Bringing mechanistic understanding and real-world impact to the link between extreme heat and mental health

A report from an expert workshop held by The Physiological Society and Wellcome Trust

May 2024
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Climate change is leading to the rise in incidence, severity, and length of periods of extreme heat. These periods are associated with various negative mental health outcomes. While the correlation between heat and some mental health problems is clear, the mechanisms driving these worsened outcomes are under-researched and poorly understood.

Similarly, the precise nature of the interaction between biological, psychological and social mechanisms driving mental health problems during periods of high or extreme heat remains unknown. A lack of global data on the mechanisms underpinning this association are preventing better understanding of how heat affects mental health outcomes in different countries, as well as culturally-appropriate and sustainable interventions that could improve mental health outcomes.

Executive summary

1. Address research gaps in the understanding of the physiological mechanisms linking heat to poorer mental health outcomes. This includes exploring physiological changes, neurotransmitter involvement, and neuro-developmental impacts.

   There is also a lack of specific research on how heat impacts different mental health problems, and the extent to which the severity of mental health problems during heat waves are driven by physiological and/or behavioural changes.

2. Develop research designs from physiology to investigate the mechanisms underpinning the association between heat and mental health problems. A better overall understanding of the mechanistic pathways linking heat to poorer mental health outcomes would enable better prioritisation of research and thereby use of the finite amount of resources available for such research. This will give us a greater understanding of these conditions and ultimately help to design effective interventions and adaptations.

Key recommendations
3. **Ensure a concerted focus on mental health problems associated with extreme heat in the Global South, particularly low- and middle-income countries (LMICs).** Research often neglects regions where most extreme heat events occur and where communities are most vulnerable to its impacts, such as the Global South. This neglect may lead to a lack of prioritisation in understanding and addressing the mental health impacts of heat and the extent to which people in these countries are able to adapt and acclimatise to heat.

4. **Improve the use and integration of existing mental health and weather and climate data.** Existing mental health records and weather and climate databases where data are available should be used to study the impact of different heat indices on mental health; these data could inform physiological adaptations to heat and related mental health problems.

5. **Implement simple, cheap and sustainable cooling interventions and evaluate their impacts on mental health.** Implementing simple, cheap and low-carbon interventions like using natural ventilation or fans to keep people cool should be promoted widely, although currently they are not widely included in government guidance and there is a lack of evidence for their impact on mental health.

6. **Promote collaboration in research design through consortia-based funding models.** Funding bodies should focus on achieving a balance between mechanistic research and larger-scale intervention studies. Funding bodies can encourage collaboration among researchers, including physiologists, funding projects that require transdisciplinary approaches.
1. Facilitate knowledge sharing and collaboration.
The Physiological Society will develop a Climate & Health Expert Group, designed to facilitate knowledge-sharing between physiologists and other crucial research disciplines including expertise from mental health science.

2. Advocate for inclusive research practices.
The Physiological Society will continue to advocate for the inclusion of age, sex, gender, socio-economic status and vulnerable populations as important factors in research on heat and mental health from the outset of study design. Through the programmes we deliver, we will encourage researchers to incorporate sex and gender considerations into questionnaires, data collection instruments and analysis, while respecting individuals’ privacy and confidentiality.

3. Support data collection on physiological parameters.
The Physiological Society will encourage researchers from other disciplines to include physiologists and monitor physiological parameters, such as heart rate and body temperature, into their studies on heat and mental health. The Physiological Society will promote the value that physiologists bring to research in this area.

4. Engage with governments to address disparities in access to cooling resources. Through projects and reports such as Red Alert: Developing a Human-centred National Heat Resilience Strategy, The Physiological Society will advocate for policies and initiatives aimed at improving access to low-carbon, human-centred cooling resources, particularly in marginalised communities. Support should also be given to transdisciplinary research efforts to understand the impact of socioeconomic barriers on access to cooling technologies and support the development of strategies to address these barriers.
Introduction

Heat and mental health

Climate change has been described by the United Nations as ‘the single biggest health threat facing humanity’. Among its many consequences, the increasing frequency and intensity of extreme heat events stand out for their immediate and profound effects on public health, including mental health. Extreme heat events are no longer rare occurrences but are becoming more frequent, intense, and prolonged, posing a direct threat to human life and health, both physical and mental.

