

**UK STRATEGY
FOR CLINICAL AND
APPLIED DIABETES
RESEARCH**

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Professor Simon Heller (University of Sheffield)
Chair of the strategy development Steering Group

FOREWORD

The UK has long punched above its weight internationally in research. Since the studies of Harold Himsworth, who in 1936, was one of the first scientists to describe the two main types of diabetes, major advances have included the first use of insulin pumps, the introduction of blood glucose monitoring and the identification and subsequent understanding of the mechanisms of monogenic diabetes.

Yet research in diabetes is now facing a crisis. Many of our current research leaders who were inspired to enter the specialty by clinician scientists working within the NHS are due to retire in the next 5-10 years and there are worrying signs that fewer individuals are emerging to replace them.

Clinical pressures, aggravated by the Covid-19 pandemic, have made it increasingly challenging to undertake research as an NHS physician and fewer young doctors are choosing diabetes as a speciality. Establishing a research career is even more difficult in other professions.

Despite the scale of the challenge, less than 1% of what's spent on diabetes care and support each year is invested in research (UK Health Research Analysis, 2018) and prior to this report there had been no comprehensive analysis of diabetes research funding across the UK. Furthermore, the challenges which diabetes presents, have inevitably changed over the last 20 years and the current UK research portfolio neglects some important areas.

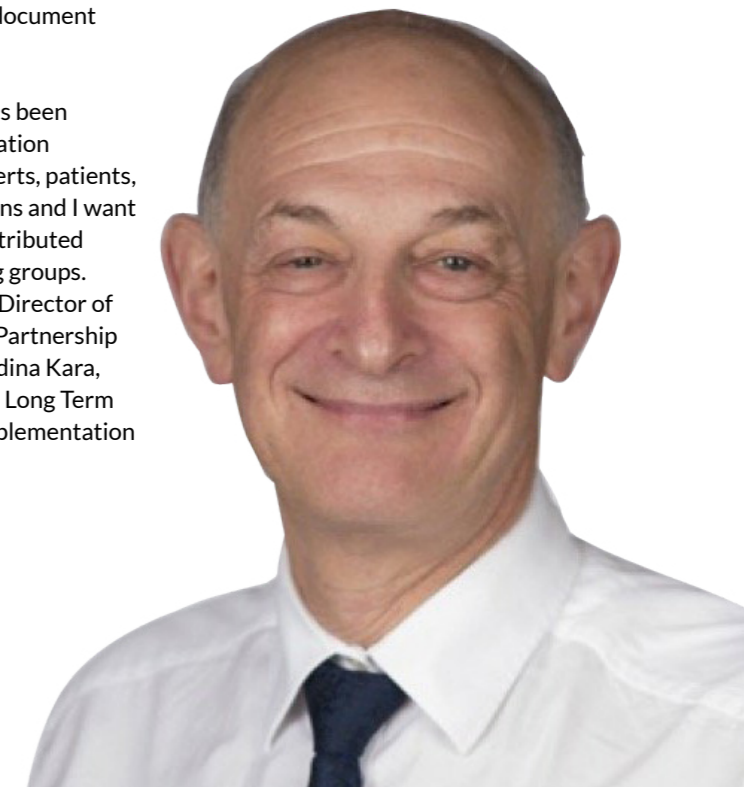
Yet the advent of the NIHR, now over 15 years old, offers a wonderful opportunity to the specialty in

providing generous funding across a range of schemes, to increase the quantity and quality of diabetes research within the NHS, public health and social care. Diabetes investigators have taken advantage of some of the programmes, for example, Biomedical Research Centres, but have failed to exploit others.

In January 2020, Diabetes UK and NIHR convened a meeting of both researchers working in different areas of NIHR infrastructure and people with diabetes to review the current state of diabetes research in the UK and identify areas of unmet need. As a result of these discussions, those at the meeting proposed the writing of a UK-wide Diabetes Clinical and Applied Research Strategy to address these challenges. This document summarises this work.

Writing this strategy has been a true national collaboration involving groups of experts, patients, researchers and clinicians and I want to thank those who contributed to the different working groups. Anna Morris, Assistant Director of Research Strategy and Partnership at Diabetes UK and Madina Kara, NIHR's former Multiple Long Term Conditions Strategy Implementation

Lead, have led their teams from Diabetes UK and NIHR brilliantly to coordinate this document. The pandemic required meetings to be virtual but they were well attended, discussion was frank and lively and the criticism was constructive. While I hope the recommendations will be welcomed, a research strategy is only successful if it is implemented effectively. This document thus represents the start of a process. It is now the responsibility of those who contributed, along with the wider diabetes community, to ensure that the strategy is implemented if it is to fulfil its aim of ensuring that research continues to bring benefit to people with diabetes.



Professor Simon Heller (University of Sheffield)
Chair of the strategy development Steering Group

Dr Goher Ayman and Rohit Patel Experts by experience

Diabetes care has come a long way in the last 100 years. Once a death sentence, we are now able to live well with diabetes. However, living with the condition is relentless and presents daily challenges along with having longer term impacts on our health. Funding and resources for diabetes research are thinly spread, and the challenge of ensuring research aims are of relevance and value to an increasingly complex and diverse population becomes more pressing.

Learning from the experiences and views of people who live with diabetes and those that care for them, is recognised by funders as vital in identifying research of greatest need and potential value. Extensive work from groups that involve experts by experience, such as [Priority Setting Partnerships \(PSPs\)](#) and the [Diabetes Research Steering Groups](#), have not only identified areas of great need for research, but that research aims must include wider aspects of living with diabetes, such as sociological,

psychological and economic elements, alongside measurable health outcomes.

This collaborative strategy is a timely stocktake of diabetes healthcare research in the UK and how well it addresses the priority areas identified. Informed by reflections on some of the most impactful research in the UK and what made them so, recommendations are made for future funding to support research across underserved priority areas. Each recommendation has been grounded in the priorities from related James Lind PSPs and the Diabetes UK Diabetes Research Steering Groups, and therefore directly aims to address the needs of the people that they will ultimately benefit.

The collaborative approach, bringing together the views of people with diabetes, healthcare professionals and researchers, has resulted in wide-ranging recommendations; from specific conditions in which

research is underfunded in relation to their urgency (type 2 diabetes, Gestational Diabetes) to making sure future diabetes research is in good hands (supporting future leaders) and actually makes a difference to the care of people with diabetes (implementation).

On a number of levels, these recommendations commit to facing the challenge of ensuring inclusive, relevant and impactful research. We welcome the much-needed focus on addressing the quickly-growing health inequalities and access to life-changing care options. We also welcome the much-needed acknowledgement that research must reflect the complexity of diabetes in the real-world, across the whole life course, and that this often includes other conditions.

We call on researchers and research funders to take up the challenge to drive forward investment in these critical areas.



“Each recommendation has been grounded in the priorities from related James Lind Alliance PSPs and the Diabetes Research Steering Groups, and therefore directly aims to address the needs of the people that they will ultimately benefit.”

Dr Goher Ayman
Expert by experience



EXECUTIVE SUMMARY

This strategy sets out areas of opportunity in clinical and applied diabetes research and provides recommendations for additional research, collaboration and infrastructure. It is intended to help research funders direct their resources to underserved priority areas, and to help researchers identify where the greatest opportunities lie to make a difference to the lives of people with and at risk of diabetes.

Given the breadth of this area, this strategy has focused on clinical and applied research. However, there are important unanswered fundamental questions and areas of unmet need in diabetes in basic science, such as a need to understand, protect and improve islet cell function. [Diabetes UK's research strategy](#) highlights these areas of need.

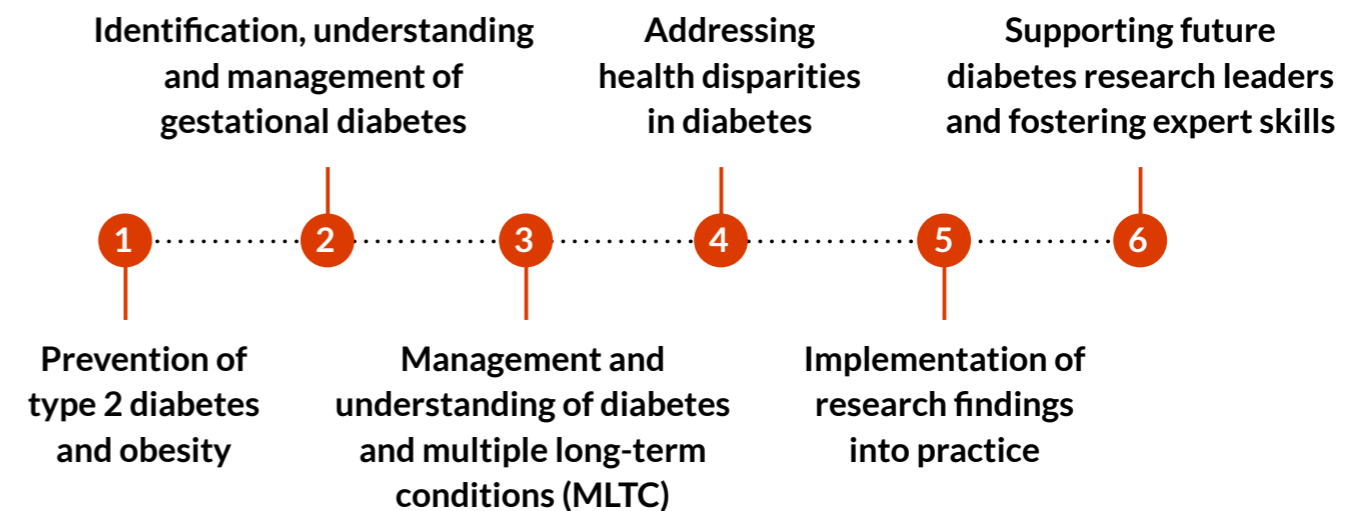
Diabetes UK and the National Institute for Health and Care

Research (NIHR) undertook a portfolio analysis of current funding of diabetes research in the UK across the period 2014-2019 ([Appendix 1](#)) and convened expert working groups to analyse the data and consider where there were opportunities to stimulate research in underserved priority areas. Membership of the groups was based upon attendees at a workshop held in January 2020 organised by Diabetes UK and the NIHR convening representatives

of the [Diabetes Research Steering Groups](#) (Diabetes UK) and NIHR infrastructure ([Appendix 2](#)) to discuss how to foster further collaborative diabetes research across the UK. The development of this strategy was the outcome of the workshop.



The groups identified six key areas where there is a need to increase research activity and address unmet need in diabetes:



Diabetes UK and NIHR recognise the important work that is taking place across the spectrum of diabetes research. The areas we highlight need increased investment, but this should be additive to existing research. We agree on the need to drive up the overall investment in diabetes research.

The working groups made wide-ranging recommendations about what could happen to increase and direct research activity in these six key areas. They range from a simple need for more focus on particular areas of research, to better use of big data, more cross-disciplinary working and increased collaboration between funders.

The recommendations were mapped against previously identified priorities of people with and at risk of diabetes gathered through James Lind Alliance Priority Setting partnerships and the work of the Diabetes Research Steering Groups. This ensures that the identified areas of opportunity are aligned to

questions that are important for the community of people living with or at risk of diabetes.

In addition, Diabetes UK and NIHR sought to learn from the many strengths of diabetes research in the UK. We spoke to people with lived experience of diabetes and UK researchers who have revolutionised diabetes, from genetic research to structured self-management. We learned about what drove their successes and identified key enablers that allow research to thrive and make a difference to clinical care. We highlight examples of these, which are not intended to be comprehensive but are based upon collective insights from our portfolio analysis and the organisations and experts involved in the development of this strategy.

The period selected for the portfolio analysis is prior to the Covid-19 pandemic but we acknowledge that the pandemic has placed an increased risk on individuals

with diabetes resulting in missed opportunities for prevention, early detection of complications, delays in routine care and treatment, increased rates of hospitalisation and mortality from Covid-19, and difficulties coping with its longer-term effects¹. We need plans for managing priorities in the management of diabetes and other long-term conditions during the current and future pandemics. In addition, the pandemic has resulted in changes in the research landscape. Many studies have been delayed and need to be assessed for their continuing viability and need. However, the areas identified in this strategy remain important as we recover from the pandemic.

This strategy sets out several areas of strength in clinical diabetes research in the UK and focuses on the enablers to their success. It also highlights areas of underinvestment, as identified through the portfolio analysis, and provides a set of recommendations for each.

SUMMARY OF KEY RECOMMENDATIONS

Following our review of strengths and opportunities within diabetes research, we make the following recommendations.

PREVENTION OF TYPE 2 DIABETES AND OBESITY



The research community to consider:

- Focus research to develop effective strategies for every life stage, to initiate and maintain healthy weight, diet and physical activity and weight loss maintenance to prevent type 2 diabetes and its complications
- Tackle prevention in high risk and underserved communities, including South Asian and African/Caribbean minority ethnic groups
- Undertake qualitative research to understand barriers to implementation and uptake of interventions by subgroups where engagement is currently lower

Funders to consider:

- Fund implementation initiatives to adapt interventions known to be effective at scale, to appeal to more people from different communities
- Support research on identification of groups at high risk of early-onset type 2 diabetes to develop tailored interventions

IDENTIFICATION, UNDERSTANDING AND MANAGEMENT OF GESTATIONAL DIABETES



The research community to consider:

- Encourage research to establish how best to follow up women post-pregnancy in primary care to reduce future risk of type 2 diabetes and gather longer term data
- Improve phenotyping of the gestational diabetes population in the UK
- Improve understanding of causes, early and late identification, prevention, interventions and outcomes of Gestational Diabetes Mellitus GDM and develop models for preconception and pregnancy which can identify women at highest risk of short and longer-term adverse outcomes
- Develop risk-stratified approaches to prevention and treatment of GDM, tailored to the individual needs of women
- Collect and audit GDM screening, diagnosis and outcome data to understand existing provision of care and to support research in this area

Funders to consider:

- Support research to understand the impact of GDM on women's mental health

MANAGEMENT AND UNDERSTANDING OF DIABETES AND MULTIPLE LONG-TERM CONDITIONS (MLTC)



The research community to consider:

- Encourage further research among individuals and populations to support improved management of MLTC
- Encourage epidemiological studies specific to diabetes and MLTC to inform priorities for developing effective interventions and policy recommendations
- Ensure the capture of core outcomes for trials which can be shared between specialties
- Encourage clinical trialists to report the prevalence of MLTC and include more representative proportions of people with MLTC

ADDRESSING HEALTH DISPARITIES IN DIABETES



The research community to consider:

- Ensure research is placed in areas of high prevalence of diabetes and where the burden of the condition is at its greatest
- Undertake engagement activities and approaches with diabetes research communities and enhance and

extend data-linkage analysis of large population datasets to ensure that under-served communities are consistently included in studies

- Consider all types of inequalities, including those not immediately obvious such as learning disabilities
- Form good networks with local communities and secure diverse patient, carer and public involvement in diabetes research design

Funders to consider:

- Tackle and understand barriers to participation in research, by capturing equality, diversity, and inclusion data in funding applications and by asking applicants to say how they will address the gaps in terms of their research and when implemented

The following recommendations promote a wider environment to support implementation of the strategy

IMPLEMENTATION OF RESEARCH FINDINGS INTO PRACTICE



Funders to consider:

- Mandate that grant applicants applying to carry out clinical research consider the pathway to implementation in funding applications
- Work together to design strategic calls and align their funding schemes to support the translation of research

Engage with the NHS to highlight the innovation pipeline, and identify a systematic approach to move promising areas into practice

- Invest in targeted support for key areas of importance to implementation, such as health psychology
- Collaborate with NICE when identifying research gaps to inform strategic research calls
- Continue to address the bureaucracy involved in research, from the application

for funding and throughout the entire process

- Introduce innovative funding mechanisms to enable the use of the next generation of trial designs such as platform and adaptive trials and benefit from the efficiencies in time and resources the designs bring
- Update Health Economic models to reflect the current costs and impact of type 2 diabetes to support better decision making on what to implement

SUPPORTING FUTURE DIABETES RESEARCH LEADERS AND FOSTERING EXPERT SKILLS



Funders to consider:

- Develop training for experts by experience involved in the diabetes research cycle to ensure that they are supported to participate
- Develop fellowship opportunities in health behaviours research, health and clinical psychology, data science, preventative and

systems-based approaches and qualitative and mixed methods research

- Develop training opportunities in implementation science through existing infrastructure and encourage early-career diabetes researchers to access them as well as collaborating with experts in these areas
- Partner with industry to fund early and mid-career researchers diabetes research
- Introduce discipline-hopping grants, which enable established engineers, physical scientists and other cross-disciplines to work in diabetes research

Develop more substantive post-fellowship posts with academic and clinical time built in

- Support integrated career pathways, with NIHR and devolved nation funders leading on supporting the development of clinical academic roles and the NHS the integration of these roles in the NHS

STRENGTHS IN CLINICAL AND APPLIED DIABETES RESEARCH

The UK has major strengths in basic, clinical and translational research which have brought world-leading advances in the understanding and care of diabetes. We are focussing on clinical and applied research strengths in this strategy to understand the vital ingredients of successful clinical research in the UK.

Given the breadth of diabetes research, for this strategy we have concentrated on research funded by public and charitable organisations, rather than on pharmacological and medical technology (medtech) industry funded research. However, we recognise the importance of continuing dialogue and seeking collaboration with the pharmaceutical and medtech and diagnostics industries who will have their own priorities and strategies for funding advances in their fields.

We focused on the following areas of UK research strength, identified due to the evidence of translation into clinical practice, and spoke to leading figures in these fields and to people living with diabetes:

- Epidemiology of diabetes (Professor Helen Colhoun, University of Edinburgh)
- Supported self-management in type 1 and type 2 diabetes (Professor Melanie Davies, University of Leicester)
- Immunotherapy in type 1 diabetes (Professor Colin Dayan, Cardiff University)
- Diagnosis and genetic diabetes (Professor Andrew Hattersley, University of Exeter)

- Supported self-management in type 1 diabetes (Professor Simon Heller, University of Sheffield)
- Diabetes technology (Professor Helen Murphy, University of East Anglia)
- Aetiology and remission of type 2 diabetes (Professor Roy Taylor, Newcastle University)
- Patient and Public involvement in research (Dr Goher Ayman, Expert by Experience and Dr Paul Robb, Expert by Experience)

Six key enablers of clinical and applied research success were identified by these experts:



Here, we showcase how these enablers have advanced the field of diabetes research internationally.

LOOKING OUTWARDS FOR INSPIRATION

Professor Roy Taylor, Professor of Medicine and Metabolism at Newcastle University, made his breakthrough after looking outside the field of diabetes and the UK. He took a sabbatical to the USA to learn magnetic resonance spectroscopy techniques – a vital precursor to his work on ‘what actually happens’ to sugars once they have been absorbed into the blood.

This led to the understanding that type 2 diabetes arises from unsustainable levels of fat in the liver and pancreas. ‘It’s been a breakthrough in achieving simplicity,’ says Professor Taylor. ‘The dramatic success has been understanding the nature of type 2 diabetes.’

This led to trials of weight loss sufficient to reduce liver fat, which demonstrated the potential to restore beta cell function among those with a recent diagnosis and send type 2 diabetes into remission. The DiRECT study of 2018 proved that type 2 diabetes could be put into remission through an intensive weight management programme delivered in primary care ([Lean et al. 2018](#)). A programme inspired

by DiRECT is now being piloted by NHS England and NHS Scotland has already started to roll a programme out. ([NHSE](#)) ([NHS Scotland](#)).

A similarly dramatic breakthrough in type 1 diabetes was the development and widespread adoption of the Dose Adjustment For Normal Eating, or DAFNE, education project. Twenty years ago, type 1 diabetes meant following a strict and undeviating diet, to ‘match’ the dose of insulin prescribed by the doctor. Professor Simon Heller, Professor of Clinical Diabetes at the University of Sheffield, says: ‘What we asked of people was huge and many rebelled.’

But he had heard that German doctors were using blood glucose monitoring to give patients more flexibility. His team visited Dusseldorf to find out how it worked. The German model involved an inpatient stay while patients were instructed in how to calculate the right dose of insulin to match the food and exercise they wanted to do that day.

Professor Heller along with his colleagues Dr Sue Roberts and Professor Stephanie Amiel realised

that this model could be adapted for the UK with high-quality training and education on an outpatient basis. The first trial of the strategy demonstrated that this was not only feasible, but also resulted in improved HbA1c and quality of life for those living with diabetes – a prerequisite for acceptance by diabetes services².

Thinking differently and looking outside the field of diabetes was also key for the development of a technology that could further transform type 1 diabetes treatment – the use of immunotherapy.

For the past 100 years, type 1 diabetes management has meant insulin therapy, with all the burden this puts on people with the condition. Building on research in other autoimmune diseases, immunotherapy drugs are now being tested and tailored to diabetes, with the aim of improving glycaemic management and delaying the onset of type 1 diabetes in people diagnosed while the beta cells are still functional.

NETWORKING, COLLABORATION AND PARTNERSHIP

The UK-T1D Immunotherapy consortium, initiated with support from Diabetes UK and JDRF, has 27 clinical sites, including world-leading research centres in type 1 diabetes, and continues to expand. It demonstrates the value of creating strong networks.

'We have probably the best research network in Europe,' says Professor Colin Dayan, Professor of Clinical Diabetes and Metabolism at Cardiff University and Lead of the Clinical Engagement and Training Core of the UK-T1D Immunotherapy consortium. 'We have as many research sites now in the UK as in the rest of Europe put together. We have a lot of clinicians encouraging and referring people to take part, and they are hugely committed.'

The consortium has completed recruitment for 11 new multicentre studies in the field to date, including first in human trials, with more underway.

The aim of the collaboration is to make type 1 diabetes a disease of adults, with immunotherapy pushing back the point at which people are diagnosed as needing insulin, from an average age 12 at present. This requires early identification of children or babies with autoimmunity to beta cells.

