts babies and children at higher risk of overheating and developing a heat-related illness as well as making any existing illnesses worse. Babies and children need to be carefully watched during hot weather (57).

The main causes of illness and death during a heatwave are respiratory and cardiovascular diseases. Additionally, there are specific heat-related illnesses that can affect the general population. These include:

- heat cramps – caused by dehydration and loss of electrolytes, often following exercise
- heat rash – small, raised spots, an itchy feeling and mild swelling
- heat oedema – mainly in the ankles, due to vasodilation and retention of fluid

- heat syncope – dizziness and fainting, due to dehydration, vasodilation, cardiovascular disease and certain medications
- heat exhaustion (more common) occurs as a result of water or sodium depletion, with non-specific features of malaise, vomiting and circulatory collapse and is present when the core temperature is between 37ºC and 40ºC – left untreated, heat exhaustion may evolve into heatstroke
- heatstroke can become a point of no return whereby the body's thermoregulation mechanism fails, leading leads to a medical emergency with symptoms of confusion, disorientation, convulsions, unconsciousness, hot dry skin and core body temperature exceeding 40ºC for between 45 minutes and 8 hours – it can result in cell death, organ failure, brain damage or death; heatstroke can be either classical or exertional (for example in athletes) (13)

Heat can exacerbate chronic conditions such as cardiovascular and respiratory systems but can equally increase the chances of other serious health issues such as:

- heart attacks
- strokes
- respiratory problems
- kidney diseases
- electrolyte disorders
- skin cancer

Extreme heat can also exacerbate a range of other health risks from increased transmission of food, vector and waterborne diseases, mental health manifestations, and drive increasing health inequities. Extreme temperatures stress health-system provision of emergency and ambulatory services and complicate responses to other health emergencies, such as the coronavirus (COVID-19) pandemic.

2.2.1.1 Cardiovascular

A linear relationship between temperature and weekly mortality was observed in England in summer 2006, with an estimated 75 extra deaths per week for each degree of increase in temperature. Part of this rise in mortality may be attributable to air pollution, which makes respiratory symptoms worse. The other main contributor is the effect of heat on the cardiovascular system. Air pollution such as ozone and particulate matter (for example PM10, PM2.5) also increases the level of cardiovascular-related deaths, as fine particles have been shown to enter the blood stream via the lungs and affect the heart.

In order for the body to keep cool, large quantities of extra blood are circulated to the skin; this causes a strain on the heart. In the elderly and those with chronic health problems this can be enough to precipitate a cardiac event, such as heart failure.

Sweating and dehydration affect electrolyte balance. For people on medications that control electrolyte balance or cardiac function, this can also be a risk. Medicines that affect thermoregulation, the ability to sweat, or electrolyte imbalance can make a person more vulnerable to the effects of heat. Such medicines include anticholinergics, vasoconstrictors, antihistamines, drugs that reduce renal function, diuretics, psychoactive drugs and antihypertensives.

2.2.1.2 Respiratory

High temperatures are also linked to poor air quality with high levels of ozone which are formed more rapidly in strong sunlight; fine particles (PM10, PM2.5) also increase in concentration during hot, still air conditions. Both are associated with respiratory and cardiovascular mortality. Given the recent predictions of the impact of climate change in the UK (UKCP), there are a number of recommendations made in the AWHP.

Hot weather can cause respiratory issues to flare up, particularly if the person becomes dehydrated. Hot weather can cause ozone levels and other air pollutants to rise up in the air these can cause and trigger breathing problems. Humidity during hot weather also make breathing problems worse.

During the spring and summer months grasses and weeds lead to increased pollen levels so hay fever and long-term lung conditions, such as chronic obstructive pulmonary disorder (COPD), can be exasperated at these times.

Severe summer storms, including thunderstorms can occur throughout the warmer months. They also present the potential for health impacts, known as thunderstorm asthma which is a term used to describe any observed increase in acute bronchospasm cases following the occurrence of thunderstorms in the local vicinity. Episodes of thunderstorm asthma can occur during peak grass and fungal spore season (June and July). Though the drivers of thunderstorm asthma are not fully understood, it is thought to include a complex mix of meteorological, environmental, and physiological factors. This can result in a surge in patients needing emergency healthcare services with exacerbated symptoms of asthma. Thunderstorm asthma events have been detected by UKHSA syndromic surveillance systems over the past 3 summers.

Aeroallergens' presence during a heatwave may exacerbate respiratory symptoms. Variations in the potency of allergen carriers (for example the amount of allergen per pollen grain) might make it difficult to correlate symptoms and effectiveness of treatment with pollen or fungal spore counts. The problem of variations in potency might be overcome by monitoring atmospheric concentrations of allergens instead of pollen grains or fungal spore counts. Climate change may result in earlier seasonal appearance of respiratory symptoms and longer duration of exposure to aeroallergens.

Although thunderstorm asthma and aeroallergen may not always be a threat during or after a heatwave event, it is important that professionals and the general public are aware of the potential risks they pose over the summer period.

2.2.1.3 Skin and eye health

Ultraviolet (UV) radiation may cause harm during heatwaves but also at other times when people expose themselves to the sun. A small amount of UV radiation is essential in the production of vitamin D, however too much exposure to the sun can have serious effects on your skin and eyes. Excessive exposure may have consequences ranging from premature ageing of the skin to skin cancer. The World Health Organization (WHO) states that the number of cases of malignant melanoma has doubled every 7 to 8 years over the last 40 years – mostly due to a marked increase in the incidence of skin cancers in fair-skinned populations were reported since the early 1970s (58).

Children are most at risk, as exposure to the sun during childhood appears to set the stage for the development of skin cancer later in life. UV radiation can also severely damage the cornea and lens of the human eye – long exposures may result in photo keratitis and a lifetime of cumulative exposure contributes to the risk of cataracts and other forms of ocular damage.

2.2.1.4 Renal health and electrolyte disorders

Hot weather can lead to dehydration and this in turn can lead to low blood pressure which can cause a decrease in kidney function. Many metabolic systems start to shut down in response to heat illness and a decline in kidney function is part of that abnormality in metabolic systems. There is breakdown of muscle tissue that results in kidney failure.

2.2.1.5 Mental health

Higher temperatures increase the risk of adverse mental health outcomes. An increase in suicide rates during previous heatwaves in the UK has been observed. Table 2 summarises the number of studies on the association between heat and 6 broad mental health outcomes (59).

Table 2. Number of studies and headline findings of review by outcome group (59)

Outcome group	Number of studies	Main findings
Suicide	17	• 49% of all included studies examined the association between suicide and temperature • 15 out of 17 studies found a positive and significant association between increasing temperatures and suicide frequency • 4 studies found a positive and significant association between violent suicides and increasing temperature
Bipolar disorder, mania and depression	5	• a positive and significant association between admissions due to bipolar disorder and increasing temperature • no significant association was found between mania or depression and increasing temperature
Schizophrenia	5	• a positive and significant correlation between temperature and exacerbation of schizophrenic symptoms • risk of mortality more than double during episodes of heat wave
Organic, dementia, Alzheimer's disease and senility	5	• risk of admission for organic mental disorders increased significantly during periods of heat wave • agitation with disruptiveness of nursing home residents with known dementia increased significantly with temperature
Alcohol and substance misuse	2	• risk of mortality due to alcohol and substance misuse increased significantly during episodes of heat wave
Other mental health outcomes and service use	7	• a number of outcomes were covered by only one study with mixed findings • risk of admissions to psychiatric hospitals increased significantly during episodes of heat wave • mortality of those diagnosed with mental health illness increased significantly during periods of heat wave

Recent studies have found that additional hot days are correlated with increased self-reported mental distress in individuals.

2.2.1.6 Infectious diseases

Evidence also exists that links increased ambient temperatures and associated dehydration with an increase in bloodstream infections caused by Gram-negative bacteria, particularly Escherichia coli (29). The risk is greatest in individuals aged over 65, emphasising the importance of ensuring adequate fluid intake in older people during periods of raised temperatures to reduce the risk of infection.

2.2.1.7 Pregnancy

Research on heat exposure and maternal health has largely focused on preterm births, with most studies finding positive association. A recent systematic review (60) confirms that high temperatures can be associated with preterm birth risk. This finding concurs with other reviews (for example (28 to 30), (61), (62), (63)). Some reviews have also found evidence for an effect of high temperatures on the risk of stillbirth (60), (64). There is a lack of evidence regarding the mechanisms by which high temperatures could trigger pre-term birth (65). Pregnant women are able to appropriately thermoregulate and can undertake exercise during moderate heat (66), (67). However, when exposed to extreme heat, there are a number of processes that may occur which could harm the mother or foetus including a reduction in placental blood flow, dehydration, and an inflammatory response that may trigger preterm birth.

2.2.1.8 Other

There are concurrent risks during a heatwave that have a negative impact on health. An example is the risk of a drought; a period of water shortage for people, the environment, agriculture, or industry, and often associated with a hot, dry summer can cause a short, intense drought. There are several health impacts associated with drought. In England the main health risks are dehydration, increased transmission of infectious diseases and impact on mental health. See here for more information on public health guidance for droughts.

