Near and far

The NIHR's regional and national economic impacts

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Preface

The Department of Health and Social Care (DHSC), through its operational arm the National Institute for Health and Care Research (NIHR), is a major public funder of health and social care research in England. Working in partnership with the National Health Service (NHS), universities, local government, other research funders, patients and the public, the DHSC through the NIHR funds, enables and delivers health and social care research that improves people's health and wellbeing and promotes economic growth. Funds are invested through the NIHR in all regions of the country to generate health gains and advances in scientific knowledge. That expenditure and its outcomes have major benefits for the economy of the regions and the UK as a whole. The research reported here was commissioned from RAND Europe by the NIHR Policy Research Programme (award number NIHR207565) to investigate the regional and national economic impacts of expenditure through the NIHR.

Plain language summary

Introduction

The Department of Health and Social Care (DHSC) invests around £1.6bn of public money each year in health and care research through the National Institute for Health and Care Research (NIHR). The aim of this report is to look into how much economic benefit the UK and its regions get from research spending through the NIHR. We were asked in particular to look at how spending in any one region of the UK has economic effects on other regions.

Money spent on research pays for jobs. It buys equipment and other goods and services. The economy benefits from researchers and suppliers spending their wages. Research can result in new products being created by companies in the UK. NIHR-funded research may also encourage private companies to do more research and development in the UK. The NIHR, as part of the DHSC, covers research in England. It has some partnerships with the health authorities in Northern Ireland, Scotland and Wales, but these nations have their own health and care research budgets, priorities and providers. The NIHR expenditures discussed in the present report include the amounts spent in Northern Ireland, Scotland and Wales, where those countries have chosen to 'buy-in' to specific NIHR programmes.

The team of researchers for the study reported here comes from RAND Europe, which is a not-for-profit research organisation, and from Birmingham City University.

What we found

Looking at previous research

Previous studies have found that public funding for health and care research helps improve health for people some years later, as well as encouraging industry to spend more money on research in the UK. No one has yet shown how public spending on research in one region creates incomes and jobs in each of the other regions.

Looking at examples of research supported by NIHR

We found that people in all parts of the UK benefit from research, wherever in the UK the research takes place.

Our evidence came from four examples of research funded through the NIHR. We talked to researchers involved in that research to better understand some of the real-life economic benefits achieved. We also collected published information about the example projects. These examples showed how jobs were created for researchers and in the NHS, private companies and the community generally. They also showed how patients were treated better as a result of the research funded through the NIHR, and whether the NHS saved money.

From a model of the economy of the UK and its regions

We found that, in addition to making people healthier, for every £100 spent through the NIHR, the UK economy benefits by £145 within

roughly 5–10 years after the expenditure. This is our best estimate, but the value is uncertain and would likely be higher over a longer time frame. We estimate that the range of credible values is from £137 to £173 per £100 spent through the NIHR, within 5–10 years. This benefit comes from the jobs paid for and from buying goods and services to do the research. It also comes from what the people in those jobs spend their incomes on, and from extra investment in research by industry prompted by the spending.

Importantly, we found that all regions of the UK benefit, not just the region where the research is done. Roughly one-third of the economic benefit occurs in the region where the NIHR spent, but the other two-thirds of the total economic benefit are spread across all other regions of the UK.

Our evidence was from analysing research spending through NIHR between financial years 2013/14 and 2017/18, the period chosen by DHSC to allow time for some of the effects of that spending to have happened. The total amount of funding stayed similar in each of these years when price inflation is taken into account. For its population size, London received more funding than any other part of the UK.

We used official statistics about the economy of each region of the UK. We used established economic methods to model what happens across the whole UK when the DHSC (through the NIHR) spends money on research in one region. This sort of regional analysis has not been done before.

What it means and what is next

In this project, we found that the money spent through the NIHR on health and social care research does not just result in better health of people in the UK. It also contributes to new jobs, extra incomes and a growing economy in all regions of the UK. The exact size of these economic effects is estimated to be in the range of £137 to £173 over 5–10 years per £100 invested, although the precise amounts can be difficult to pinpoint and may be even higher in the long term. It is clear that the benefits are felt throughout the UK, not just where the research happens. Our study is the first to show such a spread of benefits across UK regions.

Our results could be developed and improved with further work to add to our model the extra incomes generated by healthier and more productive people as a result of research funding through the NIHR.

Summary

Key points

The most important contribution of the work reported here is the estimation of the regional economic impacts of research spending through the NIHR (by the DHSC and the devolved administrations) in all parts of the UK. This has been achieved by developing a novel ecnomic modelling approach that takes into account how each region's economy interacts with all other regions' economies.

The NIHR covers health and care research in England. Health, care and associated research are devolved responsibilities in the UK. Increasingly, the four nations of the UK collaborate, and the devolved nations buy into some NIHR research programmes. Data on Northern Ireland, Scotland and Wales capture the extent to which they buy into specific NIHR programmes.

Although the NIHR spends in all regions, it spends more in some regions than in others, even after regional differences in population size have been taken into account.

All regions benefit economically from expenditure through the NIHR, in the form of short- to medium-term increases in regional income and employment.

The overall economic returns achieved at the national level are likely to exceed the returns achieved by general government expenditure in the UK when accounting for the extra industry research and development that is crowded in by research spending through the NIHR.

The majority of the economic impact from money spent in one region is likely to arise outside that region and be spread across all other regions of the UK. For every £100 of economic benefit created by spending through the NIHR in a region, roughly £32–44 stays within that region and £56–68 materialises elsewhere in the UK.

For example, taken together, the UK outside London, the South East and the East of England received 45% of expenditure through the NIHR in the five years between financial years 2013/14 and 2017/18, but a rather larger proportion (59%) of the modelled consequent increase in Gross Domestic Product (GDP) in the UK (including crowded-in industry R&D).

High-level percentage data for England shared by DHSC in April 2026 shows that, since this report's period of study, the proportion of NIHR funding in England that is outside London, the East of England and the South East has increased from 43% in 2013/14 to 50% in 2024/25.

In addition, all regions benefit from long-term health gains for their populations. We have estimated that, at a national level, the health gains from NIHR research are equivalent to a rate of return of 13% per annum in real terms. This alone greatly exceeds the minimum 3.5% per annum real rate of return that HM Treasury expects from public investments.

