Enabling greener biomedical research: Executive summary

The UK Government has set a target of reaching net-zero greenhouse gas – or carbon - emissions by 2050.[1] This transformation will affect all sectors, organisations and individuals, and each has a contribution to make in achieving climate targets. This includes the biomedical research sector.

Both 'wet lab' and clinical research are making a sizeable contribution to the UK's carbon emissions. Laboratories are resource intensive, using significant amounts of water and an average of 5-10 times more energy per m^2 than standard office spaces.[2] A 2014 study estimated that laboratory-based, or 'wet-lab' bioscience research is responsible for almost 2% of the global plastic waste.[3] The environmental impact of clinical research is also significant, with the approximately 350 000 clinical trials on ClinicalTrials.gov estimated to have a carbon footprint of 27.5 million tonnes.[4] Already, multiple individuals and organisations are pioneering and promoting greener approaches to research practice, delivering carbon savings (and in some cases cost savings as well). Based on evidence from this work, **there are practices that can be adopted immediately by individuals and organisations to make a difference.** However, there are significant obstacles to change, including uncertainty about which actions can truly make a difference, concerns about impacts on scientific quality and productivity, and not enough people with specialist expertise in sustainable research practices.

In March 2023, the Academy of Medical Sciences co-hosted a meeting with the Medical Research Council (MRC) and the National Institute of Health and Care Research (NIHR) to explore current initiatives to make biomedical research, including in 'wet lab' and clinical research, more environmentally sustainable – or greener – and potential next steps.[5] The meeting was part of the Academy's FORUM programme of events, bringing together representatives from the academic, industry and health service sectors along with patients, regulators and other relevant stakeholders.

Scene-setting talks focused on specific examples of green initiatives in laboratory science and clinical research in academic and industry settings, as well as a survey of researcher attitudes and the views of research support personnel, such as lab technicians and clinical trials unit staff. Meeting participants subsequently joined breakout groups to discuss key challenges and propose possible ways forward. These discussions highlighted several key themes falling within four general areas.

1. Prioritising environmental sustainability within the biomedical research ecosystem

'Bottom-up' activities need to be supported and complemented by a more strategic and better-resourced 'top-down' approach. Much activity to date has been driven by 'champions' with an individual commitment to sustainability. This bottom-up energy now needs to be matched by strategic commitments, investment and action by key senior stakeholders in organisational leadership roles.

---

[1] UK Department for Business, Energy and Industrial Strategy (2019). *UK becomes first major economy to pass net zero emissions law*. https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law

[2] United States Environmental Protection Agency and U.S. Department of Energy (2008). *Laboratories for the 21st Century: An Introduction to Low-Energy Design.* https://www.nrel.gov/docs/fy08osti/29413.pdf

[3] Mauricio A *et al.* (2015). *Environment: Labs should cut plastic waste too*. Nature **528(7583),** 479.

[4] Adshead F, *et al.* (2021). *A strategy to reduce the carbon footprint of clinical trials.* Lancet **398(10297),** 281-282. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01384-2/fulltext

[5] Due to time constraints, a variety of important issues were not directly considered as part of workshop discussions. These included 'dry lab' biomedical research, the sustainability impacts linked to translation of research findings, dissemination of research (including academic travel), laboratory buildings, or decision-making that balances the potential benefits of research and its environmental impact.

There is a need to develop a workforce specialising in improving the environmentally sustainability of research practice. A reliance on 'champions' has generally depended on committed individuals taking on additional activities outside their core roles. Participants agreed research sustainability should be recognised as a specialist function in its own right and incorporated into job descriptions, with due attention given to issues such as capacity-building and career pathways. It would also benefit from the creation of dedicated posts within institutions.

Environmental sustainability needs to be seen as integral to good research practice. It was felt that environmental sustainability should be as integrated into research practice as, for example, health and safety. This would require an enabling policy framework, standards and guidance, and open-access tools and training to capacitate researchers and research support staff. Different training might be required to support individuals with different roles and functions in the research endeavour (e.g. technical staff, wet lab researchers, clinical researchers, staff supporting the delivery of clinical trials, etc).

Environmental sustainability standards are required to provide shared benchmarks and to promote accountability. As for health and safety, clearly defined standards (to be achieved by laboratories, clinical trial units, and other research facilities) would need to be developed to ensure consistent good practice.