2.2.2 Effects on healthcare services

2.2.2.1 Impact on the NHS

Currently new hospitals are more at risk of overheating during hot weather compared with older, traditionally built blocks, although maladaptation of older buildings can lead to a loss of this adaptive capacity (16). A study of care homes (68), indicates that these may also be at risk from high temperatures, due to building design and management issues. The Department of Health and Social Care (DHSC) is working with its arm's length bodies to develop measures to improve patient safety and increase resilience to heatwaves in health and social care buildings. From April 2017, the NHS has required trusts and commissioners to submit data on the percentage of

clinical areas covered by thermal monitoring; the number of overheating events in clinical areas; the presence of an organisational adaptation plan; an expectation of coverage of adaptation in mandatory Sustainable Development Management Plans (SDMP); and an expectation of coverage of adaptation in trusts' annual reports. This data will enable trusts to understand and address overheating risk.

The first year of data collection shows there is still a need for work on improving data quality. Some significant outliers in reported levels of overheating suggest that not all trusts are recording and reporting in the same way. The UKHSA- and NHS England-supported Sustainable Development Unit (SDU) are working with NHS Improvement to identify if it is possible to incorporate this data into the Model Hospital to enable benchmarking. The data will help to inform the sector wide Adaptation Report.

More recently, a UKHSA (69) study investigated the experiences of several NHS hospitals during the heatwaves in 2019, focusing on impacts to health service delivery, staff welfare and patient safety. The study found that hot weather in 2019 caused significant disruption to health services, facilities and equipment and caused staff and patient discomfort and an acute increase in hospital admissions. Levels of awareness varied between clinical and non-clinical staff of the Heatwave Plan for England, Heat-Health Alerts and associated guidance. Response to heatwaves was affected by competing priorities and tensions including infection control, electric-fan usage and patient safety. This study intentionally aimed to provide more evidence on the healthcare workforce dealing with overheating in healthcare estates as a routine summer issue, rather than its response to more unusual extreme heatwave conditions.

2.2.2.2 Impact on social care

Qualitative evidence from a 2016 study (68) provides qualitative evidence about potential causes of indoor overheating in care homes and indicates that they may be overheating even in relatively cool summers. Insufficient knowledge of heating system controls was found to be an important contributing factor. Further evidence will be added to this section in 2024.

2.2.2.3 Risk of power outages

Power outage related health impacts were reported in literature with very few making an association to mortality, of which majority were found in grey literature. Associated impacts from power outages affect technology-assisted patients disproportionately, with insufficient alternative measures during an outage.

2.2.3 Excess heat mortality

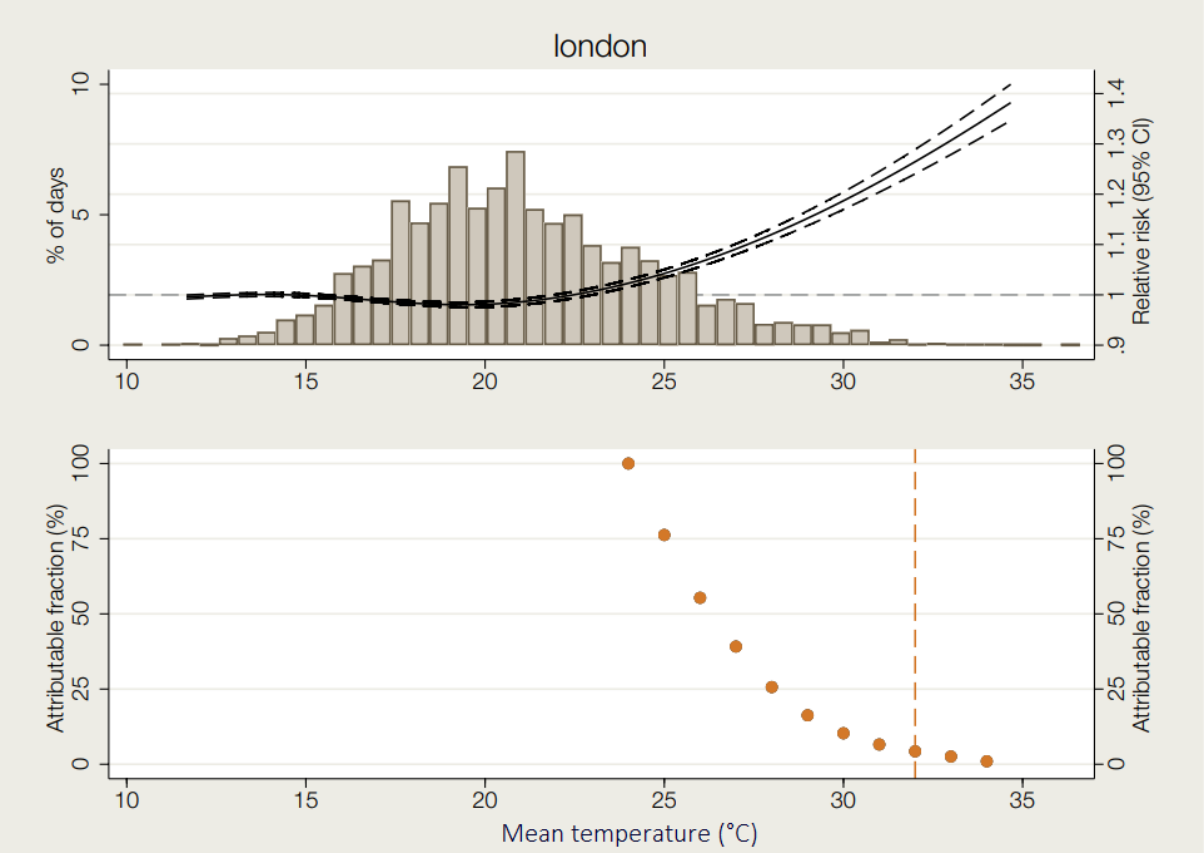
There is strong evidence that as temperatures increase above an optimum temperature that risk of all-cause mortality also increases (12 to 14) (18), (24), (55), (56), (73 to 81). The temperatures at which these increases start to occur is also dependant on the geographical location (11). The impacts on mortality during periods of hot weather are generally observed

within 24 hours of the onset of those high temperatures, and this can be seen in daily mortality time series; That is, when temperatures increase daily mortality figures also increase, which then fall back towards expected daily values as the temperatures fall back to average levels.

During hot weather the majority of all-cause excess mortality is observed in older adults (80), (55), (56). Evidence from recent years also suggests that deaths are occurring for those in care homes, in hospitals and in their own homes. Significant excess deaths are observed for deaths occurring at home and in care homes consistently across heatwaves and across different years while significant excess all-cause mortality is generally observed in hospitals during the first heat episode of the season only across most years (80). Evidence from Italy also suggests that risk of mortality during hot weather is raised for those already in hospital at the time of the heat as opposed to those entering the hospital on the hot days, with the risk the highest for those in the general medicine wards (73), (75).

While the impact on mortality during periods of high temperatures and where a Heat-Health Alert has been issued are clearly observable in the daily all-cause mortality timeseries, impacts also occur at more moderate temperatures on non-alert days (11). The evaluation of the Heatwave Plan calculated the attributable burden on mortality across the observed temperature range and concluded that once alerting temperatures were reached the attributable fraction of avoidable mortality was very low (11). In other words, assuming that actions initiated once an alert is issued were 100% effective, only a very small proportion of the overall mortality would be avoided (11). This suggests that longer term strategic actions to address heat risk are as vital to addressing this issue as responding when heatwaves occur.

Figure 4. Adjusted temperature-mortality relationship in London and heat-attributable fractions (11)



