Climate change-driven extreme heat, occupational health and productivity:

A need for human-centred policy in the UK

The Physiological Society

150 YEARS 1876 2026 LEADING DISCOVERY SCIENCE

Steering Group

We are grateful to the members of the Extreme Heat in the Workplace Steering Group who offered their time and expertise to ensure the success of the project. The views expressed in this report should not be attributed to any one individual or organisation that contributed to this work unless otherwise stated. The findings and recommendations in the report do not necessarily reflect the views of individuals on the Steering Group or their organisations.

- Dr Josh Foster, King's College London (Chair)
- Dr Shouro Dasgupta, Grantham Institute at LSE
- Dr Chris Davis, Institute of Occupational Health and Safety
- Dr Clare Eglin, University of Portsmouth
- Arthy Hartwell, Wellcome
- Professor George Havenith, Loughborough University
- Professor Emma Howard Boyd, National Heat Risk Commission
- Dr Sarah Koch, University of Basel, Switzerland
- Dr Jessica Mee, University of Worcester
- Dr Gemma Milligan, University of Portsmouth
- Dr Rebecca Neal, Bournemouth University
- Professor Madeleine Thomson, Wellcome
- Professor Heidi de Wet, University of Oxford

Authors

The following Physiological Society staff worked with the Steering Group to develop this report:

- Tom Addison
- Dariel Burdass
- Harriet Gay
- Melissa Saphra

We would like to thank the experts who shared their insights through their membership of the Steering Group, review of the drafts, submission of case studies and participation in the exhibition at the report's launch.

Acknowledgements

The following individual also gave expert advice on the report:

- Professor Mike Tipton, University of Portsmouth, President of the Physiological Society

This report was sent to the Society's Policy Committee for consideration of the contents and recommendations, and for final commentary and agreement.

- Professor Áine Kelly, Trinity College Dublin, Ireland
- Professor Heidi de Wet, University of Oxford
- Professor Hugh Montgomery, University College London

Climate change-driven extreme heat, occupational health and productivity: A need for human-centred policy in the UK

Issued: August 2026
ISBN: 978-1-0669116-0-8

To view this report online and find out more about the Society's work in this area, scan the QR code or visit:

http://physoc.org/ExtremeHeatInTheWorkplace

Report design: Andy Pamplin. Front cover: Washburn HM

Glossary

Term	Definition
Extreme heat	High temperatures and other atmospheric conditions (e.g. humidity) that exceed local historical norms and UK benchmarking. In this report, this refers to both one-off occurrences, temperature spikes and heatwaves.
Ambient air temperature	The temperature of the surrounding air in a specific location.
Humidity	The measure of water vapour in the air. High humidity raises the apparent temperature above the ambient air temperature, making it feel hotter than it is.
Wet Bulb Globe Temperature (WBGT)	A measure of the heat stress in both shaded and sunny areas, which takes into account: temperature, humidity, wind speed, sun angle and cloud cover (solar radiation).[1]
Solar load	The direct shortwave radiant energy absorbed by skin and clothing from sunlight, sky scattering, and ground reflections.[2] In effect, this is the energy transferred to the body from the sun's rays.
Maladaptation	Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas (GHG) emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence.[3]
Worker	A person who, for a certain period of time, performs services for and under the direction of another person for remuneration in indoor or outdoor environments.[4] For the purposes of this report this definition includes salaried, self-employed, 'gig' workers and freelancers.
'Gig' workers	Those engaging in more flexible, short-term work, often providing services for companies that use digital platforms.[5]
Adaptation	Adjustments in systems, behaviours, or policies to reduce harm from climate impacts or take advantage of new opportunities.
Mitigation	Actions to reduce or prevent the emission of greenhouse gases to limit future climate change.
Tropical nights	Nights when the temperature does not fall below 20 °C.[6]

Foreword

Julia King, Baroness Brown of Cambridge FREng, FRS, FMedSci
Chair, Adaptation Committee of the Climate Change Committee

If the latest round of summer heatwaves in the UK have taught us anything, it is that impacts of human-driven climate change are already upon us and the UK is currently not prepared to respond effectively to the intense and wide-ranging effects.

Our lives and livelihoods are under increasing pressure from the changing climate. But we are not powerless. In an increasingly unstable world, being well-adapted to climate change is fundamental to securing our food, energy, economic and national security.

Earlier this year, the Climate Change Committee (CCC) published A Well-Adapted UK. This new report sets out a comprehensive package of solutions to address the growing impacts of climate change affecting every aspect of life in the UK. For each area of public life that the Committee analysed, the Committee proposes a series of targets that the four national governments of the UK should look to meet to ensure resilience and adaptation across the whole of society. Action is needed urgently, the climate is becoming increasingly extreme and will continue to do so until we reach net zero globally.

It is very positive to see organisations such as the Physiological Society bringing the expertise of their membership both to address some of the questions posed in our report but also point out where gaps currently exist in the implementation and evidence to help us ensure solutions that are effective and equitable.

Back in July of last year, I gave a presentation at the Society's Global Climate and Health Summit which looked at some of the emerging data that would ultimately go on to form the evidence base for A Well-Adapted UK. From the other presentations that we heard throughout the two days of the conference, it is clear that physiologists, working alongside policymakers and other disciplines, will be crucial in ensuring that workers' productivity and health are protected as part of a well-adapted UK.

The cost of inaction is far greater than the cost of acting now. Overall, the Committee's proposals require investment of around £11 billion a year. However, we know that simple, cost-effective solutions can protect workers from extreme heat, but only if companies and employees are empowered with both the information and the agency to make workplaces safer and more productive, supported by appropriate regulation and legislation.

I am pleased to see organisations working to make our vision for a well-adapted UK a reality. I look forward to hearing that this report's recommendations have resulted in positive change.

Chair Foreword

Dr Josh Foster
Chair of the Physiological Society's Extreme Heat in the Workplace Steering Group
Lecturer in Environmental Physiology and Director of the Thermoregulation Lab, Kings College London

The climate crisis presents a growing threat to health and workplace productivity in the UK. In June 2026 alone, days above 30 °C cost the UK economy more than £1.15 billion in lost output, driven largely by the impact heat has on individual workers.[7] Projections show that we are sadly on the foothills of this impact, as heatwaves will continue to rise in their frequency, severity, and duration for at least the next few decades.

Failing to act is no longer an option. In addition to decarbonisation of all sectors, governments, businesses, and individuals must take proactive steps to protect the health and productivity of workers in the UK. However, we can only develop effective interventions for all workers if we understand how heat and other factors affect an individual's ability to remain safe, healthy and productive in hot environments.

Physiology has a crucial role to play in addressing this challenge. As physiologists, we develop a unique understanding of how heat impacts the body, what populations are the most vulnerable, and the effectiveness of different solutions.

The impact heat places on the human body, and the effectiveness of any 'solution', depends on a multitude of environmental, individual, and logistical factors. Physiology therefore has a crucial role to play in assisting the development of effective, evidence-based policies aimed at protecting the UK's workforce and economy.

While the task is immense, the UK boasts a growing list of highly skilled and experienced physiologists specialising in heat protection. I would like to sincerely thank those colleagues who have taken the time to assist in the production of this urgently needed report. I would like to extend that thanks to all physiologists worldwide who continue to rapidly enhance our knowledge and offer hope in a time of widespread climate anxiety.

Through the diligent work of the Physiological Society and physiologists, we have produced a detailed report demonstrating how heat impacts the body and potential solutions to mitigate those effects. It is my hope that the launch of this report acts as a springboard for continued engagement between physiology, policy, and industrial partnerships.

Credit: Junk Culture

Contents

Executive summary

The impact of extreme heat in the UK workforce

The UK workforce is underprepared for and insufficiently resilient against extreme heat, particularly as the management of heat risk does not effectively take a human-centred physiologically informed approach. Heat-related impacts in the health sector currently cost the UK £538 million annually and could increase by 245% by the 2050s.[8]

The UK faces unchartered territory each year with extreme heat we are not accustomed to, and infrastructure and working conditions that are not adequately adapted. Continued climate change will make this problem worse in the decades to come.

Within the workforce, extreme heat has a significant impact on not only the health but also the productivity of workers. The World Health Organization (WHO) estimates that for every 1 °C temperature rise above 20 °C, productivity falls by 2%.[9] This is made worse as temperatures become more extreme. In the case of UK, a 1 °C increase in temperature potentially reduces the number of hours worked among the UK labour force by more than a 100 million hours.[10]

The heat-related decrease in working hours adds an additional strain to the UK economy, estimated to amount to approximately £1.3 billion in lost earnings annually under a 2 °C warming scenario from 2050.[11]

What is the role of physiology?

Some workers are more vulnerable to the impact of heat exposure than others because of a lack of physiological resilience as a result of their health or inability to respond physiologically to extreme heat. Others are vulnerable because their work environments or the demands of their role overwhelm their body's physiological defensive response to heat. This is because they are less able to maintain or improve their physiological resilience or have less agency to change the demands of their work. These two factors also compound and reinforce one another. Protecting worker productivity and health requires a consideration of physiological and work demand perspectives and, in particular, those living at the intersection of multiple vulnerabilities and risks.

Physiological research and insight have the potential to inform a virtuous combination of interventions in which legal protections, employer guidance, and public health advice work together to ensure that workers and employers are aware of the individual risks associated with extreme heat. This enables different workplaces and sectors to implement appropriate measures that protect health and safety while accounting for the vulnerabilities most relevant to each worker's health status and occupational context.

Key takeaways: challenges and opportunities

- Heat, especially when combined with higher levels of humidity, is a significant productivity and health risk for the broader working population across all industries.
- Our adaptations are lagging behind the speed at which the climate is changing.
- Ambient air temperatures are not sufficient to capture heat risk alone. Maximum working air temperatures are an important starting point in the Government's recognition of the impact of heat on workers. They will be effective in protecting workers' health and productivity only if physiology is at the heart of developing the Government's response and graded thresholds.
- High risk individuals are not just those working in highly exposed sectors, they also may have physiological vulnerabilities. A greater number of physiological vulnerabilities within the working age population will put further pressure on productivity as we experience increasingly frequent and intense periods of heat.

- **Guidance on heat management for workers in the UK is well-evidenced but remains inaccessible to the working population and is short-term in focus.**[12] Additionally, public health guidance on health and wellbeing from across the four nations can be adapted in its communication to target the benefits to the working age population.
- **There are both implementation and evidence gaps in our understanding of heat risk, particularly for vulnerable workers.** Sufficient evidence currently exists for a more informed approach to managing heat in the workplace with simple and cost-effective interventions. However, significant gaps remain in our ability to predict individual responses to a given exposure and our understanding of how solutions will work in different occupational settings.

The UK Government needs to take well-planned, effective action to ensure extreme heat is managed proactively, taking physiological vulnerabilities into consideration. Without a more interventionist regulatory system, approaches to balancing productivity with worker health and safety will be left to inconsistent application from organisations in all sectors of the economy.

Summary of the report's recommendations

The report identifies where the UK Government can make better progress to protect the health, wellbeing and productivity of the workforce from the impacts of extreme heat:

→ The UK Government should set targets for extreme heat that consider wider physiological risk factors.

→ The UK Government should provide effective and physiologically informed guidance that enables all employers to protect workers from extreme heat risk while enabling them to maintain productivity.

→ The UK Government should update regulations to ensure workers' productivity and health are legally protected during periods of extreme heat.

→ The UK Government should support further research that will address gaps in understanding of how heat impacts productivity, health and safety

→ The UK Government should coordinate public health messaging across the four nations to support a wider understanding of the benefits of improving physiological resilience to heat risk for worker productivity and health

→ **To ensure recommendations are effectively implemented and human-centred, physiologists and/or physiological evidence must be included in the consultation and decision-making process.**

A complete list of the recommendations with specific actions can be found on **page 46.**

What is physiology?

Physiology helps us to understand how the human body works in health and how it responds and adapts to the challenges of everyday life. Without understanding how climate stress affects the body and the vulnerabilities and variabilities of human limits, we risk designing policies that fail to optimally protect people.

Credit: Quality Stock Arts

Chapter 1: The risks and consequences of climate-driven extreme heat on the UK working population

In this report, the Physiological Society sets out the need for a human-centred policies and strategies to protect workers from the growing risk of extreme heat across the UK as a result of climate change. To properly understand and respond to the heat-related impacts to health, safety and productivity of workers, existing and new scientific evidence needs to be considered, developed and employed in decision-making. This includes a technical understanding not only of the growing climate change risks, but also of physiology.

The risk: extreme heat in the UK

The immediate need to respond to climate change risks

Climate change is placing a huge stress on the UK's economy, health, natural ecosystems and infrastructure, and is threatening the way that we live.

The Climate Change Committee (CCC) has identified intensifying heat as one of the three major climate change hazards for the UK. The 2026 UK heatwaves show that climate change is posing an immediate threat to the UK's health.[13] It is estimated that 2,700 people have died because of the May and June 2026 heatwaves,[14] where temperatures reached a high of 37.7 °C—the highest temperature ever recorded in the UK in the month of June.[15,16] However, it is also already impacting the UK's workforce and output. Evidence shows that the June heatwave resulted in 24 million lost working hours and £1.15 billion of lost output.[17] Climate-driven health impacts are already being felt, and adaptation alone will not provide the stability to withstand climate-related pressures.[18] Emissions reduction must be urgently prioritised to prevent further irreparable damage from climate change. The physiological science is unambiguous: there are limits to which people can adapt, cope and recover, and without urgent mitigation, those limits will be repeatedly and fatally breached. At the same time, the UK is already seeing significant climate-driven impacts on health; therefore, building resilience to protect people cannot wait until emissions fall.

The CCC predicts that pairing emissions reduction with adaptation efforts could cut projected UK-based heat-related deaths in 2050 from 10,000 to 3,000 annually.[19] Therefore, mitigation and adaptation must be treated as a pairing in order to be most effective, maximise resources, avoid additional risks such as maladaptation, and lead to greater co-benefits for climate, health, national security and the economy.[20]

> *"Adaptation without mitigation is bailing out a boat while drilling more holes in the hull. The Climate Change Committee has shown that net zero will cost less than a single fossil fuel price shock, and returns between two and four pounds of benefit for every pound spent. The path to a more secure, more prosperous Britain runs through both cutting emissions and adapting well. Not one or the other."*
>
> **Professor Emma Howard Boyd CBE, Chair, National Heat Risk Commission**

Credit: stevecoleimages

The UK is adapting slower than the climate is warming, and this has created a critical resilience gap which leaves the country dangerously unprepared for the immediate and worsening impacts of the changing climate. While the UK must remain focused on achieving net zero to mitigate climate change, it must also invest in adaptation measures that address current and future climate impacts, strengthen economic resilience, and protect national stability and public health.[21]

Extreme heat will continue and become more severe

The UK is already struggling with the impacts of extreme heat. July 2026 was the driest July recorded in history and the busiest month ever recorded for fires.[22,23] Annual heat-related excess deaths could rise to 10,000 in an average year by 2050—more than tripling from the current 2026 peak annual figures.[24,25] Heatwaves are expected to intensify and increase in their frequency and length, with temperatures regularly exceeding 40 °C in parts of the UK.[26]

Extreme heat exists as a risk multiplier. It interacts with existing environmental and structural vulnerabilities to create systemic shocks, and this translates into a wide range of critical impacts across the UK's infrastructure, economy and public services.

