Written evidence submitted by the UK Health Security Agency

Environmental Audit Committee
Heat resilience and sustainable cooling inquiry: call for evidence

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's health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

1. Summary

- This document summarises evidence from UK Health Security Agency (UKHSA) and wider scientific sources to demonstrate the impact of hot weather on the health of vulnerable communities and the impact of sustainable cooling on health.
- We would like to bring to the attention of the committee UKHSA's work on the Adverse Weather and Health Plan (AWHP) which highlights the risks to health from adverse and extreme weather events and those measures which need to be taken to prevent, respond, mitigate and adapt to such events now and in the future.
- The UK Health Security Agency (UKHSA) has established a Centre for Climate and Health Security to protect health in the context of our changing climate. The Extreme Events and Health Protection (EEHP) team, an integral part of the UKHSA Centre for Climate and Health Security (CCHS), is responsible for developing, reviewing and supporting the implementation of the Adverse Weather and Health Plan and associated guidance and evidence, and for managing the weather and health early warning system.
- We have also provided information on the collaborative work that UKHSA in partnership with the Met Office has developed a new impact-based Heat-Health Alerting system.
- This document provides detailed responses to the following Terms of Reference 1,2,3,4,5,6,10 &11.

2. Evidence

ToR 1. What evidence exists on the relationship between heat and human health (mortality and morbidity), and which communities are worst affected?

A) Heat impacts on morbidity and mortality

Climate change means population exposure to heat is increasing which is of concern due to the threat posed to health and human life. According to the World Health Organisation (WHO), heat gain in the human body can be caused by a combination of external heat from the environment and internal body heat generated from metabolic processes. Rapid rises in heat gain due to exposure to hotter than average conditions compromises the body's ability to regulate

temperature and can result in a cascade of illnesses, including heat cramps, heat exhaustion, heatstroke, and hyperthermia.

Deaths and hospitalisations associated with heat can occur extremely rapidly (same day) or have a lagged effect (several days later) and result in accelerating death or illness in the already frail, particularly observed in the first days of heatwaves. Even small differences from seasonal average temperatures are associated with increased illness and death.

Heat also has important indirect health effects. Heat conditions can alter human behaviour, the transmission of diseases, health service delivery, air quality, and critical social infrastructure such as energy, transport, and water. The scale and nature of the health impacts of heat depend on the timing, intensity and duration of a temperature event, the level of acclimatisation, and the adaptability of the local population, infrastructure, and institutions to the prevailing climate. The precise threshold at which temperature represents a hazardous condition varies by region and population age and may be affected by other factors such as humidity and wind, local levels of human acclimatisation and preparedness for heat conditions.

There is strong evidence which suggests that hot weather increases the risk of various health conditions including respiratory, skin, eye, renal, electrolytes, mental ill-health and infectious diseases (see the AWHP supporting evidence document). There is strong evidence which suggests there is an interaction between heat and cardiovascular disease (CVD) and CVD-related mortality (see the AWHP supporting evidence document, Liu et al, 2022). From a physiological perspective, high temperatures can affect the viscosity of blood leading to extra strain put on the circulatory system and heart to move blood around the body, potentially leading to increased risk of a CVD event. During heatwaves an excess in a range of specific CVD deaths is consistently observed. The UKHSA syndromic surveillance systems, a system that provides weekly reporting of health syndromes and utilisation of health services showed that days with warm weather in 2023 resulted in an increase in heat-related conditions such as heat exposure, sunburn or sunstroke, unconsciousness or passing out, and allergic rhinitis (hay fever).

Over the last 5 years, the estimated number of all-cause excess deaths related to hot weather has steadily increased in England and Wales based on annual reporting on heat mortality. In 2018, all-cause excess deaths were estimated at 863; 2019 all-cause excess deaths were estimated at 892; 2020 all-cause excess deaths were estimated at 2556 (confidence interval: 2139-2926); 2021 all-cause excess deaths were estimated at 1634 (confidence interval: 1125-2143). By 2022, the estimated number of all-cause excess deaths increased to 2,985 (confidence interval: 2,258 to 3,712) across 5 heat episodes. The number of all-cause excess deaths was the highest in the Southeast region (536, confidence interval: 211-862), in persons aged 65+ years (2839, confidence interval: 2170-3508) and in previous years most deaths occurred in residents' private homes, hospice and care homes (Thompson et al, 2022). The seasonal impact of hot weather on mortality has not yet been reported for 2023. Similarly, an increase in heat-related excess mortality was observed across 35 European countries between June-August 2022 (Ballester et al, 2023).

B) Key groups at risk from hot weather

Everyone is at risk from the health consequences of hot weather as high heat directly compromise the body's ability to regulate its internal temperature. There are certain factors that

increase an individual's risk during a heatwave, for instance concurrent risk factors for cardiovascular disease and greater difficulty cooling down. As such, key groups at risk from hot weather include: older people (65+ years), children, pregnant women, people with long-term conditions, people with disabilities, people with low income or in deprivation, people who are sleeping rough, people with drug and/or alcohol dependence, people with language, culture or context limitations, and in specific settings such as prisons and social care settings (see the AWHP supporting evidence document).