Extreme ambient temperatures are associated with worsened mental health outcomes. According to the Intergovernmental Panel on Climate Change’s (IPCC) 2023 report, there is a ‘very high confidence that climate change has already negatively impacted mental health globally’.1

As Wellcome also notes, ‘Climate change is causing temperatures around the world to rise, which can have a variety of detrimental impacts on mental health’.2

The window for effective intervention is rapidly shortening. As such, any new research and studies must quickly lead to interventions. The time for action is now and projects that promote interventions should be prioritised.

Physiology and building a mechanistic understanding of the impact of heat on mental health

The Physiological Society’s recent Heat Resilience Strategy included epidemiological data demonstrating that there are increased hospital attendance or admissions for mental health problems, suicide, and suicidal behaviour during periods of extreme heat. Despite this, the mechanisms driving the interactions between worsened mental health and heat are still poorly understood, with various potential biological (e.g. impaired thermoregulation in people taking certain psychotropic medications), psychological (e.g. worsened mood and sleep), and social (impact of heat on day-to-day activities such as socialising outdoors, increased levels of violence) mechanisms proposed.

Workshop

The Physiological Society and Wellcome held a joint workshop on Thursday 15 February 2024, ‘Bringing mechanistic understanding and real-world impact to the link between extreme heat and mental health’. It brought together 80 delegates from over 16 countries around the world, covering topics from current research efforts to understand the interactions between poorer mental health and heat, to government policies that could help to improve the implementation of research insights.

Research specialisms of the delegates that attended the workshop included physiology, mental health, public health, data science, weather modelling as well as representatives of national governments and funders with an interest in this area.

This report summarises the discussions and key findings from that workshop.

Report objectives

The purpose of this report, and the related evidence-development workshop, was to explore the mental health and physiological communities’ responses to the following topics:

1. Identify and prioritise key research gaps within the heat and mental health space.
2. Understand the disciplines that should be included in a transdisciplinary community that can respond effectively and rapidly to the identified research gaps.
3. Discuss the shape and structure of future funding calls related to heat and poorer mental health.

1. ‘Including mental health as part of climate change impacts and adaptation assessment: A critical advance in IPCC AR6’ | PLOS Climate
What are the major research gaps that currently exist?

Research has highlighted the complex interplay between heat and mental health and the need to consider biological, psychological and social responses in order to explore the causal links between heat and mental health.

While the epidemiological links between extreme heat and poor mental health are clear, the mechanisms driving these links are uncertain and not yet comprehensively researched and understood. As part of the evidence gathering, we have highlighted the following areas of research as being crucial to fully establishing and understanding the causal links between heat and mental health. Pathways of interaction between heat and mental health conditions that are known to be significant but currently under researched include:

1. **Physiological responses.** How do external temperatures affect internal metabolic reactions, and how can we identify potential thresholds of temperature tolerance for different groups? How does heat interact with drugs designed to treat mental health problems? What are the consequences of heat-disrupted sleep on mental health problems? How can we quickly identify and address the interventions which will have a positive impact for the most people globally?

2. **Global perspectives.** Current research on heat and mental health in low- and middle-income countries (LMICs) is scarce and the few studies that exist tend to address observed effects rather than developing a better understanding of which mechanisms are driving these associations. A better understanding of the different physiological responses in heat adaptation, and how this builds resilience to mental health problems, would help to assess interventions in different regions.

3. **Health equity and climate change.** Inequities exist within populations concerning the impacts of extreme heat on mental health. However, there is a paucity of evidence on how pre-existing inequalities may make some people more vulnerable to the mental health impacts of extreme heat. Health equity must be at the heart of the response to climate change, with attention to the disproportionate impacts born by vulnerable communities.

