

## *Cover Sheet*

SFC Alliances for Research Challenge

**Title: Mental Health, Sleep and Circadian Rhythms**

A) Contact details:

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B) Interested partner universities/organisations:

- University of Edinburgh
- Strathclyde University
- University of Glasgow
- Public Health Scotland
- Sleep Scotland Charity.

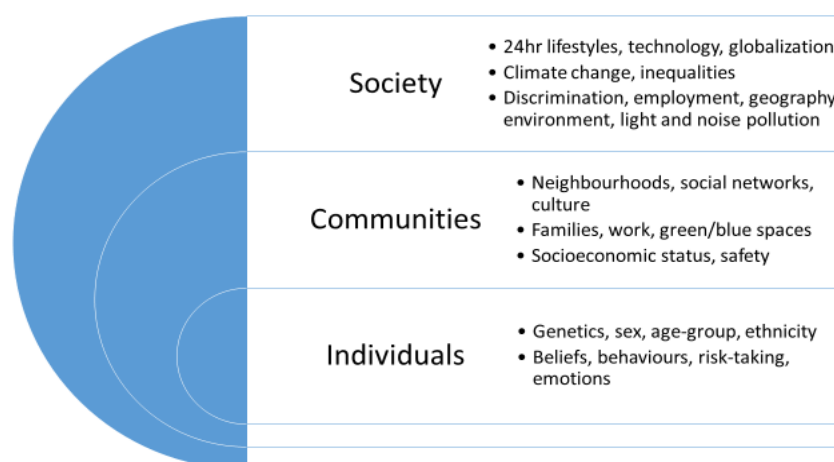
C) Disciplines that would be included:

Psychiatry, data science, sleep science, clinical psychology, health geography, public health, social sciences, geography, chronobiology, digital therapeutics.

## Mental Health, Sleep and Circadian Rhythms

**1. Background and rationale:** Circadian (24-hour) rhythms are found across all forms of life, from plants to humans. These rhythms exist at multiple molecular and cellular levels and allow organisms to optimally align physiology and behaviour to daily cycles of light and dark. Fundamental discoveries in circadian science are now leading to innovative approaches for improving human health (one of the genetic discoveries in this area was awarded the 2017 Nobel Prize in Physiology or Medicine). Our daily rhythms of sleep and activity have many important homeostatic and restorative functions, for example, in terms of emotional regulation and memory function. Healthy rhythms of sleep are also critical for metabolism and immunity. However, patterns of modern living are desynchronizing sleep and circadian rhythms through shift-work, early school start times, noise pollution, light pollution, poor access to green/blue spaces and excessive use of smartphones at night. This is associated with a wide range of adverse mental health outcomes, including mood disorders (depression and bipolar disorder), psychosis, anxiety disorders, substance misuse, chronic pain and dementia.

Healthy rhythms of sleep are particularly important for children, adolescents and young adults, who are more sensitive to the effects of sleep deprivation. More generally, this area is often overlooked by public health initiatives, which tend to focus on smoking, alcohol, diet and exercise (even though poor sleep is linked to all of these activities). Individuals and families in more deprived communities are disproportionately exposed to the causes of poor sleep, exacerbating existing social and health inequalities in Scotland. In short, mental health, sleep and circadian science represents an important and timely challenge area for ambitious and far-reaching interdisciplinary research within a socioecological model:



### *Socioecological Model of Mental Health, Sleep and Circadian Rhythms*

This socioecological framework can drive discovery science and innovation at multiple levels. For individuals: Individual variation of susceptibility to sleep and circadian disruption; the development of targeted interventions for specific age groups, sex and ethnicity (demographically-sensitive approaches); novel sleep and circadian interventions (in-person, group, web-based and using light treatments and mobile/digital technologies). For communities: We need more ecologically valid research on sleep, circadian rhythms and mental health within schools, healthcare environments and workplaces; investigations of the role of social networks, social capital, the built environment and the importance of blue/green spaces. For broader society: Research on how existing and new knowledge in the field of sleep and circadian rhythms can inform mental health policy, occupational health and address social inequalities.

**Recent advances in technology and data science make this a highly tractable area for research:** This includes advances in genomics and ‘big data’ (such as [UK Biobank](#) and [Generation Scotland](#)), new discoveries on the molecular basis of circadian rhythms, and new methods of data collection in both animal models and humans, such as wrist-worn accelerometers (to objectively infer rest/activity rhythms) and high temporal resolution ecological momentary assessments (EMA) of mood collected via smartphones. It is also now possible to link data from diverse sources to study sleep and mental health, such as linking EMA data with geolocation, weather (solar exposure and temperature) and social network activities. In terms of new treatment approaches, this field can also build on eHealth successes, such as the online [Sleepio](#) treatment for insomnia and other remote cognitive behavioural interventions. These advances bring new scope to develop and test interventions that build on collaborations between the NHS (such as the [Health Innovation South East Scotland Innovation Test Bed](#)) and third sector organisations such as [Sleep Scotland](#).