Case studies of individual awards illustrate how the economic effects of any one award emerge over time from a complex, layered and interacting network of research funding sources. Specific pieces of research build on a foundation of other underpinning work, staff training and infrastructure support, for which the funding may have come from multiple public and private sources.

Focusing on the location of the primary award holder's work address as the region that benefits from a research investment overlooks that the impacts of research spread across regions, having a national, and indeed international, impact.

Background and aims

The DHSC, through the NIHR, is the largest funder of health and social care research in the UK, with a budget of £1.6bn in 2024/25. It is focused on England. Health is a devolved matter in the UK. Separate NHS and care systems, including those covering research, operate independently in England, Northern Ireland, Scotland and Wales. The NIHR funds research programmes, research delivery and translational infrastructure and research capacity building. It funds research that commercial organisations would not undertake, but which is expected to benefit the population of the UK and, indeed, globally. In addition to advancing knowledge and generating improved health and care, research funded through the NIHR boosts incomes and employment in the UK.

The scale of the economic impacts of expenditures through the NIHR, and how those impacts affect the regions and devolved nations of the UK, is the focus of the research reported here. For brevity, we use the shorthand 'regions' to refer collectively to the nine regions of England, as used by the Office for National Statistics (ONS), plus Northern Ireland, Scotland and Wales.

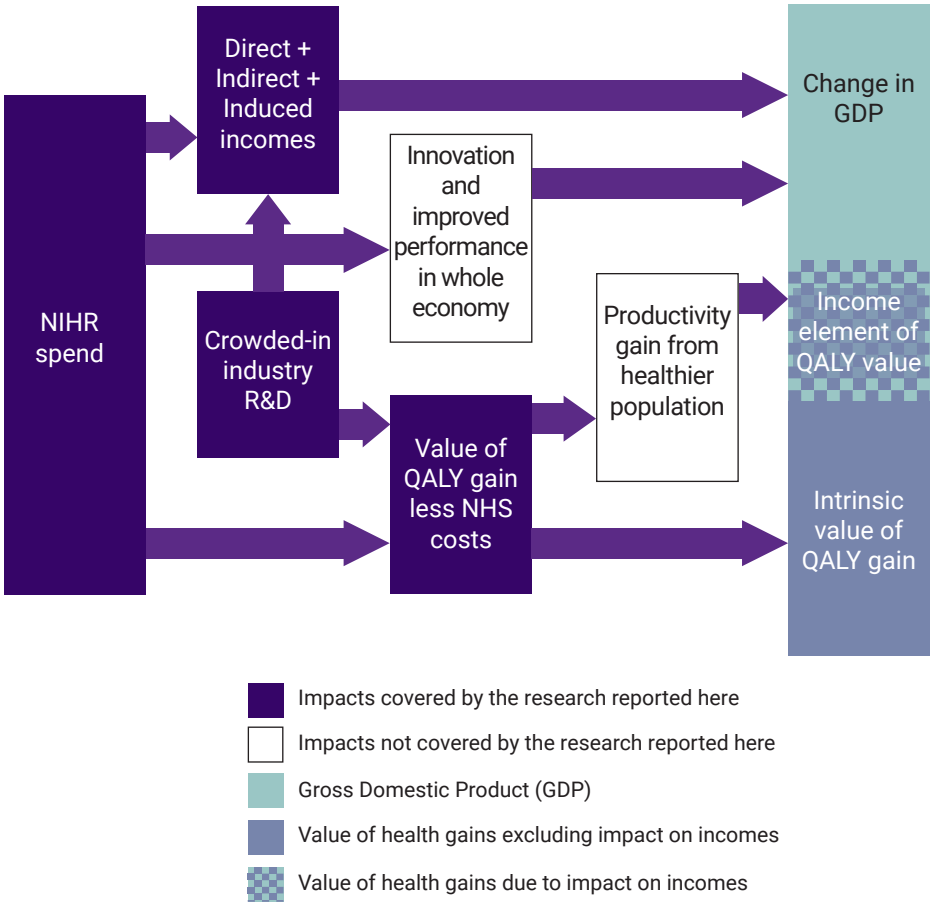
Expenditures through the NIHR are higher in some regions, particularly in South East England (which includes London, Cambridge, Oxford and Southampton), than in others, even after regional differences in population size have been taken into account. This is related to the location of particular centres of excellence or clusters, raising the question of the extent to which all regions of the country share in the economic benefits.

Following the scope of the evaluation defined by the NIHR, we have focused on the impact of research expenditure through the NIHR over the five financial years between 2013/14 and 2017/18 inclusive, the period chosen by the NIHR to allow time for some of the effects of that spending to have occurred. Our objectives were to:

1. Describe the overall patterns of NIHR-funded activities in the UK by type and region between 2023/14 and 2017/18.
2. Estimate the direct short-term economic effects of these activities regionally and nationally, including spillover and multiplier effects, and capture workforce and employment.
3. Estimate short- and long-term return on NIHR investment between 2013/14 and 2017/18, regionally and nationally.
4. Estimate the return on investment on health, using multipliers derived from literature, data and expert inputs.
5. Analyse four qualitative case studies with respect to the benefits to health and wealth on regional and national levels.
6. Synthesise economic modelling and case study findings to provide an overall picture and insights into the economic effects of NIHR activities regionally and nationally.

The literature discussing economic returns to health and care research identifies a variety of such returns. These are shown schematically in Figure S1. The scope of the research presented in this report includes the elements shaded red in Figure S1.

Figure S1: Types of economic impact from expenditure through the NIHR



Source: The research team.

On the left of the diagram, spending through the NIHR generates increased GDP in the UK (shown in green) in the short- and medium-term. In the long term, NIHR-supported research leads to a healthier UK population (in light purple), shown on the right.

Spending on health and care research through the NIHR also stimulates private sector industry to increase its R&D activity in the UK. This additional R&D also contributes to UK GDP gains in the short- and medium-term and to UK health gains in the long term.