Further networking will be crucial for new technologies to be put into practice. The consortium is engaging with the UK's National Screening Committee about the possibility of introducing screening, so that children can be picked up before their beta cells are depleted. The researchers are also creating stakeholder networks, to ensure clinicians and policymakers are engaged and onboard when new interventions are ready to roll out. Bridging the worlds of technology, diabetes, obstetrics, health economics and policy helped change practice for pregnant women with type 1 diabetes. Helen Murphy,

Professor of Medicine (Diabetes and Antenatal Care) at the University of East Anglia, and a practising clinician at Norfolk & Norwich University Hospital NHS Trust, led on the **CONCEPTT Continuous Glucose Monitoring (CGM)** trial across 31 international sites, with over 50 percent of these being in the UK. The results of the trial, published in the *Lancet*³, and the subsequent modelling showed that if all women with type 1 diabetes used CGM during weeks 10–38 of pregnancy, it would save the NHS £9,560,461 per year mostly due to reduced neonatal intensive care unit (NICU) admissions⁴. This helped influence the commitment of the NHS to offer CGM to all pregnant women with type 1 diabetes through its inclusion in the [NHS Long Term Plan](#). The onset of the Covid-19 pandemic then further hastened the implementation of this into routine practice.

Professor Murphy says 'It was important that not only did we demonstrate evidence of improved outcomes for pregnant women and neonates but that it was cost-effective; this helped influence NICE to change national clinical guidelines and gain policy champions to influence its national roll out. It's about choosing the moment and using all the opportunities and networks.'

Networks also underpinned the development and implementation of structured self-management programmes for type 2 diabetes. The programme developed by Professor Melanie Davies, Professor of Diabetes Medicine at the University of Leicester, and colleagues, was one of the first to be tested in practice.

The 2008 **DESMOND** trial, which included almost 1,000 patients, was the biggest of its kind⁵. It brought together a multi-disciplinary team of clinicians and researchers from primary and secondary care with academics, psychologists and people

living with diabetes. The strong primary care research network at Leicester University, developed over years prior to the **DESMOND** study, was critical to its success.

'You can't do effective research in diabetes without strong links with primary care – that is where the data is and where most of the patients are,' says Professor Davies. 'It's pretty critical in diabetes to have those insights and connections.'

Despite limited funding, the trial team managed to involve 200 general practices, rapidly train up sufficient staff to deliver the intervention, and recruit hundreds of newly diagnosed patients. The results demonstrated that people's attitudes to diabetes were changed by the study, that they had less depression and were more likely to quit smoking, lose weight and improve their cardiovascular risk factors.

The evidence was strong enough for structured self-management support to be included as a recommendation in the NICE guidelines for management of people newly diagnosed with type 2 diabetes, and it remains a recommendation⁶.

The world of academic research is often driven by competition, but the researchers we spoke to told us that partnership, collaboration and joint working helped them achieve better results.

Professor Davies says of the team that developed **DESMOND**: 'In research often you are in competition, but we were quite good in collaborating with each other. Because the research was driven by patient need and people very close to delivering clinical care, that results in studies that are more relevant and possibly better designed.'



The Immunotherapy Consortium is also driven by partnership. Professor Dayan says its success is due to the group's mantra of 'better together' and describes his role as 'like an air traffic controller, trying to get all the trials to coordinate their recruitment schedules and 'land' in an orderly manner.'

He says it took work to convince researchers who were used to competing for funding and patients that collaboration was the way forward. 'I think people are now convinced they can deliver more quickly if we work together. If everybody thinks it will work for them, it works,' he says.

And in the field of remission of type 2 diabetes, Professor Taylor says that he would not have been able to carry out the large-scale trial

required without collaboration. When he applied for funding, Diabetes UK suggested he team up with Professor Mike Lean of Glasgow University to conduct **DiRECT**. 'That bringing together of experts is something Diabetes UK should be proud of. We were able to do a much larger study than either of us could on our own.'

Working across the boundaries of university research and clinical practice was key for some major developments in genetic diabetes and diagnostic sciences for Professor Andrew Hattersley and his colleagues at Exeter University and the Royal Devon and Exeter NHS Trust.

Professor Hattersley says the decision to set up a laboratory offering both genetic testing and

research, without boundaries between the two streams, was crucial for their success.

He gave the example of how observations of a diabetes patient's reaction to medications fed back into the discovery that about half of patients with a particular type of genetic diabetes responded far better to sulphonylurea drugs – so well that they could stop taking insulin.

'Either [research or diagnostic laboratories] on their own would have achieved nothing. This came from the two sides together with no barriers between them,' says Professor Hattersley.



"We have probably the best research network in Europe, we have as many research sites now in the UK as in the rest of Europe put together. We have a lot of clinicians encouraging and referring people to take part, and they are hugely committed."

Professor Colin Dayan
Cardiff University

MULTI-DISCIPLINARY WORKING

One of the benefits of team-working is the ability to bring in a plethora of disciplines with complementary strengths.

A good example is the epidemiological research carried out by Professor Helen Colhoun, AXA Chair of Medical Informatics and Life Course Epidemiology at University of Edinburgh, and her team. Professor Colhoun has overseen the establishment of research-ready databases of records of diabetes patients in Scotland, using large-scale electronic health records. The ability to link these databases with unique healthcare identifiers, such as those used for hospital admissions, means researchers can access rich sources of information to investigate the epidemiology of diabetes and its complications.

The importance of these databases became clear when the Covid-19 pandemic hit in early 2020. People with diabetes were identified as being at increased risk of morbidity and mortality. Yet the scale of increased risk was unclear. Should they shield, stay at home and severely limit their outside contact for months or years on end?

'Within a very short time after the start of the Covid pandemic, we had a comprehensive assessment of Covid risks in the diabetes population in Scotland and provided key information to show that there

was wide variation in risk and it was not warranted for the majority to be shielding,' Professor Colhoun says. The team was also quickly able to evaluate the impact of the pandemic on incidence of type 1 diabetes, finding that although incidence increased by 20% in young people this was not directly due to COVID-19 infection itself.

Professor Colhoun says that multidisciplinary working is 'absolutely core' to the success of her work. 'You cannot do this sort of work with one skill set,' she says. 'I am very fortunate to have worked with a really strong team of software analysts and database programmers. What we've managed to do is bring together a high level of expertise in epidemiology, statistics, programming and software development, as well as clinical expertise in diabetes.'

She has been able to draw on experts in data science, informatics, clinical science, mathematics, public health and epidemiology. Ongoing work includes harnessing the power of artificial intelligence to enhance screening of digital retinal images, working with a pharmacologist to assess 'real world' safety and efficacy of new diabetes drugs, and working with mathematicians to understand time trends data, which could help unpick the basis of seasonal variations in type 1 diabetes.

The development of the DAFNE programme also included a wide range of disciplines, says Professor Heller. He worked with psychologists and behavioural change researchers, as well as nurses and diabetologists, especially in the development of the second phase of the programme, DAFNE Plus, which harnesses behavioural change techniques.

Multiple skills were also important for the Exeter laboratory from the start, says Professor Hattersley. He says he, as a doctor doing one day a week research, worked alongside a clinical scientist and a nurse researcher, and that all their skills complemented each other. Early in their work, the laboratory collaborated with experts in genetic sequencing in the US, and now embraces working with people with skills in mathematics and big data, as well as biochemistry and other disciplines.

The importance of working with health economists to model cost-effectiveness was demonstrated through the CONCEPTT trial. In addition, bringing together clinical communities from diabetology and maternity/ obstetrics helped result in the successful implementation of CGM across the country showing the importance of multidisciplinary working.

INVOLVING PEOPLE WITH DIABETES AND DISSEMINATING THE OUTPUTS OF RESEARCH

The researchers and people with diabetes we spoke to highlight the value of involving people living with diabetes in research.

Professor Davies says patient involvement helped ensure that the DESMOND supported self-management programme was a success. 'If you are trying to design programmes that impact on people's self-management, it would be crazy not to ask people who live with the condition 24 hours a day what would benefit them,' she says. 'It genuinely helped us design something that was going to work.'

Dr Paul Robb was a patient representative on the steering group for the DIRECT trial and described it as 'a real team effort, with the scientists and the people with diabetes bringing different but complementary expertise'. Paul's main contribution was 'bringing a

different perspective and asking the kind of questions that potential participants in the trial might eventually ask'.

He also highlighted the important role researchers have in engaging the public and people with diabetes in their research and disseminating the outputs through the media and beyond, holding Professor Roy Taylor up as a fantastic example of how to do that well. Paul noted 'Roy talks to people with diabetes and finds out what's important to them, he's a great communicator and is able to share the potential benefits of his work in a compelling way'.

Professor Colhoun has created the largest biobank collection of blood samples from people with diabetes in the world, with funding from The Chief Scientist Office and Diabetes UK. She is quick to praise the people of Scotland for being

'incredibly willing' to be involved in the research that led to the establishment of the biobank.

This willingness may stem from the 'long tradition of close engagement with people with diabetes,' at Edinburgh, ensuring that they had a seat on research boards and could advise on research priorities. 'That was also essential in helping us to not disappear into an ivory tower,' she says. 'Those things have been hugely important for us.'

Close involvement of people with diabetes helps ensure that research is focused on their needs and priorities, allows researchers to ensure that new interventions are practical and acceptable, and builds a supportive public network that can bring pressure to bear on policymakers when required.

ACCESS TO FLEXIBLE FUNDING

Access to funding is crucial for all types of research, but it doesn't have to be enormous sums of money at the outset. Several researchers mentioned the relatively small grants from organisations such as Diabetes UK which had allowed them to get started on early research and go on to secure follow-on funding from larger funders such as NIHR.

The type of funding is also important. Professor Taylor says that early programme funding from Wellcome played a big part in the success of his research into the aetiology of type 2, allowing him to do 'expensive' research using MRI technology.

'Flexibility is the big thing. It was a programme grant and that meant it was funded for four years, which was enough to get some distance down the road.' Professor Taylor also highlighted the need for funders to be prepared to take a chance on 'potentially very important

but very high-risk research' and to understand that different mechanisms might be needed when considering such research. Professor Taylor noted that an early small Diabetes UK grant, which was identified as being high risk, ultimately led to the DiRECT trial and its prompt translation into clinical practice.

An early career fellowship and subsequent career development funding from the NIHR helped Professor Murphy start her career and undertake the early stages of the research on the technology for continuous glucose monitoring. The funding and support of the Juvenile Diabetes Research Foundation (JDRF) for the CONCEPTT trial was instrumental and resulted in the expansion of the study to Canada. 'It was a real collaborative partnership between the research teams in the UK and Canada as well as with the staff at JDRF' says Professor Murphy.

Matching funding with opportunities is part of the day job for Professor Dayan at the UK-T1D Immunotherapy Consortium. The consortium runs on minimal basic funding, with money coming from multiple sources, often the pharmaceutical industry, to fund individual trials or trial arms.

Block funding such that provided for centres of excellence, collaborations, services and facilities is essential in supporting research in the UK. Within England the NIHR infrastructure funding provides a platform to enable research, acting as a targeted and strategic investment to create an environment where early stage and applied research can thrive. The NIHR Infrastructure supports a wide range of diabetes-related projects across the translational pathway as outlined in Appendix 2.

PROTECTED TIME FOR RESEARCH AND SUPPORT FOR EARLY-CAREER RESEARCHERS

Finally, time dedicated to research has been vital for many of the successful leaders we spoke to. This requires an institutional and national culture that values research. Professor Heller recounts having to pursue his research interests in his 'spare time', on top of a full-time clinical post in his early career. Only later was he afforded the opportunity to work half-time in the clinic and half in the lab.

He believes part of his job as a senior academic is to spot talent and find opportunities for new researchers at an early stage in their career.

Professor Hattersley adds: 'The key thing with early-career researchers is you have to care about what is best for them and put that above what is good for you.' That can mean stepping away from areas of research when they are making

advances, so they can get full recognition and become world leaders.



"This is an important and timely strategy. I welcome the focus on young onset type 2 diabetes, which is a major clinical concern for the future, involving a more aggressive clinical phenotype, and for which there is little current evidence around management, early identification or indeed prevention. It is vital that we stimulate investment in research in this area."

Professor Jonathan Valabhji OBE
National Clinical Director for Diabetes and Obesity at NHS England

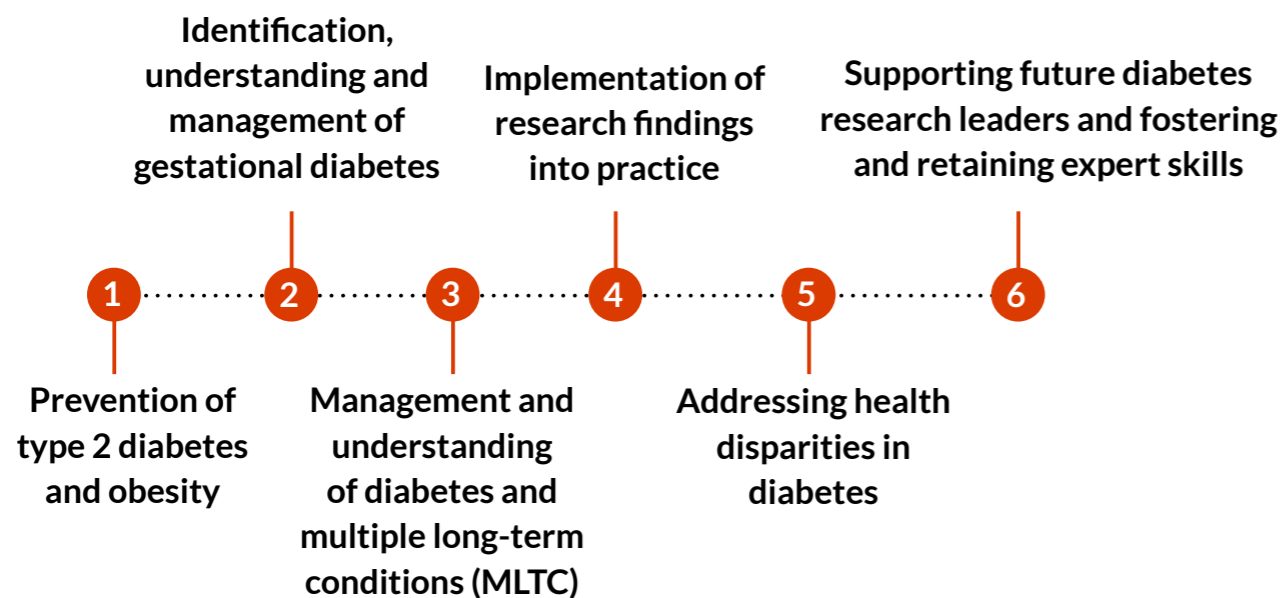


AREAS OF OPPORTUNITY

Through the portfolio analysis, we identified six areas of opportunity in the field of diabetes. The portfolio review demonstrated that these areas currently receive relatively low levels of investment and less funding comparative to the need and the potential benefits that advances in these areas would bring.

We convened working groups with expertise in these areas to outline recent advances and current challenges. The working groups made recommendations as to how researchers and research funders can tackle those challenges.

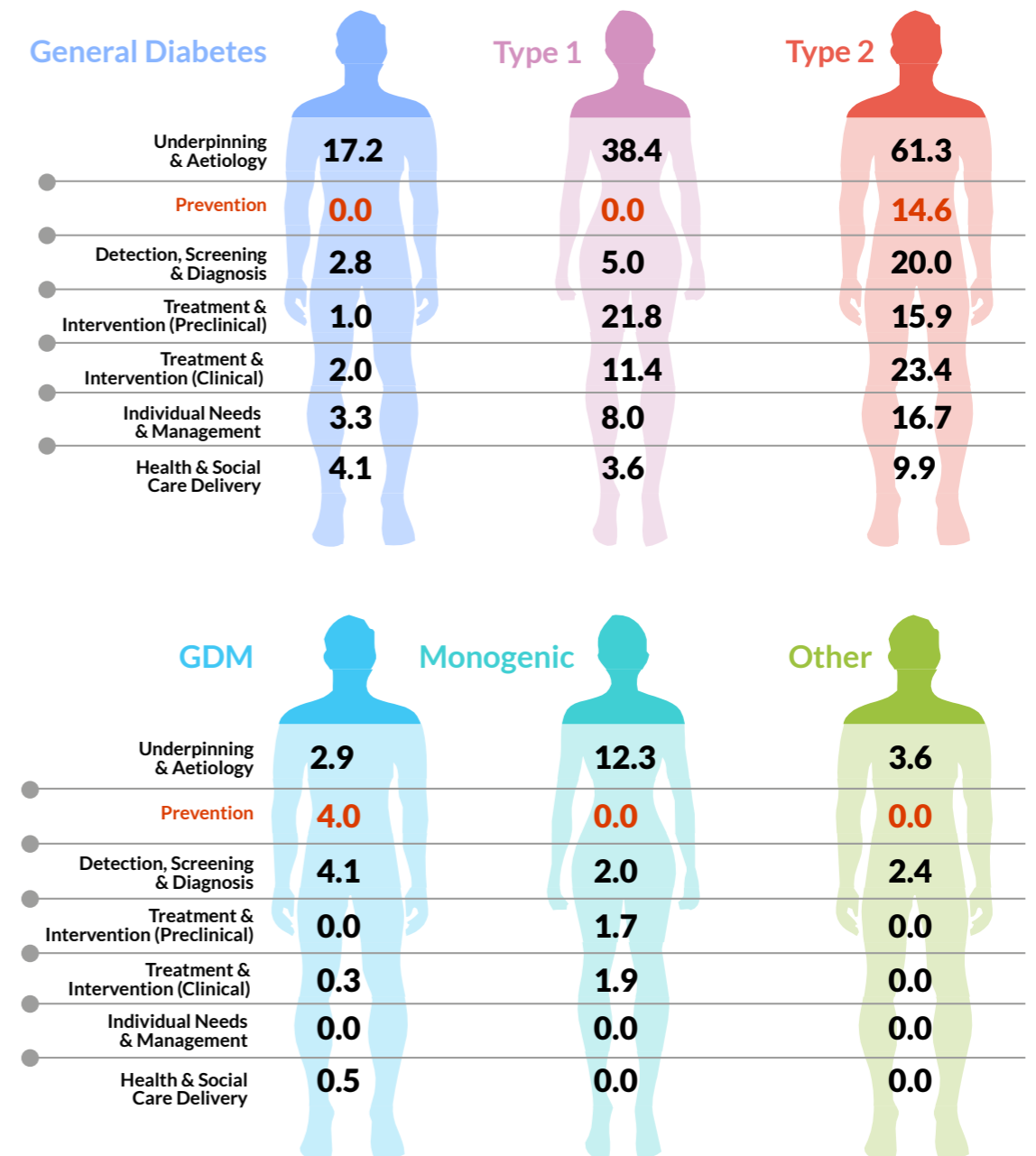
Six key enablers of clinical and applied research success were identified by these experts:



We also considered how these recommendations fit with the priorities of people living with diabetes, previously identified through James Lind Alliance priority-setting partnerships, and the work of the Diabetes Research Steering Groups.

1 PREVENTION OF TYPE 2 DIABETES AND OBESITY

Figure 1: Investment in Each Condition by Area of Research (£millions)



Background

In England the number of adults with doctor-diagnosed diabetes increased from 2% to 7% of the population between 1994 and 2019⁷, and nearly 17 million people are at increased risk of developing type 2 diabetes by 2030⁸.

Living with overweight or obesity can contribute up to 85% of the risk of developing type 2 diabetes⁹. In 2019, 66% of men and 57% of women in England were living with overweight or obesity.

People, and adolescents in particular, have become increasingly physically inactive since the mid-1990s¹⁰ in part driven by changes in the built environment and social

structures¹¹. Almost 10% of children aged 4 to 5 years and 20% aged 10 to 11 are living with obesity¹².

The Covid-19 pandemic has aggravated inequalities in childhood obesity, which were already widening progressively¹³. Poor diet and physical inactivity are important risk factors for health and specifically for type 2 diabetes¹⁴. Increasing numbers of people with early onset type 2 diabetes have poor outcomes, including accelerated microvascular complications¹⁵. Interventions in diet and physical activity could prevent or delay more than half of all cases of type 2 diabetes¹⁶. Clearly, there is huge potential to

reduce diabetes morbidity through preventive actions. Such preventive actions need to start in childhood through to adolescence when the trajectory of obesity risk becomes established. In addition, reduction of risk before, during and post pregnancy has potential to impact on the health of both the mother and offspring.

While type 2 diabetes is strongly linked with overweight and obesity, not all people with type 2 diabetes are living with overweight or obesity. As such there is a need for interventions which prevent or delay onset of type 2 in this population.

Advances in prevention initiatives

We know weight loss reduces the risk of developing type 2 diabetes, and that programmes which deliver weight loss meaningful for prevention can be offered at scale. This includes programmes focused on children delivered through local authorities¹⁷, where preventive initiatives may be more scalable and have sustained life course benefits.

This is particularly pertinent as we lack long-term data about the sustainability of weight management.

The adoption of healthy dietary practices, increased physical activity (both aerobic and resistance exercise) and reduced sedentary behaviour are all key targets for prevention of type 2 diabetes among the UK population. These targets have unequal outcomes in different populations. This may be partly due to lack of success in engaging some population groups, exacerbating inequalities¹⁸.

Development of research infrastructure and funding

The majority of type 2 diabetes research funding is focused on aetiology and management, with much less going to prevention research as shown in Figures 1 and 2. We need more funding for prevention, with interdisciplinary and systems-based research to address the whole life-course and determinants of risk. This requires infrastructure as well as money.

One good example is the [NIHR Diet and Activity Research Translation \(DART\) Collaboration](#), formed in 2019. The collaboration brings together nine NIHR Biomedical Research Centres (BRCs) in England, to increase capacity and capability in health behavioural research. The collaboration has called for more support for research into health behaviours, weight management and obesity research.

Another example of infrastructure to coordinate preventive research is the UK Prevention Research

Partnership, which supports and funds research into the primary prevention of non-communicable diseases.

Funding is essential if we are to offer people living in areas of deprivation opportunities to take part in research. These communities are at increased risk of developing type 2 diabetes, but are often overlooked or under-represented in research¹⁹.

The numbers of people developing type 2 diabetes will continue to increase and we need to understand much more about the risks and support more interdisciplinary research that addresses the wider life course determinants of risk.