Heat-related risk is made worse by the compounding of other climate or infrastructure hazards. When there is heat coupled with humidity, the effects of heat are made worse on human productivity and health.[27] When there is both drought and heat, wildfire risk increases, as demonstrated by the wildfires that raged across Scotland, France and Spain in Summer 2026.[28] When extreme heat coincides with increased levels of fine airborne particles and ozone, public health risk is exacerbated.[29] The urban heat island (UHI) effect refers to an urban area that is significantly warmer than its surrounding rural areas due to human activities. Urban areas can be up to 12 °C warmer than the surrounding countryside; this difference in temperature is due to how well the surfaces in each environment absorb and hold heat.[30]

Case study

Adapting to a Polluted World: Physiological Research and Practical Solutions for Outdoor Exposure

As a direct result of climate change, there are more severe and frequent wildfires globally. Although the UK is not yet a major source of wildfire air pollution, this is a growing issue. For example, in 2025, the area burned in the UK was the largest on record. Moreover, particulate matter from wildfires does not respect international borders. In the summer of 2025, particulate matter from Canadian wildfires was carried by the jet stream to parts of Europe, leading to high particulate levels and haze. Particulate matter released from these wildfires has long-term consequences on health, leading to increases in respiratory and cardiovascular diseases, dementia, cancer, and death[31,32]

Furthermore, ground-level ozone, a noxious gas, is created on sunny days through UV radiation-mediated conversion of oxides of nitrogen and volatile organic compounds (VOCs) from internal combustion and industrial sources. Increased ground ozone leads to symptoms such as cough, chest tightness, and shortness of breath in healthy individuals and can worsen lung function in people with respiratory conditions such as asthma and emphysema.[33]

While effective air filtration can reduce particulate matter exposure among indoor workers in modern buildings, outdoor workers remain exposed throughout the workday. This exposure is compounded in occupations such as agriculture and construction, where high levels of physical activity can increase breathing rates and therefore the inhalation of airborne pollutants. Likewise, active commuters such as cyclists and pedestrians are also exposed to increased doses of these harmful pollutants on their way to and from work. This increased inhaled dose could lead to an increase of the harmful effects.

To mitigate these health risks, physiologists study the effects of the individual pollutants on the body to understand both the mechanisms and risks of exposure to pollution. They conduct this research through direct laboratory exposure studies or field studies in affected populations. They research both healthy populations and individuals with clinical conditions.

Through this research, physiologists have been able to:

- Assess the tolerability and effectiveness of masks during various types of activity.
- Determine that activity duration is more important than the intensity of activity in terms of causing health risks.
- Determine that supplements can reduce the health effects of ground level ozone air pollution.
- Investigate the extent to which individuals can adapt to certain air pollutants.
- Quantify the doses experienced by workers as part of their tasks.

Based on this research, physiologists from Canada, Spain, France and Brazil have developed and disseminated guidelines to clinicians and the public, outlining a series of strategies for reducing the harmful effects of exposure to air pollutants exacerbated by the consequences of heat during outdoor physical activity.[34]

Professor Michael Koehle
University of British Colombia, Canada

The impact of extreme heat on health

The climate emergency is a health emergency that requires urgent action.

In its report A Well-Adapted UK, the CCC specifies that "increasingly extreme and frequent heatwaves are the greatest risk to health in the UK from climate change." There is an increasing evidence base which links extreme heat with a deterioration in mental health, aggression, and declines in learning and productivity.[35,36]

Everyone is at risk from the health impacts of extreme heat exposure, particularly people who have pre-existing vulnerabilities. Vulnerable groups including pregnant women, older people, children, people with psychosis and depression, and those with chronic physical conditions like diabetes or cardiovascular illnesses are typically less able to regulate their core temperature and cope with heat stress, which leaves them particularly exposed to the health risks which come with extreme heat.[37,38,39]

Heat vulnerability also extends to socioeconomic disparities. Low-income workers often face high levels of heat exposure but are limited in their ability to adapt to these conditions or absorb lost wages.[40]

Policy designed to combat extreme heat has focused predominantly on lowering excess mortality during periods of extreme heat. However, beyond mortality, extreme heat affects human capacity to perform effectively both mentally and physically. For example, during Europe's heatwave of 2023, Switzerland's national accident insurance fund (Suva) estimated that when temperatures rose over 30 °C, workplace accidents rose by 7%. The causes, Suva said, included physiological effects; workers struggled to concentrate at work as their bodies failed to adapt to extreme heat and lack of sleep, driven by 'tropical nights'.[41]

Heat is already acting as a physiological constraint on workforce function, and the UK must begin addressing extreme heat as a major threat to workforce productivity, safety, and occupational health.[42]

Credit: SolStock

The context: the UK's workforce and policy landscape

Extreme heat poses a significant health, social, and economic risk to the workforce

"Combined, the reduced hours and the full days not worked due to heat come to about 24 million lost hours, or approximately £1.15 billion of lost output in a single severe heatwave week [in June 2026]. This impact in lost output is on top of the negative impacts on workers' health and increased pressure on health services."

Professor Elizabeth Robinson & Dr Shouro Dasgupta, Grantham Research Institute at LSE[43]

The current and growing risk of extreme heat across the UK poses a significant threat to the health and safety of the working population. It impacts the body both physically, through increased strain on the cardiovascular system, and mentally, affecting concentration and decision-making, causing fatigue, nausea, dizziness, and, if left untreated, heat exhaustion, heatstroke, organ failure and, ultimately, death. In responding to a survey conducted by the Grantham Research Institute (GRI) based at London School of Economics, just under a third of workers stated that the high temperatures in summer 2024 had harmed their health.[44] The health-related threats of extreme heat are increasing. In the third round of this survey undertaken by GRI in 2026, 87% of workers reported at least one health-related impact during the June 2026 heatwave.[45] Managing this growing risk to workers is not just a legal duty, it also ensures that a large part of the UK population is better protected from the threat of extreme heat in environments where they spend approximately 30% of their time.[46]

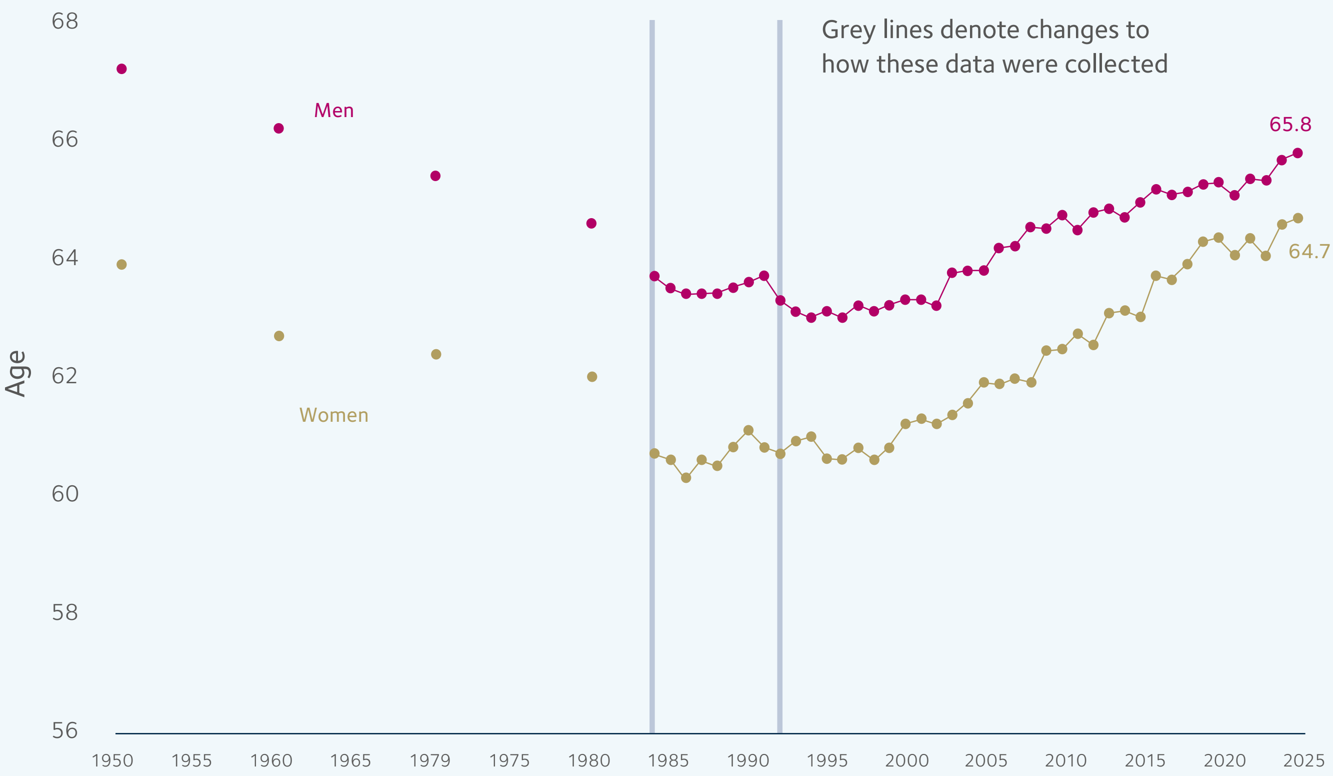
As the health and safety of workers is increasingly impacted by extreme heat risk, so is the physical work capacity and availability of the workforce.[47] The World Health Organization (WHO) estimates that for every 1 °C temperature rise above 20 °C, productivity falls by 2%.[48] This is made worse as temperatures become more extreme, with research finding that working at 35 °C/50% humidity decreases work capacity by 35%, which increases to a 76% working capacity loss when working at 40 °C/70% humidity'.[49] In the case of UK, a 1 °C increase in temperature potentially reduces the number of hours worked among the UK labour force by more than a 100 million hours. The impacts of extreme heat are made worse by consecutive heatwaves, where heat stress is prolonged, or when there are multiple heatwaves within a year, making it difficult to effectively implement adaptation strategies.[50] These challenges will become more frequent as extreme heat events increase in intensity, frequency and length.

Heat-related impacts in the health sector currently cost the UK £538 million annually and could increase by 245% by the 2050s.[51] The heat-related decrease in working hours adds an additional strain to the UK economy, estimated to amount to approximately £1.3 billion in lost earnings annually under a 2 °C warming scenario from 2050.[52] This loss is particularly pronounced among those working in sectors which are physically demanding and highly exposed to heat such as agriculture and construction and among those using personal protective equipment (PPE), as they are most prone to lost hours as a result of elevated temperatures.[53] This is in addition to the financial implications of other impacts on businesses, such as disruptions or damages to supply chains or infrastructure. For example, rail track buckling at high temperatures, which is expected to increase in frequency by four to five times by the 2050s, can lead to delayed and failed train services, and have a significant knock-on impact on commuters and nationwide productivity.[54]

As the direct risk of heat is increasing because of climate change, so too are the groups particularly susceptible to this risk. Socioeconomic inequalities may be further exacerbated as some individuals have to make the decision to protect their income over their health. Older people, who are more likely to have lower physiological resilience to extreme heat, are staying in the workforce longer, with the average age of exit from the labour market in 2025 reaching the highest recorded level since annual reporting began in 1984 (Figure 1).[55]

Trends show a decline in health and fitness across workforces, particularly in certain high-risk physically demanding industries (including law enforcement, firefighters, military personnel); this exposes workers to greater heat-related health risk and labour loss.[56,57,58,59] In addition, workers on precarious contracts such as hourly paid, piece-rate commissions, and zero hour contracts are less likely to undertake adaptation.[60] Adaptation planning must be flexible and responsive not just to the changing climate, but also the evolving nature of the UK's workforce.

Figure 1. Average age of men and women exiting from the labour market, 1950 to 2025, UK.



Credit: Department for Work and Pensions[55]

Case study

UK heatwaves are already impacting workforce health and productivity, but adaptation is limited by structural barriers rather than awareness[61]

Rising UK heat exposure is creating increasing health and productivity impacts, yet current heat-health guidance and workplace policies are based on narrow risk categories and do not reflect the lived reality of the wider working population. As a result, there is limited understanding of how heat is experienced across the workforce and why effective adaptation is not consistently achieved.

Researchers at the University of Worcester undertook a real-world, mixed-methods UK heatwave study combining population survey data and qualitative focus groups conducted during multiple heat events, capturing experiences across diverse working-age and occupational groups. It captured national patterns of heatwave preparedness, access to guidance, and adaptation behaviours, alongside lived experience of heat impacts across occupational and demographic groups.

Heatwaves were associated with widespread self-reported disruption to sleep, health, and productivity across UK adults, including those not traditionally classified as vulnerable. In this sample, 84% reported impaired sleep and 67% of employed participants reported reduced productivity during heat events. Preparedness remained low despite high awareness, and access to guidance was unevenly distributed across occupational and socioeconomic groups. Symptom burden was not uniform, with sex-related differences observed in several outcomes, and qualitative findings suggesting heightened heat sensitivity among peri- and post-menopausal women. However, the primary constraint on adaptation was structural, driven by workplace conditions, cost, and lack of enabling environments rather than awareness or willingness to act. These findings indicate perceived impacts of heat exposure and highlight the need for system-level interventions across workplace policy, public health communication, and built environment design.

Dr Jessica Mee
University of Worcester

Responding to extreme heat will support wider government commitments

Adaptation against heat risk can be a 'win-win' for employer and employee. Simple, cost-effective methods can be highly effective in empowering workers to protect themselves, preventing lost productivity and improving occupational health. The Grantham Institute has reported that advance alerts for heat episodes can reduce the probability of workers reporting adverse effects from the heat, and flexible working hours and locations have the potential to reduce losses in labour supply by two-thirds.[62]

Importantly, while employers have a duty of care for worker health and safety, the Government has a responsibility to provide the messaging, guidance, policies and regulations that enable informed workplace-level adaptations and ensure baseline worker protections.

The ongoing and growing impacts of heat risk on the workforce require action that directly aligns with various Government priorities, including:

- Protecting workers: Ahead of their 2024 election win, the now-Labour Government recognised the 'regularly unacceptably high' temperatures in some sectors and committed to 'modernising health and safety guidance with reference to extreme temperatures, preventative action and steps to ensure safety at work'.[63]
- Support economic growth and stability: The UK's Modern Industrial Strategy highlighted the Government's priority to 'deliver strong, secure, and sustainable economic growth to boost living standards for working people in every part of the UK'.[64]
- Building national resilience to risks: Building on the National Security Strategy's priority to build 'security at home', the Government's 2025 Resilience Action Plan commits to continuously assessing the UK's risks and vulnerabilities, enabling whole-of-society action, and strengthening core public sector resilience.[65]

The CCC's *Fourth Independent Assessment of UK Climate Risk* highlights "risks to the lives of vulnerable people from extreme heat" as one of the highest priority areas for action. To drive necessary adaptation in the next two years to respond to this risk, the CCC recommends the Government set maximum working temperature regulations.

Calls for the Government to introduce maximum working temperatures have increased in line with rising temperatures during heatwaves this year. These calls by trade unions and campaigners have been backed by elected officials such as mayor of London, Sir Sadiq Khan, and Hannah Spencer MP, who introduced a Maximum Workplace Temperature Bill to the House of Commons in July 2026.[66,67]

The need for action: effectively protecting worker health and productivity

The real effects of heat on workers

The CCC has warned that the UK "was built for a climate that no longer exists today". Extreme heat is causing a breadth of worsening and widespread problems for which the UK is ill prepared. This includes disrupted learning in schools, strained emergency services and increasing illness prevalence.[68]

Extreme temperatures in the workplace pose a unique and escalating threat to UK productivity and public health. Workplace demands such as PPE protocols, job security pressures and physical labour are preventing the workforce in some industry or work sectors from taking the actions needed to keep cool in extreme temperatures. This leaves certain workers at an elevated risk of compromised cognitive function, heat-related illness, and accidents in their workplace.[69]

The UK currently lacks the infrastructure and regulatory frameworks which are needed to protect its workforce from extreme heat. The consequences of this gap were demonstrated in the June 2026 heatwave, during which a survey from the Doctors' Association UK revealed that 87% of surveyed healthcare workers felt physically unwell due to the extreme heat, and 67% reported that their patient safety was affected.[70] This vulnerability in the UK's most essential services highlights the need for proactive management of extreme heat risks across all workplaces.