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. For example, the health impacts of urban heat islands (UHI) have been estimated for cities in the UK, finding that up to half of heat-related mortality may be attributable to the urban heat islands (UHI) during heatwaves (Heaviside et al 2016). Regions with a higher proportion of older people, or a higher demand for social care, are likely to be most affected. There is currently limited evidence from the UK with respect to worsened health impacts among people experiencing socioeconomic risk factors. However, studies from the US have indicated this relationship. This may be related to the cost implications or and therefore limited access to measures to reduce heat exposure, such as retrofitting measures and mechanical cooling, which may be of increasing relevance within the UK context (see UK Climate Risk Independent Assessment (CCRA3) and Arbuthnott et al, 2017).

ToR2. How can sustainable cooling solutions and adaptation strategies be implemented in such a way as to minimise overheating, reduce energy consumption and prevent overloading of the electricity grid during peak demand?

Exposure to high temperatures in summer is an issue for health and wellbeing. The health consequences due to exposure to heat are preventable by keeping the body cool. There are individual measures that can be adapted to keeping the body cool such as wearing light clothing, staying hydrated and taking a cool shower or bath (see the AWHP supporting evidence document). Another strategy is developing cooling solutions in buildings as much of this increased risk is thought to be mediated by exposure to high temperatures indoors, and homes may already be overheating even in normal summer conditions (Kovats et al, 2016). Even during a relatively cool summer, 1 in 5 homes in the UK are likely to overheat (Taylor et al, 2015).

A) Building features that lead to overheating

Overheating is a key problem for building design which occurs through bad design, poor management, or inadequate services. The Chartered Institute of Building Services Engineers (CIBSE) define overheating as indoor temperatures that are above 28°C for a long period of time can make the occupants uncomfortable, increase dissatisfaction and reduce productivity. The Energy Follow Up Survey (EFUS)[1] provides evidence from 750 homes in the UK between 2017 and 2019. The EFUS highlighted key factors that affected overheating included the following:

- **Dwelling type:** In flats, 30% of the living rooms were overheated compared with 12% in houses. The prevalence of overheating in the bedrooms of flats (17%) was not significantly different from that in houses (19%).
- **Floor area:** In dwellings with a floor area <50m^2, 35% of living rooms were overheated

[1]The Energy Follow Up Survey - efus-thermal.pdf (publishing.service.gov.uk)

compared with 7% to 16% in larger dwellings. There were no significant differences seen for main bedrooms.

- **Region:** The prevalence of overheating in living rooms and bedrooms was significantly higher in the London region compared with all other regions.
- **Energy efficiency:** There was some evidence to suggest that the prevalence of overheating in living rooms was greater in dwellings with an Energy Performance Certificate (EPC) rating of A to C (15%) compared with dwellings with EPC D or below (10%).
- **Occupancy:** Overheating in living rooms was more common in households with a pensioner present (24%) than in those without (11%). Households in the lowest two income quintiles had a higher prevalence of overheating in the living room (24% and 21%) compared with those in the highest income quintile (5%). Households with none in employment had a higher prevalence of overheating in the living room (24%) compared to those without (11%).
- **Tenure:** Households in the social sector had a higher prevalence of overheating, both in the living room and in the main bedroom (26% and 29% respectively) compared with households in the private sector (13% and 17%).
- **Type of window**: Those with large plate glass windows or converted flats from office blocks with large windows – can result in very high internal temperatures due to solar gains in summer. A study in 2018 found maximum internal temperatures of almost 50°C in a London office building converted to apartments, when they had no shading.

Healthcare infrastructure in England is generally not designed to cope with extreme heat and air conditioning is not routinely installed (Gupta et al, 2016). An estimated 90% of hospital buildings are vulnerable to overheating (Short, 2017) and National Health Service (NHS) estates are at risk of high indoor temperatures (overheating) even during moderately warm summers (Climate Change Committee, 2014); temperatures in some wards can exceed 30ºC even when external temperatures are 22ºC (Fifield et al, 2013). Existing standards for healthcare premises recommend temperatures from 18ºC to 28ºC in general wards and 18ºC to 25ºC for more sensitive areas, such as birthing and recovery rooms (Climate Change Committee, 2014). In 2019–2020, there were 3600 instances of overheating above 26ºC reported in NHS Trust buildings in England (NHS, 2020). As documented in the AWHP supporting evidence document, new hospitals tend to be 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. A study of care homes indicates that these may also be at risk from high temperatures, due to building design and management issues. In addition to concerns about patient safety, heat is an occupational health hazard and can cause discomfort and harm to staff as well as affect productivity (Casanueva et al, 2020; Climate and Health Alliance, 2021; Brooks et al, 2022).In addition to concerns about patient safety, heat is an occupational health hazard and can cause discomfort and harm to staff as well as affect productivity (Casanueva et al, 2020; Climate and Health Alliance, 2021; Brooks et al, 2022).

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; expected coverage of adaptation as mandated in the 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.

B) Implementation

Local area adaption measures are key to implementing changes to buildings to address overheating. The AWHP suggests local organisations should consider developing plans to address the proposed 9 action areas, for instance considering local risk management means each local area would need to evaluate the building infrastructures and overheating in building. The Climate Change Committee (CCC) suggests 4 categories of action to limit heat-related impacts: (1) cooler buildings, (2) behavioural change, (3) urban cooling, (4) emergency responses. In addition, local area / community adaptation will be important.