Currently there is limited research investment and collaboration with relevant stakeholders such as local authorities. Local authorities have important roles in taking action across many areas affecting health. These include influencing what

people buy and eat, encouraging healthy schools, expanding access to public sports and leisure services, promoting active workplaces, providing weight management programmes, designing built and natural environments, enabling active travel and public transport, preventing obesity in children and families and embracing system wide approaches.

Some of the possibilities are outlined in a recent NIHR Themed Review on Obesity which included 143 studies focused on obesity and discussions with local government staff²⁰.

Researchers have increasing opportunities to engage with local authorities through programmes and infrastructure such as supporting fellowships in local authorities, the NIHR School for Public Health Research and NIHR Applied Research Collaborations.

PRIORITIES OF PEOPLE LIVING WITH DIABETES

The opportunities we highlight are reflected in the following priorities of people living with diabetes, as identified through Priority-Setting Partnerships and the Diabetes Research Steering Groups:

- How do we identify people at high risk of type 2 diabetes and help to prevent the condition from developing?
- Determine the health inequalities people with or at risk of type 2 and gestational diabetes face, particularly relating to socio-demographics, and develop strategies to fight them.
- Test the effectiveness of local, regional, national, workplace or community programmes to help people manage their risk of type 2 diabetes.

The Nuffield Department of Primary Care Health Sciences has identified 'top ten' unanswered questions for obesity and weight research, with hundreds of stakeholders using a priority-setting approach following the principles of the James Lind Alliance²¹. These ten questions align well with the research needs outlined in this document.



OPPORTUNITIES AND RECOMMENDATIONS

FOSTER COLLABORATION:

- Increase funding into life-course, population weight gain, obesity, diet and activity research
 - Encourage condition-specific funders to partner with each other, to enable cross-cutting health behaviour research for prevention of obesity, multiple long-term conditions and healthy ageing
 - Improve the management of clinical data and integration
- of data across primary and secondary care
 - Bring together multi-disciplinary teams to investigate the combination of pharmacotherapeutics and health behaviours
 - Build on initiatives to support the development of a common strategy for maximising the impact of health behaviour research
 - Increase investment and collaboration in systems-

based approaches including with those in local authorities responsible for transport planning and spatial planning decisions, education, parks and greenspace, leisure services, the NHS, integrated care systems working with all relevant stakeholders, especially Directors of Public Health.

TAKE A LIFE COURSE APPROACH AND SUPPORT RESEARCH IN TRADITIONALLY UNDERSERVED GROUPS:

- Develop effective strategies for every life stage (critically including preconception, pregnancy, infancy, childhood and adolescence), to initiate and maintain healthy weight, diet and physical activity and weight loss maintenance, including
- research for both therapeutic and public health approaches using diet and physical activity
 - Increase investment to tackle prevention in high risk and underserved communities, including South Asian²² and African/Caribbean minority ethnic groups²³
 - Support research on identification of groups at high risk of early-onset type 2 diabetes to develop

tailored interventions. At-risk groups include young people living with obesity, those physically inactive, of lower socioeconomic status or from the ethnic groups indicated above, or with a strong family history of type 2 diabetes, previous gestational diabetes, in utero exposure to hyperglycaemia (including type 1, type 2 and gestational diabetes) or low birth weight.

IMPROVE COMMUNICATION, ENGAGEMENT AND TRAINING:

- Undertake qualitative research to understand barriers to implementation and uptake of interventions by subgroups where engagement is currently lower
 - Fund implementation initiatives to adapt interventions known to be effective at scale, to appeal to more people from different communities
- Develop fellowship opportunities in health behaviours research to build research capacity
 - Support people living with obesity and type 2 diabetes to input into funding application reviews and decision-making as well as dissemination and knowledge mobilisation.



“You can’t do effective research in diabetes without strong links with primary care – that is where the data is and where most of the patients are. It’s pretty critical in diabetes to have those insights and connections.”

Professor Melanie Davies
University of Leicester

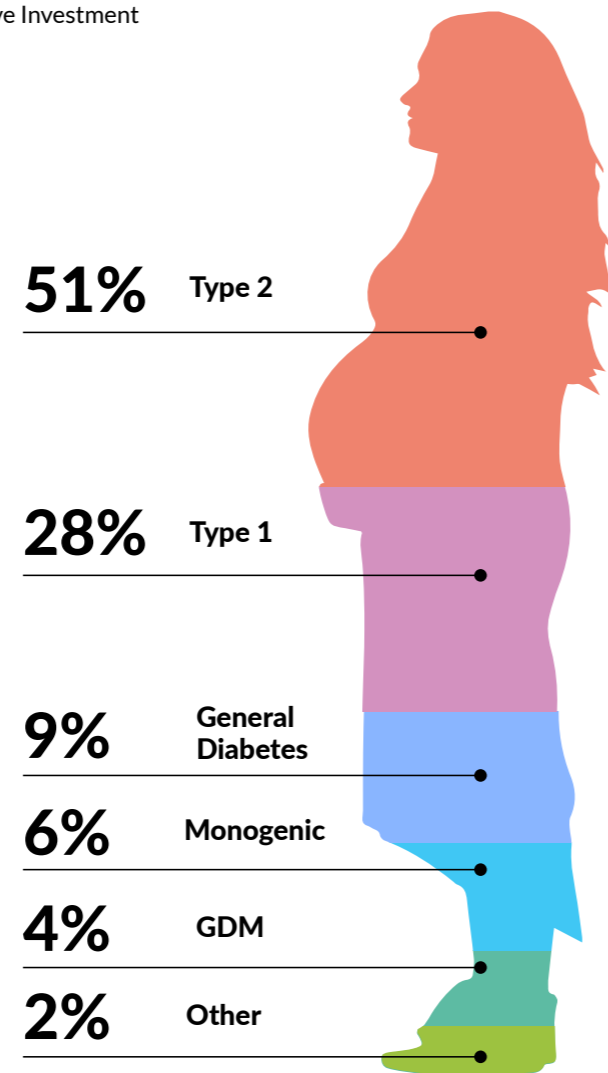
2 GESTATIONAL DIABETES

Background

Gestational diabetes (GDM) is diabetes that develops during pregnancy. It is increasingly prevalent globally²⁴, and has important health implications during pregnancy and afterwards²⁵. And there are longer term implications for both the mother and offspring, with women who have had GDM having an increased risk of future type 2 diabetes and the children exposed to maternal hyperglycemia being at greater risk of developing impaired glucose tolerance^{26,27}.

Living with overweight or obesity is an important risk factor for GDM²⁸, although it should be recognised that GDM also occurs in women with lower body weights. GDM historically has affected 4 to 5 in 100 women during pregnancy²⁴ but recently prevalence rates as high as 20 in 100 have been reported in some populations, including in the UK²⁹. However, our portfolio analysis shows that only 4% of grants funded in the 2014-2019 period went to GDM research.

Figure 3:
Relative Investment



Advances and challenges

There is an active research community focused on GDM in the UK³⁰, alongside significant international expertise and collaboration. A recent priority-setting partnership on diabetes and pregnancy has provided

recommendations for research driven by those affected by diabetes in pregnancy or working in the area³¹. The Royal College of Obstetricians and Gynaecologists (RCOG) Diabetes in Pregnancy working group focused on diabetes in pregnancy and has developed research questions to address these priorities.

And care for GDM has improved with women with GDM having, on average, pregnancy and birth outcomes similar to pregnant women in the general population^{32,33}.

However, it is difficult to get a snapshot of short- and longer-term health outcomes for women with GDM and their offspring in the UK, as there is no national audit and maternity services collect this data inconsistently. Additionally, numbers of women affected are very high and thus making it difficult to extract information without automation. Small-scale research efforts have tried to capture data, but the outcome has been patchy. This challenge is compounded by an inconsistent approach to screening and diagnosis, including diverse 'positive' glucose thresholds across the nations, as blood glucose levels in GDM and health outcomes have a continuous relationship, with no obvious inflection point that identifies a clear threshold that shows significantly greater benefit. In addition, many women with dysglycemia in pregnancy are 'missed' because women are only offered screening if they have risk-

factors for GDM. This is particularly the case in women from Chinese ethnic groups, in whom universal screening detects almost twice as many cases of GDM than screening based on known risk factors²⁴.

Researchers wishing to carry out research in GDM face challenges from the start because of this inconsistency and lack of data. Many of the research questions in GDM are significant in scale and investment required. They will require a coordinated effort, sufficient funding, and must be underpinned by good data.

Several models have been produced which can identify women at highest risk of GDM and are sometimes used as part of routine care³⁴. However, these are not consistently used and one prediction model will not fit all, with it being likely that different predictors are stronger for different populations.

Inequalities also play a part, and we note the historic under-investment in women's health research³⁵. GDM is more prevalent in communities that are less likely to be involved in research studies (such as women from ethnic minority groups). This makes it more challenging to recruit for studies.

The transient nature of GDM adds to the engagement gap, as the risks of subsequent type 2 diabetes in the mother and her offspring are not widely appreciated. It can be more challenging to engage women in patient and public involvement initiatives when they expect their condition to be transient and, therefore, patients are less likely to drive forward the agenda in GDM than in other long-term conditions.

PRIORITIES OF PEOPLE LIVING WITH DIABETES

The opportunities we highlight are reflected in the following priorities of people living with diabetes, as identified through James Lind Priority-Setting Partnerships and the Diabetes Research Steering Groups:

- How can diabetes technology be used to improve pregnancy, birth, and mother and child health outcomes?
- What is the best test to diagnose diabetes in pregnant women?
- For women with diabetes, what is the best way to manage blood sugar levels using diet and lifestyle during pregnancy?
- What are the emotional and mental well-being needs of women with diabetes before, during, and after pregnancy, and how can they best be supported?
- When is it safe for pregnant women with diabetes to give birth at full term compared with early delivery via induction or elective caesarean?
- What are the specific postnatal care and support needs of women with diabetes and their infants?
- What is the best way to test for and treat diabetes in late pregnancy i.e. after 34 weeks?
- What is the best way to reduce the risk or prevent women with gestational diabetes developing other types of diabetes any time after pregnancy?
- What are the labour and birth experiences of women with diabetes, and how can their choices and shared decision making be enhanced?

OPPORTUNITIES AND RECOMMENDATIONS

PROMOTE UNDERSTANDING OF THE NATURE OF GESTATIONAL DIABETES IN THE UK:

- Improve phenotyping of the GDM population in the UK
- Agree and standardise a common approach for GDM screening and diagnosis across the UK, including the best timing for screening, most appropriate method and best diagnostic threshold.
- Collect and audit GDM screening, diagnosis and outcome data across the UK to understand existing provision of care and to support research in this area
- Encourage research to establish when and how to best follow up women post-pregnancy in primary care (where uptake is low) to reduce future risk of type 2 diabetes and gather longer term data
- Fund research which seeks to understand which interventions are best for preconception and post-delivery weight control in this population.

FOSTER COLLABORATION:

- Extend collaboration across the obesity, diabetes and obstetrics research communities to increase high-quality applications to address evidence gaps
- Funders recommended to engage with the UK Preconception Partnership and the Office for Health Improvement and Disparities, which are developing materials to improve preconception health and care as a means of tackling health disparities, notably in relation to GDM
- Funders recommended to engage with expert colleagues such as the Royal College of Obstetricians and Gynaecologists and the Royal College of Midwives.

TAKE A LIFE COURSE APPROACH AND SUPPORT RESEARCH IN TRADITIONALLY UNDERSERVED GROUPS:

- Support the creation and use of models which can identify women with GDM at highest risk of adverse outcomes in routine care
- Drive forward relevant recommendations emerging from the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) precision medicine in diabetes initiative
- Support research to understand the impact of GDM on women's mental health
- The interpregnancy period presents an underutilised opportunity for characterisation of preventive measures to reduce the risk of GDM in subsequent pregnancies and of later type 2 diabetes, as well as enabling family intervention. The establishment of Family Hubs by DHSC in local authorities with the highest levels of deprivation presents an important opportunity in this area.
- Develop risk-stratified approaches to prevention and treatment of GDM, tailored to the individual needs of women

IMPROVE COMMUNICATION AND ENGAGEMENT:

- Support people with lived experience of GDM to take part in all stages of the research cycle
- Improve communication and engagement with non-research active clinical staff so they can change practice based on emerging research evidence.



“Gestational diabetes is a common condition in pregnancy and can have negative short and long term impact on both mother and baby. The lack of investment in gestational diabetes is stark and concerning given the scale of the problem and the implications for the health of the population now and in the future. Increased investment in research in this area is critical and urgent.”

Professor Rebecca Reynolds
University of Edinburgh

3 DIABETES AND MULTIPLE LONG-TERM CONDITIONS

Figure 4: Investment (£million) into diabetes

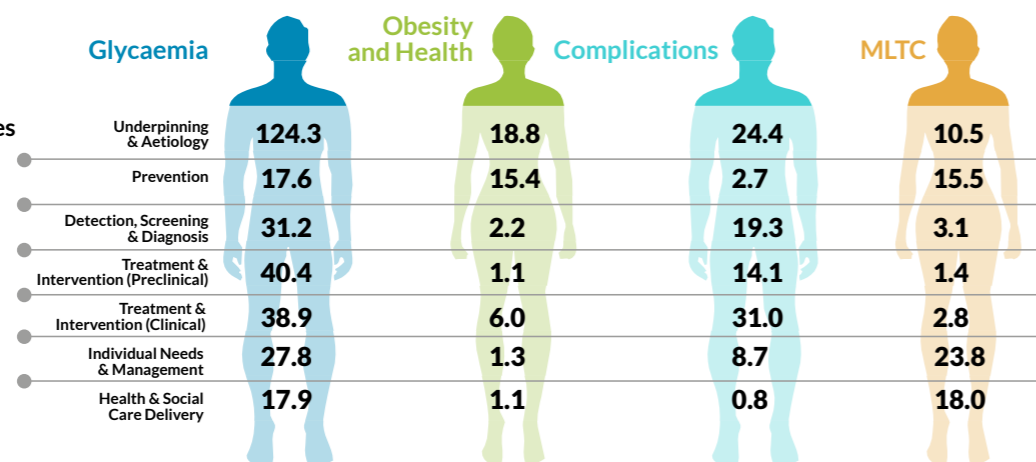
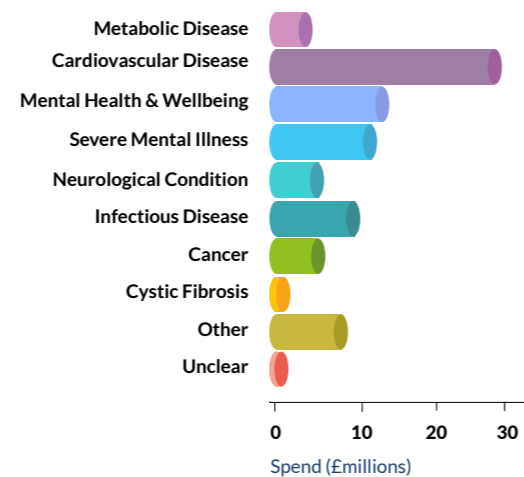


Figure 5: MLTC Research, in Total and by Area of Research (£millions)

Funders were not asked to provide all multiple long term conditions data so these figures may be an underestimate of the total funding in the UK. The data presented is on grants referring specifically to caring for a condition alongside diabetes (any form) and not all grants focussed on MLTC in general.



Background

Multiple Long-Term Conditions (MLTC) or multimorbidity, is the co-existence of two or more chronic conditions. These are either a physical non-communicable disease of long duration, such as diabetes or cancer, a mental health condition of long duration, such as a mood disorder or dementia, or an infectious disease of long duration, such as HIV or hepatitis C³⁶.

We expect MLTC to rise, which will increase demand on individuals and families, as well as the health and social care system. We need to minimise the burden through cost-effective approaches for prevention and management of diabetes, which

often sits at the centre of clusters of long-term conditions.

An estimated one in four people in the UK live with two or more MLTC. This could rise to around a fifth (17%) of the UK population with four or more long-term conditions by 2035³⁷. Almost 77% of people with type 2 diabetes have more than one comorbidity with the most common combination for people with type 2 diabetes being hypertension with hyperlipidaemia or osteoarthritis³⁸. Non-alcoholic fatty liver disease has a prevalence of 55% among type 2 diabetes patients³⁹. Approximately four in ten people with diabetes will

experience diabetes-specific emotional distress^{40,41}. As shown in Figure 4 MLTC studies focused on diabetes and cardiovascular disease receive the largest proportion of MLTC diabetes focused funding, while relatively little funding is provided for prevention, detection and treatment of metabolic disease.

The prevalence of MLTC varies by age, sex and socio-economic status. In 2017/18, the combination of diabetes and hypertension cost £457 million in secondary care alone⁴².

Advances and challenges

The importance of supporting MLTC research has been acknowledged and we have seen significant investments in MLTC research in recent years, mainly from public funders. The UK Research Institute (UKRI) and NIHR co-funded a £20 million Strategic Priorities Fund initiative, while NIHR provided £23 million to an Artificial Intelligence for MLTC funding call. This research aims to identify how conditions cluster together and their trajectories. The outcomes could highlight opportunities to identify shared mechanisms, new treatments and prevention approaches. We would like to see more analyses of electronic health records for selected populations using existing records (for example Clinical Practice Research Datalink (CPRD), UK Biobank, Office for National Statistics (ONS) data) to describe characteristics of people with MLTC and their short and long-term outcomes.

Estimating the total costs of MLTC in relation to an index condition, such as diabetes, is challenging, due to the multiple definitions of MLTC and diversity in the methods used to measure cost-of-illness (COI)⁴³. Key challenges include how to identify what predicts MLTC, how to

understand the interplay between clusters of conditions and how to recognise opportunities for primary prevention.

Inequalities in prevalence and outcomes of MLTC are widening. We need cost-effective interventions to reduce the resulting health inequalities. As childhood obesity worsens, we are likely to see further increases in MLTC, without preventive interventions delivered at scale.

By the nature of MLTC, multiple specialisms are likely to be involved in managing the care of each individual. This makes development of a holistic management approach a key challenge for health and care providers. The risk is that care fragments across specialisms, without joined-up working.

There is currently a lack of research on inpatient diabetes and how secondary care health professionals can ensure adequate care is provided to these patients. Around 1 in 6 hospital beds⁴⁴ in the UK are occupied by someone with diabetes - almost all of whom spend a day or so longer in hospital than their peers who do not have diabetes. This results in both increased costs for the healthcare system and burden on the patients.

Clinicians and allied health professionals in all specialities must be supported to develop a generalist skill set, to ensure holistic care for the growing numbers of people expected to be living with MLTC in future. Generalist skills need to be integrated into medical education and continuing professional development. Given diabetes care is multidisciplinary, diabetes research can lead the way in demonstrating the utility of developing generalist skills and the provision of holistic care.

Single disease guidelines are likely to become increasingly irrelevant and should be adapted to reflect the prevalence of MLTC. National guidelines for the management of MLTC recommend that care should be individualised for each person, although this is difficult to implement in practice. Some of the most prevalent morbidities, including obesity, osteoarthritis, hypothyroidism, asthma, COPD, anxiety and schizophrenia, have not featured in national diabetes guidelines. In addition, although people with type 2 diabetes have a raised risk of non-alcoholic fatty liver disease, liver function tests are not part of routine primary care monitoring for diabetes.

PRIORITIES OF PEOPLE LIVING WITH DIABETES

The opportunities we highlight are reflected in these priorities of people living with diabetes, as identified through James Lind Alliance Priority-Setting Partnerships and the Diabetes Research Steering Groups:

- How can diet and exercise be used to prevent frailty and manage type 2 diabetes? And how can this be delivered in a way that is acceptable to older people with type 2 diabetes from any background?

- There is a need for collaborative, multidisciplinary programmes of applied research which aim to prevent or slow the progression of diabetes complications, in people with Type 1 or Type 2 diabetes who are at extremely high risk.

There have also been JLA Priority Setting Partnerships of relevance focused on Multiple Conditions in Later Life⁴⁵ and Safe Care for Adults with Complex Health Needs⁴⁶.

OPPORTUNITIES AND RECOMMENDATIONS

FOSTER COLLABORATION:

- Increase collaboration and co-funding opportunities between public funders and consortia of condition specific funders ensuring those funders who support the development and

evaluation of interventions for obesity, cardiometabolic and mental health research are included

- Encourage collaboration between clinical academics and health economists to identify

the costs and impact of diabetes and comorbid conditions, particularly using methods to harmonise international costs.

SUPPORT PREVENTION AND MANAGEMENT OF MLTC:

- Recognise that effective primary and secondary prevention of type 2 diabetes contributes to prevention of long-term conditions such as diabetic eye, cardiovascular and kidney disease so ensure

diabetes research is supported within MLTC research

- Encourage further research among individuals and populations with MLTC to improve health behaviours and self-management
- Encourage further epidemiological studies specific to diabetes and MLTC to

inform priorities for developing effective interventions and policy recommendations

- Encourage qualitative research to understand the experiences of people affected by MLTC to help inform interventions.

CREATE AN ENVIRONMENT TO SUPPORT AND EXTEND MLTC RESEARCH:

- Capture core outcomes for trials which can be shared between specialties, so that the benefits of an intervention on other conditions can be seen

- Encourage clinical trialists to report the prevalence of MLTC and participants in comparison to the target population, and include representative proportions of people with MLTC

- Develop comprehensive screening systems for early detection of complications, using optimised methods conveniently accessed by people with MLTC.