Case study

THERMOCARE: Preparing UK Hospital Staff for Heatwave Resilience.

Overheating in UK hospitals has risen by 50% in the past five years, with significant consequences for healthcare staff health, wellbeing, and performance, as well as for patient safety. Current mitigation approaches—such as localised air conditioning, shading, or personal cooling—remain under-evaluated, while the implementation of national guidance (e.g., UKHSA's Adverse Weather and Health Plan) is inconsistent due to insufficient evidence on system impacts and cost-effectiveness. Addressing these gaps, THERMOCARE is an NIHR-funded development award that aims to co-design and evaluate sustainable, user-centred interventions to strengthen the heat resilience of healthcare staff across diverse NHS Hospital settings.

In December 2025, University Hospital Southampton (UHS) shared with the THERMOCARE team at the University of Southampton Estate Help Desk data related to overheating incidents recorded across the UHS estate during 3 periods for the 2022 UK heatwave, as well as an additional comparable period in a non-heatwave year (2021). Furthermore, UHS shared their Adverse Weather Plan, the aim of which is to enhance the Trust's resilience in the event of adverse weather (including heatwaves) and actions to ensure welfare of staff and patients.

The incident data analysed across defined heat and control periods show a marked clustering of overheating-related reports during extreme heat periods—particularly during the most sustained heatwave window, indicating that overheating risk is both predictable and repeatedly realised in operational practice. Importantly, the pattern observed is consistent with the plan's acknowledgement of physical system constraints (e.g. cooling capacity limits under high external temperatures), suggesting that recurrent reports may reflect periods where demand exceeds system capability rather than isolated local failures.

Taken together, the findings indicate that detection and reporting mechanisms are active and responsive, while recurring incidents within heat periods point to a residual vulnerability in the stability of environmental control in certain locations under heat stress.

This analysis is intended to support organisational learning and resilience building by clarifying where 'work as done' requires repeated adaptation to maintain safe care during extreme weather conditions.

Professor Davide Filingeri
University of Southampton

The current legal and regulatory framework for heat risk needs to be more human-centred and updated for rising levels of heat in the workplace

The [Workplace (Health, Safety and Welfare) Regulations 1992] state that indoor workplaces must be maintained at a 'reasonable temperature', and outdoor work settings shall 'as far as is reasonably practicable' protect workers from 'adverse weather'.[71] The UK Health and Safety Executive's (HSE) [Approved Code of Practice and Guidance] that stipulates how to suitably comply with the law, outlines recommendations for minimum temperatures for indoor work, but does not provide any maximum temperature thresholds to guide workplaces in events of extreme heat. As such, there is no equivalent for maximum workplace temperatures in the UK.

Additionally, there are gaps in government policies and legislation (such as the Approved Code of Conduct and Guidance) in providing thresholds for different physiological considerations where individual variables (such as pregnancy, age, pre-existing conditions, medications) may make workers particularly vulnerable to heat risk.

Less than a third of UK businesses currently assess climate risk, partly due to a lack of useful climate risk and adaptation information.[72] Where public health or occupational health messaging exists, it is not always accessible or far-reaching. A recent survey on national heat preparedness found that access to heat-health messaging across the UK was limited, with only 12% of respondents having received guidance from their employers and less than 10% from national public health resources in the preceding three months.[73] Additionally, the study found that guidance was often reactive and narrowly focused on infants, older adults and clinically vulnerable groups, meaning that healthy working-age adults were left out. As the tangible public health impacts of extreme heat exist across the whole population, with individual vulnerabilities being exacerbated by a wide range of factors, the Government's heat-health communication needs to extend beyond traditionally defined at-risk groups.

Different sectors (and workers) must grapple with different drivers of risk

Rising temperatures will impact many individuals and industries. However, certain sectors may be particularly exposed due to a combination of factors that include:

- physically demanding roles
- working outdoors or in settings with greater exposure to heat or humidity
- environments with significant heat-generating processes or equipment such as foundries and bakeries
- working with substances that are more harmful or volatile in higher temperatures
- requiring PPE
- workers who are not empowered to adapt or those on precarious contracts such as hourly-paid or zero hours contracts.

Key workers, such as those in emergency services, health, and social care, face significant risk due to providing vital services that require continuous operations and, often, PPE. Within hospital settings, this is often compounded with the additional pressure on services due to heat strain and growing heat-related hospital admissions and attendances.[74] With Government advice that schools should stay open during hot weather, teachers and school staff are particularly exposed to heat risk.[75] Due to reliance on these services by the public, there are significant knock-on risks to wider society if staff cannot perform their duties or if cognitive function or decision-making are impaired by heat risk.

Construction workers are highly exposed to heat risk due to being in physically demanding roles, coupled often with wearing PPE. Additionally, construction workers can often have the compounding risk of exposure to solar radiation from working outdoors. Those working in the manufacturing sector, particularly where the product or process adds additional heat stress or humidity (e.g. steel, glass and paper), may also be at greater risk. Any impact on the ability for individuals to perform effectively and safely (physically or cognitively) could be particularly detrimental across construction and manufacturing industries and lead to increased workplace accidents.[76] In addition, many construction workers are self-employed, sub-contracted, or work for small firms, making access to information, guidance, and protection harder, as well as making them less empowered to undertake many adaptation strategies such as changing shift patterns.

As extreme heat increases with climate change, vulnerabilities within the workplace will extend beyond traditional high-risk industries. The risk of extreme heat in UK homes and offices is projected to be four times higher than current levels by 2050 and will have a significant impact on the health of office-based workers. With approximately 39% of UK workers being in a hybrid or remote working arrangement, there is a reliance on individuals having the knowledge and capacity to protect themselves from heat-related health risks within home environments during the workday.[77]

Case study

Understanding the physical and thermal demands placed on emergency responders during flood rescue operations

With climate change driving more frequent and severe flood events, as well as intensifying both heatwaves and cold extremes, emergency responders are increasingly required to work in challenging environments. These are characterised by either cold water exposure, where peripheral cooling and cold stress may impair dexterity and decision-making, or hot and humid conditions, where heat strain and exhaustion can significantly reduce work capacity. At present, there is limited evidence describing the physiological requirements of flood rescue, the thermal strain experienced by responders, or the optimisation of PPE to support safe and effective performance. Research from the University of Portsmouth sought to address this.

The research aimed to evaluate the physiological and thermal responses of personnel engaged in flood rescue activities, identify key risk factors for cold- and heat-related incapacitation, and determine evidence-based strategies for optimising work-rest schedules and PPE. Ultimately, the goal was to enhance responder safety, resilience, and operational effectiveness in the face of evolving climatic and environmental demands.

Despite mid-thigh immersion in cool water, metabolic heat production combined with warm ambient conditions led to a progressive rise in core temperature. Cardiovascular and perceptual responses (heart rate, oxygen uptake, perceived exertion) indicated work at or near maximal capacity. One experienced responder was unable to sustain continuous work beyond 10 minutes at the original prescribed representative intensity; extrapolation suggested heat exhaustion in approximately 43 minutes and heat stroke in 60 minutes if work continued.

This research demonstrates that without appropriate intervention, responders operating in warm flood conditions face a significant risk of heat illness and performance impairment, underscoring the need for proactive management strategies. As a result, a number of modifications have been made to the clothing requirements and dry suit design of emergency responders. The findings have also informed national-level guidance, including the UK DEFRA Concept of Operations and evidence-based training has been introduced to support incident managers in understanding physiological risks and operational decision-making.

National policy now mandates structured work–rest cycles, including regular breaks, defined full rest periods and operational limits have been introduced, restricting frontline deployment to approximately 4 –6 hours to safeguard responder health and safety.

Dr Gemma Milligan
University of Portsmouth

How does physiology help us understand how workers respond to heat?

Physiology is the science of life: it is the branch of biology that aims to understand the mechanisms of living things, from the basis of cell function to the integrated behaviour of the whole body and the influence of the external environment. It helps us understand how the body responds to challenges and where the limits of comfort and survival lie.

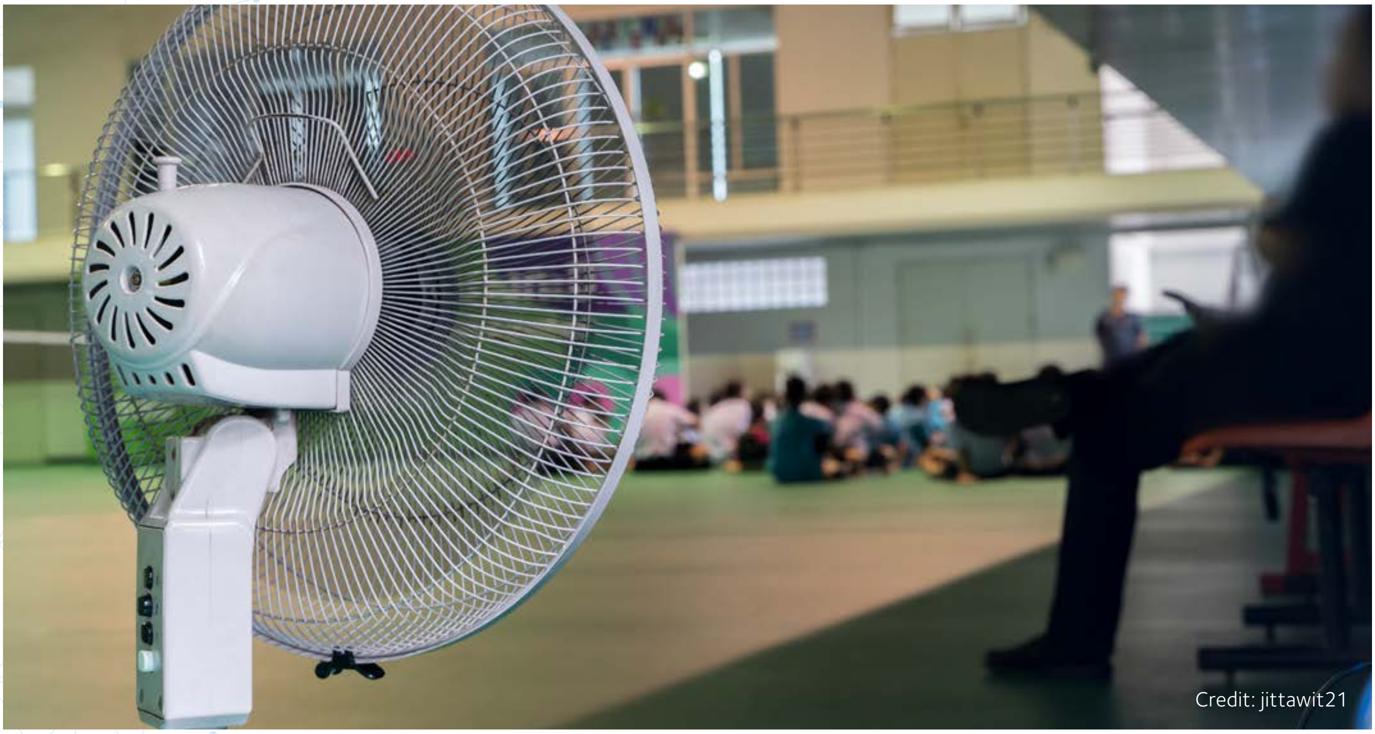
Some workers are more vulnerable to the impact of heat exposure than others because of a lack of physiological resilience as a result of their health or inability to respond physiologically to extreme heat. Others are vulnerable because their work environments or the demands of their role overwhelm their body's physiological defensive response to heat. This is because they are less able to maintain or improve their physiological resilience or have less agency to change the demands of their work. These two factors also compound and reinforce one another.

Protecting worker productivity and health requires a consideration of physiological and work demand perspectives and, in particular, those living at the intersection of multiple vulnerabilities and risks.

Physiological research and insight have the potential to inform a virtuous combination of interventions in which legal protections, employer guidance, and public health advice work together to ensure that workers and employers are aware of the individual risks associated with extreme heat. This enables them to implement appropriate measures that protect health and safety while accounting for the vulnerabilities most relevant to each worker's health status and occupational context.

This will ensure that all workers are supported to maintain their health and productivity as temperatures rise as a result of human-driven climate change.

The next chapter of this report goes into more detail about the risks and vulnerabilities related to heat that rising temperatures pose to workers and how physiology can support effective preparation and adaptation.


Credit: jittawit21

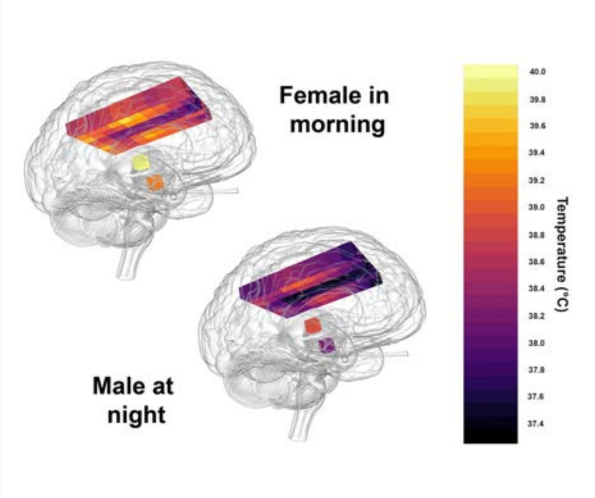
Case study

Brain temperature dynamics must inform workplace heat risk policy

Workplace heat policies often treat temperature thresholds as static and focus on body temperature. Human health, wellbeing, and productivity, however, critically depend on brain function. Brain temperature has been difficult to measure but recent work shows the brain as a highly dynamic thermal machine. Ignoring variation in this vital parameter could obscure genuine heat effects or misclassify risk, particularly in shift workers, workers with neurological impairment, and in safety-critical occupations.

In 2019, the normal value of human brain temperature and its variation was unknown. Dr Nina Rzechorzek led a collaborative study hosted at the MRC Laboratory of Molecular Biology in Cambridge, with the healthy-volunteer brain scanning conducted at Edinburgh Imaging, University of Edinburgh. The study recruited 40 participants (20 male, 20 female) aged 20 – 40 years for non-invasive brain temperature measurement using MRI-based thermometry. The participants were scanned in the morning, afternoon, and late evening, controlling for menstrual cycle phase and individual chronotype. Human brain temperature was quantified and tested for its association with key factors known to influence body temperature. This work was funded by the MRC.

The first four-dimensional map of healthy adult brain temperature—HEATWAVE—showed that adult brain temperature is higher and varies more than previously assumed according to brain region, age, menstrual cycle phase, and time of day. The observed brain temperature range was 36.1 °C to 40.9 °C. Brain temperature was higher in post-ovulatory females and in core brain regions; it also dropped at night and increased with age. These findings suggest that occupational heat research should time-stamp exposures and measurements, account for shift timing, sleep, and relevant biological factors, and avoid interpreting temperature without temporal and physiological context.