Cooler buildings
The cooler buildings category can be further broken down into 'passive' and 'active' (or mechanical) cooling methods. Passive cooling is usually the first stage which involves utilising aspects of the building design to regulate internal temperatures. This is followed by active cooling techniques which utilise energy to keep internal temperatures low by operating mechanical ventilation systems. Implementation of individual cooling interventions and approaches should form part of a whole systems approach, taking into account effectiveness, feasibility, acceptability, cost and other considerations whilst prioritising those which are easiest to implement and cause the lowest potential harm (e.g. cost, carbon footprint). It is important to recognise that in most situations it may be necessary to apply multiple individual interventions at once and there may also be situations where it is not possible to implement a passive intervention (for example, due to security concerns).

Cooling interventions include:

- **External shading:** Provides shading for windows and outdoor areas using shutters, canopies, balconies or external blinds.
- **Internal shading:** Measures such as blinds or curtains provide shading internally. This is generally lower cost but is less effective than external shading.
- **High performance windows:** Improving the glazing of windows, or using reflective coatings on windows, limits the amount of heat that is transferred through the window.
- **Ventilation:** Mechanical and natural ventilation can help to cool buildings when the outside air is cooler than the internal temperature.
- **Thermal mass:** Thermal mass is the ability of a material to absorb, store and release heat. High thermal mass buildings take time to change temperature so can mitigate peaks in external temperature by allowing the thermal mass to absorb the heat and dissipate it later.
- **Reflective:** Selecting surface finishes with a high reflectivity can reduce the warming effect of solar radiation. These can be simple measures such as painting walls, roofs and paving in white or another light colour. Cool 'reflective' roofs are designed to reflect more sunlight than conventional roofs, absorbing less solar energy, saving energy and money in buildings with or without air conditioning and reducing heat flow from the roof to occupied spaces. This lowers the temperature of the building as conventional roofs can reach temperatures of 150°F on a sunny day. Under the same condition, cool roofs can reach temperatures of 50°F (see Department of Energy).
- **Green roofs/walls:** Covering roofs and walls with certain plants can cool an urban environment through evapotranspiration and cool buildings by providing shade for the surface. Green roofs and walls also have biodiversity and wider amenity benefits.
- **Active (mechanical):** Active technologies use electricity to reduce internal

temperatures. Mechanical ventilation methods tend to circulate air to cool down buildings. Air conditioning involves lowering the temperature in a room using a compressor cycle to remove heat from an indoor space, using electricity.

- **Building form:** Designing the shape and layout of a building can reduce the risk of overheating by using the building form to shade key areas and facilitating the preferred ventilation strategy.

The Climate Change Committee (CCC) notes that implementing actions to mitigate overheating will require involvement from a broad range of organisations and people, from house occupants and private homeowners through to public agencies, and that Government has a key role in enabling this set of actors to manage overheating risks, by creating the right conditions.

Behavioural change

Individual behaviour change is critical for the success of cooling interventions as these often rely on specific lifestyle adaptations and protective actions undertaken by households. However, it is reported that people's performance of cooling behaviours is not optimal based on a recent survey in England which found that uptake of effective behaviours for keeping cool at home during hot weather is mixed. The most common actions taken by people included drinking more fluids, opening windows at night, limiting physical activity and closing curtains on windows in direct sunlight, while the least commonly taken actions were using an electric fan and closing windows exposed to direct sunlight.[2]

As noted above, in order to understand effective measures for fostering behaviour change in relation to cooling behaviours in the public, it is necessary to understand relevant barriers and facilitators affecting people's uptake of target behaviours. Some examples of research conducted within PHE/ UKHSA related to understanding barriers and facilitators of cooling behaviours are presented in the following paragraphs.

First, one known major barrier that can limit the uptake of protective behaviours in response to extreme heat can be attributed to the general low risk perception of heat-related risks as identified in this paper. Furthermore, findings from recent focus groups testing a heatwave communication toolkit with older adults (which informed recommendations for the Adverse Weather and Health Plan (AWHP)) highlighted several behavioural barriers specific to cooling behaviours at home. Identified barriers included misconceptions regarding the correct advice for opening vs. closing sun-exposed windows and curtains, as well as practical barriers to installing air conditioning or external shutters due to high costs and incompatible building characteristics. In addition, the focus groups demonstrated that people may be reluctant to opening windows during night due to safety concerns, which highlights that even those behaviours with reported high uptake (based on the above survey results) may be challenging to perform by certain groups at certain times.[3]

Finally, perceived effectiveness of behaviours may encourage or discourage people from performing behaviours. The same survey found that using an electric fan and closing sun-exposed windows was thought to be ineffective by the majority, while more commonly performed protective actions such as drinking fluids and limiting physical activity were thought to

[2] Public Health England (2020). High temperature, indoor overheating and cooling interventions (2020). *Internal report.*

[3] Ratwatte, P., Wehling, H., Brooks, K. & Weston, D. (2023). Communicating heat risks: Focus groups testing messages to improve heat risks perceptions in older adults [Manuscript in preparation].

be the most effective actions that relate to keeping cool in the home[1].