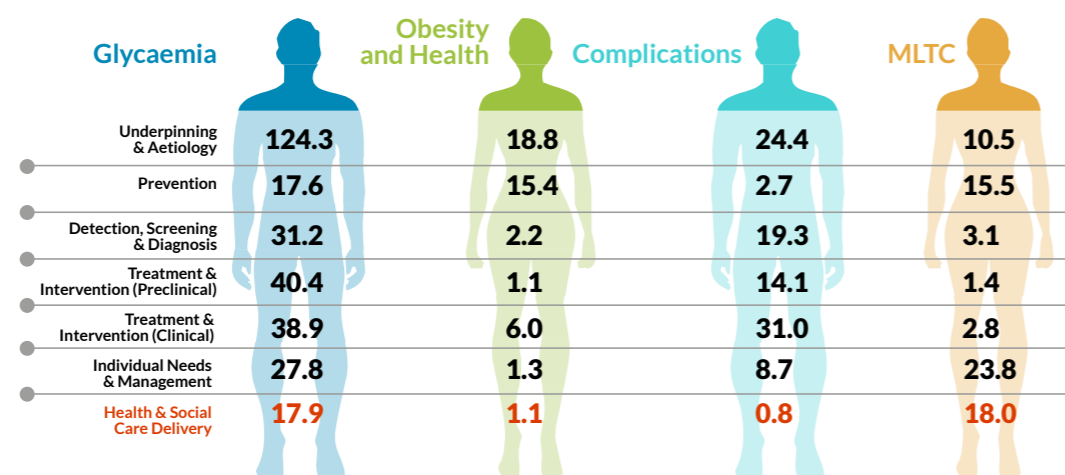


“Many studies of interventions routinely exclude people with multiple long term conditions or who are taking many different medications. Yet multiple long term conditions are common among people with diabetes. Only 12% of people with diabetes in the general population would have been included in some large trials of diabetes medication, as a result of exclusion criteria. If the majority of people with diabetes are excluded from studies, we have little way of knowing what the true effect of the intervention will be in the real world.”

Professor Kamlesh Khunti, CBE
University of Leicester

4 MOVING RESEARCH FINDINGS INTO PRACTICE

Figure 6: Total Spend per Grant Category by Area of Research (£millions)



Background

Research and evidence-based medicine have transformed healthcare, improving clinical outcomes and cost effectiveness⁴⁷. However, it can take up to 17 years before the results of research translate into improved care for patients⁴⁸.

The 2006 Cooksey review⁴⁹ noted that the leadership and vision of specific individuals led to successful translation of research into practice. The review found less evidence of a framework for systematic translation. It highlighted two gaps in translation:

- barriers to the translation of basic research and early clinical research into ideas and products
- barriers to introducing those ideas and products into clinical practice

Our portfolio analysis highlighted that, across the board, investment in research focused on health and social care delivery in diabetes was the lowest area of spend, and we know that investment in this area is critical to the translation of research into practice.

Advances and challenges

UK research has transformed the lives of people living with diabetes. Over the last 50 years structured education, type 2 diabetes prevention and screening for rare forms of diabetes have become standard care in the UK. All these areas benefited from strong clinical academic expertise and backing, sustained investment from funders and cost benefit analyses.

Nearly 20 years on from the Cooksey review, we need to recognise the importance of collaboration, training in implementation science and a systematic approach to implementation.

The costs associated with establishing and conducting clinical trials have become prohibitively expensive for small and medium sized charitable funders. A significant component of these costs relates to reporting and regulatory processes.

Administrative and regulatory burden is exacerbated within universities and the NHS. An ever-growing set of procedures and policies governs research. We need to make these policies proportionate to the research being

undertaken, without compromising safety and care.

These barriers mean that the vast majority of conducted trials are trials of drugs funded by pharmaceutical companies. We see far fewer pragmatic trials required to address gaps in the evidence base for clinical decision making, or for preventative approaches, being initiated.

We have infrastructure and expertise across the UK to support the implementation of research to practice through the NIHR Applied Research Collaborations (ARCs) and the Academic Health Science Networks (AHSNs). Now we must further link the diabetes community with the relevant expertise and infrastructure and provide training opportunities.

Effective dissemination and implementation of research findings is critical if they are to have clinical impact. Health care professionals face barriers to engagement with research findings, and to using them to change clinical practice⁵⁰.

The Covid-19 pandemic has shown how research findings can be translated into practice in an accelerated timeline, when the infrastructure and funding is available. We must learn from this experience.

PRIORITIES OF PEOPLE LIVING WITH DIABETES

The opportunities we highlight are reflected in the following priorities of people living with diabetes, as identified through James Lind Priority-Setting Partnerships and the Diabetes Research Steering Groups:

- Improve health services for diabetes care, making more effective use of patient-reported outcome measures, audit and real-world data to drive service improvement.

OPPORTUNITIES AND RECOMMENDATIONS

FOSTER COLLABORATION, TRAINING OPPORTUNITIES AND PERSONAL SUPPORT:

- Develop training opportunities in implementation science through existing infrastructure and encourage early-career diabetes researchers to access them
- Invest in targeted support for key areas of importance to implementation, such as health psychology
- Strengthen links between diabetes researchers, health economists and health psychologists and consider providing funding for the purposes of collaboration.

CREATE AN ENVIRONMENT TO SUPPORT IMPLEMENTATION:

- Require grant applicants to consider the pathway to implementation and dissemination strategies in applications
- Diabetes specific funders should make public funders aware of the pipeline of innovation to inform their strategic calls and align their funding schemes to support the translation of research
- Funders recommended to engage with the NHS and policy makers to highlight the innovation pipeline, and identify a systematic approach to move promising areas into practice
- Consider the views of stakeholders such as NICE when identifying research gaps to inform strategic research

calls and to establish how research in these areas can be translated

- Update health economic models to reflect the current type 2 diabetes phenotype
- Funders, Universities and Government must continue to work together to reduce the bureaucracy involved in research
- Innovative funding mechanisms are particularly required to enable the use of the next generation of trial designs such as platform and adaptive trials and benefit from the efficiencies in time and resources the designs bring
- Take lessons learned from accelerated timelines for implementation that have occurred as a result of the Covid-19 pandemic.

SUPPORT DISEMINATION

Funders and the research community recommended to seek

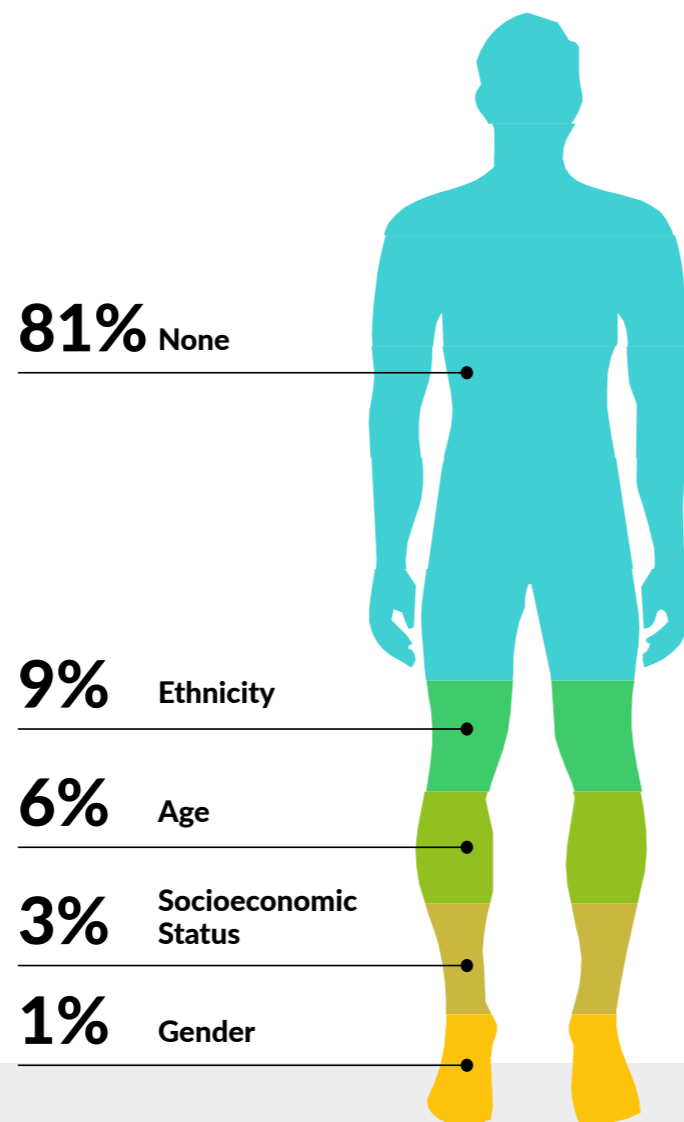
- Opportunities to share research findings with clinicians through a wide range of channels to support changes to clinical practice

- Support those with lived experience of diabetes to become involved in dissemination of research findings
- Update NICE guidelines to adopt new evidence into diabetes care in a timely way

way including guidance that addresses obesity and co-morbidity.

5 ADDRESSING DIABETES HEALTH DISPARITIES

Figure 7: Relative investment in diabetes grants (2014-2019) with a clear focus on health inequalities



Background

Inequalities in health were laid bare by the Covid-19 pandemic. Black and minority ethnic groups, as well as elderly people and those living in more deprived areas of the UK, had disproportionately higher morbidity and mortality^{51,52}. This is reflected in people with diabetes, who are also over-represented in certain communities and were hard-hit by the pandemic. The National Child Measurement programme in England has documented widening disparities in childhood obesity prevalence over the last decade, with a further sharp widening during the Covid-19 pandemic. The prevalence of obesity in the most deprived areas is more than double than that in the least deprived areas⁵³. This has important implications for disparities in diabetes.

Our portfolio analysis starkly shows that the majority of investment in diabetes research across 2014-19 did not focus on the variation in outcomes because of sex, age, socioeconomic status or ethnicity. It is vital that researchers consider the impact of health inequalities when conceiving and designing diabetes research studies in the future.

Advances and challenges

Health inequalities may come about because of ethnicity, sex, gender, age and socio-economic deprivation. However, researchers should also bear in mind other inequalities that may not seem obvious. For example, many studies of interventions routinely exclude people with multiple long-term conditions (MLTC) or who are taking multiple medications. Yet as outlined earlier in this document MLTC is common among people with diabetes. Only 12% of people with diabetes in the general population would have been included in some large trials of diabetes medication, because of exclusion criteria. If the majority of people with diabetes are excluded from studies, we have little way of knowing what the true effect of the intervention will be in the real world.

Some geographical populations are also under-served and struggle to access healthcare and research through lack of local healthcare facilities, research active institutions and transport.

If a study is equally important to everyone, the aim is usually to recruit a cohort which reflects the demographics of the general population, so (in the UK) 15% from ethnic minority backgrounds, 50% female and so on. But because diabetes is more common in certain ethnic groups, researchers should consider whether to over-recruit from these populations. A recent study on diabetes prevention recruited 28% people from ethnic minority backgrounds, to reflect the higher burden of disease in these groups⁵⁴.

Recruitment from wider populations, particularly those traditionally not reached, requires additional resources. Because of the barriers identified to their inclusion⁵⁵, it may take more effort, novel approaches and more time to engage with these communities. For example, studies may take longer to recruit study participants and work harder to retain participants. Initiatives to help address this challenge include

NIHR's underserved communities programme⁵⁶ and Diabetes UK's commitment to increasing diversity in diabetes trials.

The barriers to involving underserved communities can include lack of trust, language barriers and lacking the right networks locally. There is an obvious advantage to having good relationships with the communities you wish to reach.

Diversity in the research community is a clear advantage with experts in the area noting that if you are recruiting from ethnic minority groups, it is advantageous to have ethnic minority researchers doing the recruiting. More needs to be done to support researchers from ethnic minority backgrounds progress to senior positions, as part of ongoing equality, diversity and inclusion initiatives.

OPPORTUNITIES AND RECOMMENDATIONS

DESIGN INCLUSIVE RESEARCH

- Researchers writing funding applications recommended to make explicit their plans for tackling inequalities through more diverse study participation and explain how this affects the funding they require
- Consider the fundamental question of inequalities right from the start of any research programme
- Researchers recommended to investigate disparities of care for particular communities and design interventions to address these
- Researchers recommended to complete an inequalities impact assessment at the start of a research project and funders and universities should provide access to training opportunities and examples of good practice to support this
- Researchers recommended to take advantage of resources available. For example the Centre for Ethnic Health Research has a suite of training tools and other resources in ethnic health and inequalities, including an Inequalities Impact Assessment Tool and Cultural Competency Training for those wishing to carry out research in the community and researchers should be provided with training to utilise these tools
- Researchers recommended to remember health inequalities when reporting the baseline characteristics of participants and the results of studies. The advantages of recruiting from a diverse population may be missed unless the overall results are disaggregated, so the effect size on sub-groups can be seen. Even if sub-group analysis is underpowered to show a significant result it can be valuable for later meta-analysis
- Researchers recommended to bear in mind the impact of interventions that require participants to travel, possibly long distances, to attend healthcare facilities and focus on developing interventions that can be delivered in community settings
- Researchers and research funders need to be aware that costs of recruiting diverse populations are likely to be higher and should be reflected in grants
- Enable data-linkage analysis of large population datasets to ensure that under-represented communities are consistently included in studies
- Ensure research is placed in areas of high prevalence and where the burden of the condition is at its greatest.

WORK WITH COMMUNITIES

- Ensure communities who take part in research are properly informed about the results. Dissemination of results should not only be left to publication in peer-reviewed journals which the participants will never see
- Researchers recommended to think about the most suitable method of

disseminating results to participants, including through social media. Examples include text messaging and constructing graphics using cartoons which can be captioned or sound-tracked in different languages.

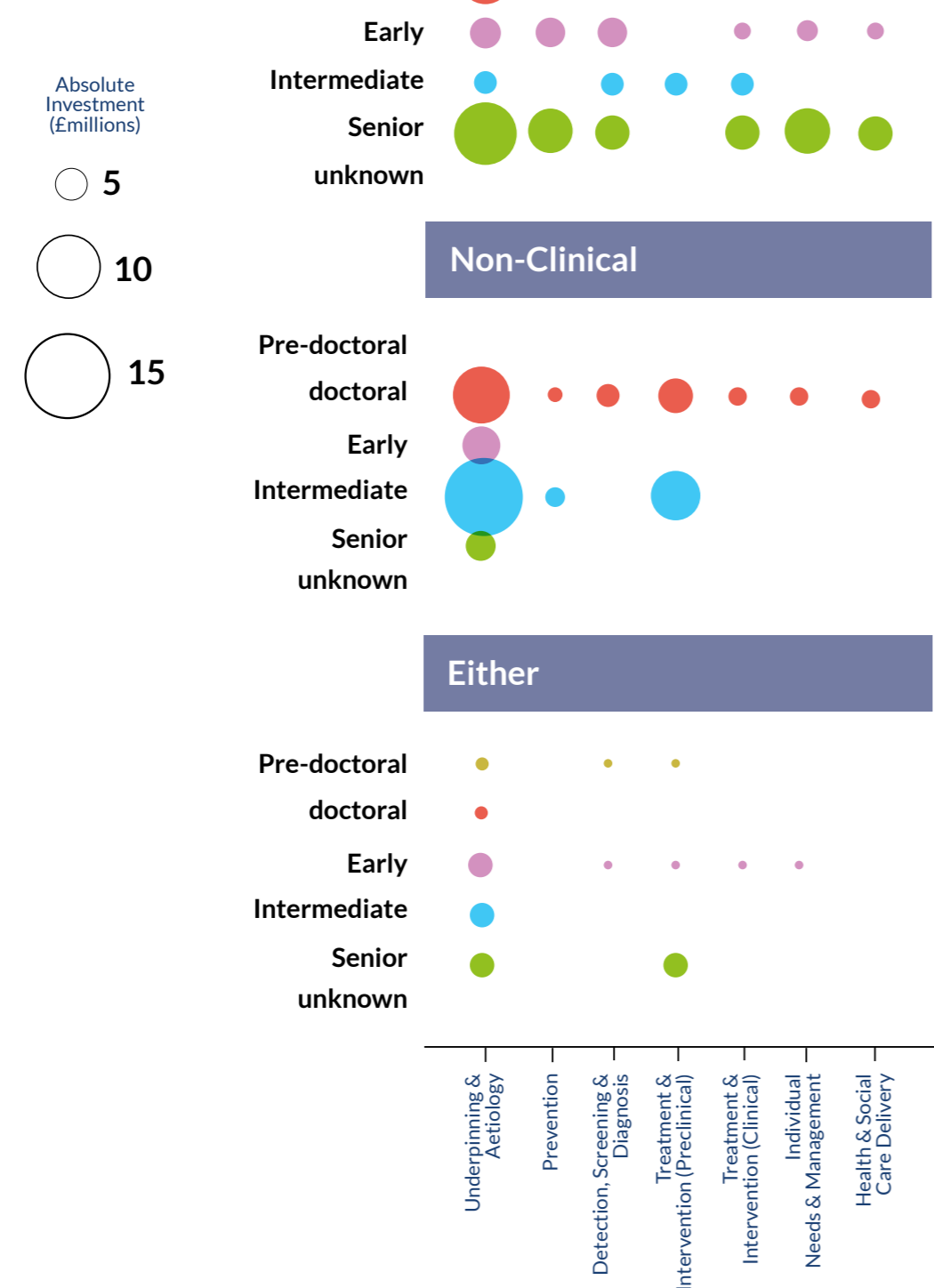
BUILD CAPACITY

- Promote the use of the [Race Equality Charter](#)⁵⁷ to increase the number of senior researchers from ethnic minority communities.

6

SUPPORTING THE DIABETES RESEARCH LEADERS OF THE FUTURE, AND FOSTERING AND RETAINING EXPERT SKILLS IN DIABETES RESEARCH

Figure 8: Number of Research Career Awards by Area of Research and Career Stage, Split by Career Path



Background

We need to encourage promising early-career researchers from a wide range of backgrounds and disciplines to choose and commit to a career in diabetes and we need to retain those researchers.

Our portfolio analysis looked at the numbers of career awards made in diabetes across the career pathway. For clinical researchers, the data showed fewer numbers of doctoral, postdoctoral and intermediate awards when compared to non-clinical awards. This may reflect the make-up of the overall population of researchers.

The portfolio analysis showed that very few award holders specialised in qualitative and mixed methods research, clinical trials or in research focused on computer modelling. And most clinical award holders are doctors, with nurses and allied health professionals less well represented. This is troubling as diabetes is a condition primarily treated in primary care, which requires input from multidisciplinary teams and has huge implications for public health.

Previous research has identified expertise gaps in paediatric,

quantitative and health psychology research. The UK Health Research Analysis 2018⁵⁸ showed that over five years only 255 of 18,308 funded projects and only 3% (£313 million) of the UK health research spend was focused on children, and only a small proportion of this would have been diabetes specific.

We know these skills exist outside of the field of diabetes, so we could develop pathways to bring individuals with these skills into diabetes research. We need to embed the necessary expertise and skills within research teams.

Advances and challenges

Charitable and government funders play a key role in supporting careers in diabetes, alongside the university sector. There are opportunities at all stages of the career pathway for both clinical and non-clinical researchers.

The Medical Research Council (MRC) has launched an interactive careers framework⁵⁹ to support researchers looking to identify options across multiple funders. To be effective, support must extend beyond the provision of salaries and research funding into mentorship and training opportunities. To that end, funders have introduced programmes such as the Academy of Medical Sciences one to one mentoring programme⁶⁰. Diabetes UK Innovators in Diabetes Programme (IdIA)⁶¹, NIHR's leadership development and mentoring opportunities and online leadership development resources⁶², as well as the Clinical Academic Training and Career hub's online resources⁶³ to help early-career researchers navigate a career in research.

People who want to maintain a diabetes research career- or indeed any research career- face other barriers such as competing roles as carers for children or relatives, which often coincide with the early career research stage. Early-stage researchers, and beyond, need flexible work plans to accommodate this and schemes to support return to work after any career breaks.

The vast majority (90%) of type 2 diabetes management happens in primary care, and diabetes prevention policies depend on primary care. GPs need to be adequately represented in diabetes research, but fellowship schemes may not reflect the different structure and work patterns which exist in primary care. GPs need additional support to develop clinical academic careers alongside their clinical practice.

Nurses, midwives and allied health professionals (AHPs) interested in a diabetes research career face their own challenges. There are few career incentives for nurses, midwives and AHPs to undertake a PhD, few opportunities post-PhD and no formally recognised or

standardised substantive posts with academic time built in.

Academic trainees are strongly supported by the Royal Colleges. Too few job opportunities in academia exist post-training, however, and there are no clear pathways to transition into academia. Most researchers from training academic posts return to service delivery posts after their post finishes.

A 2019 KPMG report⁶⁴ on the impact and value of the NIHR Clinical Research Network noted concerns from stakeholders about the ability of research staff to handle the existing volume of work. An RCPCH workforce survey in 2015⁶⁵ found that the number of academic paediatricians recorded in the RCPCH workforce census has decreased year on year; and 80% of paediatric consultants have no research-associated professional activities (PAs).

Methodologists, such as data scientists and qualitative researchers, do not have a clear career structure or pathway. Salaries and job security are

poor, often involving short-term contracts. These experts may decide to leave academia for industry roles.

We need specific funding schemes for people with knowledge of the interface of statistics, epidemiology, computer programming and diabetes research. At present there are no long-term diabetes-specific career opportunities for individuals with methodological expertise.

The UK has huge potential to tap into large-scale electronic health records. These provide a great opportunity to improve understanding of the pathogenesis of diabetes and its prevention. The many diabetes databases and data sources across the UK are constantly being augmented with new data (such as patient reported outcome measures). We need to harness expertise to interrogate the data we already have available.

This requires teams of people with high-end data and statistical programming skills, working alongside diabetes clinical staff.

It is difficult to find and retain people with these rare data skills. Private sector employers offer higher salaries and greater job security. Universities have rigid pay scales, and often link promotion to management roles rather than specialised skills, which makes it more difficult to retain skilled people.

Research leaders express concern that fewer junior doctors are entering diabetes and endocrinology as a speciality so there is a smaller pool of individuals available to enter research. We need to raise the profile of diabetes prevention and management earlier in medical school and 'market' the speciality to students. We should emphasise the

breadth and interdisciplinary nature of the diabetes research community, to encourage more people to enter this field.

Limited research training is provided as part of the clinical career pathway. The Academy of Medical Sciences report 2020⁶⁶ shows that the number of clinical academic medical and GP roles have consistently declined since 2004.

The NHS could do more to demonstrate its commitment to medical research. NHS contracts require medical staff to prioritise clinical service, limiting time available for research. The portfolio data show there are few diabetes trials (except those funded by pharmaceutical companies) and even fewer diabetes specific trialists.

PRIORITIES OF PEOPLE LIVING WITH DIABETES

The opportunities we highlight are reflected in the following priorities of people living with diabetes, as identified through James Lind Priority-Setting Partnerships and the Diabetes Research Steering Groups:

- Bring together existing data for use in research and support other researchers and organisations to contribute their information towards our common goals.