Improved population health is measured in quality-adjusted life years (QALYs). QALYs are assigned a monetary value representing people's willingness to pay for improved health. We use a value of £70,000 per QALY, as recommended by HM Treasury. Because this willingness to pay for better health may in part reflect the income gains that result from better health, there is some double-counting between the GDP (national income) gain and the value of the health gain. The quantity of double-counting is unknown but is indicated schematically in the mixed green-and-light purple part of the right-most box in Figure S1.

The research reported in the following pages does not extend to estimating the possible effect of expenditure through the NIHR on innovation and performance in the economy outside the health and care sector, nor does

it estimate the gains in productivity across the whole economy that might result from a healthier population due to NIHR-supported research. Both were outside the scope of the research. If included, they would likely result in higher estimated economic returns to NIHR-supported research.

Methods

The research reported here comprised six main work packages (WPs) to capture and generate evidence on the economic returns of spending through the NIHR and their regional distribution through a mix of methods:

1. An evidence review via a rapid evidence assessment and scoping interviews with experts in the subject area.
2. A descriptive analysis of expenditure through the NIHR.
3. Updating quantitative estimates in the literature of returns to health and care research in the form of health gains.
4. Qualitative case studies based on document review and interviews.
5. Modelling of the expected regional and national UK-wide macroeconomic impacts.
6. Synthesis and reporting.

The research team was advised by a Steering Committee of experts in the subject area and by the Patients and Public Involvement (PPI) Group that the team established for the study. One member of the PPI Group participated in the Steering Committee to help ensure appropriate feedback between the two advisory groups. In addition to participating in discussions at three meetings over the course of the project, the PPI Group members were invited, after seeing a first draft of the final report, to offer their reflections on how best to involve patients and the public in research that is not drawing on their experiences of health care.

The main advance in our research is the development, for the first time, of a regional computable general equilibrium (CGE) model of the economy to estimate expected impacts of healthcare research on the incomes and employment of each UK region in a way that allows for the fact that increased activity and employment in one region have implications for activity and employment in all other regions.

Findings

Evidence review

The review of literature from January 2008 to July 2024 (which includes the COVID-19 pandemic period) yielded 23 papers measuring economic returns to medical and health research by public and charity funders in the UK or comparable, high-income countries. Economic returns have mainly been based on input-output models and applied to single regions or entire national economies. CGE modelling has been used in only one study (in Australia), which examined the overall national economic impact of public research, including health and care research.

The literature also yields estimates of the rate at which private industry R&D spending is 'crowded-in' by public (and charity) funded research, making the UK an attractive location for this kind of activity. This is an important element of how expenditure through the NIHR generates economic impacts regionally and nationally, and is included in the CGE model of the regional and national UK economy we have developed. Interviews were conducted in late 2024 and January 2025 with 12 experts from public and charity research funders, industry, academia and regional development organisations. They confirmed our understanding from the literature and that there were no further relevant studies we had missed in the literature review. Interviewees considered the following to be an appropriate

typology of research activity supported by funding through the NIHR:

- Research programmes
- Infrastructure (translational and delivery)
- Research training and career development (capacity building).

Some interviewees highlighted the strategic importance of infrastructure spending through the NIHR, but none were aware of any evidence of different rates of economic returns across different types of research activity. All interviewees confirmed that they were not aware of any empirical evidence of how economic impacts affect all regions within the UK.

During the interview programme, we were made aware that the DHSC was developing an estimate of the long-term return on investment it is achieving. This was published on the NIHR website in October 2025. It is based on the same empirical studies as we use in the current study to estimate the rate of return due to health gains from NIHR research, and the crowding-in of additional commercial R&D spending in the UK. Its output is not directly comparable with the research in the present report, which focuses on regional CGE modelling and a shorter timescale than the 60-year horizon of the DHSC's return on investment estimate, as well as differences in the modelling of indirect benefits.

Descriptive analysis of NIHR expenditures

We analysed data on expenditure through the NIHR data (some from published NIHR annual reports, but most provided by the NIHR under a data sharing agreement) over the five years between 2013/14 and 2017/18, as specified by the NIHR in the research brief. Throughout this period, total annual expenditure through the NIHR remained broadly constant in real terms and amounted to a little under £6.7bn in total for the five years (in 2023/24 price terms – the price base used throughout this report). However, there was a change in the balance between types, with infrastructure expenditure declining from 68.6% of the total to 61.5% over that period, spending on training and development rising from 9.3% to 10.8% of the total and spending on research programmes increasing from 22.1% to 27.7%.

Throughout the five years, total expenditure through the NIHR per head of population was roughly twice as high in London as in the rest of England. Health and care are devolved responsibilities in the UK. Separate NHS systems operate independently in England, Northern Ireland, Scotland and Wales, each with its own legislation, funding and priorities. This includes research. Therefore, the large majority of spending through the NIHR is on health and care research in England, although there are some collaborations and partnerships across all four nations and likely spillover benefits to all four nations as described in the report's findings.

Rates of return from health gains

The focus of the research presented in this report is on modelling the economic impact of expenditure through the NIHR across the regions of the UK. We complement that with an estimate of the health-gain-related rate of return at the UK national level to the NIHR's expenditure, based on a review of the empirical literature and updating the health-gain internal rates of return (IRRs) reported there. An IRR is a measure of the rate of return that can be thought of as equivalent to the annual rate of interest earned on the initial research investment. Thus, for example, a 10% IRR would mean that the returns earned on each £1 of investment are equivalent to earning interest of £0.10 each year thereafter.

Studies in peer-reviewed literature have estimated health-gain outcomes from

government (including through the NIHR) and charity-funded medical and health research at the UK national level for four disease areas:

- Cancer
- Cardiovascular disease
- Mental health
- Musculoskeletal conditions.

The research team has revised the original estimates. We assume that spending through the NIHR in the four disease areas continues to yield health gains at the rates implied by the original studies, and that the costs of delivering those health gains have increased to 2023/24 financial year price terms at the general rate of inflation (measured by the GDP deflator at market prices).

Applying a value per QALY gained of £70,000 (HM Treasury's suggested value of the UK population's average willingness to pay for a QALY), and assuming that NIHR research expenditure overall achieves the same health-gain IRR as these disease areas did on average in the past, then the national IRR from health gains attributable to NIHR expenditure would be around 13% per annum in real terms.