As part of our behavioural science work in the area of climate change, we recommend that the design and evaluation of theoretically informed approaches to encouraging the uptake of cooling behaviours should be embedded in public health protection measures to support people in performing cooling behaviours at home. For example, for some behaviours/ barriers this could be achieved through evidence-informed public communication materials (as concluded in this review). More generally, we recommend work to identify barriers and facilitators relating to specific behaviours (such as those presented in the preceding paragraphs) and then develop interventions to address these barriers based on theoretically informed approaches. In our work, we draw on a range of theoretically informed approaches, including, but not limited to Change Wheel, the Person Based Approach and the Theoretical Domains Framework.

Urban cooling

The CCC suggests reducing outdoor temperatures in urban areas can help limit both on-street temperatures and internal temperatures in buildings. Urban cooling measures, such as enhancing green space (creating shading and evapotranspiration) or making building specific modifications, have the potential to reduce urban heat island effects and moderate outdoor temperatures.

Urban cooling measures include:

- **Green and blue Infrastructure.** This includes the network of urban trees and woodlands, private and public greenspaces as well as vegetated areas around water bodies. Increasing tree and vegetation cover can lower outdoor temperatures by providing shade from the canopy cover, and cooling through evapotranspiration. Green infrastructure can also simultaneously help mitigate flooding risk.
- **Green roofs.** A vegetative layer on a rooftop reduces temperature of the roof surface and surrounding air by providing shade and evapotranspiration. Green roofs can also store rainwater, thus mitigating flood risk.
- **Cool roofs/ pavements.** Cool roofs – made of materials or coatings that significantly reflect sunlight and heat away from a building – reduce roof temperatures, increase the comfort of occupants, and lower energy demand. Similar materials can be used to construct pavements which cool their surface and the surrounding air. A simulation study of cool roofs in the West Midlands estimated that the introduction of cool roofs reduced population-weighted temperature by 0.3°C and could potentially offset 25% of heat-related mortality due to the urban heat island effect during heatwaves.53 As well as benefitting individual buildings, cool roofs also reduce outdoor temperatures locally.

Recent studies have shown the benefits of urban cooling. A modelling study in Vienna found that well-designed blue and green infrastructure can reduce air temperatures by up to 1°C (Zuvela-Aloise et al, 2016).Zuvela-Aloise et al, 2016). There are numerous examples of well-designed urban cooling in the UK which brings multiple environmental benefit.

Emergency responses

Heatwaves can put pressure on health and social systems through their impact on vulnerable people. Early weather and health warning systems lie at the heart of robust adverse weather and health plans and guidance. These systems, which the WHO has shown to be one of the single most cost-effective actions which countries can take to improve civil preparedness for

adverse weather events, have been in place in England for heatwaves since 2004.

In England there are 2 early warning systems related to high temperature, including Heat-Health Alerts (HHA) and the Extreme Heat (EH) warnings as part of the National Severe Weather Warning Service (NSWWS). Since summer 2021, UKHSA and the Met Office have collaborated to ensure that the HHA and EH warnings are aligned and work together to communicate the expected impacts so that users act to minimise the potential impact.

Each system has a slightly different target audience yet work together to help focus the messages being transmitted. The HHA primarily targets the health and social care sector and responder community, while the NSWWS has a wider audience that includes the responder community, but also the general public. Due to the fact that the health sector is likely to observe impacts before other sectors, the HHA will issue yellow to red alerts, whereas NSWWS will only issue amber and red alerts for EH. To ensure both systems are aligned, UKHSA and the Met Office will work together to undertake a combined risk assessment to determine the expected impacts and the likelihood of those impacts occurring. This partnership working will ensure consistency across the systems, and a single overall message to users.

To address the risks to health, UKHSA has developed a new impact-based Heat-Health Alerting system in partnership with the Met Office. The new system is operational year-round. However, the core alerting season is between 1 June and 30 September. During the warm season, UKHSA and the Met Office will monitor the weather forecasts and where episodes of hot weather are identified using predefined evidence-based considerations, a dynamic risk assessment will be carried out and the appropriate alert issued and cascaded across the system. Please see ToR 10 for further details on what happens when an alert is issued.

The new impact-based system uses regional temperature thresholds as decision-making aids on whether to issue an alert. These thresholds were agreed upon based on the epidemiological evidence of the relationship between temperatures in the summer and mortality; observed impacts across the health and social care system during heatwave episodes in the last decade; and the long-term weather trends of each region of England.

ToR3. What actions can be taken to protect those most vulnerable to the impacts of extreme heat?

Some groups of people are especially vulnerable to the health effects of severe weather conditions, including very hot weather some of which includes older people, the very young, and people with housing or economic circumstances

It is important to note that certain vulnerable groups may not have the means to control their environment and would therefore need support with cooling and retrofitting. These may include those in hospitals, social care settings, prisons and places of detention as well as asylum seeker settings. Furthermore, for people on low income or facing deprivation, support with retrofitting measures and access to cooling measures may be required. It is therefore crucial to ensure that the measures outlined in response to ToR 2 are made available and accessible to groups of increased vulnerability.