OPPORTUNITIES AND RECOMMENDATIONS

RAISE THE PROFILE OF DIABETES RESEARCH:

- Disseminate the impact and benefit to the health service from diabetes research
- Work with medical schools through the Medical School Council for better diabetes education to be included in undergraduate medical degrees.

ENSURE DIVERSITY AND INCLUSION IN DIABETES RESEARCH FUNDING:

- Tackle and understand barriers to participation in research, by capturing equality, diversity, caring responsibility and inclusion data in funding applications, as modelled by the Wellcome Trust⁶⁷
- Consider the diversity of career pathways and offer flexible fellowship eligibility criteria which are not time-based, as modelled by the MRC and Wellcome Trust

- Consider the provision of career re-entry fellowships to support those who have left science and wish to return
- Encourage applicants to share how the pandemic or other life circumstances may have affected their career and/or productivity and take this into account when making funding decisions, as outlined by the cross-funder statement on Covid-19 in future grant applications.

CREATE A SUSTAINABLE TRAJECTORY OF PERSONAL SUPPORT FOR DIABETES RESEARCH:

- Partner with industry to fund early and mid-career researchers
- Consider the introduction of discipline-hopping grants, which enable established engineers or physical scientists and other cross-disciplines to work in diabetes biological, clinical or population health research
- Funders recommended to work with NHS Trusts and integrated care systems across England, Scotland, Northern Ireland and Wales to create substantive posts that follow on from fellowships and which have academic and clinical time built in
- The NHS and NIHR recommended to continue supporting integrated career pathways, with NIHR and devolved nation funders leading on supporting the development

of clinical academic roles and the NHS and the integration of these roles in the NHS

- Diabetes clinical training pathways must support those wishing to undertake research by making research a part of a consultant's job plan with equal priority to teaching and management activity and they should be linked into larger teams and national initiatives.

CREATE AN INTERDISCIPLINARY RESEARCH ENVIRONMENT:

- Ensure that nurses, midwives, allied health professionals and wider care professionals are supported to develop academic careers
- Recognise that primary care academics and social scientists have a broad spectrum of expertise and encourage these experts to bring their broad skills into diabetes research.
- Develop specific funding schemes for people with knowledge of the interface of statistics, epidemiology, computer programming, primary care and diabetes research
- Develop specific funding schemes for people with qualitative, mixed methods and health/clinical psychology expertise
- Diabetes funders and industry recommended to work collectively to provide

sponsorship for placements/secondments to learn more about clinical trial design and methodology. A 2007 Academy of Medical Sciences report⁶⁸ on promoting mobility between academia and industry highlights the importance of fostering interactions between academia and industry.

FACILITATE NETWORKING AND MENTORSHIP:

- Senior researchers recommended to make time to be a mentor and should explore opportunities to mentor outside of their discipline
- All researchers recommended to act as a representative of opportunities available, highlighting fellowship opportunities and contributing to research development of others in the local area.

COMMITMENTS

This strategy highlights the breadth of opportunity to make changes for people with and at risk of diabetes through research and beyond. The funders who contributed their data to the portfolio analysis recognise the transformation in diabetes care that has been possible thanks to their collective efforts.

NIHR and Diabetes UK commit to working together to stimulate research in the areas of unmet need identified through this process and commit to working with the NHS to highlight the recommendations of relevance to the health and care system. We call on the research community and funders to consider these recommendations and work collaboratively to develop innovative and high-quality funding applications that address these areas of opportunity, through existing funding schemes and any future funding that may become available.

Diabetes UK and the NIHR have already started to drive forward a number of recommendations from this strategy and make an ongoing commitment to work together, and with other funders to address these areas of priority:

- In 2022 Diabetes UK held a workshop focused on addressing health inequalities in diabetes. Chaired by Professor Kamlesh Khunti, the workshop focused on developing relevant areas of research.
- In 2022 Diabetes UK and NIHR's Programme Grants for Applied Research (PGfAR)

programme partnered to open a joint call for programmes of applied research which aim to better support people with diabetes distress.

- In 2022 Diabetes UK and NIHR's Health and Social Care Delivery Research (HS&DR) programme hosted a joint webinar to encourage diabetes experts to collaborate with health services researchers to design research focused on improving health and social care services and has opened a joint call for proposals which look to address the challenges of delivering integrated services to support the mental health of people living with diabetes and those that look to understand how care can be improved to help people manage their diabetes as they get older.
- In 2022 Diabetes UK announced a £50m partnership with the Steve Morgan Foundation and Juvenile Diabetes Research Foundation UK (JDRF) which aims to transform type 1 diabetes research, search for better treatments and discover a cure. The new treatments resulting

from this research will enter the clinical and applied research phase in due course.

- In 2023 Diabetes UK, in collaboration with the Royal College of Obstetricians and Gynaecologists (RCOG) Diabetes in Pregnancy working group, will work together to stimulate research in gestational diabetes.
- From 2023 Diabetes UK will be collecting diversity and inclusion data on all applications in line with guidance from the Wellcome Trust to help understand, and ultimately address, any barriers in the application process. NIHR is committed to supporting increased equality, diversity and inclusion and now publishes data on applicants⁶⁹.

Following the launch of this strategy Diabetes UK and NIHR will seek to work actively with the diabetes community to establish how best to move these important recommendations forward and regularly analyse the portfolio to review progress.



REFERENCES

1. Carr, M.J., et al., *Impact of COVID-19 restrictions on diabetes health checks and prescribing for people with type 2 diabetes: a UK-wide cohort study involving 618 161 people in primary care*. *BMJ Quality & Safety*, 2022. 31(7): p. 503.
2. Dafne Study, G., *Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial*. *BMJ*, 2002. 325(7367): p. 746-746.
3. Feig, D.S., et al., *Continuous glucose monitoring in pregnant women with type 1 diabetes (CONCEPTT): a multicentre international randomised controlled trial*. *The Lancet*, 2017. 390(10110): p. 2347-2359.
4. Murphy, H.R., et al., *Modelling potential cost savings from use of real-time continuous glucose monitoring in pregnant women with Type 1 diabetes*. *Diabet Med*, 2019. 36(12): p. 1652-1658.
5. Davies, M.J., et al., *Effectiveness of the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial*. *BMJ*, 2008. 336(7642): p. 491-495.
6. NICE, *Type 2 diabetes in adults: management, in NICE guideline [NG28]*. 2022.
7. NHS Digital. *Health Survey for England 2019. 2020*; Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2019>.
8. Public Health England. *Diabetes prevalence estimates for local populations*. 2015; Available from: <https://www.gov.uk/government/publications/diabetes-prevalence-estimates-for-local-populations>.
9. Ma, R.C.W. and P.C.Y. Tong, *Epidemiology of Type 2 Diabetes, in Textbook of Diabetes*. 2010. p. 45-68.
10. Conger, S.A., et al., *Time Trends in Physical Activity Using Wearable Devices: A Systematic Review and Meta-analysis of Studies from 1995 to 2017*. *Med Sci Sports Exerc*, 2022. 54(2): p. 288-298.
11. Lee, I.M., et al., *Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy*. *The Lancet*, 2012. 380(9838): p. 219-229.
12. NHS Digital. *Statistics on Obesity, Physical Activity and Diet*. 2018; Available from: <https://files.digital.nhs.uk/publication/0/0/obes-phys-acti-diet-eng-2018-rep.pdf>.
13. NHS Digital. *National Child Measurement Programme*. 2021; Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-child-measurement-programme/2020-21-school-year>.
14. Stensel, D.J., A.E. Hardman, and J.M.R. Gill, *Physical Activity and Health: The Evidence Explained*. 2021: Taylor & Francis.
15. Tommerdahl, K.L., et al., *Early microvascular complications in type 1 and type 2 diabetes: recent developments and updates*. *Pediatr Nephrol*, 2022. 37(1): p. 79-93.
16. Lindström, J., et al., *The Finnish Diabetes Prevention Study (DPS): Lifestyle intervention and 3-year results on diet and physical activity*. *Diabetes Care*, 2003. 26(12): p. 3230-6.
17. Public Health England. *Executive summary: learning from local authorities with downward trends in childhood obesity*. 2021; Available from: <https://www.gov.uk/government/publications/national-child-measurement-programme-childhood-obesity/executive-summary-learning-from-local-authorities-with-downward-trends-in-childhood-obesity>.
18. Valabhji, J., et al., *Early Outcomes From the English National Health Service Diabetes Prevention Programme*. *Diabetes Care*, 2020. 43(1): p. 152-160.
19. Kyrou, I., et al., *Sociodemographic and lifestyle-related risk factors for identifying vulnerable groups for type 2 diabetes: a narrative review with emphasis on data from Europe*. *BMC Endocrine Disorders*, 2020. 20(1): p. 134.
20. NIHR. *How can local authorities reduce obesity? Insights from NIHR research*. 2022; Available from: <https://evidence.nihr.ac.uk/how-local-authorities-can-reduce-obesity/#introduction>.
21. Nuffield Department of Primary Care Health Sciences. *The top 10 questions for obesity and weight research*. 2021; Available from: <https://www.phc.ox.ac.uk/research/participate/power/power-priorities-in-obesity-and-weight-related-research-results>.
22. Hanif, W., et al., *Type 2 diabetes in the UK South Asian population*. 2014.
23. Tillin, T., et al., *Insulin resistance and truncal obesity as important determinants of the greater incidence of diabetes in Indian Asians and African Caribbeans compared with Europeans: the Southall And Brent REvisited (SABRE) cohort*. *Diabetes Care*, 2013. 36(2): p. 383-93.
24. Chong, Y.-S., et al., *Ethnic differences translate to inadequacy of high-risk screening for gestational diabetes mellitus in an Asian population: a cohort study*. *BMC Pregnancy and Childbirth*, 2014. 14(1): p. 345.
25. Chen, L.-W., et al., *Combined analysis of gestational diabetes and maternal weight status from pre-pregnancy through post-delivery in future development of type 2 diabetes*. *Scientific Reports*, 2021. 11(1): p. 5021.
26. Bellamy, L., et al., *Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis*. *The Lancet*, 2009. 373(9677): p. 1773-1779.
27. Dalrymple, K.V., S. El-Heis, and K.M. Godfrey, *Maternal weight and gestational diabetes impacts on child health*. *Current Opinion in Clinical Nutrition & Metabolic Care*, 2022. 25(3).
28. Chu, S.Y., et al., *Maternal Obesity and Risk of Gestational Diabetes Mellitus*. *Diabetes Care*, 2007. 30(8): p. 2070-2076.
29. Godfrey, K.M., et al., *Myo-Inositol, Probiotics, and Micronutrient Supplementation From Preconception for Glycemia in Pregnancy: NiPPeR International Multicenter Double-Blind Randomized Controlled Trial*. *Diabetes Care*, 2021. 44(5): p. 1091-1099.
30. Saravanan, P., *Gestational diabetes: opportunities for improving maternal and child health*. *Lancet Diabetes Endocrinol*, 2020. 8(9): p. 793-800.
31. Ayman, G., et al., *The top 10 research priorities in diabetes and pregnancy according to women, support networks and healthcare professionals*. *Diabetic Medicine*, 2021. 38(8): p. e14588.
32. Antoun, E., et al., *Maternal dysglycaemia, changes in the infant's epigenome modified with a diet and physical activity intervention in pregnancy: Secondary analysis of a randomised control trial*. *PLOS Medicine*, 2020. 17(11): p. e1003229.
33. Tennant, P.W.G., et al., *Fasting plasma glucose, diagnosis of gestational diabetes and the risk of large for gestational age: a regression discontinuity analysis of routine data*. *BJOG: An International Journal of Obstetrics & Gynaecology*, 2022. 129(1): p. 82-89.
34. Lamain-de Ruyter, M., et al., *External validation of prognostic models to predict risk of gestational diabetes mellitus in one Dutch cohort: prospective multicentre cohort study*. *BMJ*, 2016. 354: p. i4338.
35. Department of Health and Social Care. *Women's Health Strategy for England*. 2022; Available from: <https://www.gov.uk/government/publications/womens-health-strategy-for-england/womens-health-strategy-for-england#research-and-evidence-1>.
36. The Academy of Medical Sciences. *Multimorbidity: a priority for global health research*. 2018; Available from: <https://acmedsci.ac.uk/file-download/82222577>.
37. NHS England. *Enhancing the Quality of Life for People Living with Long Term Conditions*. 2018; Available from: <https://acmedsci.ac.uk/file-download/82222577>.
38. Zghebi, S.S., et al., *Eleven-year multimorbidity burden among 637 255 people with and without type 2 diabetes: a population-based study using primary care and linked hospitalisation data*. *BMJ Open*, 2020. 10(7): p. e033866.
39. Younossi, Z.M., et al., *The global epidemiology of NAFLD and NASH in patients with type 2 diabetes: A systematic review and meta-analysis*. *Journal of Hepatology*, 2019. 71(4): p. 793-801.
40. Fisher, L., et al., *Diabetes distress in adults with type 1 diabetes: Prevalence, incidence and change over time*. *J Diabetes Complications*, 2016. 30(6): p. 1123-8.
41. Perrin, N.E., et al., *The prevalence of diabetes-specific emotional distress in people with Type 2 diabetes: a systematic review and meta-analysis*. *Diabet Med*, 2017. 34(11): p. 1508-1520.
42. Stokes, J., et al., *Multimorbidity combinations, costs of hospital care and potentially preventable emergency admissions in England: A cohort study*. *PLOS Medicine*, 2021. 18(1): p. e1003514.
43. Wang, L., et al., *A Systematic Review of Cost-of-Illness Studies of Multimorbidity*. *Appl Health Econ Health Policy*, 2018. 16(1): p. 15-29.

44. NHS Digital. *National Diabetes Inpatient Audit (NaDIA)* - 2019. 2020; Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-inpatient-audit/2019>.

45. James Lind Alliance. *Multiple Conditions in Later Life*. 2018; Available from: <https://www.jla.nihr.ac.uk/priority-setting-partnerships/health-with-multiple-conditions-in-old-age/>.

46. James Lind Alliance. *Safe Care for Adults with Complex Health Needs*. 2019; Available from: <https://www.jla.nihr.ac.uk/priority-setting-partnerships/safe-care-for-adults-with-complex-health-needs/>.

47. Fineout-Overholt, E., B.M. Melnyk, and A. Schultz. *Transforming health care from the inside out: advancing evidence-based practice in the 21st century*. J Prof Nurs, 2005. 21(6): p. 335-44.

48. Morris, Z.S., S. Wooding, and J. Grant. *The answer is 17 years, what is the question: understanding time lags in translational research*. J R Soc Med, 2011. 104(12): p. 510-20.

49. Cooksey, S.D. *A review of UK health research funding*. 2006; Available from: <https://www.gov.uk/government/publications/a-review-of-uk-health-research-funding>.

50. Walsh, M., *Perceptions of barriers to implementing research*. Nurs Stand, 1997. 11(19): p. 34-7.

51. Suleman, M., et al., *Unequal pandemic, fairer recovery: The COVID-19 impact inquiry report*. The Health Foundation, 2021.

52. ONS. *Updating ethnic contrasts in deaths involving the coronavirus (COVID-19), England: 24 January 2020 to 31 March 2021*. 2021; Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/articles/>.

53. NHS Digital. *National Child Measurement Programme, England 2020/21 School Year*. 2021; Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-child-measurement-programme/2020-21-school-year>.

54. Khunti, K., et al., *Promoting physical activity in a multi-ethnic population at high risk of diabetes: the 48-month PROPELS randomised controlled trial*. BMC Medicine, 2021. 19(1): p. 130.

55. Bodicoat, D.H., et al., *Promoting inclusion in clinical trials—a rapid review of the literature and recommendations for action*. Trials, 2021. 22(1): p. 880.

56. NIHR. *Improving inclusion of under-served groups in clinical research: Guidance from INCLUDE project*. 2020; Available from: <https://www.nihr.ac.uk/documents/improving-inclusion-of-under-served-groups-in-clinical-research-guidance-from-include-project/25435>.

57. Advance HE. *Athena Swan Charter*. 2022; Available from: <https://www.advance-he.ac.uk/equality-charters/athena-swan-charter>.

58. UK Clinical Research Collaboration. *UK Health Research Analysis 2018*. 2018; Available from: <https://hrcsonline.net/wp-content/uploads/2020/01/UK-Health-Research-Analysis-2018-for-web-v1-28Jan2020.pdf>.

59. UKRI. *Biomedical research roles and career pathways*. 2022; Available from: <https://www.ukri.org/what-we-offer/developing-people-and-skills/mrc/biomedical-research-roles-and-career-pathways/>.

60. The Academy of Medical Sciences. *Mentoring*. 2022; Available from: <https://acmedsci.ac.uk/grants-and-schemes/mentoring-and-other-schemes/mentoring-programme>.

61. Diabetes UK. *IDia – innovators in diabetes*. 2022; Available from: <https://www.diabetes.org.uk/research/for-researchers/apply-for-a-grant/idia--innovators-in-diabetes>.

62. NIHR. *NIHR Leaders Support and Development Programme*. 2022; Available from: <https://www.nihr.ac.uk/explore-nihr/academy-programmes/nihr-leaders-support-and-development-programme>.

63. CATCH. *Clinical Academic Training and Careers Hub*. 2022; Available from: <https://www.catch.ac.uk/>.

64. KPMG. *Impact and value of the NIHR Clinical Research Network*. 2019; Available from: https://www.nihr.ac.uk/documents/partners-and-industry/NIHR_Impact_and_Value_report_ACCESSIBLE_VERSION.pdf.

65. RCPCH. *Participation in child health research - a survey of health professionals (2015)*. 2015; Available from: <https://www.rcpch.ac.uk/sites/default/files/generated-pdf/document/Participation-in-child-health-research---a-survey-of-health-professionals-%25282015%2529.pdf>.

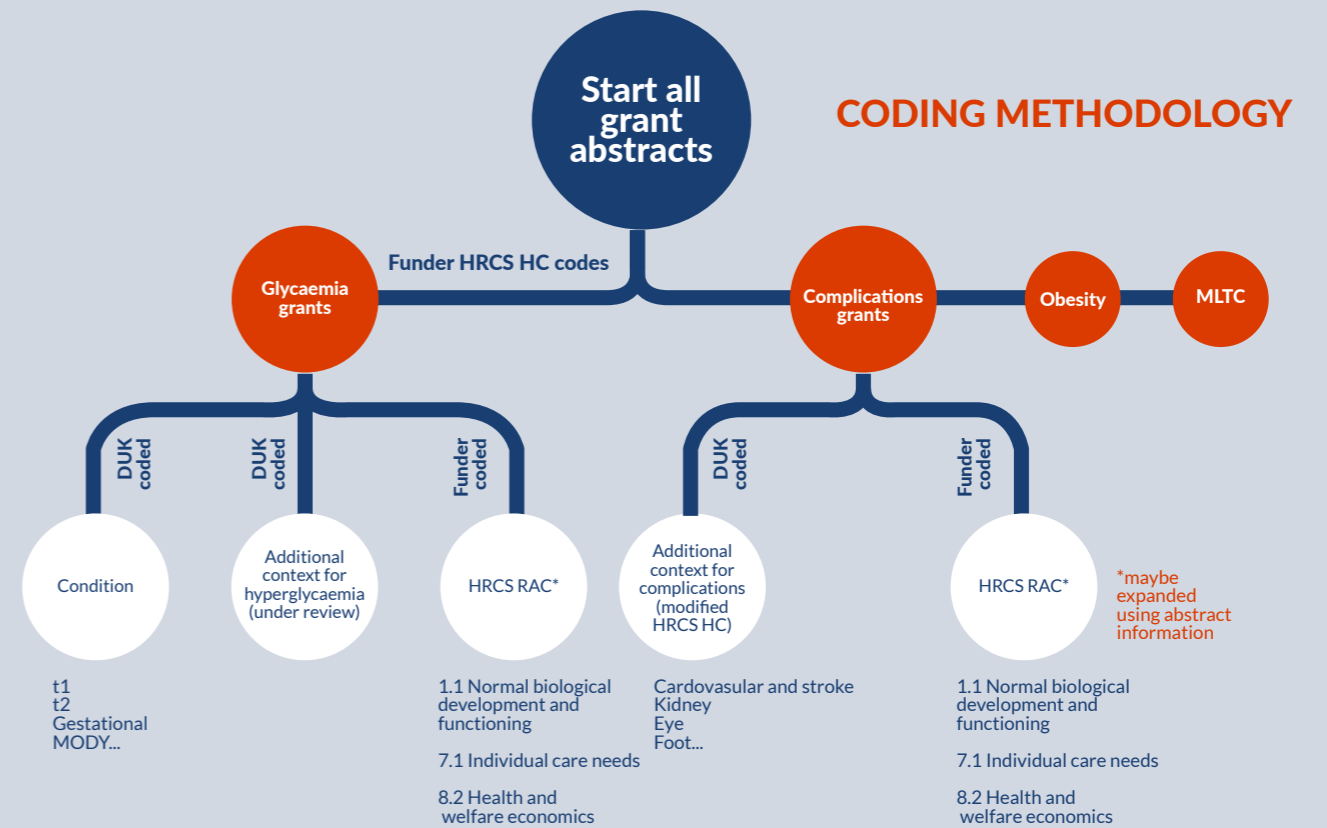
66. The Academy of Medical Sciences. *Transforming health through innovation: Integrating the NHS and academia*. 2020; Available from: <https://acmedsci.ac.uk/file-download/23932583>.

67. EDIS. *Diversity and Inclusion Survey (DAISY) Question Guidance*. 2022; Available from: <https://edisgroup.org/wp-content/uploads/2022/05/DAISY-guidance-current-updated-May-2022-V2.pdf>.

68. The Academy of Medical Sciences. *Research careers in the biomedical sciences: promoting mobility between academia and industry*. 2007; Available from: <https://acmedsci.ac.uk/viewFile/publicationDownloads/Careersi.pdf>.

69. NIHR. *Promoting equality, diversity and inclusion in research*. 2022; Available from: <https://www.nihr.ac.uk/about-us/our-key-priorities/equality-diversity-and-inclusion/>.