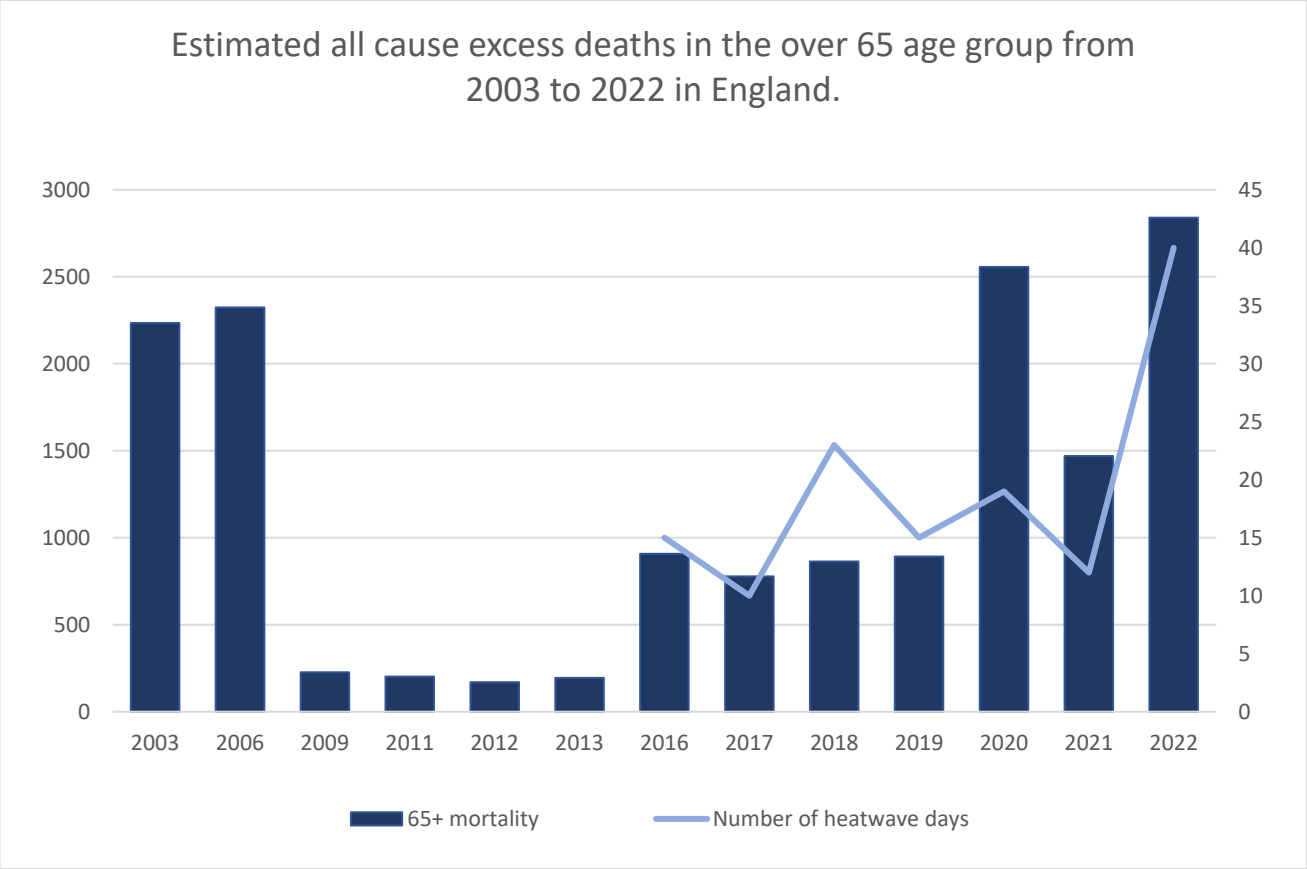
2.2.3.1 Summary of heatwave mortality reports

Heatwave mortality reports are published annually by UKHSA and summarise estimated excess all-cause mortality observed during alerting periods in the summer. Heatwave mortality monitoring helps to inform public health actions during periods of severe heat and heatwave. The reports have previously been used to inform sections of the Heatwave Plan for England and will also now feed into the AWHP and the new impact-based Weather-Health Alerting System.

The annual reports have been published by UKHSA, and formerly Public Health England (PHE), since 2016 and are available at Heat mortality monitoring reports. The methodology used was based on previous work by Green et al (76). However, following the COVID-19 pandemic, the methodology was updated to account for the impact of COVID-19 on mortality to allow the impact of heat to be isolated. Details of the 2 methodologies are available elsewhere.

In England, there appears to be an increasing trend in terms of heatwave days and heatwave-associated deaths as can be seen from Figure 5 below, which shows the estimated all-cause excess deaths in the over-65 age group from 2003 to 2022 in England. This aligns with the wider evidence-base that heatwaves will occur more often, be more intense and last longer, leading to increased impacts (54).

Figure 5. The estimated all-cause excess deaths in the over-65 age group from 2003 to 2022 in England



Recent years have led to the challenge of estimating all-cause excess mortality during heat episodes with respect to the concurrent risk COVID-19. Observed excess mortality reported in 2020 was higher than would have been expected based on the temperature mortality relationship alone (81). This suggests that there may have been other factors other than temperature alone which may have increased heat risk. In addition, there is some evidence to suggest that following the pandemic risk of cardiovascular disease outcomes has also increased which is one of the main causes of death during a heatwave. More work is needed to fully understand this and other shifting patterns in mortality since the pandemic (80).

2.3 Flooding

The third UK Climate Change Risk Assessment (CCRA) in 2021, identified flooding as one of the most important climate change adaptation challenges facing the UK. In all future climate change scenarios, direct and indirect flood risks are projected to rise over the course of the 21st century (7).

2.3.1 Health effects from flooding

Flooding has extensive and significant impacts on health that is frequently associated with both acute and long-term effects on health and wellbeing.

Direct health effects associated with flood water and its debris include:

- drowning
- physical trauma (for example concealed or displaced objects, electrocution, fire)
- skin and gut infections from exposure to contaminated flood water

Longer-term health effects that may occur as a consequence of flooding:

- mental health impacts (secondary stressors)
- carbon monoxide poisoning due to inappropriate use of generators
- respiratory disease from mould and damp
- rodent-borne disease
- other health effects (for example heart attacks)

Often only the immediate traumatic deaths from flooding are recorded. It is not always easy to identify the longer-term health effects associated with flooding, such as effects caused by displacement, destruction of homes, delayed recovery, power outages, water shortages and disruption of access to health services (7). That said, it is reported that in England, most of the health burden associated with flooding is due to the impacts of flooding on mental health and wellbeing (15). For more information, check the Flooding and Mental Health guidance.

Over the course of the 21st century increasingly higher average rainfall and changing rainfall patterns alongside rising sea levels will contribute to predicted rises in the frequency and severity of flood events. Flood risk is predicted to increase in the future across all major flood risk categories: fluvial (river), ground water, surface water and coastal flooding. While the greatest damages are likely to remain to be caused by river flooding, the greatest increase in relative risk is projected to be coastal related, which is expected to more than 2 times compared to current levels (82). This is important given that coastal flooding is associated with greater risk to life and livelihoods.

Case study: The Somerset Levels Emotional Wellbeing Recovery Programme

In March 2014, 3 part-time Emotional Flood Support Workers were contracted by the Somerset Village and Community Agents to support the emotional health needs of people affected by floods. Together with the Agents, they integrated into communities affected by flooding in the Somerset levels and attended or participated in 83 events. The majority of events were coffee mornings held at village halls, bowling clubs and visitor centres among others, with an average attendance of 15 people, with over 1,000 people attending in total.

Care and attention were given to people attending these sessions involving gentle informal conversations.

Following their contact, each individual was asked how they were managing. At the start of the meetings 80% of attendees reported feeling a lack of control and 75% reported feeling anxious. At the end of the meetings, 75% reported that they were at least coping, but 25% still reported feeling either distress or despair. Over 30 individuals received extended contact with flood support workers, either face to face or by telephone, with an average of over 10 contacts per recipient of support.

Working with other agencies was key to offering appropriate support at the right level to suit the needs of the individuals. Somerset Counselling offered free counselling sessions to people affected by the floods. Several individuals followed this through with 10 sessions each. Other referrals were made to village agents, GPs and to the Samaritans listening service, set up to support victims of flooding. In addition, there was also signposting to adult social care, coffee mornings, the Environment Agency, a Men's Shed, rotary advocates, Somerset Volunteers, talking therapies and the Warrior Programme (a charity supporting ex-service personnel in Somerset). A short film about the project is available on YouTube.

2.3.2 Impacts to healthcare from flooding

More severe weather, both flooding and extreme temperatures, pose risks to the delivery of health and social care. Flood risks to NHS and social care assets are likely to increase under climate change. Future projections indicate an increase in the number of GP surgeries, care homes, emergency service stations and hospitals in the flood risk zone, with the largest change in risk generally shown for care homes.

3. Who is most at risk?

The impacts of adverse weather events can affect everyone and can strain many aspects of our lives, including our health. However, the extent to which individuals, societies, and nations experience the negative health impacts of adverse weather events will vary based on their ability to adapt to the stressors imposed by such events. Certain populations face a disproportionate burden of the adverse health outcomes as a result. Therefore, understanding the concerns of such populations as well as factors that underpin their vulnerability help to inform the appropriate societal and national responses needed to reduce their adverse health outcomes.

3.1 Key groups at risk from cold weather

Cold-related ill-health is a complex issue involving many factors. However, there are a variety of health risks that can be brought on or exacerbated by cold weather. The key groups that are particularly at risk in the event of cold weather are:

- older people aged over 65 years old
- people with pre-existing chronic medical conditions such as heart disease, stroke or TIA, chronic obstructive pulmonary disease or diabetes
- people with mental ill-health that reduces individual's ability to self-care (including dementia)
- pregnant women (in view of potential impact of heat and cold on risk of preterm birth)
- children under the age of 5
- people with learning difficulties
- people assessed as being at risk of, or having had, recurrent falls
- people who live alone and may be unable to care for themselves
- people who are housebound or otherwise low mobility
- people living in deprived circumstances
- people living in houses with mould
- people who are fuel poor
- people experiencing homelessness or people sleeping rough
- other marginalised or socially isolated individuals or groups

3.2 Key groups at risk from hot weather

Everyone is at risk from the health consequences of heat, but there are certain factors that increase an individual's risk during a heatwave. These include:

- older people aged over 65 years
- babies and young children under the age of 5 years
- people with underlying health conditions, particularly heart problems, breathing problems, dementia, diabetes, kidney disease, Parkinson's disease or mobility problems
- people on certain medications
- people with serious mental health problems
- people who are already ill and dehydrated (for example from diarrhoea and vomiting)
- people who experience alcohol or drug dependence
- people who are physically active and spend a lot of time outside such as runners, cyclists and walkers
- people who work in jobs that require manual labour or extensive time outside
- people experiencing homelessness, including rough sleepers and those who are unable to make adaptations to their living accommodation such as sofa surfers or those living in hostels
- people who live alone and may be unable to care for themselves

More information on vulnerable factors are explained under Chapters 3.3, 3.4 and 4.