## **2. Alignment with Scottish Government priorities:**

2.1 Mental health and wellbeing are major priorities for the Scottish Government, as outlined in the most recent **Programme for Government 2021-2022 “A Fairer, Greener Scotland”** and the **Mental Health Strategy 2017-2027**. These priorities include improving mental health at a population level (for example, via primary prevention and self-management approaches) and improving existing NHS services, with a particular focus on prospective monitoring to inform early intervention and relapse prevention approaches. **Sleep and circadian rhythms are a tractable target for both psychological therapies and large-scale public health education campaigns.** Sleep also represents a less stigmatising entry point into mental health services, for example, in hard to reach groups such as young people, and men with depression, anxiety or suicidal thoughts. A focus on the assessment, diagnosis and treatment of sleep and circadian rhythms at a population level and within high risk groups - such as those with a family history of mental illness or a history of adversity/trauma, and individuals with suicidal thoughts and behaviours - could have major long-term social and economic impacts. Mental health is also a strategic priority for **Public Health Scotland (PHS)** and a focus on the relationship between sleep and mental health is an excellent fit to the recently-published **PHS Mental Health Indicators** (for both adults and children). Additionally, this research challenge area is consistent with many of the **National Performance Framework (NPF)** outcomes and indicators. For example, the Health outcome of the NPF takes a whole system approach to health and wellbeing by targeting harmful health behaviours early and from different angles.

2.2 Addressing health inequalities is a major priority within the **Programme for Government 2021-2022** and is currently the focus of an [inquiry](#) by Scottish Parliament’s Health, Social Care and Sport Committee. Smoking, alcohol, diet and exercise have been key targets for public health policy over the last three decades and continue to be highlighted as the most important structural targets for addressing health inequalities, for example within the recent Health Foundation [report](#) “*Addressing the leading risk factors for ill health*”. However, this report (and many similar reports) fails to consider the complex inter-relationship between poor sleep and alcohol, diet and exercise. Sleep deprivation is also strongly socially patterned, with individuals in more deprived communities facing many challenges that make healthy and regular sleep patterns very difficult to achieve. This includes structural and macroeconomic factors that are beyond the control of individuals, including long working hours, shift- and night-working, poor access to green and blue space, noise pollution, overcrowded homes, lack of social networks and the impact of concerns over financial insecurity. Indeed, these inequalities have been brought into sharp focus by the recent pandemic, with individuals and families in more deprived communities much less able to respond flexibly to lockdown restrictions such as home-schooling and working from home practices.

2.3 Improving educational attainment is a longstanding priority for the Scottish Government. Young people are particularly sensitive to the adverse effects of poor sleep: almost all teenagers have an evening chronotype (a biologically-driven preference for evening, rather than morning, activity) that makes it difficult for them to wake up and function well in the mornings. This can have a negative impact on learning and is exacerbated by issues such as excessive mobile phone and social media use late at night. There is also an important seasonal and geographical aspect to this, with many young people not getting enough exposure to natural daylight in the winter months (particularly in the north of Scotland). Some countries, such as Canada and Sweden, have recognised the association between sleep deprivation and poor educational attainment and have a more flexible approach to school start times for teenagers, as well as policies on morning light exposure and more outdoor learning opportunities. This work would build on the Scottish Schools Health and Wellbeing Improvement Research Network ([SHINE](#)) and the Sleep, Circadian Rhythms and Mental Health in Schools Network ([SCRAMS](#)), both of which are co-led by Prof Smith.

2.4 Collaboration with the digital health/technology sector is critical for the Scottish economy and growth. In the area of sleep and circadian science there are many opportunities for developing and testing novel digital monitoring and treatment approaches. Recent technological advances (such as smartphones and wearable sensors) have enormous potential, however they require more research and collaboration with industry partners to demonstrate cost effectiveness before clinical application. Our proposed challenge area would therefore work with **Innovation Centres in Scotland**, including the [Digital Healthcare Innovation Centre](#), [Precision Medicine Scotland](#) and the [Data Lab](#). We would also drive innovation and impact by engaging with companies such as Big Health (developing new digital therapeutics and expanding the functionality of existing eHealth treatments), Phillips (developing circadian lighting technologies in schools, nursing homes and prisons) and Condor (developing sleep and activity monitoring devices within low resource settings). More broadly, there is scope to work with employers to minimise the health impact of shift-working (currently at least 11% of Scottish workers work shifts).