APPENDIX 1:
Portfolio analysis (2014-19):
Methodology and data



- Funders provided grants active between 1 January 2014-31 December 2019
- Not all grants had data on spend
- Funders were not specifically asked to provide obesity or MLTC data so those included were captured due to their diabetes coding and could be underestimated
- Some grants submitted were judged to be infrastructure spending (e.g., institutional quinquennial reviews) and excluded unless otherwise stated. These can be found in Appendix 2
- All Spend/Investment in figures is measured in millions of pounds unless otherwise stated

APPENDIX 2:

[NIHR] Infrastructure by region noting the number of diabetes-related projects in 2018/19 i.e., active anytime between 1 April 2018 and 31 March 2019.

● Clinical Research Network (CRN) has a Diabetes Specialty Group. The CRN provides researchers with the practical support they need to make research happen. It supports the set up and delivery of clinical research in the NHS and in other health and care settings through our Study Support Service, with tailored offers of support for:

- non-commercial organisations
- the life sciences industry

EAST MIDLANDS

20 NIHR LEICESTER BRC
Cardiovascular; Lifestyle;

8 NIHR NOTTINGHAM BRC
GI & Liver; Musculoskeletal Diseases

7 NIHR LEICESTER CRF

19 NIHR NOTTINGHAM CRF

18 NIHR CLAHRC EAST MIDLANDS
Caring for Older People and Stroke Survivors;
Managing Chronic Disease;
Preventing Chronic Disease;

EAST OF ENGLAND

37 NIHR CAMBRIDGE BRC
Cardiovascular and Respiratory;
Metabolism, Endocrinology and Bone;
Mental Health;
Nutrition, Diet and Lifestyle;
Transplantation and Regenerative Medicine;
Women's Health;

24 NIHR WELLCOME TRUST CAMBRIDGE CRF

0 NIHR CLAHRC EAST OF ENGLAND

GREATER MANCHESTER

4 NIHR MANCHESTER BRC
Cancer: Prevention & Early Detection;
Dermatology;

12 NIHR WELLCOME TRUST MANCHESTER CRF

0 NIHR CLAHRC GREATER MANCHESTER

0 NIHR GREATER MANCHESTER

NORTH EAST AND NORTH CUMBRIA

8 NIHR NEWCASTLE BRC
Ageing Syndromes;
Liver Disease

16 NIHR WELLCOME TRUST NEWCASTLE CRF

NORTH WEST COAST

2 NIHR ALDER HEY CRF

4 NIHR LANCASHIRE CRF

1 NIHR ROYAL LIVERPOOL AND BROADGREEN CRF

1 NIHR CLAHRC NORTH WEST COAST
Knowledge Exchange;

OXFORD AND THAMES VALLEY

38 NIHR OXFORD BRC
Cardiovascular;
Diabetes & Metabolism;
Genomic Medicine;
Imaging;
Obesity, Diet & Lifestyle;

0 NIHR OXFORD HEALTH BRC

0 NIHR OXFORD COGNITIVE HEALTH CRF

1 NIHR CLAHRC OXFORD AND THAMES VALLEY
Patient experience and patient reported outcomes;

SOUTH WEST PENINSULA

26 NIHR EXETER CRF

0 NIHR CLAHRC SOUTH WEST PENINSULA

WESSEX

7 NIHR CAMBRIDGE BRC
Behavioural Science;
Data Science;
Lifecourse Nutrition, Lifestyle and Health;

12 NIHR WELLCOME TRUST SOUTHAMPTON CRF

WEST

10 NIHR BRISTOL BRC
Cardiovascular disease;
Nutrition;
Reproductive and Perinatal Health;
Translational Population Science;

0 NIHR CLAHRC WEST

WEST MIDLANDS

2 NIHR BIRMINGHAM BRC
Entrepreneurship and Commercialisation;
Trial Design and Delivery;

20 NIHR WELLCOME TRUST BIRMINGHAM CRF

2 NIHR COVENTRY AND WARWICKSHIRE CRF

1 NIHR CLAHRC WEST MIDLANDS
Research Methods;

YORKSHIRE AND HUMBER

7 NIHR LEEDS CRF

4 NIHR SHEFFIELD CRF

0 NIHR LEEDS BRC
NIHR SHEFFIELD BRC

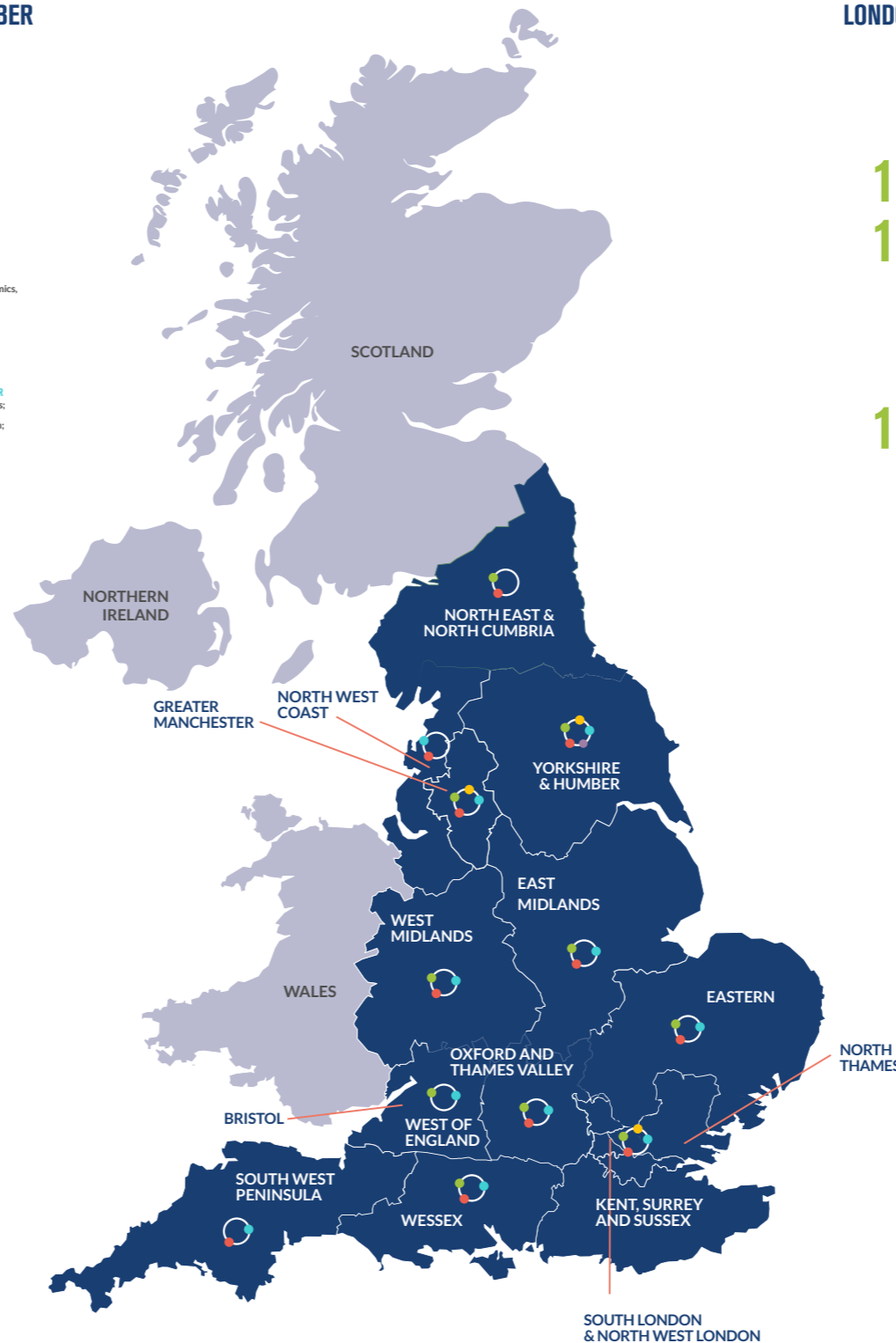
3 NIHR DEVICES FOR DIGNITY
MEDTECH CO-OPERATIVE MIC
Diabetes;

2 NIHR LEEDS IVD CO-OPERATIVE MIC
Health Informatics, Health Economics,
Multidisciplinary Pathology;
Infection;

1 NIHR LEEDS SURGICAL MIC
Vascular

7 NIHR CLAHRC YORKSHIRE AND HUMBER
Healthy Children, Healthy Families;
Mental Health and comorbidities;
Translating Knowledge into Action;

0 NIHR YORKSHIRE AND HUMBER PSTRC



LONDON

9 NIHR BARTS BRC
CV Inherited Disorders

2 NIHR GOSH BRC
Genomics and Systems Medicine;
Novel therapies for translation in
childhood diseases;

11 NIHR GUY'S AND ST THOMAS BRC
Infection and Immunity;
Women and Children's Health;

15 NIHR IMPERIAL BRC
Cancer;
Cardiovascular;
Immunology;
Metabolic Medicine & Endocrinology;
Surgery and Technology;

0 NIHR MARSDEN BRC

8 NIHR MAUDSLEY BRC
Affective Disorders & Interface with
Medicine;
Clinical & Population Informatics;
Neuroimaging;

10 NIHR MOORFIELDS BRC
Genomic Medicine and Informatics;
Inflammation and Immunotherapy;
Regenerative Medicine and Pharmaceuticals;
Visual Assessment and Imaging;

7 NIHR UCL BRC
Cardiovascular Diseases;
Healthcare Informatics & data science;
Neurological diseases;
Obesity;

0 NIHR IMPERIAL PSTRC

1 NIHR GREAT ORMOND STREET HOSPITAL CRF

14 NIHR GUY'S AND ST THOMAS' CRF

9 NIHR MOORFIELDS CRF

0 NIHR ROYAL MARSDEN CRF

15 NIHR WELLCOME TRUST IMPERIAL CRF

10 NIHR WELLCOME TRUST KING'S CRF

4 NIHR WELLCOME TRUST UCLH CRF

0 NIHR CLAHRC NORTHWEST LONDON

4 NIHR CLAHRC NORTH THAMES
Child and Adolescent Health;
Methodological Innovation;

6 NIHR CLAHRC SOUTH LONDON
Diabetes

NIHR Infrastructure by region



- BRC - Biomedical Research Centre
- CRF- Clinical Research Facility;
- MIC Medtech and In vitro diagnostic Co-operative;
- CLAHRC- Collaboration for Leadership in Applied Health Research and Care (*now Applied Research Collaboration);
- PSTRC- Patient Safety Translational Research Centre;
- CRN- Clinical Research Network

APPENDIX 3: ACKNOWLEDGEMENTS

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Professor Sarah Wild, University of Edinburgh
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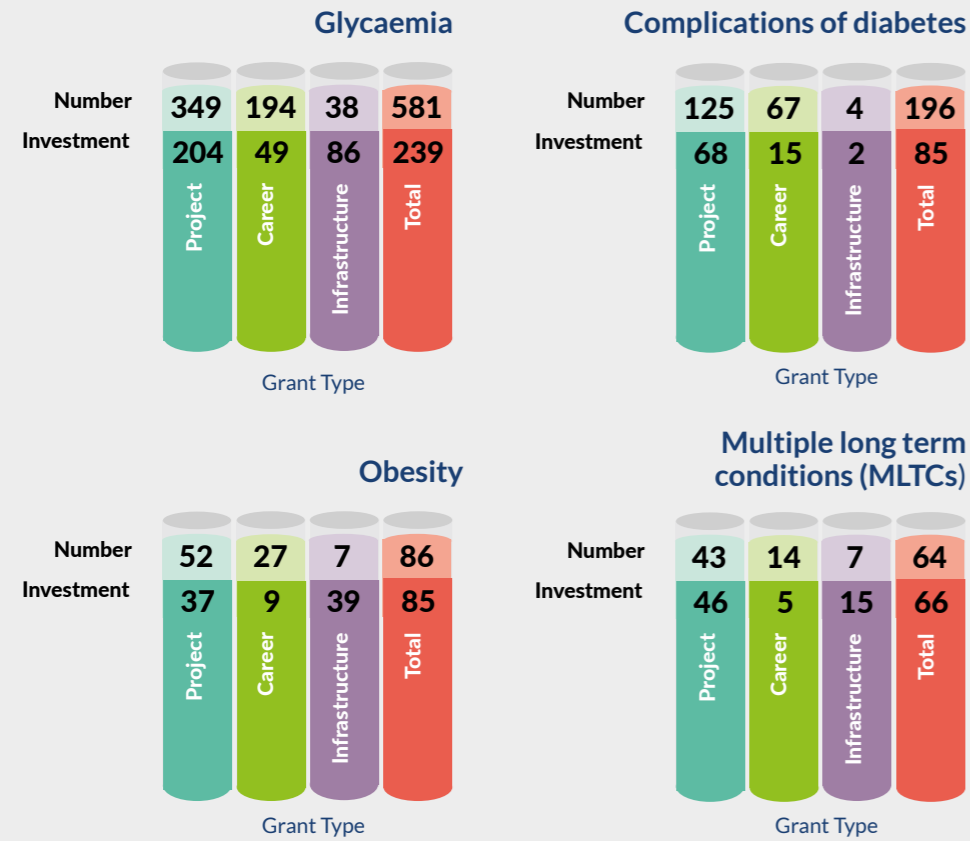
Members of the Diabetes Research Steering Groups
Attendees of the 2020 Diabetes UK/NIHR infrastructure meeting

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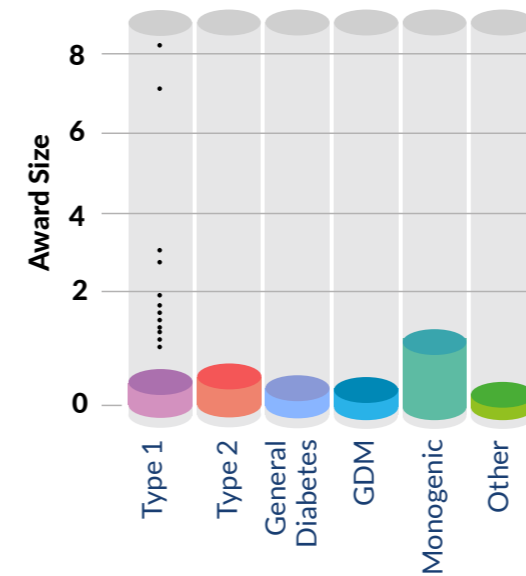
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JDRF UK
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National Institute for Health and Care Research
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APPENDIX 4: FULL PORTFOLIO REVIEW

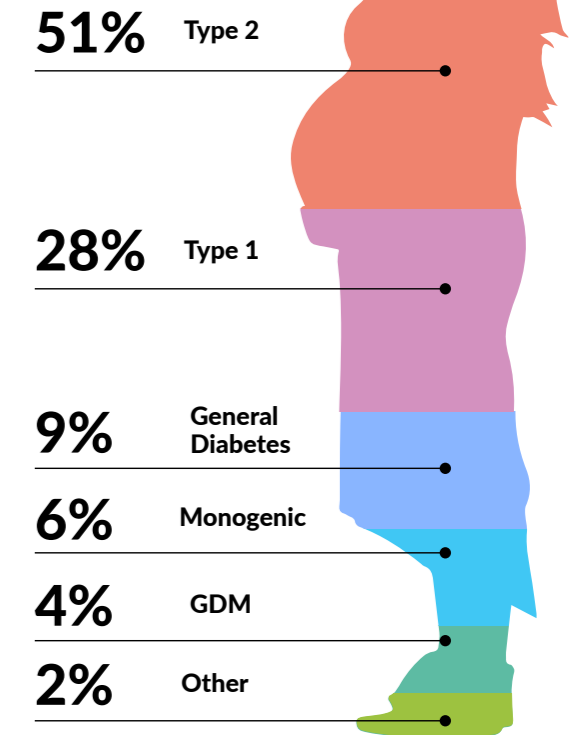
Total spend (£millions) and Number of Awards per Grant Category and Type