3.2.1 Heat health impacts on children

Children's susceptibility to high temperatures varies; those under 5 years of age, who are overweight, or who are taking certain medication may be at increased risk of adverse effects. Some children with disabilities or complex health needs may be more susceptible to high temperatures.

Children cannot control their body temperature as efficiently as adults during hot weather because they do not sweat as much and so can be at risk of ill-health from heat. Heat-related illness can range from mild heat stress to potentially life-threatening heatstroke. The main risk from heat is dehydration (not having enough water in the body). If sensible precautions are taken children are unlikely to be adversely affected by hot conditions, however, teachers, assistants, school nurses and all child carers should look out for signs of heat stress, heat exhaustion and heatstroke (83).

Children may also be at increased risk of suffering from the harmful effects of heat because they are dependent on adults, especially very young children under 5 years of age, and are less capable of adopting adaptive behaviours during periods of hot weather (79).

3.3 Socioeconomic factors

Under the umbrella of wider determinants of health, social determinants are the non-medical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems that shape the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies, and political systems.

The social determinants have an important influence on health inequities; the unfair and avoidable differences in health status seen within neighbourhoods, cities and regions of a given country. No matter the level of development or income of a country, health and illness follow a social gradient where the lower the socioeconomic position, the worse the health. Examples of social determinants that can influence health equity are income and social protection, education, employment, housing and the surrounding environment and access to health services. Studies show that socioeconomic status plays a bigger role in how it influences people's health outcomes than previously understood (84).

3.3.1 Health impacts of cold homes and fuel poverty

Fuel poverty is one of the major causes of cold homes and is determined by the interaction of 3 key drivers: energy efficiency of the household; energy prices and income. Many people, especially those disproportionately affected by the effects of cold, such as older people and those with chronic illnesses may still require temperatures above 18°C to maintain health and comfort.

In 2014, the Marmot Review Team published the Health Impacts of Cold Homes and Fuel Poverty report. This review found that fuel poor homes are less likely to be warm and dry. There is a strong evidence base showing one of the major contributing factors to a person living in low temperatures is the inability to heat their home affordably. Fuel poor households must choose either to spend more than 10% of their income on heating, which has a detrimental impact on other aspects of health and wellbeing, or to under-consume energy and live in a cold home to save money. Deprived and vulnerable households – especially those who do not have access to social housing – are more likely to live in energy inefficient housing, and less likely to have the resources or the resilience to deal with the negative impacts of cold homes and reduced income.

The review also showed a relationship between EWDs low thermal efficiency of housing and low indoor temperature. EWDs are almost 3 times higher in the coldest quarter of housing than in the warmest quarter (21.5% of all EWDs are attributable to the coldest quarter of housing, because of it being colder than other housing). Around 40% of EWDs are attributable to cardiovascular diseases and around 33% of EWDs are attributable to respiratory diseases. Furthermore, the review stated that children are twice as likely to develop respiratory problems

due to cold homes, as well as a positive correlation between cold homes and poor mental health outcomes for all ages.

The fuel poverty figures for the UK are based on complex calculations of which temperature thresholds are a part. Fuel poverty statistics are fluid and sensitive to changes in energy prices. The low cost high income measure used to calculate the number of households in fuel poverty and depth of fuel poverty (the 'fuel poverty gap') is explained further in the report Getting the measure of Fuel Poverty.

Moreover, there is a significant health impact associated with cold homes and fuel poverty. There is a strong relationship between cold temperatures and cardio-vascular and respiratory diseases. Children living in cold homes are more than twice as likely to suffer from a variety of respiratory problems than children living in warm homes.

Mental health is negatively affected by fuel poverty and cold housing for any age group. Studies have found that more than 1 in 4 adolescents living in cold housing are at risk of multiple mental health problems compared to 1 in 20 adolescents who have always lived in warm housing (85).

3.3.2 Built environment

The built environment influences human choices, which in turn affect health and the global climate. Distinct from the natural environment, the built environment is comprised of manmade components of people's surroundings, from small-scale settings (for example offices, houses, hospitals, shopping centres, and schools) to large-scale settings (for example neighbourhoods, communities, and cities), as well as roads, sidewalks, green spaces, and connecting transport systems (86). Neighbourhood design not only influences health by affecting physical activity, respiratory and cardiac health, injury risk, chronic disease risk, social connectedness, and mental health (87), but many current community design practices also adversely contribute to global climate change.

3.3.2.1 Healthcare facilities and risks to overheating

Hospital design and construction influence thermal comfort and ventilation during heatwaves (88). Hospitals in urban settings may also be affected by urban heat islands and the presence of green space or blue space nearby. In-depth studies of building and ward types have shown that some building characteristics increase the risk of overheating. For example, few hospital wards in northern Europe are air-conditioned; instead, the internal temperature is maintained by natural or mechanical ventilation.

An estimated 90% of hospital buildings are vulnerable to overheating (69) and NHS estates are at risk of high indoor temperatures (overheating) even during moderately warm summers (70); temperatures in some wards can exceed 30˚C even when external temperatures are 22˚C (71). Existing standards for healthcare premises recommend temperatures from 18˚C to 28˚C in general wards and 18˚C to 25˚C for more sensitive areas, such as birthing and recovery rooms

(72). In 2019 to 2020, there were 3,600 instances of overheating above 26°C reported in NHS trust buildings in England.

3.3.2.2 Evidence of risks to hospitals and care homes from overheating

Passive and mechanical ventilation techniques at night were identified to control night-time overheating.

In hospital settings, natural ventilation techniques were better than mechanical as these were found to reduce the concentration of airborne infectious agents.

Due to limited evidence on the effectiveness of fans in reducing heat-related harms as well as their role in dispersing viral pathogens, passive approaches are recommended (for example curtains, turning off non-essential lights and electrical equipment).

The risk of indoor overheating needs to be incorporated into a plan by facility managers and care staff.

The indoor temperature threshold at which adverse effects occur remains unclear – 26°C is identified as the most suitable temperature for at-risk groups.

High indoor temperatures affect aspects of human health, with strongest evidence for respiratory health, diabetes management and core schizophrenia.

Exacerbation of symptoms in warm indoor environments has clinical relevance to at-risk groups and those caring for them.

Though 18°C is recommended, there needs to be more research on vulnerable groups and their adaptive nature to the cold.

Strong association and effectiveness in reducing the heat-health burden is identified from heat-health advice communications, green spaces, heat-resistant building design and planning, and behaviour change (for example exhaustive activities).

3.3.2.3 High temperatures and benefits of green spaces

Green infrastructure (GI) plays an important connectivity role across cities, towns, coast and countryside at a local and landscape scale, forming an integral component of ecological networks and building more resilient landscapes. Multi-functional GI innovations offer a way to combat resilience challenges and address stresses of urban living to improve health and wellbeing (34). Some examples are:

- living in closer proximity to green spaces which is associated with improved wellbeing, reduced mental health problems and reduced health inequalities

- children with attention deficit hyperactivity disorder (ADHD) in contact with natural environments and green spaces who have reported significant improvements in symptoms when in
- the presence of green spaces in otherwise identical urban areas which is associated with reduced indicators of stress and family aggression
- exposure to natural environments or scenes of nature which have shown changes in physiological stress indicators such as blood pressure, muscle tension and EEG alpha-wave activity
- access to green spaces and natural environments which can increase the likelihood of physical activity and active travel in adults and children

3.3.2.4 Green spaces in urban settings

Urban green space is a component of green infrastructure. It is an important part of public open spaces and common services provided by a city and can serve as a health-promoting setting for all members of the urban community. It is therefore necessary to ensure that public green spaces are easily accessible for all population groups and distributed equitably within the city.

3.3.2.5 Housing and air quality

Housing tenure is linked to socioeconomic position, meaning that poorer households are more likely to experience lack of control over quality of housing and of ability and resources to undertake necessary improvements. There are also inequalities with access to good indoor air. People living and working in the most deprived areas were found to have poor indoor environments. These homes are more likely to be overcrowded, with shared spaces, poor ventilation and thermal performance, and limited amenities. These factors can lead to poor indoor air quality, cold, damp and mould, and higher fuel use (89). For information on cold homes, see chapters 3.3.1 and 3.3.2.6.

3.3.2.6 Cold homes and fuel poverty

Fuel-poor homes are less likely to be warm, dry homes. There is a strong evidence base showing one of the major contributing factors to a person living in low temperatures is the inability to heat their home affordably. This is known as fuel poverty.

Fuel poverty is determined by a combination of 3 factors which are:

- energy efficiency of the home
- household income
- fuel costs

For more information on the role of fuel poverty on vulnerable groups, please see Chapters 3.1 and 3.4.

3.3.2.7 Flooding and built environment

The local geography, including the location of and proximity to watercourses, waterbodies and the sea, and the physical arrangement of homes, other buildings, streets, parks and agricultural land, can be factors contributing to peoples' risk of experiencing flooding. For example, homes built on flood plains are at greater risk, and basement flats may be more at risk than other flats within the same building.