**3. Nature of the multidisciplinary response required and areas of Scottish research excellence:** This challenge builds on existing research excellence in Scotland. This includes strengths in psychiatry, clinical psychology, public health, chronobiology, health geography and place-based health analyses, informatics and data science at the University of Edinburgh (particularly within Edinburgh Neuroscience and the Usher Institute) and sleep/circadian science and health inequalities research at the Universities of Glasgow and Strathclyde. There are also several unique strengths in Scotland that will add value, including the capacity for large-scale routine data linkage research (the electronic Data Research and Innovation Service [eDRIS](#) and [Research Data Scotland](#)), the geographical spread of the Scottish population (urban versus rural and northern versus southern latitudes), expertise in place-based health analyses and the capacity to conduct studies at scale with young people, for example, via the Schools Health and Wellbeing Improvement Research Network ([SHINE](#)) and the Sleep, Circadian Rhythms and Mental Health in Schools Network ([SCRAMS](#)). The primary goal of this ARC is to bring together individuals and teams with world-leading expertise in diverse areas, to build new research capacity in Scotland and compete for current/emerging mental health funding opportunities.

**4. Balance between breadth and specificity:** Alliances for Research Challenges require a focus that builds on Scottish research excellence in an area where new discoveries have the potential to address Scottish Government priorities and build on a critical mass of researchers who can be competitive for emerging research funding opportunities. Our challenge area is focused on mental health and specifically the relationship between sleep, circadian rhythms and mental health. This focus is balanced by a breadth of opportunities that span the life-course (from childhood and adolescence to

old age) and that operate across individual, family, community and population domains. This balance between focus and breadth will allow the new network to be agile and responsive to mental health funding opportunities as they arise over the next few months and years. It will also build critical interdisciplinary capacity and place Scotland at the forefront internationally of research at the intersection between sleep/circadian science and mental health.

**5. Funding opportunities for this ARC:** In 2021 the **Wellcome Trust** announced that Mental Health would be one of three major strategic funding areas (alongside climate health and infectious diseases), with £16 billion to be allocated over the next ten years. They have launched several [mental health funding calls](#) in recent months, including for mental health data science, psychosis research and understanding mechanisms of interventions. In September 2022 they will announce a specific funding call focused on sleep, circadian science and mental health. Similarly, mental health is currently a priority area across all [UKRI Councils](#). Chronobiology and mental health is a future strategic area within the MRC Neurosciences and Mental Health Board (of which Prof Smith is a member) and in late 2022 **the MRC will be launching a £61m funding call to establish a UK-wide Adolescent Health Study (AHS)**, recruiting 100,000 young people aged 8-18 into a longitudinal cohort, primarily via schools. A key aspect of the data collection in the AHS will be passive data capture via mobile technologies and accelerometer data to assess sleep and rest/activity rhythms. Our proposed network will be well placed to compete for this funding. Additionally, Prof Smith recently submitted an MRC Partnership Grant to establish a UK-wide 'Mental Health and Circadian Science' research network to stimulate high value collaborative research at the intersection of mental health science and sleep/circadian science. More broadly, our proposed challenge area is closely aligned with many of the ambitions of the new [UKRI strategy 2022 to 2027](#), e.g., *Priority 2.1: Strengthening clusters/partnerships, locally, nationally and globally*. Our network will therefore open up new opportunities for both UK and international collaborations, including [Innovate UK](#) funding in the area of digital therapeutics and chronotherapies.

**6. Coalition of Scottish universities and partners to deliver an ARC in this area:** This challenge area would be led by [Professor Daniel Smith](#), Head of Psychiatry and Co-Director of the Edinburgh Mental Health Network. At the REF2021 for UoA4 (Psychology, Psychiatry and Neurosciences) Edinburgh was ranked second in the UK by research quality and third by research power. Computer Science and Informatics (UoS11) in Edinburgh was ranked first in the UK. We will build on a network of established research groups across Scotland: **Edinburgh:** Sleep Medicine (Dr Renata Riha), Chronopsychiatry (Prof Daniel Smith, Prof Andrew Millar, Dr Thanasis Tsanas and Dr Maria Gardani) and the Centre for Research on Environment, Society and Health (Prof Jamie Pearce); **Glasgow:** Sleep Research Group at Strathclyde University (Dr Leanne Fleming); Chronobiology Research Group (Prof Stephany Biello) and the Social and Population Health Sciences Unit, University of Glasgow. We will also work with **Public Health Scotland** (Dr Ross Whitehead and colleagues), the NHS across Scotland, eDRIS, the charity **Sleep Scotland** and **industry partners** such as Phillips and Big Health, as well as **UK collaborators**, such as the Oxford Centre for Sleep and Neuroscience Research. A key goal will be to expand the network in Scotland in an open and inclusive way by proactively identifying new partners and collaborators.

**7. Added benefit of SFC funding:** This funding will allow research groups in Scotland to develop a critical mass of expertise that will be competitive for new collaborative research funding opportunities in mental health, most notably from the Wellcome Trust and UKRI/MRC. This requires the coordination of ambitious and highly interdisciplinary research within a socioecological framework and across different methodological approaches and scales of analysis. As noted above, this collaboration is strongly aligned to Scottish Government priorities for mental health (and other priority areas) and will add value to several existing and planned programmes of research, knowledge exchange and both public and policy engagement.