There is evidence that people experiencing vulnerabilities lack the information they require to take action in hot weather, therefore more action on this may be effective. This could be achieved through improved engagement with communities and groups whose needs are less-

well understood and utilisation of trusted networks to understand specific needs and localised support, for example with Gypsy Roma Traveller communities and people experiencing homelessness whose living conditions can worsen exposure to heat. Granular data can help target the planning and implementation of responses to reduce the health effects of climate change. This would include data on specific communities and intersectoral issues, such as older people with low incomes and registered disabled.

The Adverse Weather and Health Plan (AWHP) 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.

All organisations must carefully consider the needs of vulnerable groups within their local populations, and it is the responsibility of each local area to ensure that preparedness and response plans are drawn up and tested. These responsibilities include, but are not limited to, developing a specific and detailed plan for how they will protect the most vulnerable people in their local areas in the case of adverse weather events.

UKHSA have revised and updated hot weather guidance offering advice for caring for people most at risk during hot weather. This includes specific guidance for healthcare professionals, for social care managers, staff, and carers, for teachers and professionals, and for those with responsibilities for people sleeping rough. Actions that could be considered include considering environmental changes that could reduce exposure to heat; drinking plenty of fluids throughout the day and monitoring for signs of dehydration; planning activities for times of the day when it is cooler such as the morning or evening keeping out of the sun at the hottest time of the day.

Heat Health Alert Action Cards have also been updated which summarise suggested actions to be taken by different professional bodies and organisations in the event of extreme heat to support the public, including those most vulnerable to the effects of heat. Suggested actions are outlined for each type of Heat Health Alert as well as steps that can be taken in advance of hot weather to reduce the impact of heat on those most vulnerable to heat-related illnesses. Feedback from providers and commissioners of health and social care were sought and incorporated.

In addition, the Beat the Heat materials provide information on who is at greatest risk of ill health from the heat, how to recognise when health may be affected by heat, actions that can be taken to cool themselves and their home, and what to do if someone becomes unwell because of the heat. These documents are aimed at the public, including those who are most vulnerable to the effects of hot weather.

UKHSA Centre for Climate and Health Security is working with a local authority to pilot a tool to help identify local communities with greater vulnerability to climate change including heat exposure to help support local adaptation efforts.

Behavioural insights

The above guidance materials were updated using behavioural science-informed recommendations to optimise risk perception in vulnerable groups (particularly older adults) and to increase uptake of endorsed protective actions included in the AWHP. These recommendations were developed from research conducted through the National Institute for Health Research (NIHR) Health Protection Research Units (HPRUs) in Environmental Change

and Health, and Behavioural Sciences and Evaluation. This research – conducted within UKHSA and focused on vulnerable groups (specifically older adults) – aimed at improving understanding of barriers to heat-related risk perception and subsequent uptake of protective behaviours. Examples from this research are presented in the following paragraphs:

- Firstly, we conducted a literature review that identified determinants of extreme weather risk perceptions in older adults. The key findings from this review highlight that risk perception can be affected by varying knowledge about risks (inaccuracies or incomplete knowledge about personal heat-health risks), and presence of comorbidities (having respiratory or cardiovascular disease increases risk perception). Furthermore, age self-identity (more specifically, rejecting association of frailty and therefore, heightened risk, with older age), and perceived weather severity (belief from past experiences that weather is not severe) can impact people's risk perception. Another factor for consideration that the review identified relates to people's primary motivation to engage in behaviours that alleviate physical discomfort which can result in a tendency to perform behaviours with lower impacts on health. Finally, an external locus of control (i.e., belief that as weather is uncontrollable that the effects of weather on health are out of the realm of personal control) was related to low risk perception. These findings emphasise that older adults are at a heightened risk not only due to physiological factors but also attributing to low-risk perception of the health risks of heat.
- Furthermore, interviews with older adults to explore their risk perception and experiences during the 2022 heatwave supported and supplemented the findings from the literature review, with people mostly expressing a low heat-related risk due to reasons such as positive associations with weather and believing they were able to manage the heat despite experiencing discomfort, or believing other groups were more at risk. In cases where risk was felt, people typically had one or more health conditions (e.g. cardiovascular disease, chronic obstructive pulmonary disorder) and had an awareness of the relationship between their co-morbidity and exacerbation in symptoms during hot weather[4].
- We also conducted focus groups[2] with older adults to test an updated behavioural science- informed message toolkit informed by the literature review findings (reported above) and relevant evidence on effective communication interventions in this area. Examples of existing interventions demonstrating positive effects on older people's risk reduction include the use of targeted messages triggering prior experience of people's negative experiences with heat (such as health-related health symptoms) identified in this paper and using strength-based messages with language and imagery that avoids associations with potentially disempowering terms, such as 'vulnerable' or 'elderly (see this study). Key relevant recommendations for communicating protective actions developed from the focus group work included: using positive framing of suggested behaviour changes (suggesting that people make adaptations versus telling people to cease or limit potentially risky behaviour); avoiding repetition of behaviours viewed as 'common-sense' and highlighting 'lesser-known behaviours instead (e.g., advice on opening/closing of windows and internal curtains/blinds); considering socially relevant information for specific vulnerable groups (e.g., for older adults consider risks of over-hydration and frequent urination); addressing common misconceptions and

[4] UKHSA (2023). Understanding the impact of extreme heat in adult social care: A qualitative research study [internal report].

communicating information as clearly and specific as possible to provide advice people can act upon (e.g. information on SPF ratings) and; focusing on co-benefits of behaviour adaptation (e.g., cost savings from switching off electric equipment that generates heat)[2].