Actions to reduce the risk of flooding, and its consequential effects on mental health, include building new developments in areas at lower risk of flooding. For reducing the risks to existing households in areas of flood risk, sustainable drainage systems (SuDS) should be considered. Examples of SuDS include increasing green spaces, removing paving for natural drainage, or introducing small-scale SuDS interventions such as green roofs or rain gardens can assist. These actions can contribute to co-benefits of improved mental wellbeing associated with green space, air and water quality, and increased biodiversity, as well as drainage (15).

In the response phase, the built environment plays a role in providing physical spaces for refuge and to offer practical and psychosocial support to affected individuals.

3.4 Behavioural factors: study of older adult health risk perception during hot and cold weather

Risk perception refers to an individual's judgement or assessment of the immediate or long-term threats to their health and wellbeing. Evidence and understanding of the predictors associated with heat and cold risk perception in older adults in England has been limited. Therefore, in 2019 UKHSA commissioned marketing research company Ipsos MORI to carry out 2 surveys to explore public perceptions, awareness, and experience of the risks of both hot and cold weather. Please note, the use of 'older adults' refers to people aged 65 years and above.

3.4.1 Methods

Two surveys (one focused on health risk perception of hot weather and the other on cold weather) were conducted face-to-face from 26 July to 4 August 2019, following a period of very hot weather in the UK and Europe. A representative sample of the English population aged 65 years of age or above was used for both surveys. Quotas were set for age by gender, region, working status and tenure.

Two binomial logistic regression models were used to assess participant heat risk perception (whether participant agreed or disagreed or neither agreed nor disagreed with the statement "Hot/cold weather is a risk to my health"). The independent variables for model 1 included demographic characteristics and participant perception of other groups' health being at risk during hot or cold weather. The independent variables in model 2 included actions taken during hot or cold weather and reasons for actions not taken.

The survey covered 3 themes:

- opinions on hot weather
- perceptions of risk to health from hot weather to themselves or others
- experiences during recent hot weather, actions taken or not taken and reasons behind them

3.4.2 Key findings

This section details the findings from the survey results.

3.4.2.1 Symptoms experienced during hot or cold weather

In both surveys, older adults reported experiencing some weather related health symptoms during a recent period of hot or cold weather. Approximately, 20% of older adults that were included in the hot weather survey reported having no associated symptoms. The most commonly reported heat-related symptoms were:

- difficulty keeping cool and feeling too hot (40%)
- difficulty sleeping (52%)
- physical symptoms such as a headache, dehydration or sunburn (11%)

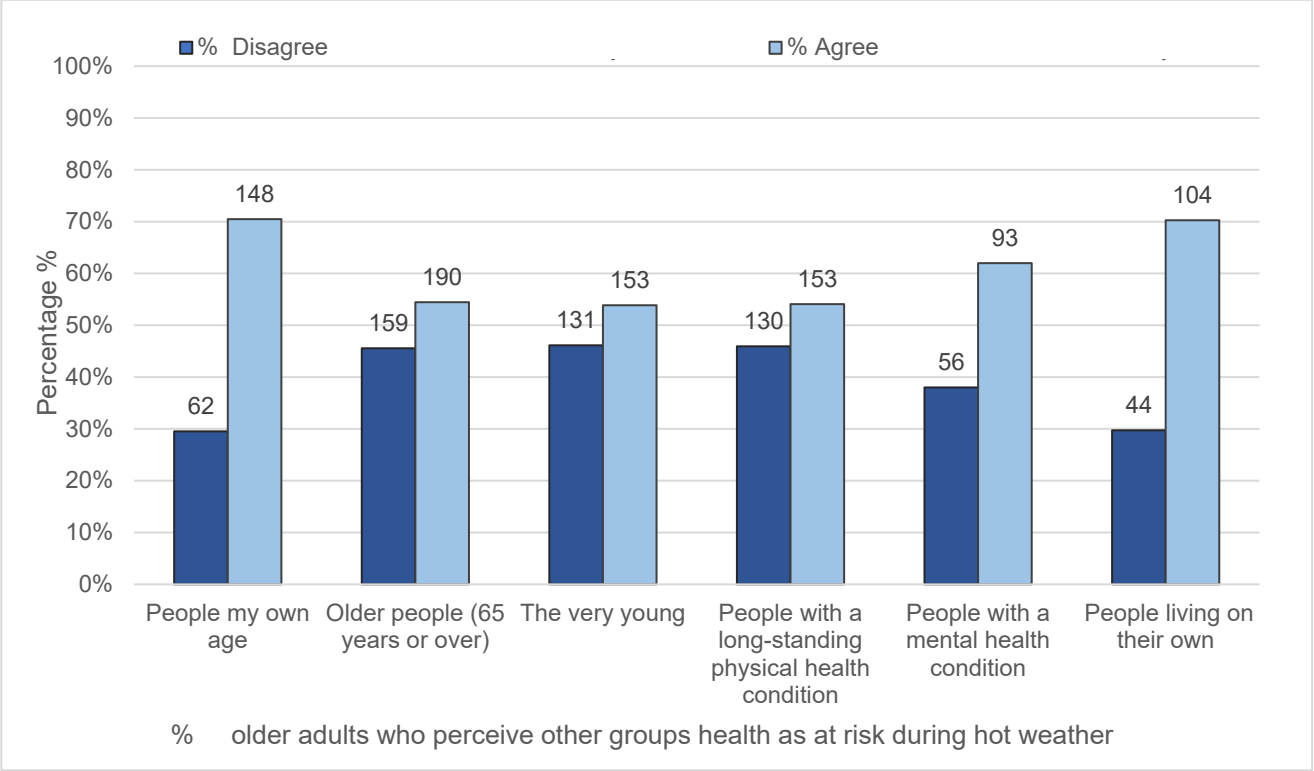
In the cold survey, older adults reported experiencing fewer symptoms during recent cold weather. Approximately, 60% reported having no health issues however, approximately 10% of participants reported experiencing one of the following:

- difficulty keeping warm
- flu or flu-like symptoms
- difficulty staying active
- feelings of depression

3.4.2.2 Risk perception of hot weather

Figure 6 shows the percentage of older adults who perceive other groups health to be at risk during hot weather by whether they agree or disagree their health to be at risk. As expected, a higher percentage of older adults who perceive their own health as at risk also perceive other vulnerable groups to be at risk. Interestingly, over a quarter of older adults who do not perceive their own health as at risk reported perceiving other older adults' health as being at risk during hot weather. However, when older adults were asked about the risk to health of people of the same age as themselves, the perception of risk decreased considerably, suggesting a lower risk perception for themselves and their current age group.

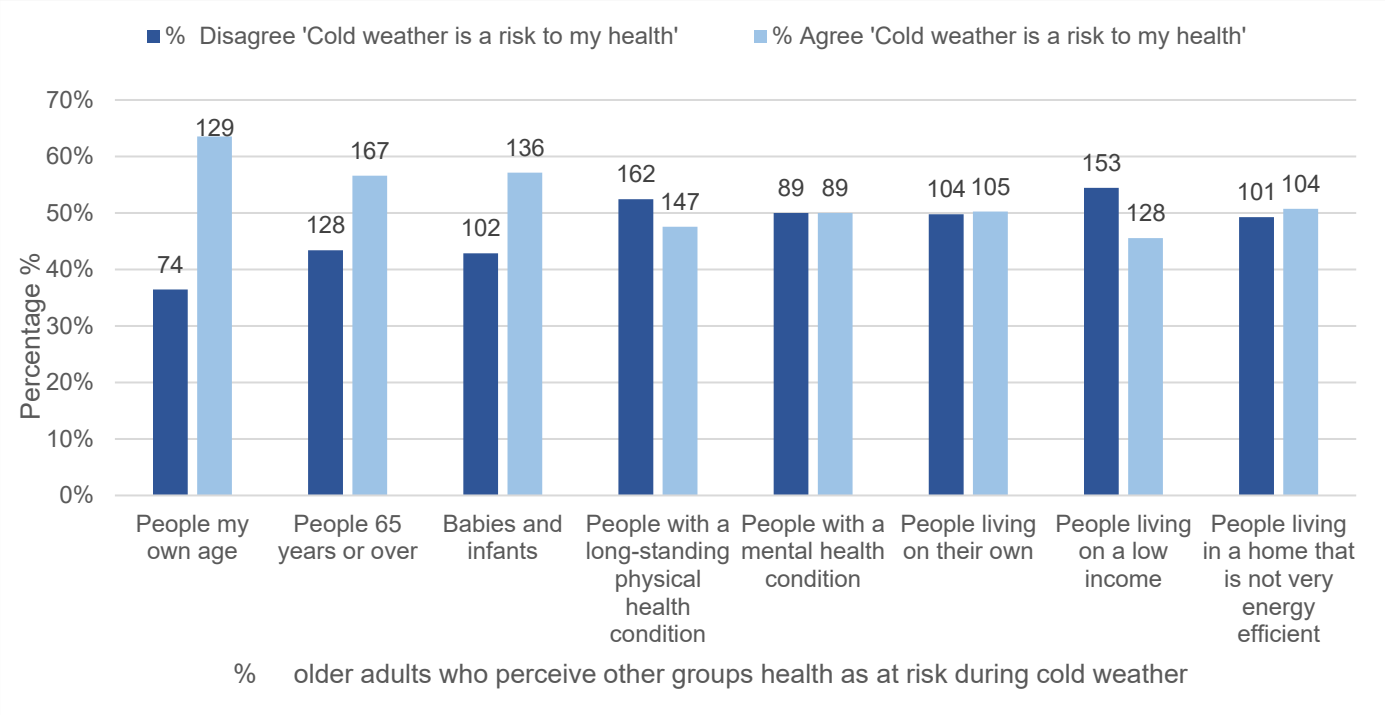
Figure 6. Percentage of older adults who perceive other groups health to be at risk during hot weather by whether they agree or disagree their health to be at risk (n = 472)



3.4.2.3 Risk perception of cold weather

Figure 7 illustrates older adults' risk perception of their own health and their perception of other vulnerable groups' health risk during cold weather. Similarly, to the responses by older adults in the hot weather survey, a higher percentage of older adults who perceive their own health to be at risk during cold weather also reported people of the same age and older adults to have an increased risk. A slight increase in the percentage of older adults who reported not perceiving their own health to be at risk but identify those with long-standing physical health conditions and people living on a low income as having a risk to their health during cold weather.