Coordination, perhaps through a central entity, is required for environmental sustainability in biomedical research. Action is currently fragmented, with multiple individuals and bodies independently undertaking their own sustainability activities. Some efforts are being made to create consensus – for example, the UK Research and Innovation (UKRI) is developing a concordat on sustainability to help align activities of certain types of research organisations, such as funders and research institutions. Meeting participants felt that coordination and alignment of activities (perhaps through a central entity) would be beneficial to: promote networking and consortia development; provide an open access point to curated and, where relevant, assured information, tools and resources; facilitate the development of common metrics and standards; and establish a research agenda to build the evidence base supporting environmentally sustainable research practice. The scope and key functions of any new activity or entity would need to be carefully defined in relation to initiatives such as the UKRI concordat on sustainability.

2. Generating and disseminating evidence on environmentally sustainable research practices

Additional data would be useful on the environmental impact of research activities, equipment and consumables. Decision-making can be hampered by the fact that the carbon impact of many research activities cannot be accurately quantified. This makes it difficult for researchers, purchasers and funders to make comparisons, prioritise actions, or determine the impact of interventions. More evidence about the environmental impact of research would therefore be useful to close key knowledge gaps and support decision-making. However, meeting participants commented that decisions can be made with a degree of uncertainty, and so incomplete data should not necessarily be seen as a reason for inertia.

Standardised and evidence-based metrics on sustainability are urgently required to guide decision-making, and facilitate comparisons between products and processes. If funders were to consider the environmental impact of research during the grant application process, a standardised tool to assess a project's environmental sustainability would be useful to allow comparability between applications.

Mechanisms are needed to ensure effective dissemination of information and sharing of experience. Evidence is beginning to emerge from studies of the environmental sustainability of research, and good practice is being developed. While the results of rigorous academic studies can be disseminated through the academic literature, it may not necessarily reach all those responsible

for research sustainability, such as research support personnel in both wet lab and clinical research settings, through this route. Other types of output, such as case studies, could be produced, while communication channels such as social media, networks/communities of practice and peer learning could also support sharing of information.

A critical mass of experts is needed to study and develop environmentally sustainable research practices. Individuals with experience and expertise in research practice and sustainability are needed to generate the evidence to support decision-making and promote good practice, and to inform development of guidance. There is a need to consider how best to nurture and grow this group of suitably trained professionals. In particular, opportunities should be created for research support personnel and early career researchers.

3. Accelerating introduction of more environmentally sustainable practices in clinical research

A greater focus on green practice is required in clinical trials and other clinical research. Environmental sustainability has yet to be as prioritised in clinical research to the same degree as in laboratory research. This is in part due to specific challenges faced in the clinical research community, such as perceived regulatory barriers and lack of a central focal point or accreditation scheme (such as the Laboratory Efficiency Accreditation Frameworks (LEAF)) for clinical researchers wanting to look at environmental impact. The scope for greener clinical research should be more systematically assessed, drawing on the experience of groups in academia and industry that are promoting more environmentally sustainable practices.

Public and patient engagement should be built into a sustainability agenda for clinical research. It will be important to ensure any changes made to improve the environmental sustainability of a study are acceptable to participants in the research. Public and patient engagement and involvement could also enable and empower members of the public with an interest in sustainability to advocate for greener clinical research and to suggest practical changes that might underpin greener clinical studies.

4. Promoting and informing behaviour change

Coordinated and concerted efforts are needed to ensure that sustainability is embedded in the behaviour of individual researchers. As well as training and education, there is an opportunity to apply behavioural science frameworks to identify and implement interventions to influence the behaviour of researchers in wet lab and clinical research in different sectors. Efforts will be needed to ensure that key drivers of academic behaviour (e.g. securing grant funding, publishing papers) do not discourage green research practices and to communicate where key drivers of academic behaviour are aligned with environmentally sustainable research practice.

From the workshop discussions, it seemed clear that there was appetite within the UK biomedical research sector to adopt greener ways of working. Multiple stakeholders – individual researchers, technicians, the institutions they work for, funding agencies, pharmaceutical and biotech companies, regulatory authorities, clinical trials units, contract research organisations and publishers – can all take steps to reduce their own carbon footprints, and can incentivise changes in practice among those that they have influence over.