4. **Behavioural and societal impacts.** Heat can lead to changes in behaviour, social activities, and community dynamics, with physiological responses leading people to engage in riskier behaviours during periods of hot weather (e.g., increased alcohol and drug consumption). More research is also required to understand how following measures to decrease the risk of the impact of heat on physical health, such as remaining indoors with windows and shutters closed, could inadvertently have side effects for mental health (e.g., increasing feelings of isolation which have been strongly connected to poor mental health).

5. **Environmental factors and diet.** Better understanding is required of the connection between mental health and the body’s ability to respond to ambient heat. This is based on a better understanding of how diet, nutrition and the gut microbiome support whole system resilience, with further research required on which diets impact mental health and how this relationship may be modified by climate change.

Which mental health conditions are being prioritised in research and where is the evidence lacking?

The mental health conditions being prioritised in research generally are primarily depression and anxiety given their prevalence in all age groups globally. However, the causes of these conditions remain poorly understood, multi-faceted and interlinked.
Evidence gaps have been identified in the following areas:

1. **Physiological mechanisms linking heat to poorer mental health.** Research is needed to better understand the mechanisms underpinning the relationship between extreme heat and poor mental health. This includes exploring physiological changes, neurotransmitter involvement, and neurodevelopmental impacts.

   There is also a lack of specific research on the continuum of mental health and heat-related impacts, and the extent to which the severity of mental health problems during heat waves are driven by physiological or behavioural changes.

2. **Links between heat and mental health problems in LMICs.** Participants felt that research often neglects regions where the majority of heatwaves occur, such as LMICs in the Global South. This neglect may lead to disparities in understanding and addressing mental health impacts. People in these countries may be acclimatised to the heat and at relatively lower risk of mental health problems related to extreme heat, although this is an assumption that would need to be tested. Conversely, there may be others at higher risk due to lower overall resources or access to adaptations. However, the lack of data are preventing these questions from being addressed as well as obscuring the impact of extreme heat on mental health in different regions. There is therefore, an imperative that research takes place in the most affected areas and communities to develop effective and tailored interventions.

3. **Humidity and temperature.** Participants argued that the definition of extreme heat should reflect an individual’s ability to respond effectively to extreme heat, taking into consideration wider factors such as humidity and air speed to develop a better understanding of the relationship between heat and mental health as well as interventions that are effective depending on the specific environment people living with mental health problems are in, and how effectively they are able to respond.

4. **The impact of heat on pharmacological interventions for mental health.** Participants discussed the impact of heat on some pharmacological interventions such as psychotropic medications. However, little research existed in this area and participants noted a lack of awareness regarding the specific mechanisms of action of medication and how it interacts with extreme heat exposure and thermoregulation. Some participants also mentioned the issue of exploring how psychotropics themselves (and related processes such as stockage and maintenance) may be affected by extreme heat.

5. **Sleep.** There was discussion of the impact of heat on sleep quality and the mechanistic links between poorer sleep and mental health conditions.

6. **Microbiome.** Physiological research into the impact of heat and body temperature changes on the gut microbiome is sparse and research on the relationship between the microbiome and mental health is contentious. There is therefore further research required into how heat can affect the variety and availability of food and specific nutritional requirements globally, as well as their impacts on mental health.

7. **Autonomic Nervous System (ANS).** Physiological research can help us better understand the relationship between the ANS and mental health, and how it is affected by heat.

8. **Children’s mental health and vulnerability.** Children’s vulnerability to heat is also an area needing attention given their increased susceptibility to heating and more limited ability to change their behaviour. The impact that heat can have on physical and mental health during childhood development should also be considered.³

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³ Harvard University. Extreme Heat Affects Early Childhood Development and Health. Available at: [https://developingchild.harvard.edu/heat-paper/](https://developingchild.harvard.edu/heat-paper/)
How can we prioritise research gaps?

In order to ensure research and implementation meets the greatest global need, and can be translated quickly and effectively, we have identified areas of current research which could be applied to the challenges and research gaps identified. Additionally, research prioritisation criteria must be identified based on demand and the likelihood of developing well-evidenced and effective interventions based on high quality research.