Dr Nina Rzechorzek
University of Cambridge

Credit: Nes

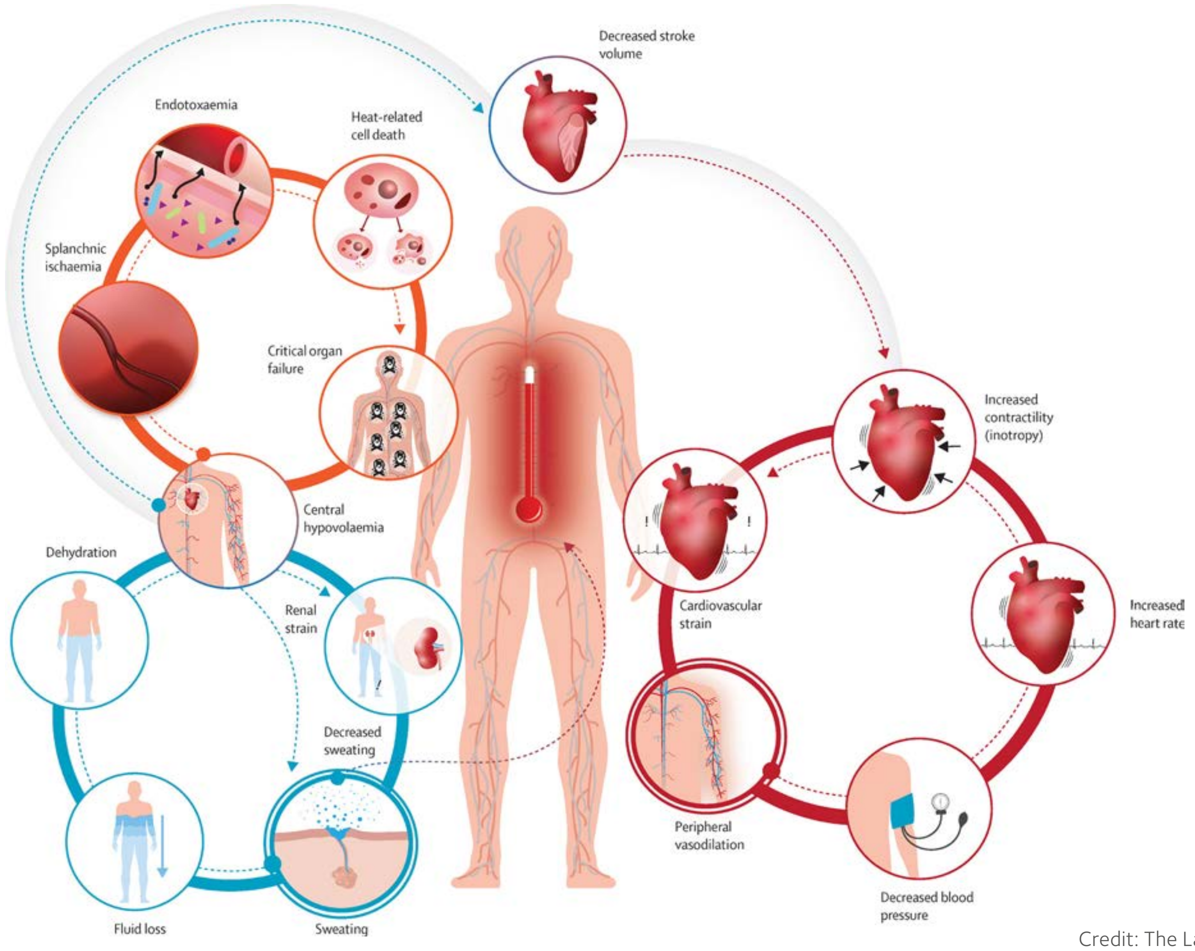
Chapter 2: What does physiology tell us about how our bodies respond to extreme heat?

The effect of heat on the body

The following section gives a brief explanation of how the body responds to heat, how different weather conditions can affect how the body perceives heat and how different vulnerabilities can change how effectively an individual can respond to heat.

Resting body temperature tends to fluctuate between 36.5 °C and 37.5 °C depending on time of day, activity, fitness, age and hormonal cycles. In response to heat accumulating in the body, from physical work and/or hot environments, humans trigger thermoregulatory responses (vasodilation, sweating) which work to prevent body temperatures reaching unsafe levels. Early signs of heat illness include light-headedness or dizziness, fast pulse, fast breathing, fatigue, cramps, nausea, headache, visual disturbance and pins and needles in fingers and lips.

Figure 2: Illustration of the physiological pathways of human heat strain.



Credit: The Lancet[78]

Table 1: Differences between heat exhaustion and heat stroke

Symptoms of heat illness[79]	
Heat exhaustion	Heat stroke
Feeling faint or dizzy	Feeling confused
Excessive sweating	No sweating
Clammy skin	Temperature over 40 °C; dry skin
Nausea or vomiting	Nausea or vomiting
Muscle cramps	Loss of consciousness; convulsions; seizures

The body responds to prevent overheating through the following physiological functions:

Vasodilation

The blood plays a critical role in temperature regulation. It distributes heat from the deep core and muscles to the skin surface, where that heat can be lost to the environment.[80] Blood vessels leading to the skin capillaries become wider, allowing more blood to flow to the skin surface, and more heat to be lost to the environment assuming the temperature gradient is in the right direction.

As the arteries and veins expand, the heart rate and cardiac output increase in order to help maintain blood pressure. An inadequate response from the heart (as may be expected in heart disease or very poor fitness), or severe heat strain and dehydration can result in fainting and progress to full cardiovascular collapse.

Sweat production

As core body temperature rises, the sweat glands in the skin release sweat. The sweat must evaporate from the skin surface in order to transfer heat energy from the skin and the blood beneath it into the environment. Progressive fluid loss that is not adequately replaced can place further strain on the heart, while aggravating strain on vital organs and decision-making ability.

Breathing changes

In the heat, breathing may be faster and deeper. This can typically cause light-headedness, and results in minimal heat loss compared to what occurs at the skin surface. At rest, breathing rate typically only increases when a person's core temperature exceeds an acceptable or safe level. This means that heavy breathing is an early warning sign that a worker should cool down before continuing any further heat exposure.

Heat loss

Once the heat reaches the skin, it is dissipated into the surrounding air through four primary mechanisms.[81]

- Evaporation is the transfer of heat by the evaporation of water. Because it takes a great deal of energy for water molecules to change from a liquid to a gas, evaporating water (in the form of sweat) removes energy in the form of heat from the skin. However, the rate at which evaporation occurs depends on humidity—more sweat evaporates in lower humidity environments. Sweating is the primary means of cooling the body when air temperatures are above 30 °C. Wearing clothing impairs this process through decreasing evaporation.

- **Radiation** is the transfer of heat via electromagnetic waves (mainly infrared). This occurs between any two objects when their temperatures differ. A radiator can warm a room via radiant heat, and at work, machinery can act as a radiator. On a sunny day, the radiation from the sun warms the skin. The same principle works from the body to the environment. The amount of radiative heat exchange varies with ambient temperature, skin temperature and clothing.
- **Conduction** is the transfer of heat by two objects that are in direct contact with one another. It occurs when the skin comes in contact with a cold or warm object including air or water. For example, when holding a glass of ice water, the heat from your skin will warm the glass and in turn melt the ice.
- **Convection** is the movement of heat away from the body. In a cool environment, air warmed by the transfer of heat from the skin rises and is replaced by cooler air that is subsequently heated. The magnitude of convection depends on the temperature difference between skin and the environment (when the air is hotter than the skin, convection transports heat to the skin rather than away from it), on clothing worn and the presence of wind or other airflow (forced convection). Convection can also occur in water, following the same principles.

In addition to these physiological responses, there are also a number of behavioural responses which increase the efficacy of the body's physiological response or prevent exposure to higher temperatures before they occur. These include administrative and engineering controls such as active and passive cooling (e.g., immersion cooling, or use of air conditioning devices or ventilation practises by opening windows or doors to generate a draft of air), standing in the shade, reducing physical activity levels, drinking more fluids and wearing fewer or lighter items of clothing.

The body's experience of heat in different weather conditions

Ambient air temperature – The most commonly understood aspect of heat is the role of ambient air temperature on the body's ability to lose heat. As temperatures rise, the body is less effective at losing heat as the difference between the air temperature and the body's surface temperature reduces. When air temperature rises above skin temperatures dry heat is transported to the skin rather than away from it, and only evaporation is effective for cooling.

Humidity – Humidity is also a barrier to the body's ability to lose heat. As humidity rises, the proportion of sweat that evaporates reduces, with the remainder either sitting on the skin or dripping off the body without contributing to the cooling process.[82] Additionally, sweat soaked into clothing evaporates, which can provide some cooling but is not as effective as evaporation from the skin.[83]

Wind speed – Conversely, high wind speed can help to cool the body by improving convection and sweat evaporation by bringing a constant supply of cooler, drier air molecules across the skin. When the air temperature is higher than skin temperature (around 33 °C to 35 °C), the wind stops cooling the body by convection and instead transfers heat by this route from the hot air to the body. Heat loss by evaporation however, continues to be assisted by air movement.

Solar load – Solar radiation markedly increases human thermal load, especially during high-intensity activities, where thermoregulatory strain responses are further exacerbated.[84] This will further increase the radiant load experienced by workers operating machinery.

Wet Bulb Global Temperature (WBGT)

The WBGT index measures a combination of the four factors outlined above to give a more realistic description of how a human will experience heat during physical activity. It was designed in the 1950s by the US military to calculate guidelines for keeping soldiers safe.

All three scenarios in Table 2 for example have an air temperature of 30 °C, and yet how hot it will feel and the requirements for thermoregulation can vary by over 6 °C before taking into consideration other factors such as PPE or pre-existing medical conditions.

Tangible effects of heat on functioning, productivity, health, and occupational safety

Heat-related illness

Heat exhaustion can occur during heat exposure, especially when combined with physical activity and manual labour in hot (and humid) environments. Symptoms include increased sweating, dizziness, nausea and a headache.

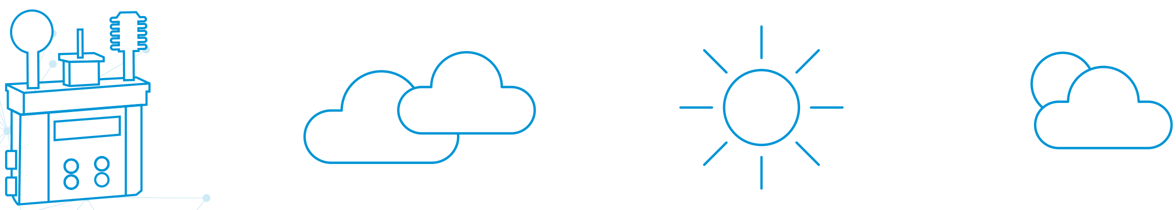
Without treatment, heat exhaustion can turn into the most severe form of heat-related illness: heat stroke. Additional heatstroke symptoms include persistent confusion, changes in behaviour (like aggression or agitation) and slurred speech.

Heatstroke requires immediate cooling and emergency medical intervention to prevent damage to the brain, heart, kidneys and muscles. This damage gets worse the longer treatment is delayed, which increases the risk of serious complications or death.[85]

Cognitive function

A growing body of research is beginning to link high heat exposure to a decline in cognitive function, particularly when combined with the other impacts of heat such as poorer quality sleep. The addition of hot environmental conditions will exacerbate poor cognitive functioning (including reduced reaction times, irritability and reduced working memory hindering logical decision making) and negatively affect performance outcomes.[86] Recent data

Table 2: Example of measuring Wet Bulb Global Temperature (WBGT) compared to ambient air temperature – WBGT weightings: 0.7 wet bulb temperature; 0.2 globe temperature; 0.1 dry bulb temperature



Dry bulb temperature (i.e., air temperature)	30 °C	30 °C	30 °C
Cloud cover (i.e., solar load)	Cloud (no sun)	Sunny	Light cloud
Humidity	50 %	35 %	90 %
WBGT	**25.9 °C**	**29.5 °C**	**32.0 °C**

collected following periods of extreme heat between 2024 and 2026 show that on average 3.6% of respondents report an accident or injury.[87]

In addition, some studies have suggested that exposure to the sun and thus solar radiation (for outdoor workers such as those in the construction and agricultural sectors) has more of an impact on cognitive function than either heat or humidity.[88] However, there are a number of limitations to current studies, such as small sample sizes, short time period of controlled exposure to heat, different trial designs and the health and age of the study participants.

Case study

Protecting construction workers from extreme heat through effective cooling solutions

Construction workers are highly vulnerable to heat stress due to prolonged outdoor exposure, physically demanding work, long hours, limited access to cooling measures, and the constraints of wearing PPE. Heat exposure can impair physical and mental health, increase the risk of accidents and injuries, and reduce productivity. As avoiding heat exposure is rarely possible on construction sites, effective adaptation measures are essential. However, current UK workplace heat guidance is largely generic and not tailored to construction, leaving employers to rely on their own judgement.

Researchers at the University of Reading conducted the first UK study of heat adaptation practices on construction sites, surveying 307 operatives and site managers from medium and large contractors between April and September 2025.

The findings showed workers are already experiencing heat-related illness, increased fatigue, irritability, reduced concentration and lower morale, with impacts on wellbeing and productivity reported even at 20 – 25 °C. In the absence of sector-specific guidance, managers and operatives rely on personal experience, resulting in inconsistent implementation of heat adaptation measures. Managers also perceived these measures to be more available and effective than operatives, suggesting a gap between policy and practice.

Credit: AI-generated image using StockCake AI

Overall, the findings highlight an urgent need for evidence-based, construction-specific heat adaptation guidance. A physiologist could address this gap by conducting multi-disciplinary research in real construction environments, rather than controlled chambers, to evaluate managerial interventions, engineering controls such as shading and cooling technologies, and PPE adaptations that reduce heat strain while maintaining safety, providing the evidence needed to inform effective UK guidance.

Dr Alba Fuertes
University of Reading

Long-term effects

Some people who experience heatstroke may have medical consequences that can affect them the rest of their life. Heatstroke victims have a greater frequency of developing chronic heart disease and kidney diseases later in life.

The mechanisms behind this increased risk are not fully understood but some animal studies suggest that heatstroke causes changes to cells and how they respond to future challenges, making them less able to withstand additional stresses in their environment or to fight off other chronic forms of disease.[89]

Why are workers more likely to be vulnerable to increased temperatures?

The physiological responses to increasing body temperature are supported or challenged by environmental factors and behaviour which make these responses more or less effective.

Workers are vulnerable to increased heat because they are limited in their ability to adapt their behaviour, work rate, or clothing to support their body's physiological responses to dissipate heat. However, by the nature of most work practices and requirements, these modifications are not as easy to adopt.[90]

This is in addition to existing physiological vulnerabilities that need to be considered in the context of an individual's resilience to extreme heat such as their age, sex, pre-existing conditions including medication-intake, which is known to affect thermoregulation, and whether the worker is pregnant, or menopausal.

This section of the report briefly outlines factors that exacerbate or mitigate heat by interacting with the body's physiological responses to heat stresses.

Physical activity requirements

Environmental heat exposure is not the only source of heat that the body must compensate for in the workplace. Physical work places a metabolic demand on the body that requires skeletal muscle contraction. These contractions are relatively inefficient, with only approximately 20–25% of the energy expended contributing to mechanical work, while the remaining energy is released as heat.[91]

Heat does not typically reduce an individual's maximum strength or aerobic capacity; however, it can significantly impair their capacity to sustain physical work over time.[92] As body temperature rises, workers are required to operate at a higher proportion of their maximum physical capacity to perform the same task. As a result, tasks feel more demanding, fatigue develops more quickly, endurance is reduced, and time to exhaustion is shortened. This can affect both productivity and the ability to safely maintain work rates throughout a shift. Although fitter individuals can work for longer in hot environments, maintain lower body temperatures, and better tolerate heat strain than less fit individuals, excessive increases in core temperature impair physical performance in all workers. Consequently, heat-related reductions in work capacity, endurance, and productivity cannot be eliminated by fitness alone.[93]

Compounding other climate risks, such as air pollution

Ground-level ozone and particulate matter are produced when sunlight promotes chemical reactions between pollutants such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs) from combustion processes related to vehicle use, industry, and other sources. Higher temperatures speed up these chemical reactions and strong sunlight during heat waves further increases this secondary formation of ground level ozone and particulate matter.[94]

When working outdoors in hot environments, particularly where roles are physically demanding, breathing rate increases to meet the body's elevated oxygen demands. This increase in ventilation results in a greater volume of air being inhaled each minute. Consequently, breathing deeper or faster in polluted air pulls a much larger volume of these toxic particles and gases deep into the lungs in a shorter amount of time which negatively impacts the health of the outdoor worker. Indoor workers can be equally at risk, particularly if indoor spaces are poorly ventilated and without systemic filtering of the air.