As is made clear in the original studies in the literature, any estimated IRR figure is highly sensitive to numerous assumptions, including the value of a QALY that is applied, the duration and time profile of health gains consequent on research and the proportion of those gains that are attributed to public research in the UK. Furthermore, other things will have changed in the time since, besides inflation. For example, new research outputs will have been produced, and the pattern of spending through the NIHR will have changed somewhat. This brings significant uncertainty to the estimates. The true IRR from health gains could be considerably higher or lower than 13%, but that value is a reasonable estimate based on the information available.

Case studies

The research team conducted four qualitative case studies through interviews with key participants and documentary review. The case studies were identified in discussion with the NIHR to enable a wide range of impacts to be investigated. By examining specific examples of NIHR awards, the case studies illustrate how research investments translate into tangible benefits, such as policy influence, commercial outcomes, health improvements and economic contributions at both regional and national levels.

The case studies show that impact emerges from a complex, layered and interacting network of research funding sources. Specific pieces of research build on a foundation of other underpinning work, which may include infrastructure support, fellowship awards and methodological development, for which funding may have come through the NIHR or from other sources, such as medical research charities. The case studies also show how impacts will likely evolve over time. Consequently, the time point of analysis will have a material impact on the nature and level of impact attributed to research.

Finally, focusing on the location of funding – particularly the primary award holder's work address – as the region benefiting from a research investment overlooks the fact that many studies are multi-site and multi-regional. The impacts of research then spread across regions to have a national, and indeed international, impact.

Economic modelling

The research team created a CGE model of the economies of the 12 regions of the UK (nine regions of England, Northern Ireland, Scotland and Wales) and how those economies interact, based on data from the UK Office for National Statistics. This approach is an important

advance in modelling the economic impact of research. Previous studies have used simple input-output multipliers to estimate this impact. Our approach goes further by relaxing some restrictive assumptions and by modelling the economic interactions between regions. The regional CGE model takes into account that the supply of labour and capital is not infinitely flexible. But our model does not include productivity gains in the economy that might result from improved population health.

The CGE model results capture the short- to medium-term economic effects of spending through the NIHR once markets, including labour markets, have re-balanced. This can be assumed to happen within 5–10 years.

We have studied the impact on incomes and employment in the 12 regions of £6.7bn expenditure (in 2023/24 price terms) through the NIHR over the five financial years from 2013/14 to 2017/18. Numerous scenarios have been modelled and compared with a hypothetical baseline where there is no expenditure through the NIHR. The main findings from the model are as follows:

- Expenditure through the NIHR in any one region not only generates economic activity there, but also in all other parts of the UK.
- The majority of the eventual total impact on incomes and employment happens outside the region where the expenditure was originally made. For every £100 of economic benefit created by spending through the NIHR, roughly £32–44 stays local, and £56–68 materialises elsewhere in the UK.
- Before allowing for additional stimulated R&D from industry, the impact on incomes and employment in the UK nationally is expected to be equal to a multiplier of 1.09 (range = 1.04–1.29). In other words, every £100 of expenditure through the NIHR is expected to yield £109 (range = £104–129) of national income. This is a similar multiplier (i.e. similar modelled impact) to when the expenditure is assumed to be on general government services rather than on health and care research.
- When the effect of crowding-in additional R&D by industry is also taken into account, the multiplier achieved nationally by expenditure through the NIHR is expected to increase to 1.45 (range = 1.37–1.73), so that every £100 of expenditure through the NIHR yields £145 (range = £137–173) of national income over the next 5–10 years.
- The UK outside London, the South East and the East of England received 45% of expenditure through the NIHR in the five years from 2013/14 to 2017/18, but received a rather larger proportion (59%) of the modelled consequent increase in GDP in the UK (including crowded-in industry R&D).
- High-level percentage data for England shared by DHSC in April 2026 shows that, since the period of the study considered in this report, the proportion of funding in England via the NIHR that is outside London, the East of England and the South East has increased from 43% in 2013/14 to 50% in 2024/25.
- Spending through the NIHR delivers positive labour market effects in all regions, with an estimated 0.50% (range = 0.49–0.55%) increase in the UK-wide wage bill without crowding-in of private R&D, and an estimated 0.68% (range = 0.66–0.75%) increase when crowding-in is included. This reflects a nationwide rise in labour demand, capturing both additional employment and higher wages generated by the expansion of research-related economic activity.

Conclusions and recommendations for future research

The single most important contribution of the work reported here is the estimation of the regional economic impacts of research spending through the NIHR in all regions. This has been achieved by developing a novel modelling approach using a CGE model of all regions (including devolved nations) of the UK. This model takes into account how any one region's economy interacts with all other regions' economies.

All regions have benefited from short-, medium- and long-term increases in regional income and employment. The majority of the economic impact from money spent in one region looks likely to arise outside that region and be spread across all other parts of the UK. The overall economic returns achieved are likely to exceed the returns achieved by general government expenditure in the UK when account is taken of the extra industry R&D that is crowded in by NIHR and other public research spending. The economic impacts achieved by NIHR-funded research emerge over time and from a complex ecology of public, charity and commercial research funders supporting infrastructure and staff interacting across regions.

In addition to the regional economic effects on incomes and employment, we have estimated that, assuming each QALY gained is valued at £70,000, the national-level health gains from NIHR research are equivalent to an IRR of around 13% per annum in real terms. But as part of this research we have not conducted any new studies of particular health-improving innovations that can be traced back in part to activities funded through the NIHR, so this figure is subject to considerable uncertainty.

Future research would be useful to improve the regional and national estimation of the economic impacts of spending through the NIHR, including:

- Analysis of the economic impacts of different types of research activity and whether some types yield higher returns than others.
- New studies of the health gains and cost impacts of the adoption of outcomes from research to which spending through the NIHR contributed. New studies in the disease areas already in the literature (cancer, cardiovascular disease, mental health and musculoskeletal disease) would be valuable, as well as studies of disease areas not yet investigated in this way (e.g. infectious, respiratory and metabolic diseases).
- Measuring the inter-regional speed of the spread of health benefits from research and understanding the factors determining that speed. Different regions may absorb research outcomes more rapidly than others.
- Estimating productivity impacts from health gains and building them into the regional CGE model of the economy.
- Developing a dynamic version of the regional CGE model to permit greater understanding of the time profile of economic impacts regionally and nationally.