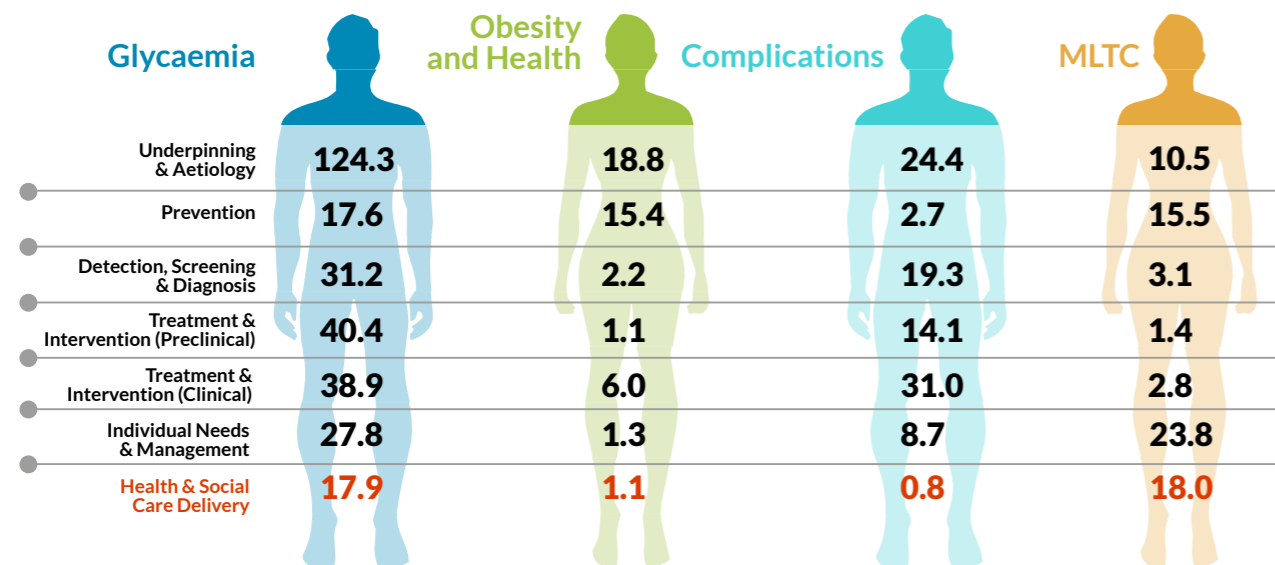
Relative Investment



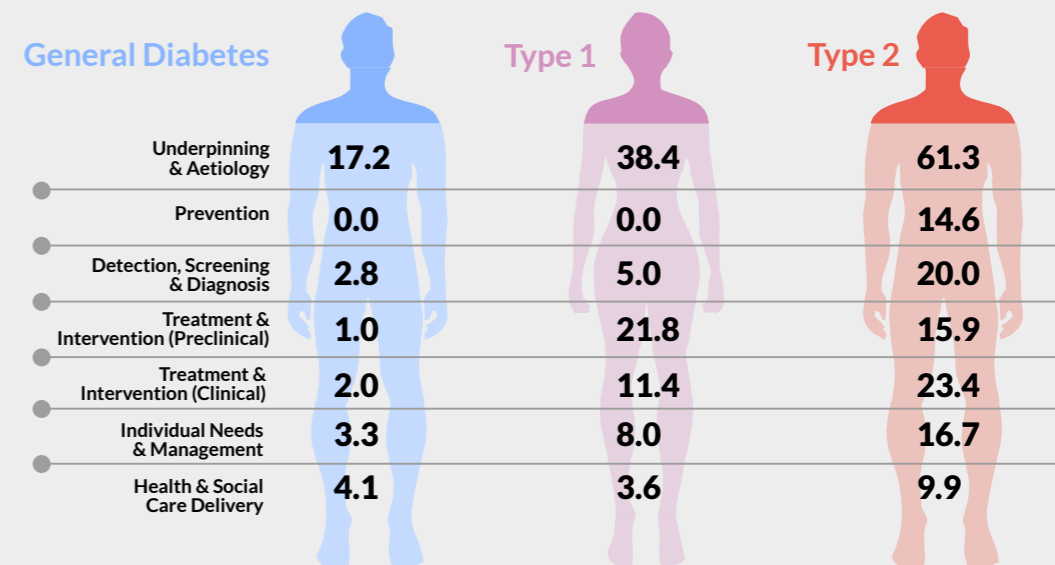
Average Award Size Between Conditions



Total Spend (£millions) per Grant Category by Area of Research

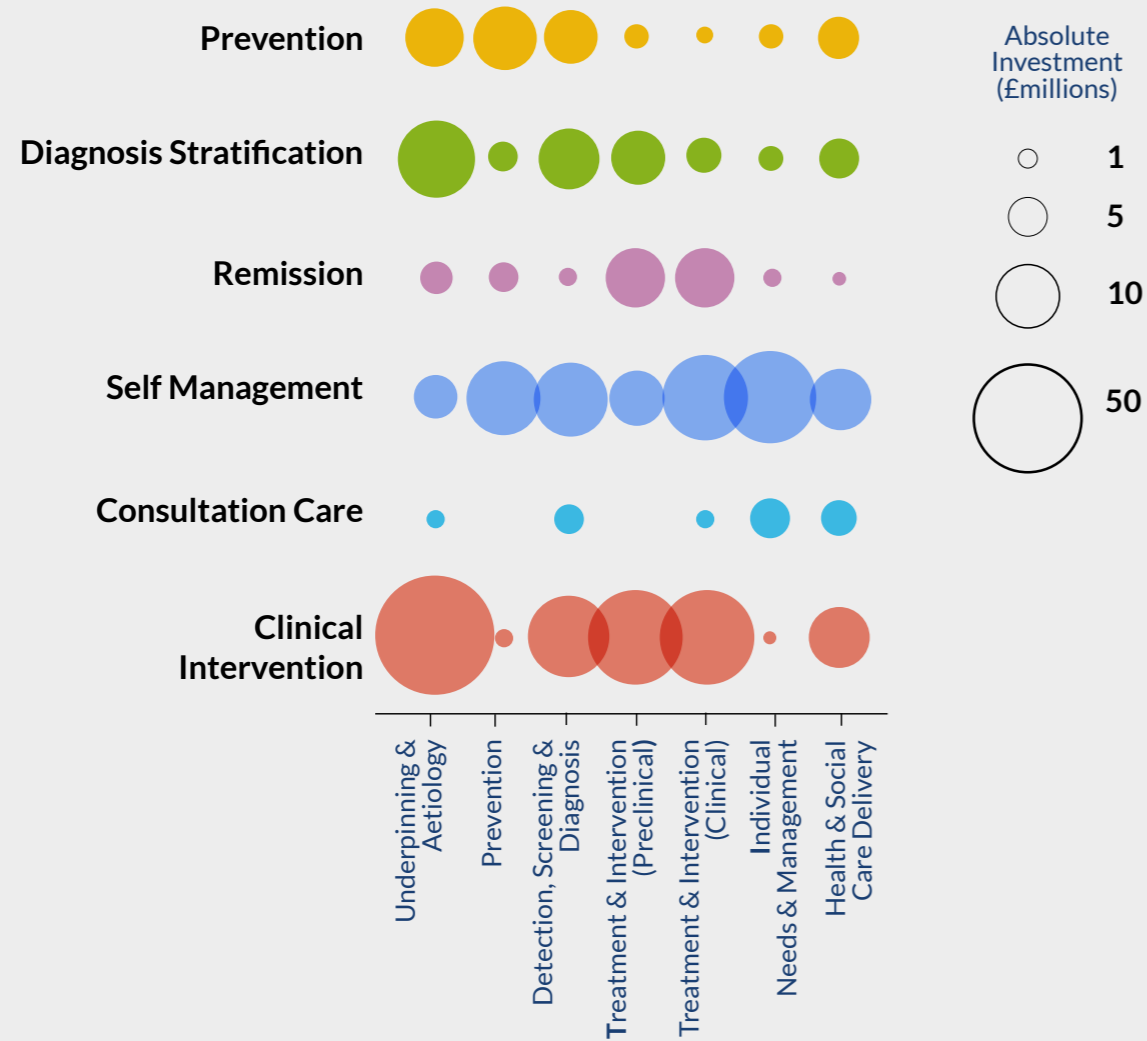


Investment (£millions) in Each Condition by Area of Research

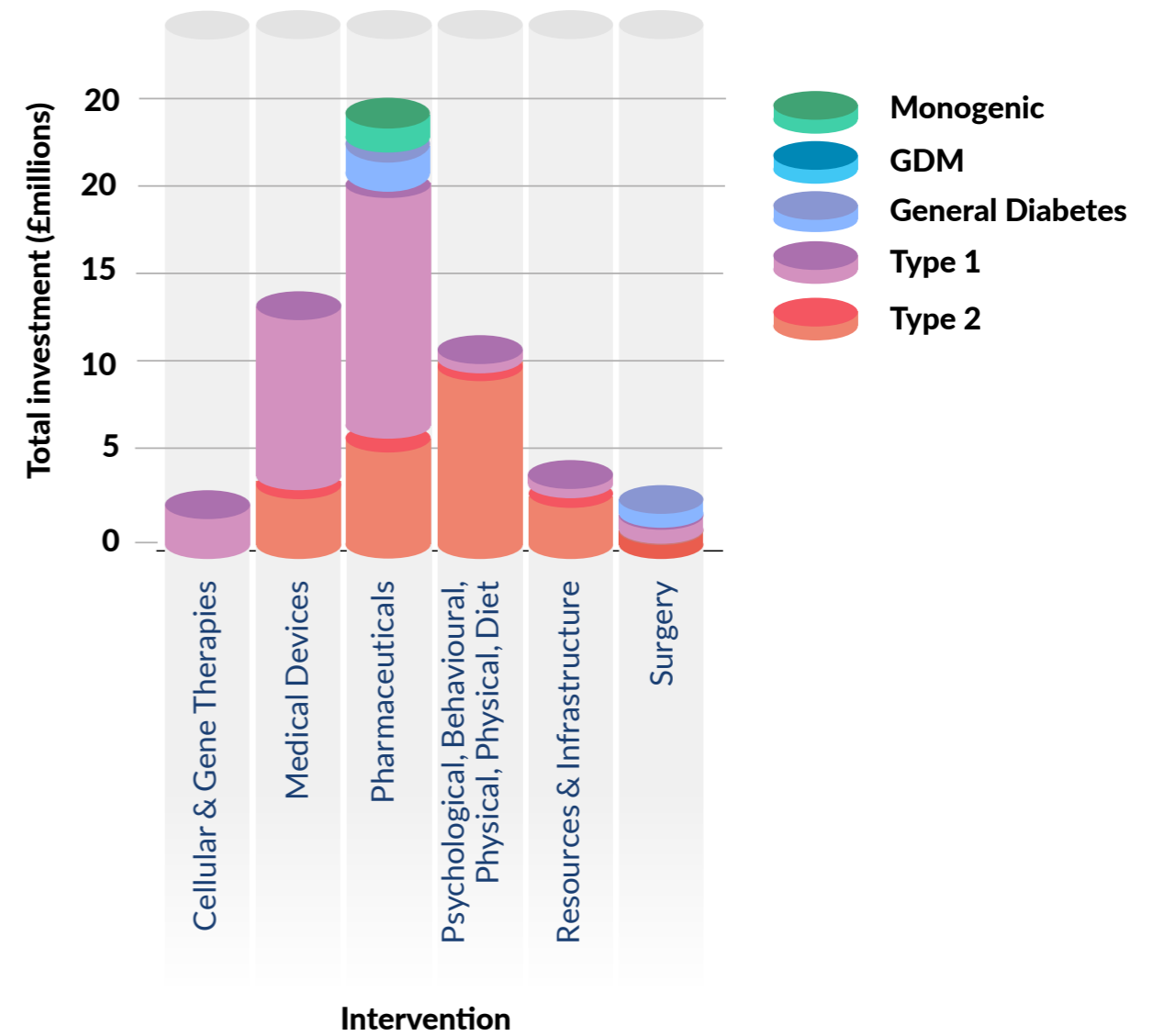


APPENDIX 4: FULL PORTFOLIO REVIEW

Investment (£millions) in Improving Clinical Experiences by Area Of Research

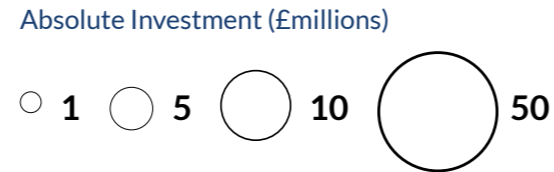


Spend (£millions) on Types of Intervention by Condition

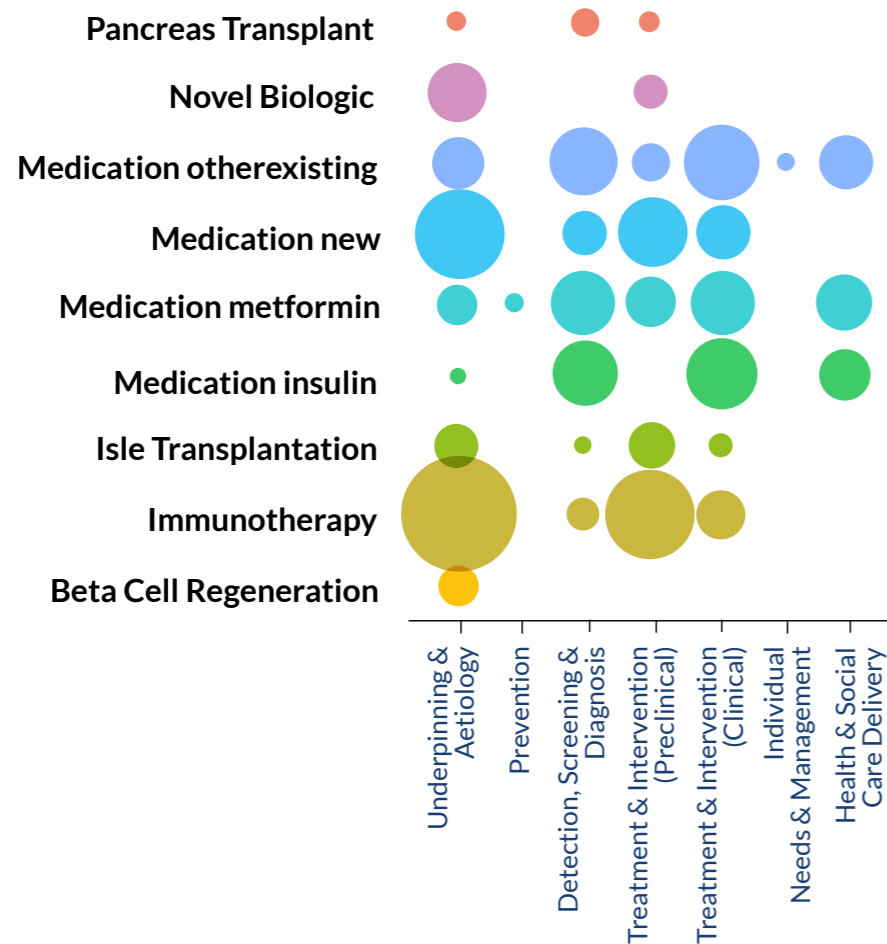


APPENDIX 4: FULL PORTFOLIO REVIEW

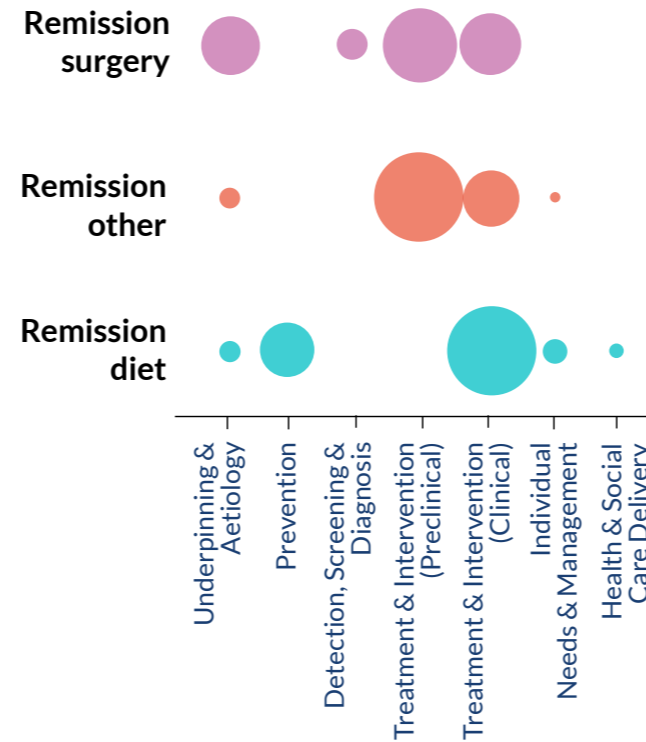
Further Breakdown on Investment in Key Clinical Experiences



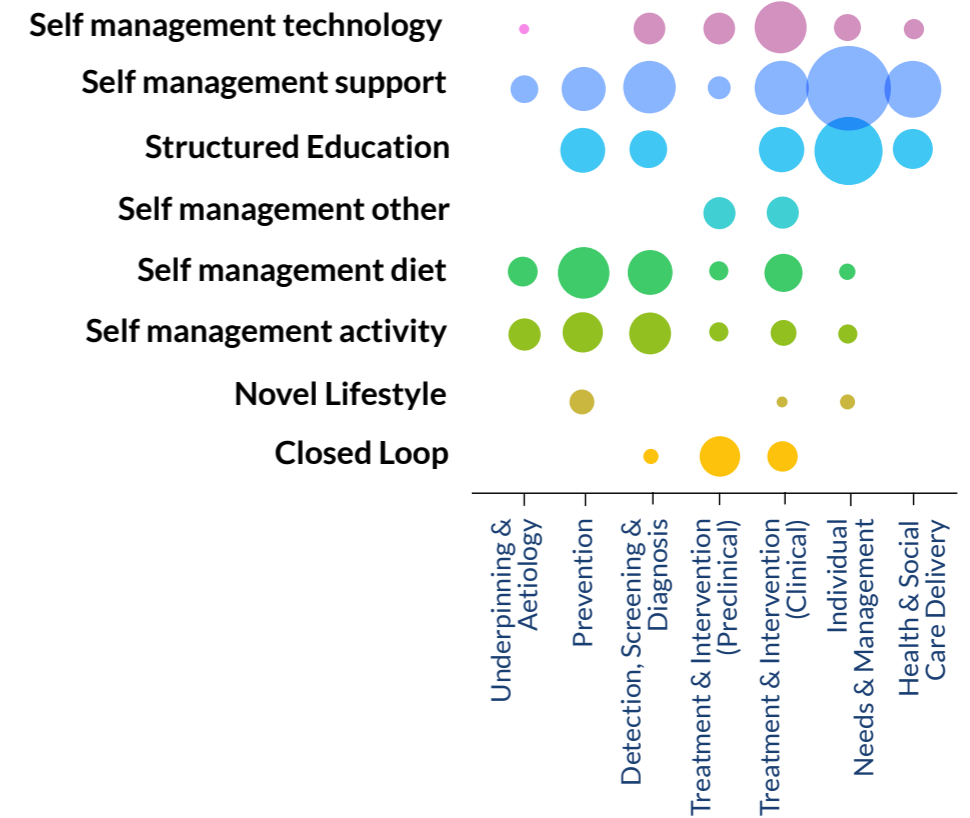
Clinical Interventions



Remission

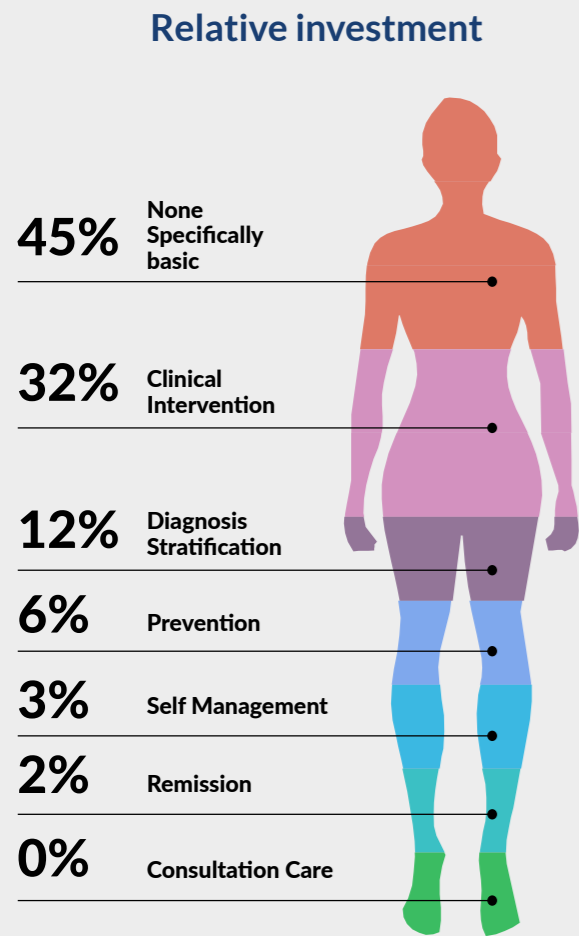


Self management

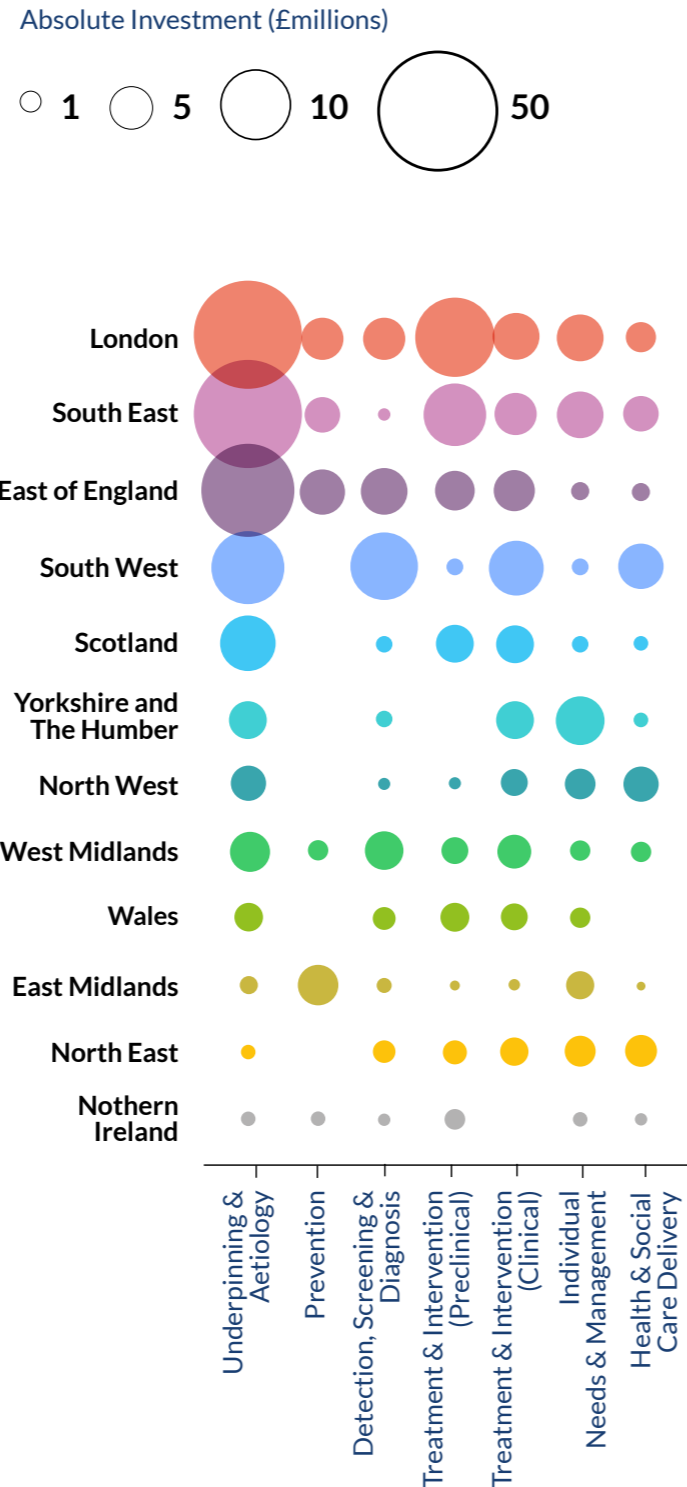


APPENDIX 4: FULL PORTFOLIO REVIEW

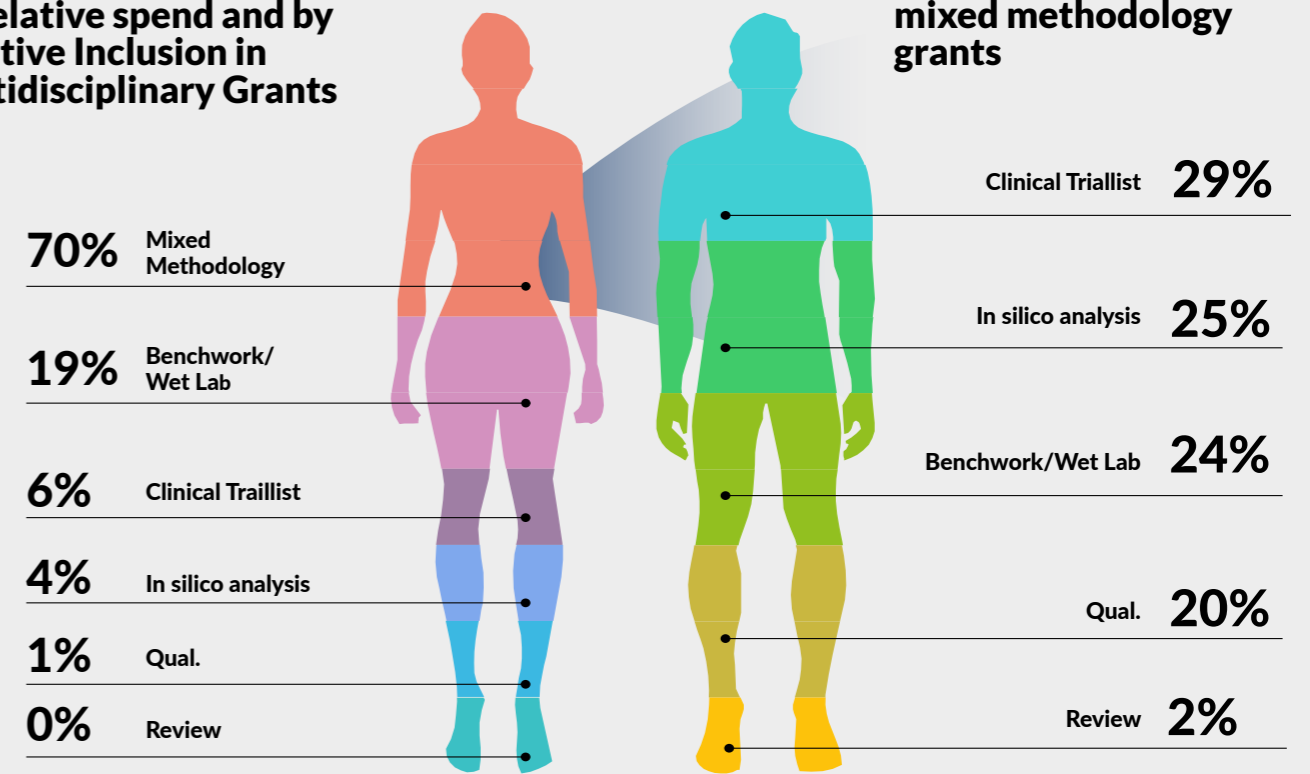
Clinical Experience Focus for Underpinning Research and Aetiology Grants