Figure 7. Percentage of older adults who perceive other groups health to be at risk during cold weather by whether they agree or disagree that cold weather is a risk to their own health



3.4.2.4 Hot and cold weather-related behaviours

The findings from this analysis showed there was no clear demographic determinant (such as age or income) that predicted older adults perceiving themselves to be at risk in hot weather.

Annual income, education and tenancy were the demographic predictors for older adults' health risk perception in cold weather. Those who earned over £25,000 were 26% less likely to perceive their health as at risk. Additionally, older adults who had a degree or higher or owned their own home were 32% and 35% less likely to perceive their health as at risk in cold weather. In both the hot and cold weather surveys, perceiving people of the same age or people living alone as at risk increased the likelihood of an older adult perceiving their own health to be at risk during recent hot weather or cold spells. Additionally, in the hot weather survey, perceiving other older people aged 65 years and above was associated with an increased likelihood of older adults' personal risk perception, however, this association was not found in the cold weather survey.

In both, the hot and cold weather surveys, there were no real differences in the proportion of adults reporting at least one action to reduce the impact of cold (89%) and the impact of heat (90%).

3.4.2.5 Hot weather survey

More than half of older adults reported heat related behaviours which were:

- drinking more fluids (84%)
- opening windows at night or during cooler parts of the day (61%)
- wearing loose clothing and/or a hat (59%)
- finding somewhere that felt cool (53%)
- keeping curtains closed on windows exposed to direct sunlight (50%)

Older adults who reported using or buying a fan during hot weather were 45% more likely to perceive their health to be at risk in hot weather. Older adults who reported staying indoors or limiting strenuous activity to cooler parts of the day were significantly more likely to perceive their health as at risk in hot weather. Keeping the windows or curtains exposed to direct sunlight closed increased the likelihood of older adults perceiving their health to be at risk in hot weather by 32%.

Furthermore, participants were asked what their reasoning was for taking certain actions to reduce potential harm to their health compared to more or all suggested actions during hot weather. The most reported were:

- “I didn’t think there was a need to act”
- “My health was not at risk”
- “I didn’t think this would be relevant to me”
- “I didn’t think it would make a difference”
- “It didn’t occur to me”

3.4.2.6 Cold weather survey

The most frequently reported behaviours adopted (more than half of respondents) were:

- layering clothing (80%)
- heating home to at least 18˚C (77%)
- having boiler checked by an engineer (61%)
- heating rooms most occupied (59%)
- keeping bedroom window closed at night (59%)
- checking the forecast and planning ahead (53%)
- drinking warm drinks (58%)

In cold weather, older adult respondents who stocked up on food and medicine or wrapped a scarf around their mouth to protect their lungs were more likely to perceive their health to be at risk, although the latter association was relatively weak. Finally, older adults who checked the forecast and planned ahead were 27% less likely to agree that their health is at risk during cold weather.

Participants were asked what their reasoning was for taking certain actions to reduce potential harm to their health compared to more or all suggested actions during cold weather. The most reported were:

- “I didn’t think there was a need”
- “It didn’t occur to me”
- “My health was not at risk”

3.4.3 Key messages

Less than half of participants perceived their health was at risk or adopted positive behaviours during hot weather.

Considerably more older adults reported experiencing at least one health symptom during hot weather compared to cold weather.

There were education, income and home ownership differences in cold risk perception but no demographic differences in heat risk perception.

During cold weather, older adults with an income above £25,000, educated at degree level or higher, owning their own home compared to renting, were less likely to perceive their health as at risk in cold weather.

Perceiving people of the same age or people living alone or other older adults’ health as at risk increased the likelihood of an older adult perceiving their own health to be at risk during hot weather or cold spells.

During cold weather, stocking up on food and medicine was significantly negatively correlated with income and education in older adults.

Several behaviours in hot weather were associated with older adults perceiving their health to be at an increased risk including using a fan, limiting activity, staying indoors and keeping windows or curtains closed.

Stocking up on food and medicine or wrapping a scarf around the mouth to protect lungs in cold weather were significant predictors of cold risk perception in older adults.

Checking the forecast and planning ahead significantly reduced the odds of older adults perceiving health to be at risk in cold weather.

4. Addressing health inequalities

This chapter presents preliminary findings and recommendations from an examination of the approach to health inequalities taken in the Cold Weather (8) and Heatwave Plans for England (12). This was conducted by UKHSA in order to identify gaps and recommend areas for further development and implementation within the AWHP. A full report on health inequalities will be published in 2023 and this information will be included in the next iteration of this document in 2024.

4.1 Methods

Both plans were reviewed and screened for gaps and areas requiring further development of approaches to address health inequalities, and to inform future in-depth work.

Guiding questions were used to support analysis of policy approaches to health inequalities with the aim to expand and transform the ways in which policy problems and processes are understood and critically analysed to ensure fine-tuned and equitable policy recommendations and responses.

In order to ensure a thorough review, stakeholders were consulted on around 2 key areas of development: people experiencing homelessness, people sleeping rough and older people.

4.2 Findings

In alignment with the framework and requirements of the AWHP that will provide the broader construct from which the Heatwave and Cold Weather guidance documents will be informed, this review investigated:

- how groups can be differentially affected
- existing inequalities
- interventions for improvement

4.2.1 How can groups be differentially affected

The plans amplify specific vulnerable populations including older people (aged 65 years and above), the very young (under 5 years of age) and people with pre-existing medical conditions. In addition, those whose health, housing or economic circumstances may put them at greater risk of harm from very hot weather.

Specific guidance documents within the plans go on to further define high-risk groups or subgroups living in the community and for those in care home or hospitals.

4.2.2 Existing inequalities

While both plans stipulate a number of broad vulnerable groups, a number of areas for further development have been highlighted in the review and the targeted stakeholder consultation. These are:

- on addressing vulnerability, plans tended to focus on older people with limited or no detail on other potentially vulnerable groups
- where vulnerable groups are highlighted, groups are often approached as homogenous (for example all 65 years of age+) with little detail on those most vulnerable or sub-groups that would require targeted or priority responses (for example older people living alone or with dementia)
- evidence of harms further focused on particular areas (for example cold homes) with less detail in other scenarios or settings
- absence of guidance for both specific vulnerable groups or settings (for example people experiencing homelessness and people sleeping rough, prisons)
- in response to the limitations of identification of inequalities above, subsequent targeted responses and effective interventions are thus also lacking, resulting in difficulties for commissioners or providers to effectively deploy limited resources which leads to potential augmentation of existing inequalities (inequity in response)
- communication and accessibility of information or guidance for specific cultural groups (languages) and seldom heard groups (for example people experiencing homelessness and travellers) are currently limited

4.2.3 Interventions for improvement

The findings from the research, combined with the initial stakeholder consultations, show potential improvements which are:

- further definition of vulnerable subgroups to account for heterogeneity within groups and to identify those most at risk – this would allow for more targeted, effective and responsive action across the health and care system
- availability and guidance on use of disaggregated data – this could support the identification of those most at risk
- increased breadth of evidence of harms across scenarios and settings to enable more effective system-wide responses
- increased accessibility of information and alert systems
- more evidence for specific interventions for
    - vulnerable groups such as people who are sleeping rough
    - subgroups that are not currently defined such as older people with specific co-morbidities or living alone or in deprivation
    - specific settings such as prisons and where evidence is absent

- improved accessibility of guidance and messaging for both individuals and professionals – language, culture and context limitations (for example interventions within means)
- ensuring system-wide approaches and following-on from the above point – specific resources for local authorities on vulnerable groups to better inform longer-term planning, preparedness and actions
- ensuring providers support those most vulnerable – guidance to protect the workforce (particularly during heatwaves) currently does not exist and thereby impacts service provision and protection of vulnerable groups
- greater involvement and engagement of vulnerable and seldom-heard groups or those with lived experience to ensure culturally adapted and responsive approaches (for example via specialist UKHSA teams, existing partner networks or academic partner leverage)
- extending the approach to addressing health inequalities to beyond action plans – visible prioritisation and inclusion of health equity as a focus with AWHP and aligned strategies, responses and monitoring and evaluation could strengthen system responses

4.3 Preliminary recommendations

The review work to-date has described the current approach taken to health inequalities and vulnerability in the Cold Weather and Heatwave Plans. This work has also included potential areas for development to initiate transformation of the AWHP and aligned guidance to improve the current approaches to vulnerability by embedding a more defined health equity response.