We have identified the areas of research below that would make the most significant difference to how we conceptualise and understand the link between extreme heat and mental health, regardless of how feasible this research is currently:

1. **Thresholds for heat tolerance.** Physiological research can explore the thresholds at which certain populations cannot tolerate heat, and the impact on mental health problems. Factors should include heat metrics, ambient and body temperatures, geographical location, baseline levels of resilience, age, sex, health status (including intake of medications) and existing infrastructure to protect against extreme heat. The interaction of these factors should be considered, as should individual variation.

2. **Implementation and equitable translation.** We are already seeing the impacts of rising heat on mental health problems. The incidence of this is likely to worsen and bridging the gap between research findings and real world action as urgently as possible is crucial. A starting point for this understanding is translating research findings from existing effective interventions to novel settings and populations, particularly among the most vulnerable populations (such as older people, children, agricultural workers in low- and middle-income countries (LMICs), people with disabilities including people living with severe mental health problems and pregnant individuals). This translation of existing interventions should also extend to developing new interventions. Those with lived experience of both extreme heat and mental health problems should be involved throughout the research process.

3. **Understanding pathways.** A better overall understanding of the mechanistic pathways linking heat to poorer mental health would allow for the better prioritisation of research and interventions based on a finite amount of resource being available for this research.

4. **Research strategies.** Integrating mental health measurements into existing physical health studies on heat and building heat measurements into existing projects looking at mental health problems to bridge the gap between these two areas of research.

5. **Collaboration with other academic disciplines.** There is a need to investigate the interplay between psychological, social and physical variables that contribute to the relationship between heat and mental health. Research should look to explore the relationship between these variables and understand how they interact to affect mental health, with scope to group variables based on existing epidemiological data to speed up translation of research findings.

There is also the need to rapidly foster greater partnership with the climate community – specifically biometeorologists, experts in measuring the thermal environment and climate modellers to build a better understanding of the specific data that can predict a rise in incidence and worsening of mental health problems.
6. **Global response.** Globally, there is variation in the relationship between heat, extreme heat events and mental health, which makes quantifying the impact of short and long-term heat episodes more difficult. Despite this variation, cost-effective, human-centred, sustainable and culturally-relevant interventions should be promoted and made accessible throughout the world.

**What opportunities exist currently to develop evidence-based interventions?**

There are a number of opportunities that are already well evidenced for other health conditions that could be applied to the topic of heat and mental health. Some of these opportunities include:

1. **Cold water immersion.** Historical practices such as cold water immersion, particularly cold water swimming, have anecdotal evidence for improving mental health. It should be noted however, that evidence demonstrates a rise in drowning during periods of extreme heat as people seek refuge from heat in cold water. It should also be noted that there is controversial history surrounding the use of cold water to treat psychiatric illness (e.g., compulsory cold baths were used in the 19th century to supposedly treat people staying in long-term psychiatric care in Europe).

2. **Better use of existing health data.** Existing health records and weather databases from High Income Countries should be leveraged to study the impact of different heat indices on mental health conditions. Such data could inform physiological adaptations to heat and potentially mental health.

3. **Simple, cheap and sustainable cooling interventions.** Simple, cheap, and low-carbon interventions, like natural convection or fanning, should be promoted widely, although currently they are not widely included in government guidance.

4. **Role of controlled clinical work and basic science.** Structures for conducting controlled clinical studies and basic science research, including animal studies, to investigate the mechanisms underlying the impact of heat on mental health are in place but currently underused and under-valued within discussions on the topic. There are virtually no studies focusing on mental health and heat that have used these methods.

5. **General mental health assessment tools to regularly capture data and benchmarks.** The use of general mental health assessment tools or questionnaires that can be administered throughout the year to capture fluctuations in mental health as related to temperature changes should be considered. These assessments can be conducted in non-clinical environments or through existing technology to complement mechanistic studies.

6. **Timestamping in cohort studies.** Timestamping in cohort studies could be implemented to better link mental health data with specific environmental events, such as heatwaves. This can help explore the interaction between mental health and climate/environmental conditions more effectively.