- In addition to the above research focused on the public, research commissioned by the Centre for Climate and Health Security (CCHS) explored healthcare professionals (HCPs) (residential care home and domiciliary workers caring for people with learning difficulties, older adults and end of life care) perceptions of the utility of 'Heatwave Plan for England' and heat-health alerts during summer 2022. Key findings included insights for optimising dissemination and content of heatwave guidance, specific guidance on enhancing the role and resources of care managers and feedback on heat-health alerts relating to refinement of format and content[5]. The primary recommendations for updating guidance materials, providing targeted advice for HCPs, arising from this research included: the need to specify actionable guidance for caring for individuals with different conditions (to provide clear and practical actions that HCPs can adopt) during hot weather; to provide specific advice for different care settings (e.g., home-carers vs residential home carers), to include advice on how to look after the mental health of patients and healthcare workers and; to clearly specify risk factors and behaviours to facilitate identification of different types of heat-related illness among care workers.

ToR 4. To what extent do the Government's Climate Change Risk Assessment and National Adaptation Programme (as well as other related strategies such as the Net Zero Strategy and Heat and Buildings Strategy) identify and address the risks from extreme heat? (Note: The third NAP, covering the five-year period from 2023-2028, is expected to be published in the summer of 2023)

The third National Adaptation Programme (NAP3) covers the government's response to climate risks to health, communities, and the built environment, which represent 13 of the 61 risks and opportunities identified in the third Climate Change Risk Assessment (CCRA3).

The Monetary Valuation of Risks and Opportunities in CCRA3 (Table 42) identified that the estimated England's economic costs from extreme heat related risks to health and socioeconomic change, as a result of climate change, to be £6.4 billion per year.

This report also identified many early adaptation investments that deliver high value for money. The benefit-cost ratios typically range from 2:1 to 10:1 – i.e., every £1 invested in adaptation could result in £2 to £10 in net economic benefits. Some of them relate to the AWHP's implementation, also illustrated in **diagram 1** below:

- Heat alert and heatwave planning: above 10:1
- Weather and Climate Services including early warning: above 10:1
- Capacity Building: around 10:1

[5] UKHSA (2023). Extreme Heat Research in Adult Social Care Settings- Health Care Professional (HCP) sample [internal report].

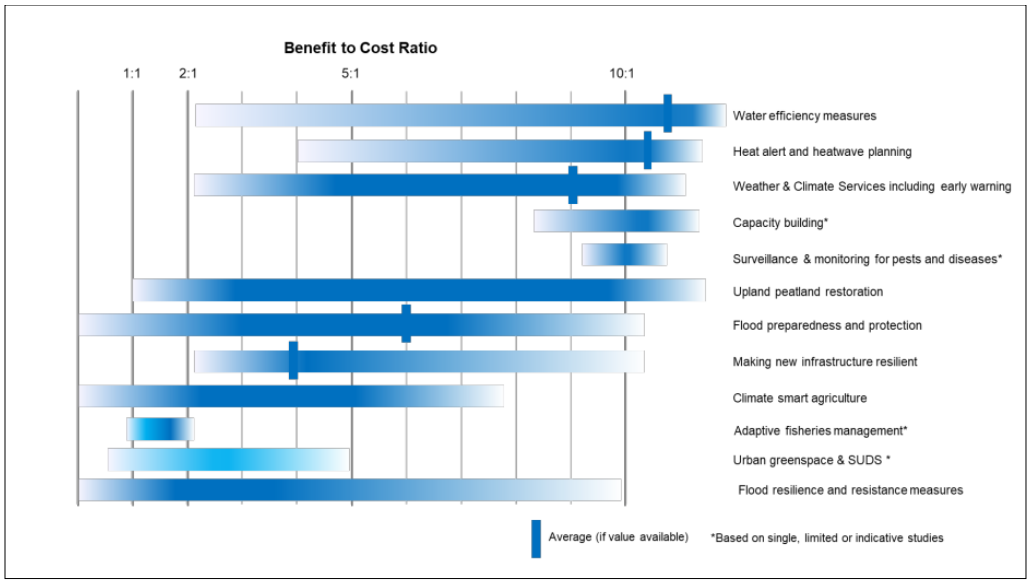

Diagram 1. Benefit to cost ratios for adaptation for selected CCRA3 risks.

As one of UKHSA's key deliverables under the second NAP, the Adverse Weather and Health Plan (AWHP) aims to bring together and improve current guidance on weather and health into a single plan for action. It builds on existing measures taken by government, its agencies, NHS England and local authorities, to protect individuals and communities from the health effects of adverse weather events (including heat) and to build community resilience. The AWHP was published April 2023 and has been in effect since 1st June 2023. To further establish how risks to public health are addressed, the AWHP will include a cost effectiveness chapter by 2025 in its annual report and capture AWHP's specific return of investment.

Furthermore, UKHSA is updating the evidence base on the health impacts of climate change through producing a UK-focused report, 'Health Effects of Climate Change in the UK'. The fourth iteration of the report (due to be published in Autumn 2023) will include an update of the estimates of direct and indirect climate-related health impacts using the UKCP18 climate projections and reviews the health impacts of multiple climate-related risks such as temperature, flooding, outdoor and indoor air quality, food supply, and infectious diseases. The fifth iteration of the report is a deliverable under the third NAP and will be published by the end of the NAP3 period (2023-2028).