While this review covered a breadth of actions within a system-wide approach, responses and guidance in some areas have been highlighted by stakeholders as lacking in terms of defining vulnerable populations, using effective actions to deploy and where to target limited resources, culturally appropriate communication, and effective system-wide approaches.

Further recommendations at this stage are:

1. In the short-term, work could focus on consolidating evidence on vulnerable populations both in terms of breadth and detail, as this is necessary to better inform responses.
2. Building on this, medium-term work could include necessary translations and consolidation of evidence-based interventions or best practice guides supported by appropriate metrics or evaluation plans.
3. Longer-term solutions could include roundtable work to clearly establish cross-sectoral agency roles and accountabilities to co-produce or ensure alignment between cross-sectoral guidance and longer-term strategic plans.

Specific areas for further work have been identified and next steps for consideration and co-design by all partners will need to address:

- how proposed policy solutions will reduce inequalities
- how implementation and uptake will be assured
- how reductions in inequalities will be measured and monitored

To ensure maximum implementation and effectiveness as well as resource efficiency the evolving AWHP equity work will need to align with other national initiatives (for example Cabinet Office vulnerable persons guidance and winter response work) in these areas as well as respond to regional and local prioritisation, processes and needs.

5. Recommendations mapping

The table in the Appendix presents a comprehensive list of recommendations identified from a review of previous national weather and health plans, associated primary and secondary evidence, including evaluation and guidance documents. This long list has informed the development of high-level recommendations for best practice, including, but not limited to:

- priority for capacity development for health and social care workforce and, strategic, long-term planning, prevention and investment, enabling staff to prepare and respond, as well as to improve health system resilience to current and future adverse weather and health risks
- ensuring a long-term strategic approach by Health and Wellbeing Boards, directors of public health and commissioners to assess needs and then commission, plan, implement, monitor and evaluate interventions to reduce harm to the public or population from adverse weather – this includes
    - emphasising year-round planning with a multi-agency approach to tackle wider determinants, such as economic, social and housing issues
    - reviewing plans and strategies regularly throughout the year to ensure they meet local needs and draw on the capacities, assets and organisations that exist in a specific place
    - moving from emergency response to adaptation with a focus on preparation, transformation and building community resilience to adverse weather and climate change
- defining and identify populations most at risk from adverse weather events, effective actions, culturally appropriate communications and effective system-wide approaches that build trust and meet needs
- public engagement that focuses on more effective messaging regarding adverse weather and health risks, especially for those most at risk, on preparedness and taking protective actions, including seeking financial and health-related advice – any engagement should be developed using an evidence-based approach to behaviour change
- increased awareness of the health impacts of adverse weather and climate change at all levels in local areas and encouraging people to take specific actions such as accessing help, seeking treatment or advice, checking the forecast and helping others who may be at risk

These recommendations should be implemented with the necessary resources and guide the long-term strategic planning of the various delivery groups.

As part of the AWHP's process approach and improvement principles, the aim for the 2024 publication is to review and map the long list presented in the Appendix to align with the AWHP's 9 axes of action which are:

- service delivery
- capacity building
- organisational arrangements
- communication
- risk management
- early warning systems
- research and data analysis
- quality assurance
- policy development and accountability

6. Further information

For further reading, the following links provide latest information and research on adverse weather events and best practice for preparedness and response.

UK:

- The Climate Change Committee (CCC)
- UKHSA Extreme Weather Events Current Awareness Bulletin

Europe:

- Copernicus Climate Change Services
- European Mortality Monitoring Activity (EuroMOMO)

International:

- WHO – WMO Joint Climate and Health Programme
- Global Heat Health Information Network (GHHIN)
- International Association of National Public Health Institutes (IANPHI)
- South Asia Heat Health Information Network (SAHHIN)

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Appendix: Recommendations table

Source	Recommendation
3rd Strategy for Climate Adaptation reporting 2018	Ensure all clinical areas in NHS trusts have appropriate thermal monitoring in place, with number of overheating events.
3rd Strategy for Climate Adaptation reporting 2018	Local plans should have regard to the cumulative impacts of flood risk, rather than from individual development sites. Clarify policy on the exception test that may need to be applied when considering development in locations at risk of flooding.
3rd Strategy for Climate Adaptation reporting 2018	Actions to improve the resilience to new hospitals buildings and care homes to overheating within an organisational adaptation plan and an expectation of coverage of adaptation in mandatory Sustainable Development Management Plans (SDMP); and an expectation of coverage of adaptation in trusts' annual reports.
3rd Strategy for Climate Adaptation reporting 2018	Encourage all NHS providers to use the Sustainable Development Assessment Tool to self-assess progress on adaptation.
3rd Strategy for Climate Adaptation reporting 2018	Encourage NHS trusts to report consistently on risk assessment for overheating events. The thermal monitoring and numbers of overheating events should be incorporated into the Model Hospital to allow benchmarking of performance.
3rd Strategy for Climate Adaptation reporting 2018	Annual review of the coverage of adaptation by NHS SDU in mandatory provider trust and commissioners sustainability reports. Include sustainable development metrics in the annual Health check report.

Source	Recommendation
3rd Strategy for Climate Adaptation reporting 2018	Best practice in adaptation to be recognised annually thought the Sustainable Health and Care awards.
PIRU HWP 2019 and PIRU CWP 2015	Improve communication about the importance of general preparedness represented by level 0 and 1. emphasis to year-round planning with multi-agency approach to tackle wider determinants, such as economic, social and housing issues.
PIRU HWP 2019 and PIRU CWP 2015	Identify and provide preventive services to vulnerable people who are not routinely in contact with health or social care providers: Guidance and strategy.
HWP Making the case 2015 and CWP Local partnerships survey report 2014	Joint strategic needs assessments to identify challenges and joint health and wellbeing strategies to agree actions in operational plans, reflecting elements of the CWP and HWP.
PIRU HWP 2019	Improve the communication and the preparedness to the risk of adverse health effects during temperatures below the current heat-health alert thresholds.
PIRU HWP 2019	Improve the mechanisms to monitor activities during and following a heatwave alert.
PIRU HWP 2019	Make the managers and frontline staff to improve their awareness of the HWP. To recognise the role of NHS providers, CCGs, and local authorities in the HWP.
PIRU HWP 2019	UKHSA and the Local Government Association to review the capacity and capability of local authorities and other health and social care partner

Source	Recommendation
	organisations to implement actions from the HWP, including the partnership between primary and community care organisations.
PIRU HWP 2019	Review the advice provided to local authorities and health and social care providers.
PIRU HWP 2019	Revise public health advice to improve public awareness of the risks of hot weather to health: realistic self-assessment of risk among population groups, focus on the risk of under-estimation of the risks, tailor messages and media usage of different population groups, increase knowledge of the effectiveness of the protective behaviours.
PIRU HWP 2019	Provide evidence-based recommendation on air conditioning in hospitals, care home and other facilities.
PIRU HWP 2019	Mandatory training about the HWP awareness and the health risks of cold weather and actions for all healthcare staff.
PIRU HWP 2019	Improve healthcare and social staff welfare during severe events.
HWP Making the case 2015	Work heatwave and cold weather planning into the new health and social care structures, including LRFs and Health and Wellbeing Boards in preparation and response and longer-term actions.
HWP Making the case 2015	Work in partnership with local authorities and social care services to identify vulnerable populations and geographical areas to target planning.
HWP Making the case 2015	Preparation of the directors of public health to take an active role in setting a local agenda.

Source	Recommendation
HWP Making the case 2015	Use the Green Infrastructure Partnership (DEFRA, DHSC, DLUHC) to inform the local practitioners on the benefits of green infrastructure including opportunities. (parks, trees, ponds or lakes, cool pavements, cool or green roofs).
HWP Making the case 2015	Promote homes insolation and ventilation by targeted communication with vulnerable occupants at local level: external wall insulation can be better than internal wall insulation in preventing overheating. Open windows when the air outside is cooler at night time or in the early morning.
HWP Making the case 2015	Medium term (10 to 30 years): Target vulnerable areas to renew the building design of hospitals and other healthcare facilities to aid passive cooling. Consider build underground car parks, not extend car parks, insulation of buildings, reflective paint, increase opportunities for night-time ventilation, and maximise green space.
HWP Making the case 2015	Medium term (10 to 30 years): Encourage active transport and public transport. Use of low emission vehicles for NHS business.
HWP Making the case 2015	Long term (30+ years) planning to build zero carbon and energy minimized hospitals and health care facilities and with green space and water surrounding to aid passive cooling. Development of temperature-resistant drugs and laboratory materials.
PIRU CWP 2015 and Making the case CWP 2017	Development of information governance and data-sharing guidance between partners to enable impact on the community.
PIRU CWP 2015 and Making the case CWP 2017	Development of existing information sharing platforms to local areas (examples of best practice and practical case studies).