However, even with the current level of knowledge, we can be reasonably confident that expenditures through the NIHR have beneficial economic effects in all regions as well as nationally.

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Glossary

ABPI	**Association of the British Pharmaceutical Industry**: The trade association of the research-based pharmaceutical industry in the UK.
BRC	**Biomedical Research Centres**
Capital	Plant, equipment and land used in the production of goods and services.
CGE	**Computable General Equilibrium:** A type of model commonly used by economists to estimate the expected effects on a national or regional economy of policy interventions. This type of model takes into account that changes in demand in one market (e.g. for one type of good or service or for labour or capital) may cause changed prices and hence quantities supplied and demanded in all other markets. CGE models assume that, eventually, following an initial change, a new equilibrium will be reached in which supply equals demand in all markets.
CRN	**Clinical Research Network** (predecessor of the current Research Delivery Network).
DHSC	**Department of Health and Social Care**: The government ministry responsible for health and social care in England.
FTE	**Full-time equivalent**
GDHI	**Gross Disposable Household Income**
GDP	**Gross Domestic Product**: The total income produced by an economy in a time period, usually a year. This will, by definition, equal the total value of the economy's output in that period.
GVA	**Gross Value Added**
HTA	**Health Technology Assessment**
ICU	**Intensive Care Unit** (within a hospital).
Input-output	Approach to modelling the interdependencies between sectors of a national economy in the form of inputs to one sector being outputs from other sectors, and outputs from one sector being inputs to other sectors.
IRR	**Internal Rate of Return**: A way of representing the returns to an investment that shows what real annual rate of interest earned on that investment the returns would be equivalent to.

i4i	Invention for Innovation (NIHR funding programme)
Labour	People's inputs of time and skills used in the production of goods and services
MAMS	**Multi-arm, multi-stage**
MRC	**Medical Research Council**
Multiplier	A multiplier of 1.12, say, means that £1-worth of initial economic activity will eventually generate a total of £1.12-worth of economic activity.
NHS	**National Health Service**
NICE	**National Institute for Health and Care Excellence**: The public organisation responsible for guidance to health and care practitioners on treatments offered by the NHS in England.
NIHR	**National Institute for Health and Care Research**: The public organisation that funds health and social care research in England.
NUTS1	**Nomenclature of Units for Territorial Statistics, Level 1** (UK regional classification).
OECD	**Organisation for Economic Cooperation and Development**: An international organisation of 38 mostly high-income countries, including the UK.
ONS	**Office for National Statistics**: The public organisation responsible for collecting, analysing and disseminating statistics about the UK's economy, society and population.
PI	**Principal Investigator**.
PPI	**Patient and Public Involvement**.
QALY	**Quality-Adjusted Life Year**: A measure of health gain or loss that combines length of life and quality of life.
R&D	**Research and Development**.
RDN	**Research Delivery Network**
REF	**Research Excellence Framework**.
RHFCE	**Regional Household Final Consumption Expenditure**.
SAM	**Social Accounting Matrix**.
WP	**Work Package**.

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Chapter 1. **Background and research objectives**

1.1. The role of the NIHR

The National Institute for Health and Care Research (NIHR) was founded in 2006 by the Department of Health and Social Care (DHSC) with a mission to create a leading-edge health research system focused on the needs of patients and the public in England (Evans 2006). Health and care are devolved in the UK. Separate NHS and care systems operate independently in England, Northern Ireland, Scotland and Wales, each with its own legislation, funding and priorities. The NIHR's geographical focus is England, but a proportion of its funding comes from and is spent in the devolved nations of the UK. This proportion has increased since autumn 2023, paid for by the devolved administrations. Over time, the remit of NIHR has expanded to incorporate research on social care, global health and policy research (NIHR 2021). The NIHR describes itself as making 'a difference to people's lives through four key themes: Impact, Innovation, Inclusion and Investment' (NIHR 2025a).

The DHSC, through the NIHR, is the largest funder of health and care research in the UK (UK Clinical Research Collaboration 2023), with a budget of £1.3bn in financial year 2023/24 (NIHR 2024a) and rising to £1.6bn in 2024/25 (excluding official development assistance) (NIHR 2025c). Under its current mission to 'improve the health and wealth of the nation through research', it funds a wide range of activities, such as broad research programmes and themed research calls, and funding streams dedicated to supporting the career development of researchers (NIHR Academy) or research infrastructure (e.g. Biomedical Research Centres and Research Delivery Network (formerly Clinical Research Network)).

The NIHR funds non-commercial research activity and support, i.e. research that the commercial sector alone would not undertake but which is expected to benefit the UK population and indeed the wider world. The NIHR also supports pre-commercial activity that helps industry design and deliver commercial research effectively and efficiently. Non-commercial and pre-commercial research funded through the NIHR can have many potentially long-lasting impacts, including strengthening the UK's research capacity and infrastructure (the skilled workforce plus facilities and equipment that enable high-quality health and social care research). It also generates and spreads new knowledge, leading to improvements in the population's health and social care, and increasing efficiency in the health and social care system. In addition to knowledge and health, NIHR-funded research also boosts incomes and employment in the UK, benefiting the UK economy.

The NIHR's purpose since its inception has been to promote the health and wealth of the country. It has always also had an economic growth mandate, which has been reaffirmed in the Life Sciences Sector Plan (GOV.UK 2025). Thus, the NIHR has a role in aiding economic growth in England. The NIHR explicitly acknowledges a duty to deliver the benefits of UK taxpayer-funded investment in health and care research to wider society, including by generating positive economic impact through improvements in health and care (NIHR 2023b). The scale of the economic impacts of the expenditures through the NIHR

and how those impacts affect the regions and devolved nations of the UK is the focus of the research reported here. For brevity, throughout the report we use the shorthand 'regions' to refer collectively to the nine regions of England, as used by the Office for National Statistics (ONS) (ONS 2021), together with the devolved nations: Northern Ireland, Scotland and Wales.