Breathing ozone irritates the lungs and the rest of the respiratory system, leading to shortness of breath. It can also cause inflammation, reduce physical activity capacity and exercise performance[95] and make the lungs more susceptible to other triggers of inflammation, such as pollen and mould spores.

Personal protective equipment

PPE is equipment worn to minimise exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with workplace hazards. PPE may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.[96] While not strictly 'protective', professional uniform guidelines can also limit a worker's ability to dress in clothing that supports thermal exchange between the body and the environment.

In order that PPE can most effectively protect workers from harm, it is crucial to understand:

- the nature of all hazards
- the likelihood of the risk materialising
- the severity of the consequences
- any tensions to manage between co-existing risks (e.g. simultaneous exposure to workplace hazards and heat).

PPE can prevent the body from cooling as it significantly reduces thermal exchanges between the body and the environment, which will therefore increase the thermal burden.[97] It reduces the body's ability to dissipate heat by restricting the pathways through which heat exchange occurs, as described earlier. It may fit closely to the body, which can increase work demand and heat production, and reduce ventilation next to the skin and therefore convective heat loss. It may act as an insulative layer that impedes heat loss from the body.[98] Sweat evaporation from the skin is impaired due to the humid microclimate created by the body within the PPE. For example, impermeable vapour-barrier overalls, such as those worn by workers handling or removing hazardous materials, are the equivalent of increasing the WBGT temperature a worker is exposed to by 11 °C.[99]

Balancing and prioritising the risks posed by the additional heat strain created by PPE and the hazards that PPE is designed to protect workers from is best understood by those responsible for health and safety in the context of the work being undertaken.

Credit: sturti

Case study

Heat Stress Prevention in Military Helicopter Aircrew

Hot weather is hazardous to military helicopter aircrew required to wear protective clothing and equipment, particularly when combined with moderate to hard physical work. Heat stress effects include degraded (physical and cognitive) performance and heat-related illness. Applying environmental temperature limits is one approach to preventing heat stress, and common wet-bulb-globe temperature (WBGT) thresholds, adjusted for clothing and physical work rate, are used across the three UK military services for this purpose (JSP 375, Ch41). However, it was not known if these thresholds were appropriate or could be easily used in airborne applications.

WBGT thresholds (26 and 20 °C; air temperature, 33 and 22 °C) were assessed in laboratory simulations with volunteers, incorporating representative aircrew clothing and role work rate (pilot or rear crew). Physiological, subjective and cognitive performance measures informed threshold suitability, and thermal manikin and modelling activities enabled the prediction of WBGT thresholds across a range of aircrew clothing (summer and immersion) and flight durations.

The work identified issues with applying the JSP WBGT thresholds to helicopter aircrew, not least due to the complexity and variation of aircrew thermal environments and physical work rate. Aircrew-specific WBGT thresholds, relevant to both pilots and rear crew, were proposed which should be treated as guidance but not regulatory absolutes.

Aircrew-specific WBGT thresholds are provided as guidance for helicopter duty holders to inform heat stress risk assessment. Other elements of JSP 375 Ch41 are highly relevant and will become more so as human-caused climate change increases global summer temperatures.

Table 1: Proposed WBGT thresholds (ºC)

Flight time	Summer Clothing	Immersion Clothing
< 1.5 hours (h)	28	26
1.5 – 2.5 h	27	22
2.5 - 4 h	26	20

Dr Andy Weller
QinetiQ

Case study

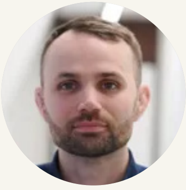
Are middle to older age workers under greater risk during hot work?

While a strong literature-base supports a greater heat risk in those aged over 70 years, much less is known about workers approaching retirement age who still have to perform physical work in hot environments. This lab-based project determined core body temperature and perceptual responses to simulated occupational heat stress at 40 °C for 3 hours. Responses were compared between young healthy adults (18–35 years) and middle to older age adults (50–65 years).

To recreate the work conditions in the lab, participants walked on a treadmill at 4 km/h for up to 3 hours in 40 °C with 20% humidity. The conditions were chosen to replicate the peak heat conditions during the 2022 UK heat wave. Deep body (core) temperature, thermal perception, and heart rate were measured.

Older workers showed a significantly faster core temperature increase than younger adults: over 90% of the younger group completed the 3 hours, while most older workers were removed from the trial early due to obtaining a high core temperature (39 °C). Further, older workers operating at a greater percentage of their maximum heart rate, meaning they were under greater cardiovascular and thermal strain.

Older workers did not perceive that they were hotter, showing identical 'perceptual' responses to the young group. These data should be considered when protecting older workers from high heat stress environments.



Dr Josh Foster
King's College London

Age

Ageing is suggested to be an important secondary factor for heat exposure risk in the population. The elevated risk in the older workforce is due to a direct impact of ageing on temperature regulation, a potential loss of physical fitness and the presence of other diseases and medications.[100] Hence, middle-aged (45–64 year old) men and women are more work-heat intolerant, and suffer more physiological strain during heat acclimation than their younger colleagues.[101]

Women’s health

Most of our present knowledge regarding human responses to thermal stress is primarily a result of research conducted on male participants. In a typical workforce, there will be differences between male and female responses to heat. However, when factors such as cardiovascular fitness level, body size, and acclimation state are standardised, the differences between the sexes tend to disappear. Differences that remain are related to menstruation, menopause and pregnancy.

Pre-menopausal or naturally menstruating women do have a lower sweat rate than men of equal fitness, size, and acclimation which is disadvantageous in hot, dry environments, but advantageous in humid environments. Menstrual cycle effects on thermoregulation are more nuanced than an absolute difference in core temperature: resting core temperature reliably rises by around 0.3–0.5 °C in the luteal phase relative to the follicular phase. This shifts the onset threshold at which sweating and cutaneous vasodilation begin, meaning the body starts defending against heat at a higher starting point, not that its capacity to regulate heat is impaired. Hormonal contraceptive use can produce a larger shift in body temperature and thermoeffector responses. It is therefore more likely that aerobic capacity, surface area-to-mass ratio, and state of acclimation are more important than sex in determining physiological responses to heat stress.[102] Nevertheless, this should not negate the socioeconomic and cultural differences that drive gender-based differences in response to heat and the importance of symptom management, even if the physiological risk is not elevated.[103] While outside the scope of this report, these should be considered as part of any future work designed to protect female workers from the impact of extreme heat.

As mentioned above, menopause and pregnancy are two exceptions to this pattern, where physiological change itself, not just fitness, size, or acclimation state, alters how the body manages heat. Both are areas where research remains sparse: little research has examined heat strain in relation to women's reproductive health, and almost none has focused on menopausal health. More research is needed to inform the UK's response to extreme heat driven by human-made climate change, ensuring it accounts for sex-based issues like pregnancy and menopause across the life span.

While the impact of hot flushes experienced during perimenopause have been ignored historically, it is increasingly recognised that hot flushes have a negative and prolonged impact on quality of life in the domains of health, sleep, work performance, and relationships.[104,105] The chronic reduction in oestrogen during menopause narrows the thermoneutral zone (the ambient temperatures where no sweating or shivering are required to maintain body temperature) so smaller temperature changes trigger hot flushes and sweating, often preceded by a change in skin conductance rather than a measurable rise in core temperature. This makes heat more uncomfortable and disruptive, even without a direct health risk, the impact is felt more through reduced productivity and poor sleep.[106] There is some evidence that physical activity post menopause improves heat tolerance, and that HRT modifies exercise-heat strain,[107] though more research is needed in this area. Even where physiological risk is not elevated, symptom management matters: workplace support—menopause policies, access to cooling, line manager awareness—can meaningfully improve wellbeing regardless of risk level and support productivity in the workplace.

Pregnancy induces numerous physiological changes in addition to changes in body mass. Cardiovascular changes occur gradually throughout pregnancy so that by the third trimester, blood volume and cardiac output increase by almost 50%.[108] Pregnant women exposed to high temperatures experience increased rates of miscarriage, congenital abnormalities, preterm birth, stillbirth and low birth weight babies.[109] For example, women exposed to heatwaves are 16% more likely to have a preterm birth than those not exposed.[110] There is a paucity of mechanistic data on the impact of extreme heat on the health of both a pregnant woman and the development of their fetus. This is due to a combination of difficulties in recruiting and retaining volunteers for clinical trials involving pregnant women and the additional ethical barriers to the development of these trials. As such, more research meeting stringent ethical criteria must be undertaken and shared to assess the impact of heat on pregnant women and the short and long-term consequences to childhood development of exposure to heat during pregnancy. Evidence on maternal thermoregulatory recovery in the postpartum period—and its knock-on effect on return to work—is similarly lacking and would be a valuable addition to future research in this area. Midwives can play a crucial role in this research since they are predominantly older and female and therefore likely to be impacted at work by heat while also being required to make a crucial contribution to the standard of care and indirectly influencing birth outcomes.

Case study

Maternal And preGnancy hEalth duriNg elevaTed heAt (MAGENTA)

Heat waves are increasing in frequency and intensity across the UK due to climate change, yet moderate-climate countries remain under-researched and under-prepared for heat-related health risks. Pregnant women are physiologically vulnerable to heat stress, with evidence linking elevated temperatures to adverse pregnancy outcomes including preterm birth and stillbirth. MAGENTA addresses a critical evidence gap by quantifying heat-pregnancy associations in UK populations, with a focus on deprived communities facing compounded environmental risk.

The project combines environmental data, anonymised electronic health records, participatory research including biological samples from pregnant women in Wales and future forecasting approaches.

The Magenta project includes four areas of focus (work packages (WP)): WP1 uses GeoAI to combine earth observation data, Met Office temperature records, and other environmental data sources to build longitudinal, household-level models of indoor and ambient heat stress exposure for every home in Wales and London. WP2 creates dynamic electronic mother-baby cohorts in both Wales (via Secure Anonymised Information Linkage Databank) and London (via the ONS Secure Research Service), linking environmental exposures to pregnancy and birth outcomes across more than a decade of data. WP3 recruits a consenting cohort of pregnant women in south Wales to directly measure biological, maternal, and fetal responses to heat stress, including biological sample collection. WP4 uses simulation modelling to forecast future pregnancy health scenarios under IPCC climate projections. Throughout the project, community events and stakeholder workshops ensure findings are co-produced with and communicated to the public and policymakers.

Work is ongoing. To date, MAGENTA has generated novel datasets and methodological innovations by integrating laboratory, big data, and climate forecasting approaches. New data outputs include geo-AI neural network-derived land surface temperature at 1km × 1km resolution for Great Britain, modelled indoor heat exposures, and biosampled immunological data from pregnant women before, during and after heat waves. The latter includes novel measures of heat stress from sweat samples, for example. Combined, this provides unprecedented granularity on heat exposure across the pregnancy period. The SAIL Databank infrastructure underpinning this work offers a scalable platform that could be extended to examine heat exposures in workplace settings, opening new avenues for occupational health research in future.

Professor Lucy Griffiths
Swansea University

Dr Amy Mizen
Swansea University

Pre-existing conditions (physical and mental)

Pre-existing health issues such as diabetes, obesity, hypertension, respiratory diseases like asthma and kidney disease, as well as a suite of rare diseases such as cystic fibrosis and neurological diseases make people more vulnerable to heat.[111] This is because the body's heat loss mechanisms are compromised or put under additional strain, limiting the ability to keep core temperature at normal levels. This puts extra strain on the heart, lungs and kidneys. Additionally, some medication to address these conditions can also increase heat risk by reducing blood flow to the skin, increasing heat production or impairing sweating.

The Physiological Society's 2023 Heat Resilience Strategy included epidemiological data demonstrating that hospital attendance or admissions for mental health problems, suicide, and suicidal behaviour are increased during periods of extreme heat and this is likely to also exacerbate mental health problems at work such as burnout and occupational stress through heat-related irritability and aggression. Despite this, the mechanisms driving the interactions between worsened mental health and heat are still poorly understood, with various potential biological, psychological and social mechanisms proposed. More research is required to better understand the physiological mechanisms linking heat to poorer mental health outcome and support already stretched mental health services across the UK.

Workplace-based responses and adaptations

Workplace adaptation covers the measures that change the relationship between rising heat and its effects on worker health and productivity, either by lowering the heat load a worker experiences or by reducing the physiological strain that a given exposure produces; these measures can be worker-led, employer-led or government-mandated.[112] Workers adapt largely through behaviour, from changing clothing and taking additional breaks to working more slowly, increasing fluid intake and shifting the timing of tasks. Employers can lower both the heat load and the physical demands of the job through shading, rescheduling work to cooler parts of the day, mechanisation, rest and recovery spaces, and active or passive cooling. Government action works through legislation and enforcement, most directly by setting maximum working temperature thresholds (preferably defined by WBGT), work-rest scheduling and restricting work during extreme heat. The capacity to act is unevenly distributed, however, shaped by contract type, workplace conditions and cost, and evidence on the effectiveness and relative costs of many options remains limited.[113]

Nevertheless, simple and cost-effective cooling solutions already exist (such as providing shade and water through makeshift cooling oases) and can be easily and immediately adopted in a variety of settings to protect productivity and health. The need for low-cost solutions for managing heat is particularly relevant in small to medium enterprises, which often lack specialist occupational and health and safety capacity. These businesses and workers may face higher risks and need targeted support, clearer guidance and stronger enforcement measures.

Active and passive cooling

Increasing wind speed alleviates physiological heat strain by both making the evaporation of sweat from the skin more efficient and improving convection by lowering the temperature of the air near the skin. This effect is reduced in humid conditions, where the air is already closer to saturation and evaporative cooling is limited regardless of air movement. Interventions such as cooling vests and towels or immersing hands in cold water increase the efficiency of conductive/convective cooling as heat from the body passes into the colder water which is then replaced by the flow of the liquid. Alongside these active interventions, hydration status remains one of the most basic determinants of sweat capacity and cardiovascular strain in the heat and should be considered a foundational part of any cooling strategy (for more information on hydration, please see page 40).

In indoor work settings, cooling is more often achieved through the use of air conditioning which can keep indoor spaces at significantly lower temperatures than the outdoor environment. However, this is hugely energy intensive, and without more energy efficient approaches, demand for space cooling will more than triple by 2050, consuming as much electricity as all of China and India today.[114]

Passive building-level measures optimise a building's architecture through design and construction strategies to significantly reduce energy demand while improving thermal comfort without mechanical heating or cooling. Strategies such as ventilation control, reflective roofing, window placement, external shading, and urban greening offer a lower-energy alternative or complement to mechanical air conditioning and should be considered as part of integrated heat adaptation strategies.

Additionally, not all indoor work settings are appropriate for air conditioning or increasing air movement. Hospital wards with infection control protocols, for example, are limited in how they can move air around the ward without risking infection.

For outdoor workers, the picture is more complex. For these workers, cooling garments, cool oases, rest/work scheduling (see page 40 for more information) and extremity cooling may be more appropriate depending on the availability and location of these interventions. Cost and access may be barriers to this in practice, particularly for outdoor and lower-paid workers, who may have the least control over their thermal environment.