**Ensuring the voice of people with lived experience is considered in the prioritisation of outcomes and research related to heat and mental health**

1. **Consult people with lived experience.** Individuals with lived experience of mental health problems must be included in the development of future research initiatives and in the design and conduct of studies and interventions. This could include informing research priorities, governance, design, delivery, monitoring, dissemination of mental health research, among other activities. This will help researchers better understand: lived experiences of managing mental health problems during periods of extreme heat; what affects people living with mental health problems during
periods of temperature fluctuations; and what they believe should be done to improve their mental health over the short and medium-term.

Similarly, experiments and interventions should be co-designed in collaboration with individuals with lived experiences to ensure that research questions, methodologies, and outcomes are relevant, inclusive, and responsive to their needs.

2. **Engage communities and harder to reach populations.** Communities and harder to reach populations should be a critical part of collaborative working to understand how heat impacts mental health, and to develop culturally sensitive interventions. Individuals from such communities should be included in workshops, round tables, and advisory committees where research priorities, methodologies, and findings are discussed.

3. **Compensate fairly for lived experience engagement and community involvement.** The value of community involvement must be recognised through the fair compensation of individuals for their time and expertise. This will require funding mechanisms to prioritise community engagement efforts, mandating that a portion of research funding is allocated to these initiatives.

### How can we measure the impact of heat throughout the body and how this affects brain health and mental health problems?

1. **Use of wearable devices compared to current standard measurement tools.** Wearable devices have the potential to continuously monitor temperature changes throughout the body. While this approach may be less invasive than other techniques to measure body heat (e.g., ingestibles), it should be noted that there are concerns about the accuracy of surface temperature measurements compared to core temperature. Despite this, core temperature measures are harder to take and are best measured in laboratories although technology is advancing to address this through the development of ingestible thermometers.

2. **Integration of neurology.** Neurological measures can provide insights into the relationship between temperature regulation and brain health. Techniques such as brain imaging and brain temperature measurement could help explore this relationship, but these studies will be comparatively small in scale and should be linked to wider cohort studies as closely as possible.

3. **Longitudinal studies.** Following individuals over the life course can provide valuable data on the cumulative effects of heat exposure on physical and mental health. Tight control and close monitoring of acute heat exposures, combined with brain imaging, could offer insights into the immediate impacts on mental health. Longitudinal studies allow for the measurement of mental health before and after heatwaves which represents an important research design element in strengthening causal inference.

4. **Animal models.** Animal models can be used to study the physiological and neurological effects of heat exposure. These models allow for controlled experiments to investigate the mechanisms underlying the association between extreme heat and mental health problems.

5. **Heat mechanisms and measurement.** Understanding the mechanisms through which heat affects mental health is crucial. Consensus and harmonisation in measuring heat-related variables are necessary. Studies should consider both short-term and chronic exposures, as well as the interaction of heat with other stressors like air pollution.

A rigorous and standardised description of mental health problems would ensure consistency across studies and interventions. This can help facilitate comparison and synthesis of findings across different research projects globally.
What measures can be put in place to effectively address research gaps?

Finally, we explored the responsibilities of different stakeholders involved in improving mental health in a world that was already seeing the impact of climate change on rising temperatures and the incidence of extreme heat events.

What is the role of funding bodies and learned societies in addressing these research gaps?

Our findings on the role of funding bodies fall into two groups: (i) how can funders develop funding calls that seek to address the research gaps that exist in our understanding, and (ii) how they can support capacity building to ensure the better implementation of evidence and research.

Future funding calls

Promoting collaboration in research design through consortia-based funding models. Funding bodies should focus on achieving a balance between mechanistic research and larger-scale intervention studies. Funding bodies can encourage collaboration among researchers by funding projects that require transdisciplinary approaches including physiologists.

Include thermophysiologists in funding review panels. Funders should ensure that thermophysiologists are represented on funding review panels related to heat and mental health. They should also encourage diversity in panel composition to ensure that proposals involving heat-related research receive adequate consideration and support.