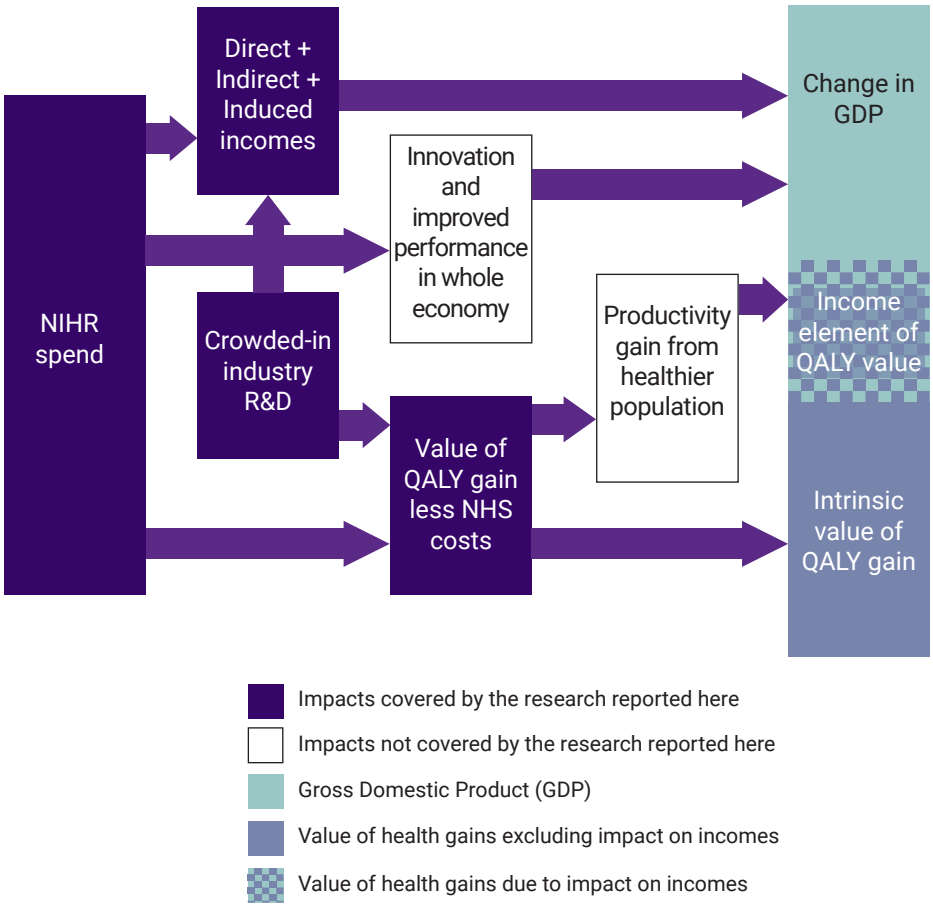
1.2. Evidence about the economic impacts of spending through the NIHR

Existing evaluations of the economic returns to expenditure through the NIHR or other research funders' spending have primarily assessed the effects at the national level. For example, a seminal 2008 study by a team including RAND Europe researchers estimated the national rates of return on a broad range of public-sector plus charity medical research expenditure in the UK. The study considered a combination of impacts on the UK's national income (Gross Domestic Product – GDP) and population health, specifically estimating the health gains from research in cardiovascular disease and mental health (HERG et al. 2008). Parts of that study's methodology were later adopted to estimate returns in terms of health improvements from research expenditure in the UK on cancer (Glover et al. 2014) and musculoskeletal disease (Glover et al. 2018), as well as to measure the complementarity of public and private medical research funding in the UK, in other words the extent to which public and charitable research expenditure prompts ('crowds in') research and development expenditures by industry R&D. (Sussex et al. 2016)

Other evaluations have focused on the returns achieved by specific NIHR funding programmes or aspects of its funding, including NIHR Health Technology Assessment (HTA) (Guthrie, Hafner et al. 2015), NIHR Clinical Research Network (CRN) (KPMG 2016), non-commercial clinical research in the UK, including that funded through the NIHR (Frontier Economics 2025), NIHR Biomedical Research Centres (BRCs) (Craig et al. 2020; Smith et al. 2019), and NIHR's Open Access policy (NIHR 2022). Beyond economic outcomes, some studies have explored broader impacts of funding through the NIHR, including case studies and qualitative assessments of research and innovation programmes (Lichten et al. 2017; Morgan Jones et al. 2016; RAND Europe 2015; RAND Europe 2017; Rentel et al. 2021).

Taken together, the literature discussing economic returns to health and care research identifies a variety of such returns. These are brought together schematically in Figure 1. Spending through the NIHR, on the left of the diagram, ultimately generates increased GDP (shown in green) and a healthier population (in light purple), shown on the right. Improved population health is measured in quality-adjusted life years (QALYs), which combine changes in patients' length of life as a result of treatment and in their health-related quality of life. QALYs enable health gains to be quantified and compared across health care interventions regardless of the disease area. They are the main metric of health outcomes used by the National Institute for Health and Care Excellence (NICE) and other health technology assessment bodies. QALYs are assigned a monetary value that represents people's average willingness to pay for improved health. Because this willingness to pay for better health may partly reflect the income gains people expect will result from having better health, there is some double-counting between the GDP (national income) gain and the value of the health gain. The magnitude of double-counting is unknown but is indicated schematically in the green-and-light purple section of the right-most box in Figure 1.

Figure 1: Types of economic impact from expenditure through the NIHR



Source: The research team.

The scope of the research reported in the following pages includes the elements shaded purple in Figure 1. The research provides estimates of the extra incomes (GDP) generated by spending through the NIHR between 2013/14 and 2017/18 in each region of the UK in the short- and medium-terms: directly as the NIHR money is spent on researchers and other staff; indirectly as that money is spent on goods and services provided by other parts of the economy; and induced further incomes as the incomes from direct and indirect spending are in turn spent by the recipients on their consumed goods and services, which in turn generates further incomes for other people, which are then spent on goods and services, and so on.

There is strong evidence that public spending on health and care research stimulates the pharmaceutical industry to increase its own R&D) spending in the UK – an effect also known as 'crowding-in'. The research reported here has modelled how much of that crowded-in commercial R&D arises in the short- and medium-term in each region of the UK.