By acting together and drawing on the experience of integrating other essential activities, (such as public and patient involvement where much progress has been made in incorporating this into routine research practice), a green culture can be embedded in biomedical research, helping to achieve ambitious national climate targets – and creating a healthier world for all.

Proposed next steps from the workshop

Workshop attendees proposed next steps for wet-lab research, clinical research and biomedical research within the above themes. These are listed here in brief. For a full discussion of the practicality and acceptability of each innovation, please see the full report.

1. Prioritising sustainability within the biomedical research ecosystem

1.1 As an urgent priority, there should be increased commitment from institutional and organisational leaders to improve the environmental sustainability of biomedical research, including supporting bottom-up approaches.

1.2 Evidence-based actions that can be taken to reduce environmental impact should be identified by and implemented across organisations.

1.3 Staffing plans, including plans for the training of current staff and researchers, should be developed by organisations to underpin a long-term shift to green research practice.

1.4 Teams responsible for organisation-wide sustainability should include technical staff with expertise in environmentally sustainable research practice, especially universities and other organisations that are particularly research-active.

1.5 Strategies should be developed at an organisational level to promote and sustain a green research culture, for example through induction processes, training and staff appraisal procedures, learning from how this has been achieved for health and safety, PPI and EDI.

1.6 Acceptable ways to improve the environmental sustainability of research practice while maintaining sufficient research quality should be explored in an evidence-based manner and in collaboration with funders, researchers, technical staff, trial participants (in the case of clinical research), and other key stakeholders.

1.7 Green research standards should be developed and monitored to enable more environmentally sustainable research practice. A suitable organisation to do this will need to be identified.

1.8 There is a need for organisations to implement sustainable procurement frameworks.

1.9 Lessons learned from NHS sustainable procurement practices should be identified and shared.

1.10 The remit and purpose of a central coordinating entity for green research should be mapped out (in relation to pre-existing initiatives) and taken forward in collaboration with research organisations across the biomedical sector, including wet lab and clinical research, and with stakeholders across academia, healthcare and industry.

2. Generating and disseminating evidence based on sustainable research practices

2.1 Additional data on carbon footprints and other sustainability-related impacts of research processes and equipment should be generated to inform decision-making, prioritising areas with most uncertainty and most impact.

2.2 Tools to enable practical use of this new evidence in decision-making by researchers and research support personnel should be developed, such as institutional databases to support procurement decisions.

2.3 A common set of metrics for determining carbon footprints and other sustainability-related impacts should be agreed.

2.4 A tool that can be utilised by funders and researchers during grant applications should be developed.

2.5 Greater sharing of sustainability analyses, through the academic literature and other routes should be encouraged. Research journals and funders would be well placed to do this.

2.6 A repository or platform for the sharing of information should be established.

2.7 Programmes of support required to establish and sustain a critical mass of researchers investigating green research practice should be developed, including opportunities for early career researchers and research support personnel. Funders and research institutions would be well placed to take this forward.

3. Accelerating introduction of more environmentally sustainable practices in clinical research

3.1 Regulators (e.g. the HRA and MHRA) should work with key stakeholders to determine how they can positively influence the environmental sustainability of clinical trials.

3.2 The individuals or groups who could have responsibilities for promoting green practice in clinical studies need to be identified.

3.3 Pharmaceutical companies along with other organisations should share their tools and approaches to the greening of clinical trials.

3.4 Case studies to illustrate green innovations in clinical trial research practice should be developed and shared.

3.5 Approaches to reduce the environmental impact of clinical trials should be acceptable to trial participants and PPI and engagement will be an important mechanism to achieve this. This is a particularly relevant consideration for the NIHR and the HRA.

3.6 The lessons that PPI mainstreaming could have for embedding of sustainability in research practice and culture should be explored, including learning from the ways policies and standards were introduced to improve PPI in research. This is a particularly relevant consideration for funders and regulators.

4. Promoting and informing behaviour change

4.1 Factors likely to discourage adoption of green research practice should be identified and addressed. Some of these factors are associated with the drive to publish, and research journals are well placed to help address them. Incentives for best practice should also be developed and promoted.

4.2 Funders should consider how best to embed evaluation of the sustainability of research practices into grant applications and funding committees, using clear effective messaging that encourages buy-in of researchers whilst being conscious of the administrative burden on researchers.

4.3 Behavioural science studies should be conducted to understand and identify interventions that encourage researcher behaviour to adopt more environmentally sustainable behaviours in their work.