Physical workload guidance for hot conditions

A number of physically demanding industries have begun to put guidelines in place to limit the type and intensity of work undertaken during periods of extreme heat. The UK military for example, has adopted Joint Service Publication (JSP) 375 which includes the following limits on work at different WBGT limits for acclimatised and non-acclimatised non-acclimatised personnel (See Table 3).

Additionally, the International Organization for Standardization (ISO) has developed *ISO 7243:2017: Ergonomics of the thermal environment – Assessment of heat stress using the WBGT (wet bulb globe temperature)* which is a screening method for evaluating the heat stress to which a worker (either indoor or outdoor) is exposed and for establishing the presence or absence of heat strain over the course of a shift lasting up to 8 hours.

Workers in the UK already take some steps to protect their health and productivity during periods of extreme heat but, crucially, only where they are empowered to do so by their employer. There is scope for the UK to learn how to best protect workers from countries or cities who already have long-term experience managing extreme heat. This learning can be used in the UK to enhance public awareness of climate risks, increase protection of vulnerable populations, and encourage workers and employers to take necessary actions in anticipation of heat and heatwaves.[115]

Table 3: JSP 375 Management of Health and Safety in Defence limits on work for military personnel at different WBGT limits

Acclimatised WBGT Limits	Non-acclimatised WBGT Limits	Maximum work rate (not to be exceeded)
No maximum limit	32 °C	Low Example, lying, guard duty, driving.
30 °C	26 °C	Medium Example, marching 2.25 mph (3.6 kph) 30 kg load
27 °C	24 °C	High Example, marching 3.5 mph (5.6 kph) 20 kg load, patrolling, digging, field assaults.
25 °C	20 °C	Very High Example, marching 5 mph (8 kph) no load, marching 3.5 mph (5.6 kph) 30 kg load.
20 °C	Maximum 30 minutes at 20 °C	Extreme Example, running in sports kit.

Case study

Project HeatSafe: A multi-component heat adaptation intervention package to protect outdoor construction workers in Singapore from the health and productivity impacts of rising temperatures

Climate warming increasingly threatens the health, well-being, and work productivity of occupational workers in Southeast Asia, particularly those in outdoor settings such as construction sites. There is a need for sustainable, scalable preventive measures to reduce heat-related impacts on these workers.

A real-world intervention study was conducted at an outdoor construction site in Singapore in May 2023, using a within-participants crossover design. Workers participated in both a control condition (normal routine) and an intervention condition, one week apart.

The intervention package comprised four components: heat stress education videos delivered in workers' native languages, three additional 15-minute shaded rest breaks per day, increased access to cold water with insulated bottle sleeves, and optimised work attire with enhanced heat dissipation properties. The package was informed by prior physiological and ethnographic profiling, site manager surveys, and recommendations from Singapore's Workplace Safety and Health Council.

While physiological and perceptual responses were similar across conditions, workers in the intervention condition showed a 10% higher step count and 14% higher step rate, suggesting improved productivity. Focus group discussions revealed positive worker perceptions. The findings demonstrate the feasibility of implementing such interventions at scale, with plans to extend the work across Southeast Asia through the National University of Singapore Heat Resilience & Performance Centre's role as the Global Heat Health Information Network Southeast Asia Hub.

Professor Jason Kai Wei Lee
National University of Singapore

Pearl Tan
National University of Singapore

Case study

Reducing heat strain and maintain productivity for garment workers in Bangladesh

Garment workers face some of the most precarious working conditions in the world and are increasingly at risk from extreme heat stress caused by climate change. A new University of Sydney-led study reveals how simple, affordable interventions could offer critical protection to those working in dangerously hot conditions.

Healthy non-smoking adults aged 18 to 40 completed a randomized crossover trial at the University of Sydney, undertaking three acclimatization sessions followed by six 3-hour experimental trials: no intervention (40 °C, 38% humidity), electric fan only, electric fan with water, simulated roof modification (37.5 °C, 40% humidity), roof modification plus electric fan, and air conditioning, with conditions replicating peak Bangladeshi garment factory temperatures derived from year-long sensor data and building energy modelling.

Core temperature, heart rate, and sweat loss were measured continuously, alongside perceptual ratings of thermal discomfort, thermal sensation, and thirst at 30-minute intervals. Work performance was assessed via sex-specific tasks mimicking real factory work: ironing for males and sewing for females. Participants wore traditional Bangladeshi work clothing, and trials consisted of five 30-minute work bouts with short movement breaks, with safety thresholds in place for core temperature and heart rate.

Findings showed that sustainable cooling interventions can reduce heat strain and maintain productivity in Bangladeshi garment factories, with roof modifications (lowering temperatures by 2.5 °C) being most effective at the building level, further enhanced by fan use, while electric fans combined with free water access represent the best personal-level alternative, with water breaks not harming and potentially improving productivity. These findings may extend beyond the Bangladeshi garment sector to other indoor work environments where heat stress poses a significant risk to worker health and wellbeing.

Dr James Smallcombe
University of Sydney, Australia

Professor Ollie Jay
University of Sydney, Australia

Work-rest scheduling

In high-temperature environments, the human body faces serious challenges in regulating heat. When physical work and PPE add to that heat burden, workers become vulnerable to exhaustion, dehydration, heat stroke, and other serious health risks. Work-rest schedules are structured plans designed to help workers recover during heat exposure, reduce physiological strain, and lower the risk of heat-related illness.[116] This work-rest scheduling may carry requirements and costs for additional staff.

Reducing physical demands through technical alternatives

Technological innovation such as cooling vests and greater reliance on mechanised work can reduce both the physical activity required for roles and workers' exposure to extreme heat. However, this is not appropriate for every role. These alternatives must not increase dependency on fossil fuel powered machinery, which contribute to extreme heat and its related challenges.

Acclimatisation

The human body is adaptable and can better tolerate hot climates through persistent heat exposure, especially if experienced on consecutive days. Key adaptations which improve heat resilience likely include reduced heat production from an individual's own metabolism and improved heat loss responses (i.e., expanded blood volume and greater sweat production). Such adaptations can be induced using either artificially controlled (acclimation) or naturally occurring (acclimatisation) environments. Workers exposed to elevated heat infrequently or only for certain periods of the year, such as seasonal pickers, should be progressively re-exposed at the start of the hot season, after a break from heat, or in preparation for the heat season.[117]

Unfortunately, while useful for specialist groups (such as elite athletes), acclimation is difficult to scale to the wider working population, and naturally occurring adaptation through workplace heat exposure is a more realistic method. Natural acclimatisation through daily workplace heat exposure will typically occur over two weeks to a month. Workers unaccustomed to heat, which includes most of the UK population, should always be considered more at risk during this period and be monitored frequently while their bodies adjust. New workers will typically benefit from being 'paired' with a more experienced worker during this period, adopting similar pacing behaviours, rest and rehydration breaks where appropriate.[118]

More research is required to understand how to most equitably and quickly acclimate the workforce ahead of extreme heat events and how public health advice from other countries can be adapted to a UK context. In particular, there is a gap in understanding how to translate structured acclimation or acclimatisation protocols, designed for athletes with controlled training loads and recovery, into practical, equitable guidance for workers who cannot control their environmental exposure, working hours, or fitness levels in the same way.

Hydration and electrolyte replacement

Hydration and electrolyte replacement are crucial responses to extreme heat to replace the fluid and minerals lost from sweating. The upper rate at which fluid will empty from the stomach during exercise or physical exertion is around 1 litre per hour. For those working at a very high intensity at a WBGT of 25 °C, the fluid requirements are approximately 2 litres per hour but fluid requirements will vary by individual based on variables such as sweat rate, body size and acclimation state.[119] Hyponatraemia, when the concentration of sodium in plasma falls, is a possibility with excessive overhydration in the workplace and can lead to confusion, muscle cramps and, in extreme cases, seizures and decreased consciousness.[120]

The Workplace (Health, Safety and Welfare) Regulations 1992 require all employers to make safe drinking water available to all workers but cannot mandate that workers drink sufficient fluids before, during and after their work shifts.[121] Ensuring workers rehydrate appropriately remains a challenge particularly in key worker roles, 'gig' workers, those in insecure, low paid work and those that work at height.[122] Practical deterrents in the workplace also exist that discourage workers from hydrating properly, including toilet access and cleanliness, and unpaid breaks to use the toilets that are available. While these barriers are socioeconomic in nature, they have a significant impact on worker health and productivity both during periods of extreme heat and beyond. Low-cost interventions such as checking urine colour are effective at ensuring that workers are aware of their hydration status throughout their shifts.

Across three rounds of data collected by the Grantham Research Institute, LSE and the Euro-Mediterranean Center on Climate Change, increased hydration was reported to be the most common response to heat for both workers and employers. Drinking water or other fluids more often was the single most frequently reported change in workers' own behaviour, cited by 52% of respondents in 2024, 39% in 2025, and 55% in 2026, ahead of any change to hours, breaks or location. It was also the most common employer-led measure: 26% of respondents in 2024, 22% in 2025 and 23% in 2026 reported that their employer had provided greater access to fluids to stay hydrated, ahead of changes to the work environment such as cooling, ventilation or shade.[123]

Strategies for building individual resilience to heat

Improved sleep hygiene

Sleep is crucial for retaining physiological and psychological function. A number of human-based studies has yielded evidence that partial sleep deprivation of less than 5 hours of sleep either in one continuous block or fragmented through the night, disrupts our physiological function and can lead to depression, anger, and confusion, aggravate perceived fatigue, impair cognitive function (including alertness and decision-making, vigilance, executive function) and reduce physical capacity.[124] As temperatures in the UK rise, we are experiencing an increasing number of 'tropical nights' where the temperature overnight does not drop below 20 °C, which prevents good quality, restful sleep.

Shift-workers, military and emergency-response personnel, in particular, are often required to perform their role while in a state of prolonged wakefulness and are therefore at particular risk of the physiological and psychological effects of poor sleep.[125]

Improved fitness

Improved aerobic fitness is protective in hot environments and induces many of the same physiological adaptations as heat acclimation, including expanded plasma volume and an earlier onset of sweating, meaning fitter individuals typically arrive at a given heat exposure already partially adapted, even without prior heat exposure itself. This raises the possibility that improving general aerobic fitness in the months before summer, for example in spring, could serve as a practical, accessible strategy for the general population to prepare for seasonal heat, alongside or in place of formal heat acclimation protocols.

Improve or maintain a healthy body mass index

Fatal heatstroke occurs 3.5 times more frequently in adults who are overweight or obese than in individuals of average body weight. An obese person has a smaller ratio of body surface area to body mass for effective sweat evaporation than a leaner person of the same height. The extra weight that obese individuals carry increases how hard the body must work for the same level of physical activity, which elevates the rate of heat production.[126] As such, people with obesity exhibit greater elevation in core temperature than lean individuals for the same workload.[127]

Improved hydration ahead of starting work and during non-working days

While the physiological benefits of hydration have been previously listed in more detail (see page 40), arriving at work adequately hydrated is an important step in preventing dehydration. Nonetheless, research has shown that during hot periods, most workers tend to arrive at work in an already dehydrated status, i.e. they start work with a fluid deficit.[128]

This is a particular risk for those workers who cannot stop for frequent drink breaks during work either because of PPE requirements for their role or the demands of their role (such as working at height or in contaminated areas). It is also of note, although outside the scope of this report, that behavioural and cultural norms in certain workplace settings and a lack of access to clean toilet facilities, reduce the likelihood of a worker maintaining an adequate level of hydration both before and during work.[129]

Medication interaction awareness

As climate change makes heatwaves and days of extreme temperatures and humidity more frequent, it is beginning to affect the stability of medications for a variety of conditions. Exposure to extreme temperatures and/or humidity can affect the composition and integrity of medications and impact clinical efficacy. This is particularly important for drugs with a narrow therapeutic window.[130]

Additionally, even when stored and administered correctly, some medicines can further increase already higher rates of sweating or dehydration, or make it harder for the body to cope with heat.

People taking diuretics, already lose more fluid through urination. This can cause dehydration and mineral imbalances. Blood pressure medicines such as ACE inhibitors, beta-blockers, or calcium channel blockers can also make it harder for the body to regulate temperature, especially during sudden hot spells. ACE inhibitors can even suppress the natural thirst response.

Some diabetes medicines, including insulin and metformin, also increase the risk of dehydration or make early symptoms harder to spot. Antipsychotic medications, or stimulant medications for attention disorders can increase body temperature, increasing the risk of heat illness.[131]

Credit: safakcakir

Heat is already acting as a physiological constraint on workforce function, but current UK policy frameworks still treat it primarily as an infrequent risk to the most vulnerable in society rather than a system-wide occupational health risk.

Credit: huseyinturk_photograph

Chapter 3: Policy action

Conclusions

The UK workforce is underprepared for and insufficiently resilient against extreme heat, particularly as the management of heat risk does not effectively take a human-centred physiologically informed approach. The UK faces unchartered territory each year with extreme heat we are not accustomed to, and infrastructure and working conditions that are not adequately adapted. Continued climate change will make this problem worse in the decades to come.

Key takeaways: challenges and opportunities

- Physiological research helps identify and support interventions and behaviours that best protect workers from the effects of heat, humidity and radiant heat load.

- Heat, especially when combined with higher levels of humidity, is a significant productivity and health risk for the broader working population across all industries. The impact of heat risk on the workforce will create significant knock-on effects, particularly for key workers.

- Our adaptations are lagging behind the speed at which the climate is changing. Indoor and outdoor work in the UK is poorly adapted to deal with the problems of heat, particularly when coupled with humidity, and is designed for a climate that no longer exists.

- Ambient air temperatures are not sufficient to capture heat risk alone. Maximum working air temperatures are an important starting point in the Government's recognition of the impact of heat on workers. They will be effective in protecting workers' health and productivity only if physiology is at the heart of developing the Government's response and graded thresholds. Physiological research identifies a variety of factors beyond air temperature that can affect an individual's ability to work in periods of extreme heat.

- High risk individuals are not just those working in highly exposed sectors, they also may have physiological vulnerabilities (e.g. pregnancy, non-communicable diseases). A greater number of physiological vulnerabilities within the working age population will put further pressure on productivity as we experience increasingly frequent and intense periods of heat as detailed in the report *State of the UK Climate in 2025*.[132]

- Guidance on heat management for workers in the UK is well-evidenced but remains inaccessible to the working population and is short-term in focus.[133] Additionally, public health guidance on health and wellbeing from across the four nations can be adapted in its communication to target the benefits to the working age population.

- There are both implementation and evidence gaps in our understanding of heat risk, particularly for vulnerable workers. Sufficient evidence currently exists for a more informed approach to managing heat in the workplace with simple and cost-effective interventions. However, significant gaps remain in our ability to predict individual responses to a given exposure and our understanding of how solutions will work in different occupational settings.

The UK Government needs to take well-planned, effective action to ensure extreme heat is managed proactively, taking physiological vulnerabilities into consideration. Without a more interventionist regulatory system, approaches to balancing productivity with worker health and safety will be left to inconsistent application from organisations in all sectors of the economy.

Recommendations to Government and policy-makers

The UK Government should set targets for extreme heat that consider wider physiological risk factors.

Actions:

1. Identify a 2030 target for productivity and health outcomes during extreme heat episodes, beyond the 2050 excess heat-related mortality rate proposed by the CCC.
2. Engage in knowledge-sharing with countries and regions experienced in managing extreme heat to build targets and policy approaches that consider the effect of chronic heat, compounding climate risks, 'tropical nights' and the long-term cumulative impact of heat.

The UK Government should provide effective and physiologically informed guidance that enables all employers to protect workers from extreme heat risk while enabling them to maintain productivity.