Finally, the research team updated the empirical literature's national estimates of the rate of return to health and care research expenditure that is represented by long-term

gains in health care less the costs to the NHS of implementing the innovations that produce those health gains. It was not possible within the scope of the study to estimate these gains at the regional level.

Two further potential benefits that were beyond the scope of the present research to estimate are shown in the white boxes in Figure 1 and outlined below:

- Innovations and consequent improved performance in the economy outside the health and care sector that may occur due to the research that NIHR supports, e.g. due to new technologies and knowledge being applied in a variety of economic sectors, or due to a better trained workforce, some of whom choose to move out of the health and care sector to work in other sectors.
- Improvements in productivity due to a healthier workforce, resulting from NIHR-supported research.

Both these types of impact would benefit from future research to estimate their magnitudes.

While the research report here was underway, the DHSC published an estimate of the long-term return on investment it is achieving at a national level (NIHR 2025d). The estimate includes no original research but combines results from some of the empirical studies referred to earlier in this section, along with some additional assumptions to estimate a long-term 'return on investment' over a 60-year timeframe (the sum of benefits over a period of years divided by the initial expenditure through the NIHR that is credited with having generated those benefits).

1.3. Regional economic impacts

The geographical spread of the economic returns to NIHR and other public research funding within the UK has not yet been estimated, despite being a matter of public policy concern (Ministry of Housing, Communities and Local Government 2024). While the NIHR is centred on and funds research delivered in England, it collaborates on and co-funds research in Northern Ireland, Scotland and Wales. Indeed, since autumn 2023, the NIHR has increased access for researchers in those three nations via changes to agreements with the devolved administrations (NIHR 2023c). Expenditures through the NIHR generate economic impacts in regions outside England, as well as within. Most previous studies and reports have focused on national economic effects; and when the focus has been subnational, the estimated impacts have been specific to a single region and have omitted effects outside the area where the research expenditure took place.

As demonstrated later in Chapter 4, expenditure through the NIHR is higher in some regions than in others, particularly in London, even after accounting for regional differences in population size. Though likely related to the location of centres of excellence or clusters, it nevertheless raises the question of the extent to which other regions of the country share in the economic benefits that follow from those research expenditures. For example, Craig et al. (2020) noted that Biomedical Research Centre funding in England is highly skewed towards Oxford, Cambridge and London, and the local economic benefits in these areas could therefore contribute to sustaining economic inequalities across the country. However, high-level, percentage data for England shared by the DHSC in April 2026 shows that, since the period of the study considered in this report, the proportion of NIHR funding in England that is outside London, the East of England and the South East has been increasing: up from 43% in 2013/14 to 50% in 2024/25.

Outside the UK, evidence on the regional economic impacts of research funding is also limited. A study by ACIL Allen (2023) in Australia used computable general equilibrium (CGE) modelling to assess the economic impact of Australian Research Council funding. CGE modelling is capable of incorporating multiple regions, sectors and industries in projecting the expected economic impacts, but even the authors of this study did not show the effects on the different regions of Australia, focusing only on the national economic impact. As in the UK, other international studies have primarily focused on national effects or on selected regions within a country. For example, a study in Australia described examples of how research funding could generate local economic benefits for the region where the research is located through employment, economic activity or by attracting further research funding locally (Paul et al. 2024).

Thus, while there are studies acknowledging the difference between national and locally created economic impacts of research funding, there is little direct evidence specifically quantifying the different regional impacts or the interactions between the regions.

1.4. Methods for estimating the regional and national economic impact of expenditure through the NIHR

Most previous studies on the economic impact of NIHR or comparable research expenditures have used input-output models, applied to a single region or nationally (Craig et al. 2020; Smith et al. 2019). Input-output models are quantitative frameworks describing how outputs from one economic sector become inputs for another, considering an interconnected system of economic activities. They can be useful for estimating the effect of additional spending in a single region, but they do not take into account how spending in one region will affect jobs and incomes in other regions, e.g. because some people move between regions to take up the jobs created, and so risk exaggerating the net impact at a national level when all regions are considered together. Input-output models assume an unlimited supply of labour and capital, no relative price changes, no substitution between inputs (e.g. labour versus capital), no interdependencies between economies in different regions and no substitution between domestic versus imported goods (Grady & Muller 1988).

The economics literature suggests that a more advanced modelling approach would be appropriate. Brandsma et al. (2015) and Christensen (2022) discuss regional CGE models to assess the economic impact of regional R&D policies. In such models, all markets in all regions are interrelated and solved simultaneously, capturing how economic shocks ripple across the system. Such an approach can simulate how regional NIHR R&D funding raises (regional) demand for skilled labour, thereby increasing wages, while reducing labour availability (and competitiveness) in other regions. A general equilibrium modelling approach has been used in an Australian study to estimate economic returns to research at a national level (ACIL Allen 2023). However, we are not aware of such an approach yet being used for regional analysis or in the UK. The CGE model is comparative-static, meaning that it compares two equilibrium states of the economy: before and after the expenditure via NIHR has taken place. This means that results capture the short- to medium-term economic effects of spending through the NIHR once markets have

rebalanced, which can be assumed to happen within the first 5–10 years.

1.5. Aims and objectives

Our research presented in this report has at its heart an innovative CGE-based approach to modelling the regional economic impacts of research expenditures through the NIHR across all parts of the UK. Overall, the project aims to reflect on diverse aspects of economic effects from the activities supported by funding through the NIHR, and to evaluate its economic effects at both regional and national levels.

Following the scope of the evaluation defined by the NIHR, we have focused on the impact of research expenditure through the NIHR over the five financial years from 2013/14 to 2017/18 inclusive, the period chosen by the NIHR to allow time for some of the effects of that spending to have occurred. Our objectives were to:

1. Describe the overall patterns of NIHR-funded activities in the UK, by type and region, between 2013/14 and 2017/18.
2. Estimate direct short-term economic effects of these activities regionally and nationally, including spillover and multiplier effects, and capture workforce and employment.
3. Estimate short- and long-term return on investment through the NIHR in the period 2013/14 to 2017/18 regionally and nationally.
4. Estimate the return on investment on health, using multipliers derived from literature, data and expert inputs.
5. Analyse four qualitative case studies with respect to the benefits to health and wealth on regional and national levels.
6. Synthesise economic modelling and case study findings to provide an overall picture and insights into the regional and national economic effects of activities funded through the NIHR.