Publicise studies which do not demonstrate impact. Funding bodies should promote studies with negative results on the relationship between heat and mental health to provide valuable insights, prevent unnecessary duplication of effort given the ever-shortening timeframes associated with climate change, increase the rigour of the quality of science in this area and help prevent future redundant research efforts.

Capacity-building

Facilitating collaboration and knowledge sharing. Funding bodies and learned societies can organise meetings, conferences, and online platforms to facilitate collaboration and knowledge sharing among researchers. These platforms provide opportunities for researchers to learn from one another, develop shared goals, and identify opportunities for collaboration.

Supporting early career researchers and researchers in and from LMICs. Funding bodies and learned societies should foster the development of early career researchers and researchers in and from LMICs in this field by providing grants and opportunities for career development. This helps ensure a diverse global pool of researchers working on heat and mental health.

Encourage trans-disciplinary research.

The support of transdisciplinary research that promotes and address the intersection of heat and mental health would bring together researchers from diverse disciplines, including physiology, and regions to collaborate on integrated research projects.

Promote North-South and South-South collaboration. Evidence also pointed to the need to facilitate collaboration between institutions and researchers from different geographic regions, including both North-South and South-South partnerships.

4. Multidisciplinary approaches involve combining research from several academic disciplines or professional specialisations to address a specific problem such as extreme heat and mental health.

5. Transdisciplinary research efforts will bring together investigators from different disciplines working jointly to create new and innovative solutions that integrate and move beyond discipline-specific approaches to address a common problem. It will be particularly important in the context of extreme heat and mental health where multiple stakeholders must be involved.
This could be achieved through encouraging exchange programmes, joint research projects and knowledge sharing initiatives to foster cross-regional collaboration. Funders could facilitate this through tighter requirements for researchers applying for funding to demonstrate equitable collaboration across disciplines and regions.

Funding agencies can stipulate: (i) That proposals must involve researchers from multiple disciplines and geographic locations to encourage cross-disciplinary collaboration, and (ii) That data produced from studies are made more easily accessible globally to allow for the testing and analysis of findings in other settings.

How can The Physiological Society and other such learned societies address these gaps?

**Facilitate knowledge sharing and collaboration.**
The Physiological Society will organise conferences, workshops, and networking events to bring together a community in order to facilitate knowledge sharing and collaboration among researchers, practitioners, policymakers, people with lived experience, and community stakeholders working in the field of heat-related mental health. This will encourage the exchange of best practices, research findings, and innovative interventions. As a first step, The Physiological Society will develop a Climate & Health Expert Group, designed to facilitate this knowledge sharing between physiologists and other crucial research disciplines, including expertise from mental health science.

**Advocate for inclusive research practices.**
The learned society community should continue to advocate for the inclusion of age, sex, gender and vulnerable populations in research on heat and mental health from the outset of study design. Through the programmes they deliver, learned societies, including The Physiological Society, should encourage researchers to incorporate demographic information into questionnaires, data collection instruments, and analysis while respecting individuals’ privacy and confidentiality.

**Support data collection on physiological variables.**
Encourage researchers from other disciplines to incorporate physiologists into their studies on heat and mental health and monitor physiological variables, such as heart rate and body temperature.

**Engage with governments to address disparities in access to cooling resources.** As with The Physiological Society’s recent report *Red Alert: Developing a Human-centred National Heat Resilience Strategy*, learned societies and national academies should advocate for policies and initiatives aimed at improving access to low-carbon, human-centred cooling resources, particularly in marginalised communities. Support should also be given to transdisciplinary research efforts to understand the impact of socioeconomic barriers on access to cooling technologies and support the development of strategies to address these barriers.

**Mutual understanding and language between health and climate researchers.** In order to develop truly transdisciplinary working, more time and resource must be committed to ensuring a common language and literacy between climate and health researchers and communities. This will not only foster transdisciplinary working but also ensure a shared communication to governments and funders about the challenges and opportunities related to research and action.

**What will be the role of governments?**
Participants felt that governments around the world had a responsibility to not only facilitate research and implementation of evidence within their own jurisdictions, but also to promote research, collaboration, capacity building, and action to protect the lives of the most vulnerable around the world.