ToR 5. Does the current planning framework do enough to encourage heat resilience measures such as cooling shelters, water bodies, green infrastructure and shading to be integrated into urban planning? Where such measures are incorporated, how accessible and successful are they?

Temperatures in the South of England are on average warmer than those in the North of England with London typically experiencing the highest average summer temperatures. This may be in part due to the 'urban heat island' (UHI) effect, whereby the built environment retains heat and emits it to the surrounding environment, amplifying temperatures in cities (in particular at night-time) compared to more rural surroundings. The health impacts of the UHI have been estimated for cities in the UK, finding that up to half of heat-related mortality may be attributable to the UHI during heatwaves (Heaviside et al 2016). Cool 'reflective' roofs may be able to offset up to 25% of heat-related mortality associated with the UHI during heatwaves (18% over the

summer period) (Macintyre et al 2019), with benefits suggested to increase in future, with a doubling of the number of heat-related deaths avoided by the 2080s (RCP8.5) compared to summer 2006, and with insignificant changes in the impact of cool-roofs on cold-related mortality (Macintyre et al 2021). Through the NIHR Health Protection Research Unit (HPRU) in Environmental Change and Health (ECH), UKHSA has collaborated on work related to the built environment, heat and health. The HPRU in ECH provides research to support decision-making relating to the impacts of climate change and other environmental changes that affect human health, with a focus on the following topics: Housing and climate change; Indicators of climate change impacts and responses; Food systems and agriculture; Flooding and coastal change; Heat, drought, wildfires; Green and blue space; Vector-borne disease and other infections; The health benefits of low carbon development; Risks from climate change impacts external to the UK; Threats to planetary health beyond climate change; Air pollution interventions.

The 'Improving Access to Greenspace: A new review for 2020' report highlights evidence and actions to help local areas consider how good-quality greenspace can support the delivery of health, social, environmental and economic priorities, at a relatively low cost. The report also highlights the benefit of greenspace for health, and that disadvantaged groups appear to gain a larger health benefit and have reduced socioeconomic related inequalities in health when living in greener communities.

During a heatwave, spending time in a cool environment can protect health and has been shown to reduce mortality (Vandentorren 2003). Internationally, cooling centres are often implemented as part of a wider heat response plan and provide a place of refuge from extreme heat for the general public or a particular target group, for example people sleeping rough. Overall heat response plans are thought to reduce heat related mortality (Ebi 2004, Chau 2009), however the role and impact of cooling centres, *per se*, is difficult to evaluate and is unclear. A literature review by the United States Centre of Disease Control, identified several barriers to the effectiveness of cooling centres. These included awareness of their existence by target population, ease of access, location, attractiveness as a place to spend time versus alternative options and issues of stigma. An unintended consequence could be greater exposure to extreme heat on the journey to and from the centre (e.g. on public transport). People may seek alternative cool spaces which have other primary purposes, such as air-conditioned shopping malls or other venues. Overall robust evidence for or against the use of cooling centres in hot weather to improve health outcomes is currently lacking and no specific recommendation can be made.

UKHSA works with other government departments to provide evidence such as this to help support evidence based policy making. Further evidence is needed on effective interventions to protect health from the effects of heat exposure and to inform efforts to ensure more resilient communities.

ToR 6. What can be done to protect the UK's existing public and private sector housing stock from the impacts of extreme heat while ensuring that homes are sufficiently warm in the winter months?

We note that the Department for Energy Security and Net Zero (DESNZ) is best placed to respond in detail regarding what can be done to protect the UK's existing public and private sector housing stock from the impacts of extreme heat while ensuring that homes are sufficiently warm in the winter months.

A) Public health actions

Under Evidence has been provided under ToR2, as identified by the CCC report in relation to the 4 categories of action to limit heat-related impacts and support infrastructure: cooler buildings, behavioural change, urban cooling, and emergency responses.

A key component of the Adverse Weather and Health Plan's (AWHP) resources is its weather-based advice addressed to the public and professionals on actions to protect themselves and others from the adverse impacts of hot and cold weather. These messages are derived from behavioural science insights and evidence-based research to appropriately determine the best recommendations and actions (including when and how to implement them) that can be taken up by health professionals, emergency workers and individuals.

The full collection of guidance materials can be found here: Adverse Weather and Health Plan (AWHP).

For heat related advice, UKHSA has published: Hot weather and health: guidance and advice, this collection includes resources sch as Beat the Heat advice, Keeping cool at home checklist and Hot weather action cards for health professionals across sectors.

For cold weather advice, UKHSA has published: Cold weather and health: guidance and advice, this includes resources such as Keep Warm Keep Well, and Cold Weather action cards for health professionals.

B) Evidence gaps in science, research and data

In order to make interventions or policies related to overheating, it is important to build the scientific evidence base and data sources on overheating in homes. Existing evidence in this area includes the research conducted by the Department for Communities and Local Government in 2012: Investigation into Overheating in Homes Analysis of Gaps and Recommendations, which will be followed up in the next National Adaptation Programme for the UK.