Actions:

3. Review the Approved Code of Practice and Guidance for The Workplace (Health, Safety and Welfare) Regulations 1992 to:
    a. provide more specific guidance for employers on 'reasonable' temperatures for indoor work and 'adverse weather' for outdoor work in relation to heat risk and humidity
    b. provide different temperature thresholds for employer action based on compounding physiological risk factors
    c. specifically highlight to employers the risks for pregnant workers, different ages, notable illnesses and medications, and mental health conditions
    d. promote simple and cost-effective cooling solutions that businesses can easily adopt and adapt to different settings and sectors, particularly for small to medium enterprises
    e. provide guidance on making balanced, risk-based decisions for use of PPE
4. Benchmark and monitor the uptake and accessibility of HSE's heat guidance for employers.
5. Develop a framework that links employer action to heat alerts, which specifies the steps an employer takes when a warning is issued and supports employers to amplify and tailor that messaging for their own workforce.

The UK Government should update regulations to ensure workers' productivity and health are legally protected during periods of extreme heat.

Actions:

6. The Cabinet Office should coordinate cross-departmental and devolved engagement on human-centred maximum working temperatures, with physiologists and other key experts and sectors providing robust evidence.

7. Establish graded temperature thresholds based on environmental factors, role demands and physiological risks for industries particularly exposed to extreme heat. This includes:
   a. maximum working temperatures for workers in particularly exposed industries (e.g. construction workers)
   b. sector-specific adjustments for key workers providing vital services that require continuous operations (e.g. healthcare workers)

8. Introduce specific protections for those in insecure work (such as gig workers) to ensure individuals are not forced to choose between their health and income.

The UK Government should support further research that will address gaps in understanding of how heat impacts productivity, health and safety

Actions:

9. Invest in commissioned research that addresses current evidence gaps in:
   a. the personalisation of physiological risk predictions for a variety of workers, including the consideration of sex-based vulnerabilities like pregnancy and menopause
   b. the effective implementation of current knowledge on heat strain risks and solutions into different occupationally relevant settings and contexts
   c. defining and supporting the most vulnerable groups of workers and building resilience as the working population ages
   d. surveillance of temperatures in the workplace, alongside heat-health surveillance of workers themselves
   e. cognitive functional impairment from heat risk exposure, particularly in work settings across health and social care, emergency services, education and construction
   f. the full range of economic costs of heat on the labour force, and the medium- and long-term consequences for labour mobility and workforce participation, to demonstrate the urgency of the challenge
   g. current understanding of the physiological mechanisms linking heat to poorer mental health outcomes

The UK Government should coordinate public health messaging across the four nations to support a wider understanding of the benefits of improving physiological resilience to heat risk for worker productivity and health

Actions:

10. Review the uptake and accessibility of public health guidance across the UK on keeping productive and healthy before and during periods of extreme heat.

11. Increase the rollout and effectiveness of early warning systems, building on existing alert protocols, so that alerts are communicated across Government departments, reach the whole workforce, and are appropriately tailored to specific areas and work environments.

12. Launch a coordinated and targeted public health campaign on heat risks for workers that provide solutions that are clear, simple, cost-effective, accessible and adaptable. Messaging needs to communicate:

    a. How individuals have varying susceptibility to heat risk

    b. Simple strategies that can be easily adopted

    c. Proactive measures and preparedness, including how to acclimate or avoid the cumulative health impacts of heat

To ensure recommendations are effectively implemented and human-centred, physiologists and/or physiological evidence must be included in the consultation and decision-making process.

References

1. National Weather Service. Wet bulb globe temperature. Available from: https://www.weather.gov/car/WBGT
2. Hodder, S. G., et al. The effects of solar radiation on thermal comfort. Int J Biometeorol. 2007; 51 (3): 233-43. Available from: https://doi.org/10.1007/s00484-006-0061-0
3. Intergovernmental Panel on Climate Change (IPCC). IPCC 6th Assessment Report Working Group II Annex II. Available from: https://www.ipcc.ch/report/ar6/wg2/chapter/annex-ii/
4. Court of Justice of the European Union. Allonby v. Accrington & Rossendale College, Case C-256/01. 2004; ECR I-873. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:62001CJ0256
5. Robinson E. J. Z., et al. Protecting UK workers' health and incomes in a warming world. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. 2025. Available from: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2025/12/Protecting-UK-workers-health-and-incomes-in-a-warming-world-1.pdf
6. Met Office. Understand tropical nights and their impact. 2025. Available from: https://www.metoffice.gov.uk/blog/2025/understand-tropical-nights-and-their-impact
7. Robinson, E.J.Z., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://doi.org/10.21953/researchonline.lse.ac.uk.00140309
8. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/
9. World Health Organization, & World Meteorological Organization. Climate change and workplace heat stress: technical report and guidance. Available from: https://www.who.int/publications/i/item/9789240099814
10. Robinson, E., & Dasgupta, S. Improving the resilience of the UK labour force in a 1.5C world. Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/improving-the-resilience-of-the-uk-labour-force-in-a-1-5c-world
11. Office for National Statistics. Impact of hot days on productivity in Great Britain: methodology. ONS Working Paper Series. Available from: https://www.ons.gov.uk/methodology/methodologicalpublications/generalmethodology/onsworkingpaperseries/impactofhotdaysonproductivityingreatbritainmethodology
12. Robinson, E., & Dasgupta, S. Workers' health and the economy are suffering due to climate change. London School of Economics and Political Science (LSE) Politics and Policy Blog. Available from: https://blogs.lse.ac.uk/politicsandpolicy/workers-health-and-the-economy-are-suffering-due-to-climate-change/
13. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/
14. Met Office. More than 2,700 excess deaths estimated in England and Wales during May and June heatwaves. Available from: https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2026/more-than-2700-excess-deaths-estimated-in-england-and-wales-during-may-and-june-heatwaves
15. Met Office. June 2026 heatwave: A recap of the temperature records. Met Office Blog. Available from: https://www.metoffice.gov.uk/blog/2026/june-2026-heatwave-a-recap-of-the-temperature-records
16. Fawkes, C. England's warmest June on record following historic heatwave. BBC Weather. Available from: https://www.bbc.co.uk/weather/articles/cjdg98g8lg8o
17. Robinson, E. J. Z., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://doi.org/10.21953/researchonline.lse.ac.uk.00140309
18. Cissé, G., et al. Health, Wellbeing, and the Changing Structure of Communities. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1041–1170. Available from: https://doi.org/10.1017/9781009325844.009
19. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/
20. The Physiological Society. Phase One Report from the 2025 Global Climate and Health Summit: Protecting people, shaping policy: Physiology and partnerships at the heart of climate and health. Available from: https://static.physoc.org/app/uploads/2025/10/31170353/Phase-One-Report-from-the-2025-Global-Climate-and-Health-Summit-WEB-VERSION.pdf
21. Climate Change Committee. Progress in adapting to climate change: 2025 report to Parliament. Available from: https://www.theccc.org.uk/wp-content/uploads/2025/04/Progress-in-adapting-to-climate-change-2025-1.pdf
22. Met Office. An early look at the July statistics: just how dry has it been? Met Office News and Media. Available from: https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2026/an-early-look-at-the-july-statistics-just-how-dry-has-it-been-
23. Neill, P., & Davies, C. Hundreds evacuated after 'apocalyptic' wildfire near Suffolk nuclear power station. The Guardian. Available from: https://www.theguardian.com/uk-news/2026/jul/30/major-incident-fire-suffolk-coast-dunwich-heath-leiston
24. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/
25. Met Office. More than 2,700 excess deaths estimated in England and Wales during May and June heatwaves. Available from: https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2026/more-than-2700-excess-deaths-estimated-in-england-and-wales-during-may-and-june-heatwaves
26. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/
27. BBC News. Climate change: Summers could become 'too hot for humans'. Available from: https://www.bbc.co.uk/news/science-environment-53415298
28. Sun, Q., et al. Global heat stress on health, wildfires, and agricultural crops under different levels of climate warming. Environ Int. 2019; 128: 125-36. Available from: https://doi.org/10.1016/j.envint.2019.04.025
29. World Meteorological Organization, & World Health Organization. Heatwaves and health: Guidance on warning-system development (WMO-No. 1142). Available from: https://heathealth.info/wp-content/uploads/WMO_WHO_Heat_Health_Guidance_2015.pdf
30. Beddow, H. How the urban heat island effect makes cities vulnerable to climate change. UK Green Building Council (UKGBC). Available from: https://ukgbc.org/news/how-the-urban-heat-island-effect-makes-cities-vulnerable-to-climate-change/
31. Hamanaka, R. B., & Mutlu, G. M. Particulate Matter Air Pollution: Effects on the Cardiovascular System. Front Endocrinol (Lausanne). 2018 Nov 16;9:680. doi: 10.3389/fendo.2018.00680. PMID: 30505291; PMCID: PMC6250783.
32. Zhang, B., et al. Comparison of Particulate Air Pollution From Different Emission Sources and Incident Dementia in the US. JAMA Intern Med. 2023 Oct 1;183(10):1080-1089. doi: 10.1001/jamainternmed.2023.3300. PMID: 37578757; PMCID: PMC10425875.
33. Kim S. Y., Kim E., & Kim W. J. Health Effects of Ozone on Respiratory Diseases. Tuberc Respir Dis (Seoul). 2020 Dec;83(Supple 1):S6-S11. doi: 10.4046/trd.2020.0154. Epub 2020 Dec 1. PMID: 33261243; PMCID: PMC7837374.
34. Canadian Society for Exercise Physiology. Personal strategies to mitigate the effects of air pollution exposure during sport and exercise. Available from: https://csep.ca/2023/06/07/personal-strategies-to-mitigate-the-effects-of-air-pollution-exposure-during-sport-and-exercise-2/
35. Padhy, S. K., et al. Mental health effects of climate change. Indian J Occup Environ Med. 2015; 19 (1): 3-7. Available from: https://doi.org/10.4103/0019-5278.156997
36. Assari, S., & Zare, H. Extreme heat exposure is associated with lower learning, general cognitive ability, and memory among US children. Open J Neurosci. 2025; 3: 10-22. Available from: https://doi.org/10.31586/ojn.2025.1277
37. Li-Maloney, C., et al. Pregnancy and extreme heat events: A rapid review of evidence related to health outcomes, risk factors and interventions. Women and Birth. 2025; 38 (4): 101931. Available from: https://doi.org/10.1016/j.wombi.2025.101931
38. Falchetta, G., et al. Global projections of heat exposure of older adults. Nat Commun. 2024; 15 (1): 3678. Available from: https://doi.org/10.1038/s41467-024-47197-5
39. UK Health Security Agency. Heat summary - Health Effects of Climate Change (HECC) full report. GOV.UK. Available from: https://www.gov.uk/guidance/heat-summary-health-effects-of-climate-change-hecc-full-report
40. Gronlund, C. J. Racial and socioeconomic disparities in heat-related health effects and their mechanisms: A review. Curr Epidemiol Rep. 2014; 1 (3): 165-73. Available from: https://doi.org/10.1007/s40471-014-0014-4
41. Foulkes, I. WHO warns of risks of extreme heat in the workplace. BBC News. Available from: https://www.bbc.co.uk/news/articles/c5ylwxl5n01o
42. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/
43. Robinson, E., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/climate-changes-heat-tax-on-the-uks-labour-force-and-economy/
44. Robinson, E., & Dasgupta, S. Improving the resilience of the UK labour force in a 1.5C world. Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/improving-the-resilience-of-the-uk-labour-force-in-a-1-5c-world/

45. Robinson, E., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/climate-changes-heat-tax-on-the-uks-labour-force-and-economy/

46. Office for National Statistics. Time use in the UK: 23 September to 1 October 2023. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/bulletins/timeuseintheuk/23septemberto1october2023

47. Dasgupta, S., et al. Heat stress and the labour force. Nat Rev Earth Environ 2024; 5: 859–872. Available from: https://doi.org/10.1038/s43017-024-00606-1

48. World Health Organization, & World Meteorological Organization. Climate change and workplace heat stress: technical report and guidance. Available from: https://www.who.int/publications/i/item/9789240099814

49. Smallcombe, J. W., et al. Quantifying the impact of heat on human physical work capacity; part IV: interactions between work duration and heat stress severity. Int J Biometeorol. 2022; 66 (11): 2297-308. Available from: https://doi.org/10.1007/s00484-022-02370-7

50. OECD. The Heat is On: Heat Stress, Productivity and Adaptation Among Firms. Available from: https://www.oecd.org/en/publications/the-heat-is-on-heat-stress-productivity-and-adaptation-among-firms_19d94638-en.html

51. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/

52. Office for National Statistics. Impact of hot days on productivity in Great Britain: methodology. ONS Working Paper Series. Available from: https://www.ons.gov.uk/methodology/methodologicalpublications/generalmethodology/onsworkingpaperseries/impactofhotdaysonproductivityingreatbritainmethodology

53. Robinson, E., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/climate-changes-heat-tax-on-the-uks-labour-force-and-economy/

54. Environmental Audit Committee. Heatwaves: adapting to climate change (House of Commons). Available from: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/82607.htm

55. Department for Work and Pensions. Economic labour market status of individuals aged 50 and over, trends over time: September 2025. GOV.UK. Available from: https://www.gov.uk/government/statistics/economic-labour-market-status-of-individuals-aged-50-and-over-trends-over-time-september-2025/economic-labour-market-status-of-individuals-aged-50-and-over-trends-over-time-september-2025

56. Orr, R., et al. Police Fitness: An International Perspective on Current and Future Challenges. Sports (Basel). 2025; 13 (7). Available from: https://doi.org/10.3390/sports13070219

57. Potter, A. W., & Friedl, K. E. US Army Accession and Retention Standards: Impact on Obesity and Medical Readiness. Mil Med. 2025; 190 (7–8): e1587–94. Available from: https://doi.org/10.1093/milmed/usae554

58. Sergi, T. E., et al. Relationship between body mass index and health and occupational performance among law enforcement officers, firefighters, and military personnel: A systematic review. Curr Dev Nutr. 2023; 7 (1): 100020. Available from: https://doi.org/10.1016/j.cdnut.2022.100020

59. Foster, J., et al. Aerobic fitness as a parameter of importance for labour loss in the heat. J Sci Med Sport. 2021; 24 (11): 1107-12. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1440244021001146

60. Robinson, E. J. Z., Howarth, C., Zhou, Y., & Dasgupta S. Improving the resilience of the UK labour force in a 1.5 °C world. Grantham Research Institute on Climate Change and the Environment Working Paper 423. London School of Economics and Political Science. 2025; 423. Available from: https://www.lse.ac.uk/granthaminstitute/publication/improving-the-resilience-of-the-uk-labour-force-in-a-1-5c-world/

61. Mee, J.A., et al. Beyond Vulnerable Groups: Heat Preparedness, Impact, and Structural Barriers to Adaptation in UK Adults. 2026. [Unpublished]

62. Robinson, E. J. Z., Howarth, C., Zhou, Y., & Dasgupta S. Improving the resilience of the UK labour force in a 1.5 °C world. Grantham Research Institute on Climate Change and the Environment Working Paper 423. London School of Economics and Political Science. 2025; 423. Available from: https://www.lse.ac.uk/granthaminstitute/publication/improving-the-resilience-of-the-uk-labour-force-in-a-1-5c-world/

63. Labour Party. Make Work Pay. Available from: https://labour.org.uk/wp-content/uploads/2024/06/MakeWorkPay.pdf

64. Department for Business and Trade. The UK's modern industrial strategy. GOV.UK. Available from: https://www.gov.uk/government/collections/the-uks-modern-industrial-strategy-2025