**In-country**

**Funding and support.** Governments should fund projects and resources to support research initiatives focused on mental health, including studies addressing the impact of heat on mental health. By prioritising funding in this area, governments can incentivise researchers to study the relationship...
between extreme heat and mental health challenges and develop evidence-based interventions. Governments such as Canada via Health Canada are already looking to invest in research as a consequence of the additional demands placed on health systems as a result of recent extreme heat events.

**Policy development and implementation.** Governments play a crucial role in developing policies and regulations aimed at mitigating the impact of heat on mental health. This may include implementing heatwave response plans, establishing guidelines for heat-safe environments and integrating mental health considerations into public health policies.

**Information sharing.** Governments can ensure that existing information and resources relevant to heat-related mental health are accessible to all individuals, including those with mental health problems or disabilities, and share these materials with governments at sub-national and international levels. This may involve developing tailored communication strategies to safeguard mental health during heatwaves, providing information in multiple languages and formats, and collaborating with community organisations to reach vulnerable populations.

**Closer integration of mental health into public health systems.** Governments can integrate mental health considerations into public health systems and emergency response protocols. This may involve training healthcare providers to recognise, prioritise and address mental health issues that may be exacerbated by extreme heat, establishing support services for individuals whose mental health may worsen in the context of extreme heat, and ensuring access to mental health care during heatwaves and extreme weather events.

**Inter-governmental collaboration**

**Collaboration with international organisations.** Governments can collaborate with international organisations like the World Health Organization (WHO) to identify global research priorities and coordinate efforts to address poor mental health in the context of extreme heat on a global scale. This collaboration can help streamline research efforts and ensure that the evidence generated benefits everyone. By raising awareness about the impact of heat on mental health, and advocating for policy action, governments can collaborate to mobilise support for research, prevention, and intervention efforts globally.
## Appendix 1: Evidence-gathering workshop agenda

The workshop consisted of a main session followed by three break out room sessions. The agenda was as follows:

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<th>Item</th>
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<td>Professor Mike Tipton, The Physiological Society (Co-Chair)</td>
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<td>Dr Winnie Wefelmeyer, Wellcome (Co-Chair)</td>
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<td>Heat and physiology</td>
<td>Professor Mike Tipton, The Physiological Society</td>
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<td>Introduction to heat and mental health</td>
<td>Professor Madeleine Thomson, Wellcome</td>
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<td>Dr Catherine Sebastian, Wellcome</td>
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<td>Heat and mental health research landscape</td>
<td>Dr Alessandro Massazza, Wellcome</td>
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<td>Connecting Climate Minds</td>
<td>Dr Emma Lawrance, Connecting Climate Minds</td>
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<td>Session 1: Are there any other major research gaps that currently exist?</td>
<td>The Physiological Society and Wellcome breakout room Chairs</td>
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<td>Session 2: What are the research gaps that are game changing and where do the low-hanging fruit of opportunities exist? How does this help us prioritise research gaps?</td>
<td>The Physiological Society and Wellcome breakout room Chairs</td>
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<td>Session 3: How can we effectively address these research gaps?</td>
<td>The Physiological Society and Wellcome breakout room Chairs</td>
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<tr>
<td>Thanks and meeting close</td>
<td>Professor Mike Tipton, The Physiological Society</td>
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The Physiological Society

As the largest network of physiologists in Europe, with academic journals of global reach, The Physiological Society continues a 145 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 and publishing the latest developments in our scientific journals. 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.

Wellcome

Wellcome is a global charitable foundation established in 1936. Through its work, Wellcome supports science to solve the urgent health issues facing everyone. Wellcome funds curiosity-driven research, and takes on three of the biggest health challenges facing humanity – climate change, infectious disease and mental health. With a £36.8 billion investment portfolio, Wellcome gives researchers the time and resources they need to make breakthroughs. Wellcome also works with policy makers, run advocacy campaigns, and form partnerships with other organisations to ensure everyone, everywhere benefits from advances in health science.