The Appendix of the AWHP Supporting Evidence Document 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 to be implemented with the necessary resources and guide the long-term strategic planning of the various delivery groups.

Awareness campaigns specifically focused on overheating homes (in addition to those generally on extreme heat) should be targeted towards the public and health and social care professionals / other professionals who may visit the homes of individuals with increased clinical vulnerability and may be able to identify overheating hazards and signpost households to appropriate support.

ToR 10. How effectively is the Government working across departments and with local authorities to ensure a coordinated approach is taken to heat resilience?

In October 2022, UKHSA launched the Centre for Climate and Health Security (CCHS) to lead UKHSA's climate health activity, providing a focus for partnerships and collaborations with

academia, local authorities, and other public sector organisations. The creation of this centre will also streamline the academia engagement with UKHSA on the topics of climate change, weather, and health.

UKHSA's Extreme Events and Health Protection (EEHP) team, located within the CCHS, is responsible for developing, reviewing and supporting the implementation of the Adverse Weather and Health Plan (AWHP) is and associated guidance and evidence, and for managing the Weather-Health Alerting System.

The Plan will be implemented and delivered by a range of groups and organisations working in partnership across sectors and at different levels. There are 7 delivery groups referred to in the Plan. These include national delivery, regional delivery, local delivery, other governmental departments, academia, third sector and private sector.

The complete list of stakeholders involved in the delivery of responses to adverse weather events at national, regional and local level, and their roles and responsibilities are defined under Appendix 1 of the AWHP. Through this Plan, UKHSA will continue to work with partner organisations at national level to support a coordinated response to the challenges of climate change, adverse weather and health issues.

The Plan also highlights that existing local and regional infrastructure and channels can be used to support a shift from emergency response to prevention and longer-term planning on climate change adaptation activities. However, to do this requires a clear governance framework across the system which gives clarity about local policy frameworks and responsibilities for delivery across the system, standards to be delivered, and the levers which exist and how to leverage that support.

The Plan aims to collate adaptation activities across the system and clarify the systems of implementation, accountability, monitoring and evaluation across the different levels. The future iterations of the AWHP will provide a collection of case studies of adaptation activities which stakeholders are developing in respect of climate change and response to adverse weather events. This will help clarify systems of implementation, accountability, monitoring and evaluation across different levels of government.

Weather-Health Alerting System

The Weather-Health Alerting System operates year-round. When a heat health alert is issued by the Met Office and UKHSA, it is cascaded to:

- the public via news and social media
- the Cabinet Office, the Department of Health and Social Care (DHSC) and other
- government departments and agencies
- NHS England
- UKHSA and regional teams
- local authorities, including the directors of public health, local resilience forums (LFRs)
- and local health resilience partnerships (LHRPs)

The NHS England national team cascades the alert to NHS England regional teams. The NHS England regional teams then cascade the alert to the Integrated Care Boards (ICBs). The ICBs and local authorities work closely within the Integrated Care Partnerships (ICPs). ICBs cascade the alert to the NHS funded organisations.

Further points to note on this cascade are that UKHSA would be expected to liaise with directors of public health to offer support, but formal alerting would be expected through usual local authority channels.

Local Health Resilience Partnerships, Health and Wellbeing Boards, Integrated Care Partnerships are strategic and planning bodies, but may wish to be included in local alert cascades.

NHS England regional teams and ICBs should work collaboratively to ensure that between them they have a cascade mechanism for weather and health alerts to all providers of NHS funded services both in business as usual hours and the out of hours period in their areas.

Local authorities, including the directors of public health, LRFs, LHRPs cascade the alert to:

- health and wellbeing boards (HWBs)
- social services
- day care centres
- residential homes and children's homes
- winter warmth advice services
- community and voluntary organisations

This cascade diagram can be viewed here: Weather-Health Alerting System cascade.

ToR 11. Does the UK need a dedicated Heat Resilience Strategy? What lessons can be learned from other nations when it comes to national strategies for heat resilience?

From a public health perspective, a strategy has already been established. UKHSA published the Adverse Weather and Health Plan (AWHP) in April 2023. The Plan outlines the important 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, including periods of heat. 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 Alerting system (heat and cold), developed in collaboration with the Met Office

Learning from both experience of implementing the Heatwave and Cold Weather Plans for England since 2004 and 2011, respectively, and shared experiences from international partners have all feed into and directed the development of the AWHP and new Heat-Health Alerting system. This means that from an international perspective, the AWHP and underpinning Heat-Health Alerting system are innovative approaches to addressing health risks associated with high temperatures.

UKHSA are actively engaged with global partners in relation to heat-health activities via the G7, International Association of National Public Health Institutions (see G7 report on Heat

Preparedness through Early Warning System), World Health Organisation (WHO) and World Meteorological Organisation (WMO) and the Global Heat-Health Information Network (GHHIN) to produce examples of best practice and evidence. Through these partnerships UKHSA are sharing UK innovative approaches to Heat-Health Action Planning and response. A key example is that UKHSA is providing expertise to the updated guidance from the WMO/WHO on development of Heat-Health Early Warning Systems and the accompanying WMO Handbook on Heat Indicines which will provide the global community with actionable information that can be used to help countries develop and implement heatwave early warning systems.

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