65. Cabinet Office. UK Government Resilience Action Plan. GOV.UK. Available from: https://www.gov.uk/government/publications/uk-government-resilience-action-plan/uk-government-resilience-action-plan-html

66. Taylor, M. Sadiq Khan backs calls for UK maximum workplace temperature. The Guardian. Available from: https://www.theguardian.com/environment/2026/jul/15/sadiq-khan-backs-calls-uk-maximum-workplace-temperature

67. Maximum Workplace Temperature Bill. UK Parliament. Available from: https://bills.parliament.uk/bills/4263

68. Howarth, C., et al. Turning up the heat: Learning from the summer 2022 heatwaves in England to inform UK policy on extreme heat (Evidence Report). Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. Available from: https://www.lse.ac.uk/granthaminstitute/publication/turning-up-the-heat/

69. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/

70. Doctors' Association UK. Extreme heat in the NHS: DAUK heatwave survey written summary. Available from: https://dauk.org/wp-content/uploads/2026/07/DAUK_extreme_heat_NHS_readable_report_30_June_2026.pdf

71. The Workplace (Health, Safety and Welfare) Regulations 1992, SI 1992/3004. Available from: https://www.legislation.gov.uk/uksi/1992/3004/contents

72. Climate Change Committee. A well-adapted UK: The fourth independent assessment of UK climate risk. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/

73. Mee, J.A., et al. Beyond Vulnerable Groups: Heat Preparedness, Impact, and Structural Barriers to Adaptation in UK Adults. 2026. [Unpublished]

74. 'UK-wide heat-related hospital attendances and admissions could triple by 2050 compared to current levels.' Climate Change Committee. A Well-Adapted UK. Available from: https://www.theccc.org.uk/publication/a-well-adapted-uk/

75. Department for Education. Hot weather and heatwaves: guidance for schools and other education settings. Education Hub. Available from: https://educationhub.blog.gov.uk/2026/06/hot-weather-and-heatwaves-guidance-for-schools-and-other-education-settings/

76. Nazneen, S., Choi, S. D., & Ibarra-Mejia, G. Extreme Heat Exposure in the Construction Industry: A Scoping Review on Risk Factors and Heat-Related Health Consequences. Int J Environ Res Public Health. 2025; 22 (11): 1651. Available from: https://doi.org/10.3390/ijerph22111651

77. Office for National Statistics. Public opinions and social trends, Great Britain: working arrangements. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/datasets/publicopinionsandsocialtrendsgreatbritainworkingarrangements

78. Ebi, K. L., et al. Hot weather and heat extremes: health risks. Lancet. 2021; 398 (10301): 698-708. Available from: https://doi.org/10.1016/s0140-6736(21)01208-3

79. Adapted from BBC News. What to do if you think someone has heat exhaustion or heatstroke. Available from: https://www.bbc.co.uk/news/articles/ckgl51jjp3jo

80. NHS Blood and Transplant. Functions of blood: Regulation. Available from: https://www.blood.co.uk/news-and-campaigns/the-donor/latest-stories/functions-of-blood-regulation/

81. Lumen Learning. Energy and heat balance. Anatomy and Physiology II. Available from: https://courses.lumenlearning.com/suny-ap2/chapter/energy-and-heat-balance/

82. Baldwin, J. W., et al. Humidity's Role in Heat-Related Health Outcomes: A Heated Debate. Environ Health Perspect. 2023; 131 (5): 55001. Available from: https://doi.org/10.1289/EHP11807

83. Havenith, G., et al. Evaporative cooling: effective latent heat of evaporation in relation to evaporation distance from the skin. J Appl Physiol. 2013; 114 (6): 778-785. Available from: https://doi.org/10.1152/japplphysiol.01271.2012

84. Havenith, G. Individualized model of human thermoregulation for the simulation of heat stress response. J Appl Physiol. 2001; 90 (5): 1943-54. Available from: https://doi.org/10.1152/jappl.2001.90.5.1943

85. Mayo Clinic. Heat stroke: Symptoms and causes. Available from: https://www.mayoclinic.org/diseases-conditions/heat-stroke/symptoms-causes/syc-20353581

86. Schmit, C., et al. Cognitive Functioning and Heat Strain: Performance Responses and Protective Strategies. Sports Med. 2017; 47 (7): 1289–1302. Available from: https://doi.org/10.1007/s40279-016-0657-z

87. Robinson, E., Howarth, C., Zhou, Y., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/climate-changes-heat-tax-on-the-uks-labour-force-and-economy/

88. Ioannou, L. G., et al. The Impacts of Sun Exposure on Worker Physiology and Cognition: Multi-Country Evidence and Interventions. Int J Environ Res Public Health. 2021; 18 (14): 7698. Available from: https://doi.org/10.3390/ijerph18147698

89. University of Florida. Heatstroke's long term damage to the body. UF News. Available from: https://news.ufl.edu/2022/07/heatstrokes-long-term-damage-to-the-body/

90. Robinson, E. J. Z., et al. Improving the resilience of the UK labour force in a 1.5 °C world. Grantham Research Institute on Climate Change and the Environment Working Paper 423. London: London School of Economics and Political Science. Available from: https://www.lse.ac.uk/granthaminstitute/publication/improving-the-resilience-of-the-uk-labour-force-in-a-1-5c-world/

91. Perrault, H. Efficiency of movement in health and chronic disease. Clin Invest Med. 2006; 29 (2): 117-21. Available from: https://pubmed.ncbi.nlm.nih.gov/16737088/

92. Smallcombe, J. W., et al., Quantifying the impact of heat on human physical work capacity; part IV: interactions between work duration and heat stress severity. Int J Biometeorol. 2022; 66 (12): 2463-2476. Available from: https://doi.org/10.1007/s00484-022-02370-7

93. Cheung, S. S., et al. Thermal stress, human performance, and physical employment standards. Applied Physiology, Nutrition, and Metabolism. 2016: 41 (6): S148–S164. https://doi.org/10.1139/apnm-2015-0518

94. Achebak, H., et al. Heat Exposure and Cause-Specific Hospital Admissions in Spain: A Nationwide Cross-Sectional Study. Environ Health Perspect. 2024; 132 (5): 57009. Available from: https://doi.org/10.1289/EHP13254

95. Gomes, E. C., Stone, V., & Florida-James, G. Impact of heat and pollution on oxidative stress and CC16 secretion after 8 km run. Eur J Appl Physiol. 2011; 111 (9): 2089–97. Available from: https://doi.org/10.1007/s00421-011-1839-y

96. Occupational Safety and Health Administration (OSHA). Personal Protective Equipment. US Department of Labor. Available from: https://www.osha.gov/personal-protective-equipment

97. Eglin, C and Tipton, M. in Baxter, P., et al. (Eds.). Hunter's Diseases of Occupations (10th ed.). CRC Press. https://doi.org/10.1201/b13467

98. Dorman, L. E., & Havenith, G. The effects of protective clothing on energy consumption during different activities. Eur J Appl Physiol. 2009; 105 (3): 463-70. Available from: https://doi.org/10.1007/s00421-008-0924-2

99. Bernard, T. E., et al. WBGT clothing adjustments for four clothing ensembles under three relative humidity levels. J Occup Environ Hyg. 2005;1;2 (5):251-6. Available from: https://doi.org/10.1080/15459620590934224

100. Kenny, G. P., et al. Heat stress in older individuals and patients with common chronic diseases. CMAJ. 2010; 182 (10): 1053-1060. Available from: https://doi.org/10.1503/cmaj.081050

101. Foster, J., et al. Individual responses to heat stress: implications for hyperthermia and physical work capacity. Front Physiol. 2020; 11: 541483. Available from: https://doi.org/10.3389/fphys.2020.541483

102. Kenney, W. L. A review of comparative responses of men and women to heat stress. Environ Res. 1985; 37 (1): 1–11. Available from: https://doi.org/10.1016/0013-9351(85)90044-1

103. Shayegh, S., & Dasgupta, S. Climate change, labour availability and the future of gender inequality in South Africa. Climate and Development.2024;16 (3), 209–226. Available from: https://doi.org/10.1080/17565529.2022.2074349

104. Gombert-Labedens, M., et al. Effects of menopause on temperature regulation. Temperature (Austin). 2025; 12 (2): 92–132. Available from: https://doi.org/10.1080/23328940.2025.2484499

105. Tataryn, I. V., et al. Postmenopausal hot flushes: a disorder of thermoregulation. Maturitas. 1980; 2 (2): 101–7. Available from: https://doi.org/10.1016/0378-5122(80)90043-2

106. Woodward, S., & Freedman, R. R. The thermoregulatory effects of menopausal hot flashes on sleep. Sleep. 1994; 17 (6): 497–501. Available from: https://doi.org/10.1093/sleep/17.6.497

107. Moran, D. S., et al. Aging and assessment of physiological strain during exercise-heat stress. Am J Physiol Regul Integr Comp Physiol. 2002; 282 (4): R1063–R1069. Available from: https://doi.org/10.1152/ajpregu.00364.2001

108. Samuels, L., et al. Physiological mechanisms of the impact of heat during pregnancy and the clinical implications: review of the evidence from an expert group meeting. Int J Biometeorol. 2022; 66 (8): 1505–13. Available from: https://doi.org/10.1007/s00484-022-02301-6

109. Chersich, M. F., et al. Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: systematic review and meta-analysis. BMJ. 2020; 371: m3811. Available from: https://doi.org/10.1136/bmj.m3811

110. Bonell, A. Heat stress and its severity during pregnancy: The worsening realities of heat stress for pregnant women in West Africa. Physiol News. 2022; (127). Available from: https://www.physoc.org/magazine-articles/heat-stress-and-its-severity-during-pregnancy/

111. Shayegh, S., & Dasgupta, S. Climate change, labour availability and the future of gender inequality in South Africa. Climate and Development. 2024;16(3), 209–226. Available from: https://doi.org/10.1080/17565529.2022.2074349

112. Dasgupta, S., et al. Heat stress and the labour force. Nat Rev Earth Environ 5. 2024; 859–872. Available from: https://doi.org/10.1038/s43017-024-00606-1

113. Dasgupta, S., et al. Heat stress and the labour force. Nat Rev Earth Environ 5. 2024; 859–872. Available from: https://doi.org/10.1038/s43017-024-00606-1

114. International Energy Agency (IEA). The Future of Cooling. Available from: https://www.iea.org/reports/the-future-of-cooling

115. Robinson, E. J. Z., et al. Improving the resilience of the UK labour force in a 1.5 °C world. Grantham Research Institute on Climate Change and the Environment Working Paper 423. London: London School of Economics and Political Science. Available from: https://www.lse.ac.uk/granthaminstitute/publication/improving-the-resilience-of-the-uk-labour-force-in-a-1-5c-world/

116. Heat Stress. Examples of work-rest schedules for workers in high-temperature jobs. Available from: https://heatstress.com/blog/examples-of-work-rest-schedules-for-workers-in-high-temperature-jobs

117. Brown, H. A., et al (2022). Seasonal Heat Acclimatisation in Healthy Adults: A Systematic Review. Sports medicine (Auckland, N.Z.). 2022; 52(9), 2111–2128. Available from: https://doi.org/10.1007/s40279-022-01677-0

118. Foster, J., Hodder, SG., Lloyd A. B., & Havenith, G. Individual Responses to Heat Stress: Implications for Hyperthermia and Physical Work Capacity. Front Physiol. 2020;11 (11):541483. . Available from: https://doi.org/10.3389/fphys.2020.541483

119. Eglin, C and Tipton, M. in Baxter, P., et al. (Eds.). Hunter's Diseases of Occupations (10th ed.). CRC Press. https://doi.org/10.1201/b13467

120. Dineen, R., Thompson, CJ., & Sherlock, M. Hyponatraemia - presentations and management. Clin Med (Lond). 2017;17 (3):263-269. doi: 10.7861/clinmedicine.17-3-263. PMID: 28572229; PMCID: PMC6297575.

121. UK Legislation. The Workplace (Health, Safety and Welfare) Regulations 1992. Available from: https://www.legislation.gov.uk/uksi/1992/3004/contents

122. University of Melbourne. How much should parasitic gig companies contribute to city finances? Pursuit. Available from: https://pursuit.unimelb.edu.au/articles/how-much-should-parasitic-gig-companies-contribute-to-city-finances

123. Robinson, E., Howarth, C., Zhou, Y., & Dasgupta, S. Climate change's heat tax on the UK's labour force and economy (Research Briefing). Grantham Research Institute on Climate Change and the Environment. Available from: https://www.lse.ac.uk/granthaminstitute/publication/climate-changes-heat-tax-on-the-uks-labour-force-and-economy/

124. Keramidas, M. E., & Botonis, P. G. Short-term sleep deprivation and human thermoregulatory function during thermal challenges. Exp Physiol. 2021;106 (5): 1139–48. Available from: https://doi.org/10.1113/EP089467

125. Lowe, C. J., Safati, A., & Hall, P. A. The neurocognitive consequences of sleep restriction: A meta-analytic review. Neurosci Biobehav Rev. 2017; 80: 586-604. Available from: doi: 10.1016/j.neubiorev.2017.07.010

126. Kenny, G. P., et al. Heat stress in older individuals and patients with common chronic diseases. CMAJ. 2010; 182 (10): 1053–60. Available from: https://doi.org/10.1503/cmaj.081050

127. Bar-Or, O., Lundegren, H. M., & Buskirk, E. R. Heat tolerance of exercising obese and lean women. J Appl Physiol. 1969; 26 (4): 403–9. Available from: https://doi.org/10.1152/jappl.1969.26.4.403

128. Piil, J.F., et al. High prevalence of hypohydration in occupations with heat stress—Perspectives for performance in combined cognitive and motor tasks. 2018; PLoS ONE 13 (10): e0205321. Available from: https://doi.org/10.1371/journal.pone.0205321

129. Trades Union Congress (TUC). Toilets at Work: A report on workers' experience of toilet access and facilities. Available from: https://www.tuc.org.uk/sites/default/files/2024-11/Toilet%20report.pdf

130. Gulcebi, M., Macrohon, B., & Sisodiya, S. Climate change and melting medications. Epilepsia. 2025; 66 (10): 4073–4. Available from: https://doi.org/10.1111/epi.18618

131. Medicines and Healthcare products Regulatory Agency (MHRA). Don't let this heatwave affect your medicines: Three important tips from the MHRA. GOV.UK. Available from: https://www.gov.uk/government/news/dont-let-this-heatwave-affect-your-medicines-three-important-tips-from-the-mhra

132. Kendon, M., et al. State of the UK Climate in 2025. Int J Climatol. 2026; 46 (S1): e70470. Available from: https://doi.org/10.1002/joc.70470

133. Robinson, E., & Dasgupta, S. Workers' health and the economy are suffering due to climate change. London School of Economics and Political Science (LSE) Politics and Policy Blog. Available from: https://blogs.lse.ac.uk/politicsandpolicy/workers-health-and-the-economy-are-suffering-due-to-climate-change/

The Physiological Society

As the largest network of physiologists in Europe, with academic journals of global reach, The Physiological Society continues a 150-year tradition of being at the forefront of the life sciences. We support the advancement of physiology by promoting collaboration between physiologists around the world, organising world-class conferences, publishing the latest developments in our scientific journals, and bringing scientific evidence and expertise to policy. We are a rigorous and independent source of scientific knowledge, drawing on the expertise of a diverse community of physiologists across career stages who support us in our various activities, including our policy work. Through this work, we connect policymakers and other stakeholders with the latest evidence and expertise from the physiological sciences, helping to inform decisions that affect health and society. Research in physiology helps us to understand how the body works in health, what goes wrong in disease, and how the body responds to the challenges of everyday life.

@ThePhySoc

physoc

@thephysoc

PhysocTV

the-physiological-society