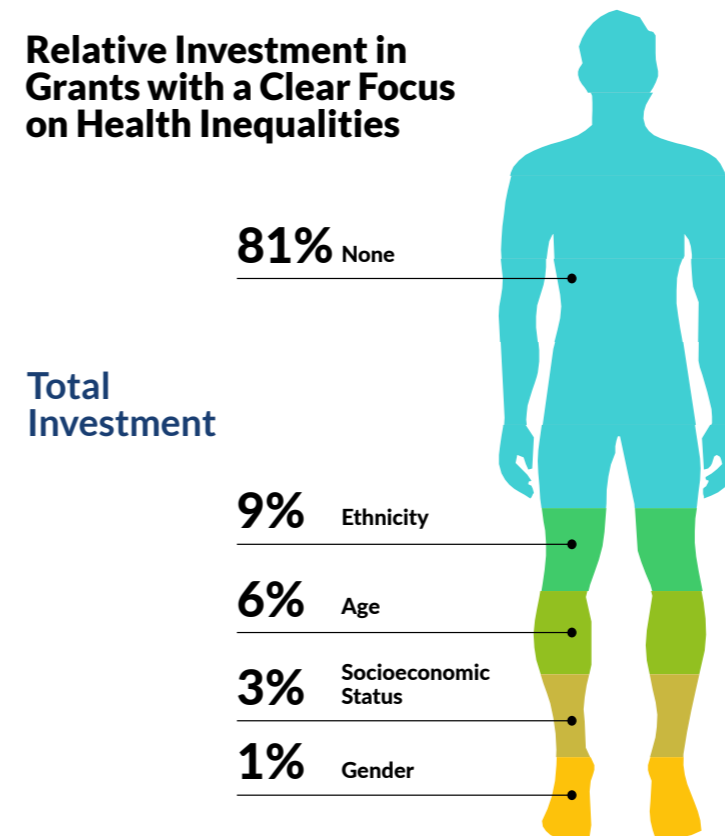
Area of Research Spend (£millions) for Each Region



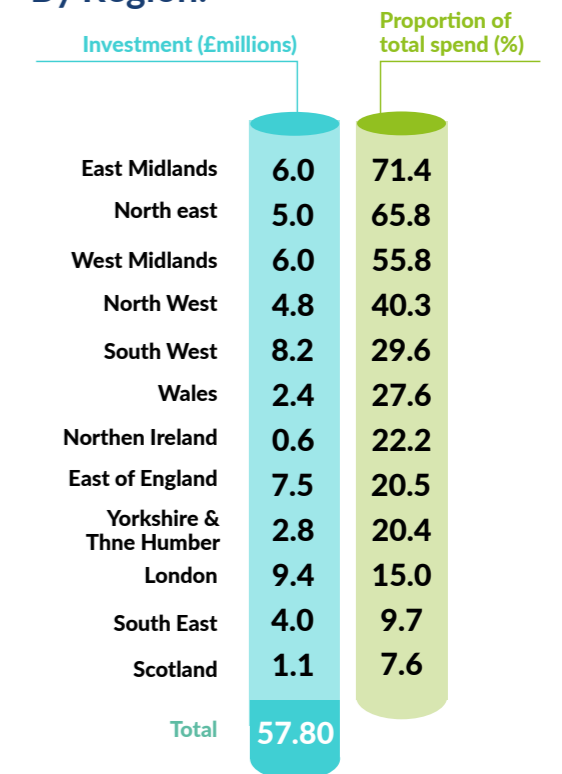
Methodologies in Grants by relative spend and by Relative Inclusion in Multidisciplinary Grants



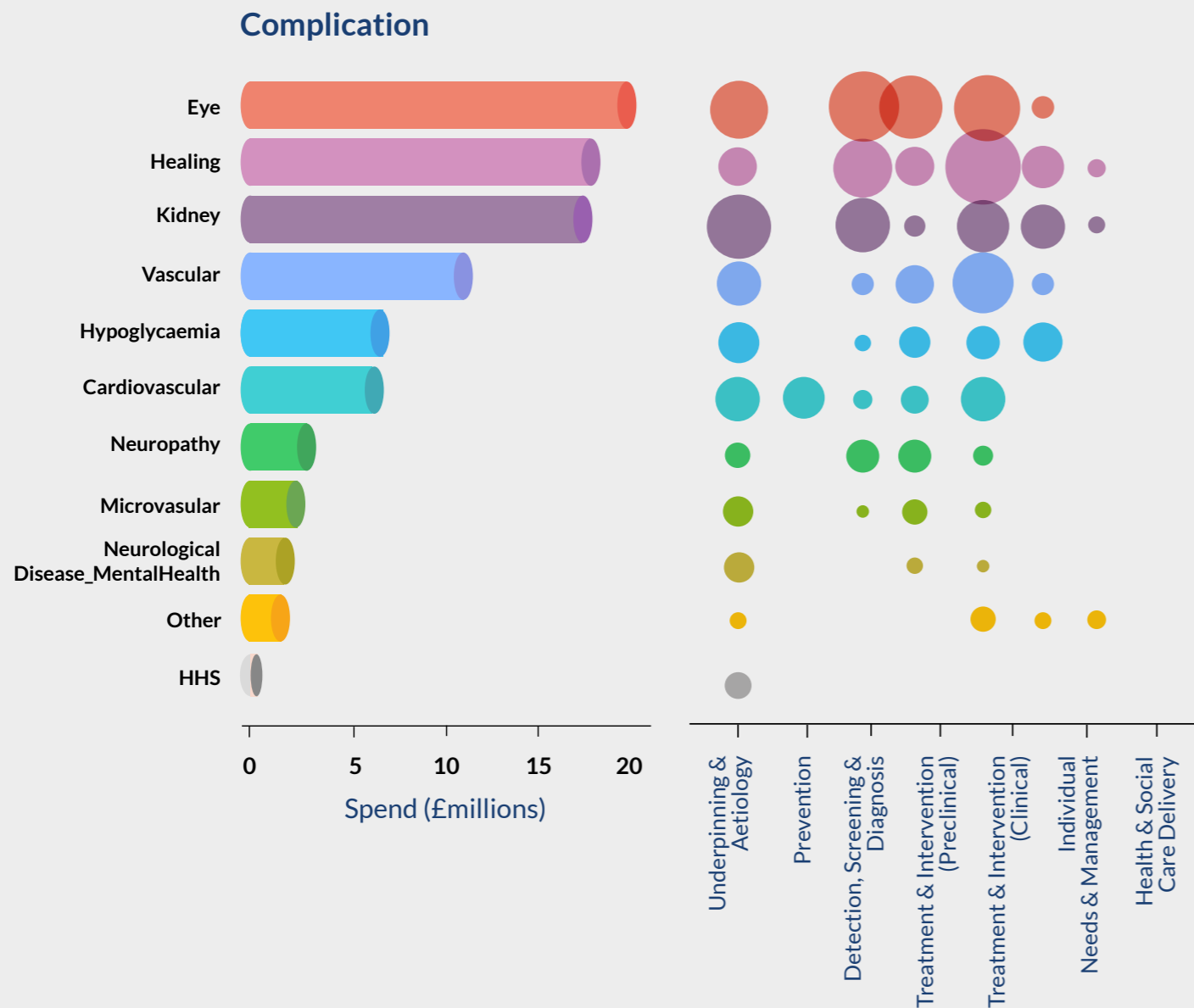
Relative Investment in Grants with a Clear Focus on Health Inequalities



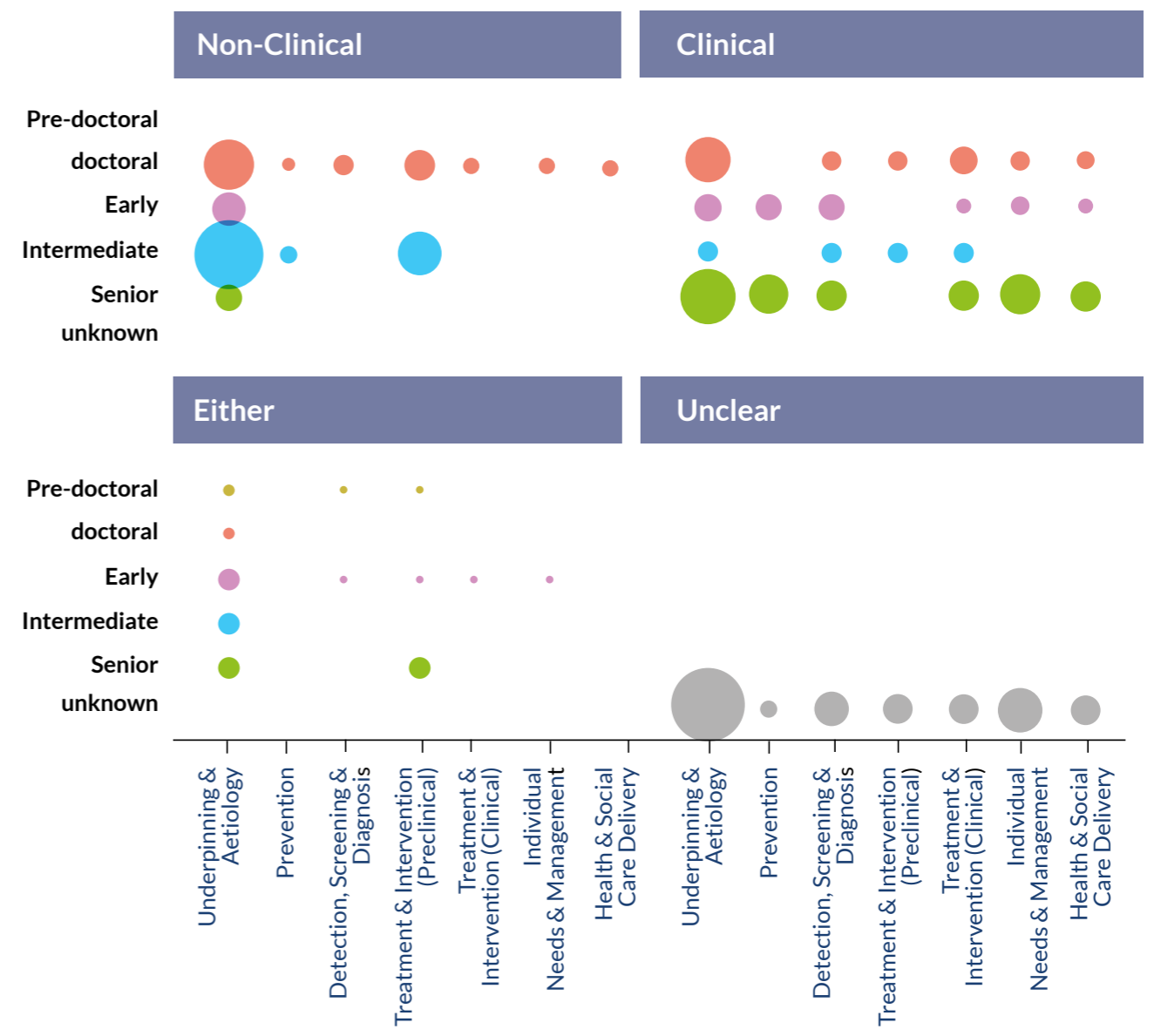
By Region:



Investment into Complications Research, in Total and by Area of Research

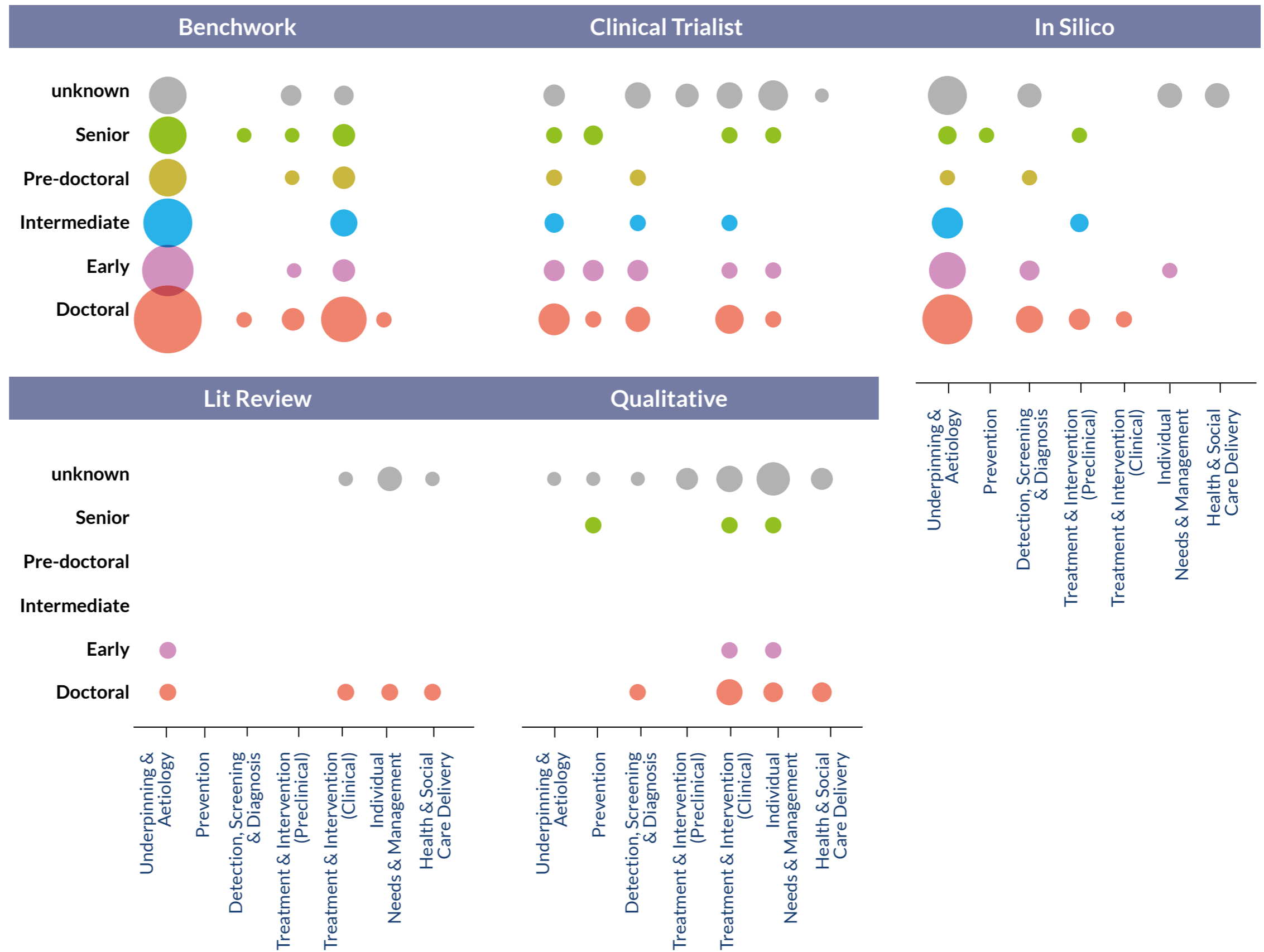
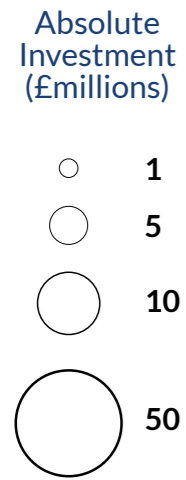


Investment (£millions) in Research Careers by Area of Research and Career Stage, Split by Career Path



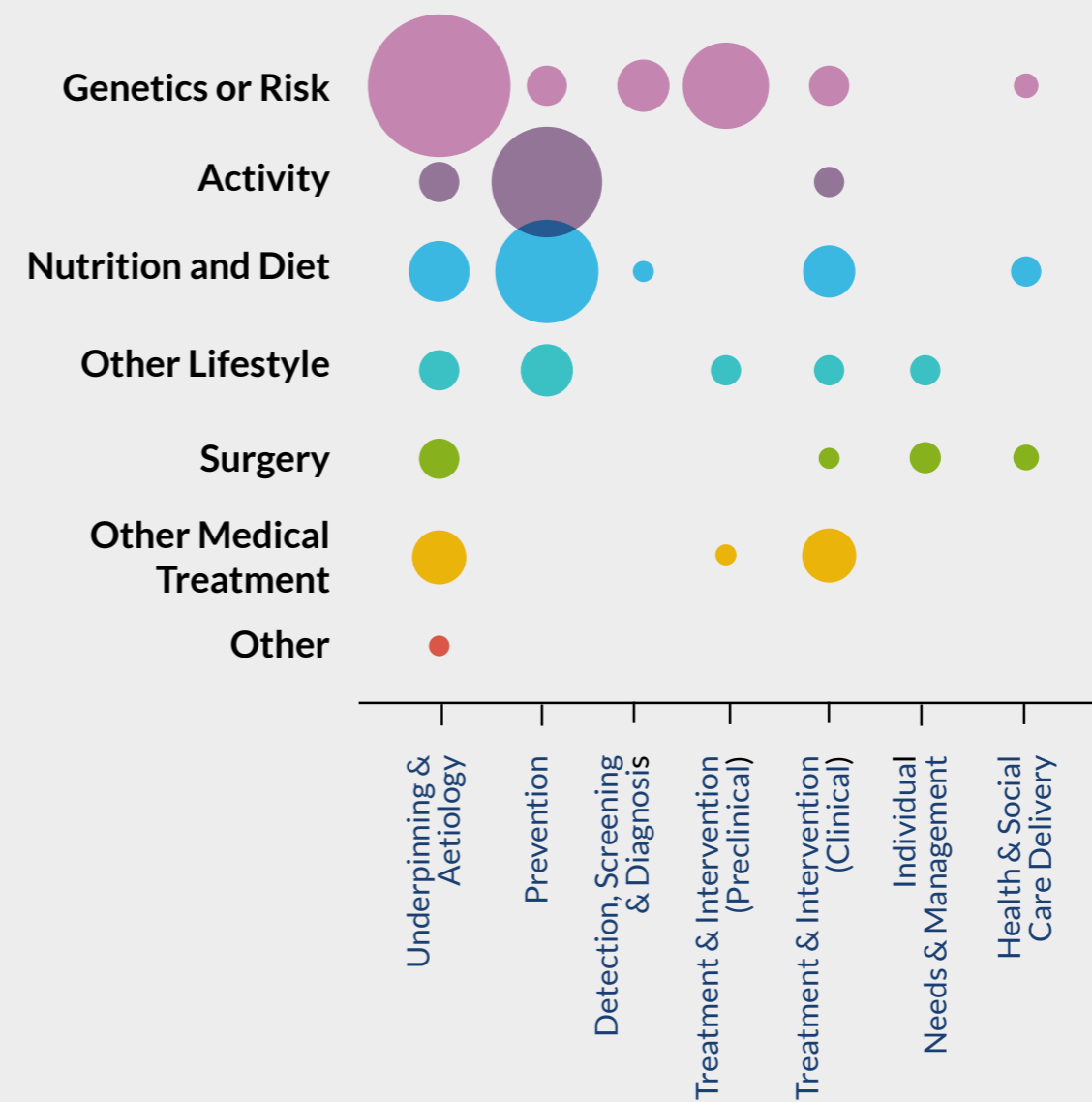
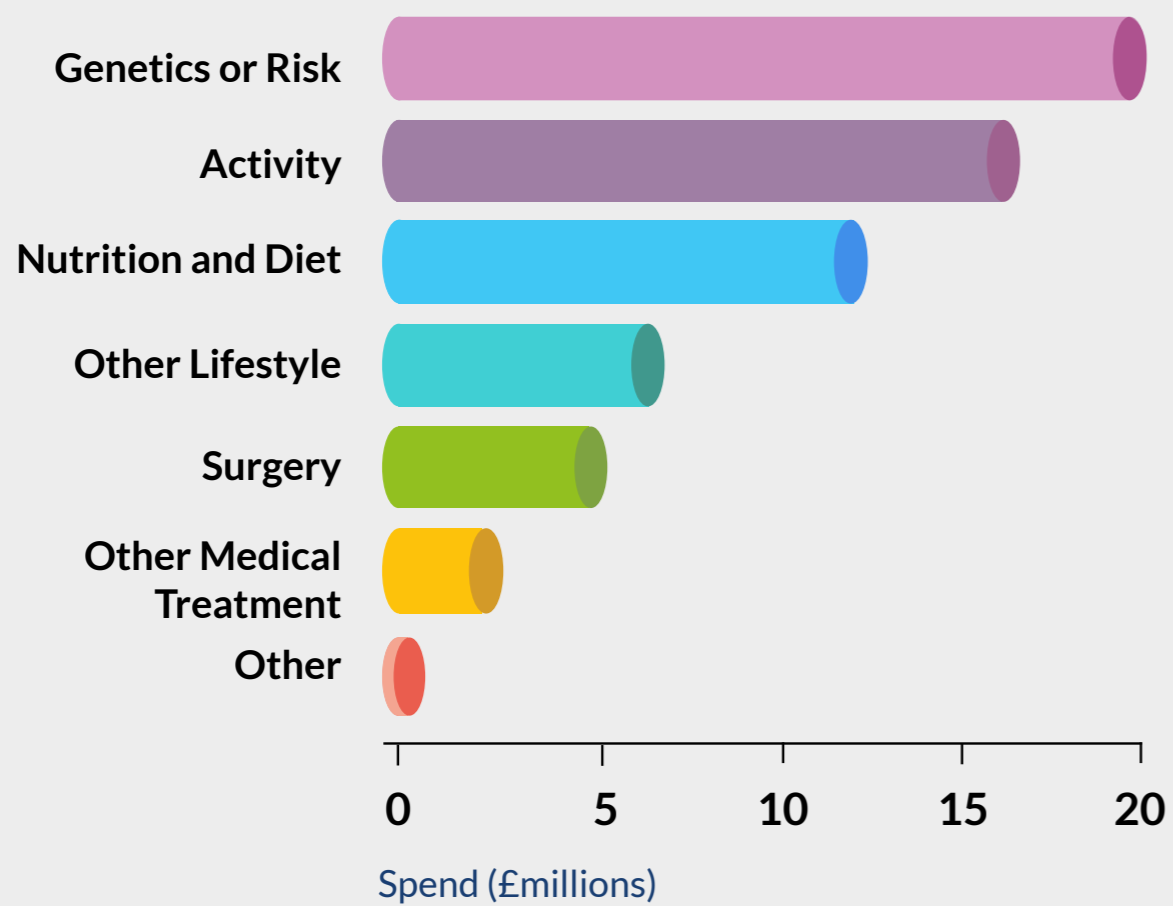
APPENDIX 4: FULL PORTFOLIO REVIEW

Investment (£millions) in Research Careers by Area of Research and Career Stage, Split by Disciplines Trained



APPENDIX 4: FULL PORTFOLIO REVIEW

Investment (£millions) into Focus Areas of Obesity Research, in Total and by Area of Research



APPENDIX 4: FULL PORTFOLIO REVIEW

Investment (£millions) into MLTC Research, in Total and by Area of Research