Source	Recommendation
PIRU CWP 2015	Improve the model of cost effectiveness of the plan.
PIRU CWP 2015	Integration of actions into local strategies and plans by local emergency planner. Development of local arrangements to ensure that cold weather planning as an integral element of wider winter resilience planning locally with roles and responsibilities clearly laid out and review of the actions.
PIRU CWP 2015	Provide further guidance to raise the profile of the plan and prevention of Excess Winter Deaths, on the agenda of Health and Well Being Boards and the Local Health Resilience Partnerships.
PIRU CWP 2015	Include the plan into the local Joint Strategic Needs Assessments with GPs and CCGs.
PIRU CWP 2015	Link the CWP with local Community Risk Register Assessments to allow a flexibility in the local response (level of graduation and ‘scalability’ in the actions within an alert level more proportionate).
PIRU CWP 2015	Sustainable, rapid and easy to conduct annual evaluations and reviews of the plan. Factors: direct and indirect costs of implementation, evaluation of variables relating to mental health, long-term cost benefit analysis, mortality mapping for rural-urban differences.
PIRU CWP 2015	Cold weather alerts: geographically specific, reduced frequency (that is alerting at start and end of winter period, only when there is a change in alert level, alerting to renew or extend expiring alert, focussing on periods when threshold levels are reached), adding specific recommendations, colour-coded (like flooding alerts), including link to Met Office weather alert and weather pattern maps.

Source	Recommendation
PIRU CWP 2015	Targeted resources at those who live in cold homes who are socially isolated.
PIRU CWP 2015	CWP should encourage better joint working across agencies and proactive response. Implementation of the plan should be led by public health manager.
PIRU CWP 2015	Focus on the level of care provided by health services over a longer period after a cold spell to track the delayed effects of cold alert.
PIRU CWP 2015	Scoping study to explore the current work in the economics of improving and adapting the housing stock, research and policy issues and possible methodologies.
CWP Making the case 2017	Identify and target actions to the housings with children in poverty and known to have asthma and recurrent infections, adults with chronic conditions who work and live in low temperatures, to increase energy efficiency through installing insulation and efficient heating systems, maximisation measures (that is benefit checks).
CWP Making the case 2017	Provide interventions to tackle each of these fuel poverty factors, such as insulation, efficient central heating systems, and income maximisation measures increase the likelihood that the home can be kept warm affordably.
CWP Making the case 2017	Communication to encourage the communities and individuals to look after themselves and others, focused on those engaging with social care and those who care for them, and the socially isolated people.
CWP Making the case 2017	Communication and education about the indirect impacts of fuel poverty and low indoors temperatures: lower dietary opportunities, impacts of wellbeing, falls and injuries over 65s, flu vaccination coverage, cardiovascular and respiratory diseases under 75.

Source	Recommendation
CWP Making the case 2017	Adaptation and mitigation strategies should also be incorporated into sustainability plans. The key influence for this indicator is the Climate Change Act 2008 which sets out targets for the reduction of carbon emissions by 2050.
CWP Making the case 2017	Insist on the level 0 and 1 actions in the interventions to prevent cold-related illness and death. Communicate about the negative health effects of cold temperatures start at relatively moderate outdoor temperatures of around 4°C to 8°C (depending on region).
CWP Making the case 2017	Continue to the cost-benefit of energy efficiency against fuel poverty measures for health, using both quality adjusted life years (QALY) and impacts of estimated net present value (NPV) by DECC.
CWP Making the case 2017	Improve the methodology to capture the wider benefits of measures to address fuel poverty, such as the full impacts on mental health and wellbeing, lifestyle and social justice in both the short and long term.
CWP Making the case 2017	Encourage to include the Warm Homes Healthy people programmes in the integrated care board (ICB) and local authority commissions.
CWP Making the case 2017	Include fuel poverty and excess winter mortality and morbidity into core business of JNSAs and joint health and wellbeing strategies (HWSs), in order to inform year-round commissioning.
CWP Making the case 2017	Central and sustainable fundings to allow local authority to take a year-round, long-term approach in the development of the programmes planning recommended by ‘level 0’ in the plan, for example simple measures to tackle fuel poverty.

Source	Recommendation
CWP Making the case 2017	Messages should be simplified for maximal inclusivity and relevance.
CWP Making the case 2017	Identify hospitalised people who are living in low temperatures or with fuel poverty and follow them after they are discharged home to avoid readmissions.
CWP Making the case 2017	Identify those people who have Category 1 fall hazards in their home and take remedial action will reduce the risk of fall.
CWP Making the case 2017	Improve the communication about the beneficials helps to the targeted public living in cold houses.
CWP Making the case 2017	Helpline for housing and fuel poverty queries, and single point contact of referral to help, accessible and easy to find. Single point contact could be housing association or community centre for sharing of information.
CWP Making the case 2017	Help the health professionals in signposting and referring individuals to these sources of winter warmth or financial support.
NICE guidance on Excess winter deaths	Ensure there is a ‘single point of contact’ health and housing referral service for people living in cold homes, who could provide tailored solutions. Inspections to buildings to ensure they meet ventilation and other trading standards.
NICE guidance on Excess winter deaths	Develop presential or virtual trainings, that is: • train health and social care practitioners, housing professional, faith and voluntary sector to help people living in cold houses • train heating engineers, meter installers and those providing building insulation to help vulnerable people at home

Source	Recommendation
	• raise awareness among practitioners and the public about how to keep warm a house
NICE guidance on Excess winter deaths	Ensure that health (primary and secondary) and social care, voluntary sector, housing services, installation and maintenance contractors, trading standards officer and environmental health offices could: • identify people at risk • make every contact count with an assessment of the heating needs of people • discharge vulnerable people from health and social care to a warm home
CWP Making the case 2017	Make the level 1 focused around shorter term initiatives such as seasonal flu immunisation, rapid winter warmth initiatives (implemented through WHHP), awareness campaigns for health and social care provider staff (incorporate action into routine care of vulnerable individuals as signposting or referral), checking emergency and business continuity plans.
CWP Making the case 2017	Establish more research about the potential benefits of preventive health measures targeted at vulnerable groups at the right time for example by sending text alerts direct to patients or making automated calls direct to patients. The evidence remains inconclusive.
CWP Making the case 2017	Consider the geographical variabilities and the adaptation to climate change in the calculation of the excess winter mortality.
CWP Local partnerships survey report 2014	Increase the monitoring and evaluation of projects (increase resources locally and create a national evaluation framework, funding bodies should require to report back of the projects).
CWP Local partnerships survey report 2014	Improve the data-sharing and personal data protection: creation data governance protocols, consent forms or referral schemes.

Source	Recommendation
CWP Local partnerships survey report 2014	Local equity audit to ensure programmes do not exclude those most at need. It would help to ensure that interventions are focused on addressing inequality locally and are proportionate to the level of need.
CWP Local partnerships survey report 2014	Better understanding on the local pathways in the local strategic plans.
CWP Local partnerships survey report 2014	Protect and nurture partnerships to continue to explore a pragmatic and collaborative approaches at strategic and organisation level. Fundings needs to be ensure for collaborative projects. Involvement of the voluntary and private sector (energy companies), and the health sector (including engaging and training professionals).
CWP Local partnerships survey report 2014	Implement a system wide approach of interventions.
CWP Local partnerships survey report 2014	Establish more research about the links between prolonged exposed to cold and damp conditions at home and poor health outcomes.
CWP Local partnerships survey report 2014	Focus on awareness raising in the communication strategies, with the provision of advice and education, linked with other campaigns as community energy efficiency events, benefits checks and debt advice, flu jab programme, hygiene advice older people's festival.
CWP Local partnerships survey report 2014	Services provided through affordable warmth and other similar programmes need to describe the distribution of urban or rural populations and the distribution of interventions across the locality. To be implement with further research and investigation.
CWP Local partnerships survey report 2014	Ensure that contacts were not missing or out of date before the cold weather alert levels 2 and 3 to have an efficient information cascade system.

Source	Recommendation
CWP Local partnerships survey report 2014	Short term interventions for emergency assistance: delivery of warm packs, supply of emergency heating, provision of warm meals, snow wardens providing a snow clearance service, emergency shopping and ensuring access to medical services, hardship grants and other short term emergency payments, provision of blankets and warm clothing, handyman emergency repair service, targeted support for people experiencing homelessness and people sleeping rough.
CWP Local partnerships survey report 2014	Longer term interventions for sustainable home: energy efficiency grant schemes operated through or funded by energy supplier, installing home safety measures, boiler servicing, repairs, replacement, installing major energy saving measures (for example loft or wall insultation), installing minor energy saving measures (for example draught proofing).
CWP Local partnerships survey report 2014	Target actions on social isolation and fuel poverty, for example: raising events for community healthcare staff, referential patients with respiratory and heart failure to financial inclusion checks, presentation by environmental health and housing officers to local healthcare workers, for example identify and refer vulnerable people virtually with the Healthy Housing Hub.
CWP Local partnerships survey report 2014	Creation of steering groups as ‘Be prepared for winter SG’ including representatives from public health, local authority risk and resilience, neighbourhood services, NHS providers, social care, housing, care and repair services, voluntary organisations, CCG, environmental health, energy efficiency officers and financial inclusion.

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

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