The purple shaded elements in Figure 1 show the scope of the research undertaken here. In the rest of the report, we first give an overview of the various methods we have adopted in the research, followed by the findings of the scoping work undertaken (a literature review and stakeholder interviews) and a descriptive analysis of expenditures through the NIHR by region. Subsequent chapters present, in turn, the findings from our update of the returns from health gains reported in the literature, four qualitative case studies of exemplar NIHR research, and our CGE modelling of regional and national impacts of expenditures through the NIHR on GDP and employment. We then synthesise all the evidence and discuss the implications. We end by offering our conclusions and some recommendations for further research to enhance understanding of the regional and national economic impacts of taxpayer-funded health and social care research.

Chapter 2. **Overview of research methods**

2.1. Overall approach

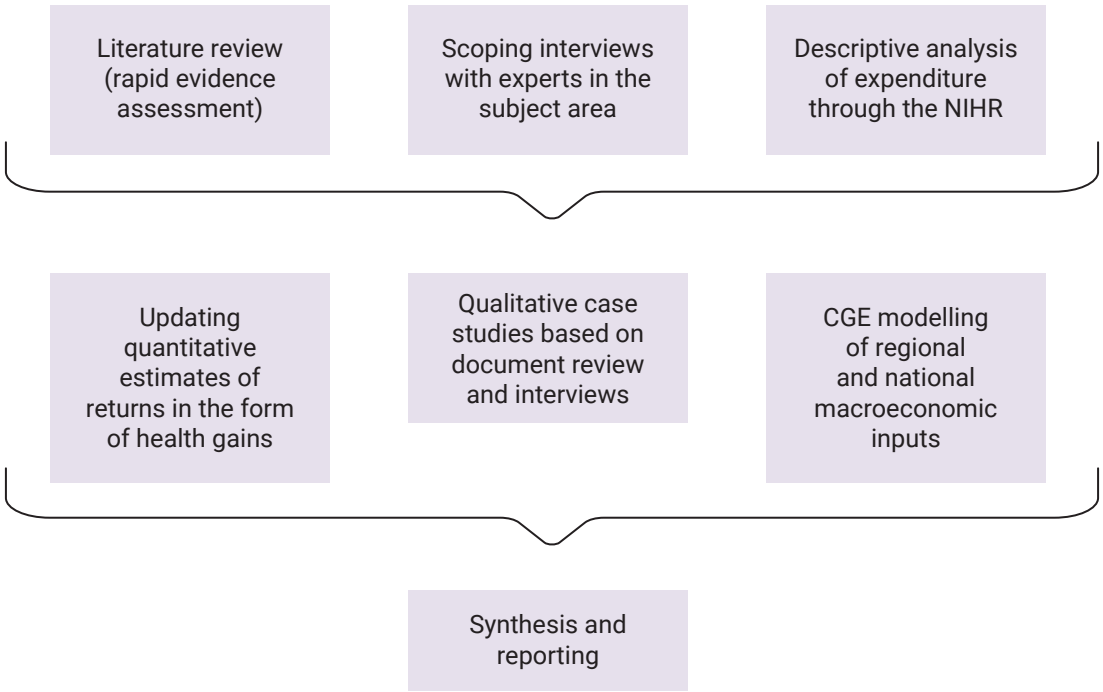
The research reported here comprised six main work packages (WPs) to capture and generate evidence on the economic returns of spending through the NIHR and their geographic distribution through a mix of methods, principally:

1. An evidence review via rapid evidence assessment and scoping interviews with experts in the subject area
2. Descriptive analysis of expenditure through the NIHR
3. Updating quantitative estimates in the literature of returns to health and care research in the form of health gains
4. Qualitative case studies based on document review and interviews
5. Modelling of the expected regional and national macroeconomic impacts
6. Synthesis and reporting.

All WPs were underpinned by data from and on the NIHR. The data included published NIHR annual reports and aggregate annual spending by type. We also received under a data sharing agreement with the DHSC data on the regional distribution of spending through the NIHR by type, and the Researchfish dataset of NIHR-funded projects (NIHR 2024b) to draw from for the case studies. The progress and results of the separate WPs built on each other. For example, the literature review of existing evidence provided an overview of the modelling methods to be considered for the regional economic impact analysis, scoping interviews with experts and case studies underscored the importance of economic impacts that might not be easily captured by economic modelling, and the geographic distribution of spending through the NIHR was used directly as an input to the CGE model.

The research team was advised by a Steering Committee of experts in the subject area and by the members of the Patient and Public Involvement (PPI) Group established for the study. Below, we describe the project's governance and the involvement of members of the public, followed by a high-level summary of the methods for each WP. Details of the methods are described in technical appendices, one per WP. Figure 2 presents an overview of the WPs.

Figure 2: Flowchart of WPs



2.2. Governance

2.2.1. Ethics and approvals

The project was ethically approved by RAND's Human Subjects Protection Committee (Sastry 2024).

2.2.2. Protocol

The research protocol was published on the Open Science Framework platform in February 2025 (RAND Europe 2025).

2.2.3. Steering Committee

The research benefited greatly from the advice of a Steering Committee of experts in the subject area and a representative of the project PPI Group (see below). The research team met online with the Steering Committee five times over the 18 months of the project's duration, discussing the project's progress and emerging results, and consulting on methods and interpretation of findings. Individual members of the Steering Committee also contributed by sending further suggestions and useful references to the research team via email and by participating individually in more focused discussions, e.g. on technical aspects of the CGE modelling.

In its final two meetings, in June 2025 and September 2025 respectively, the Steering Committee was joined by guests from the NIHR's independent advisory group assembled for the project. NIHR staff were not present at any of the Committee's meetings to help ensure independence.

2.2.4. Communication with the NIHR during the study

The research team communicated with the NIHR at intervals throughout the study, from May 2024 to September 2025, to report on progress and address operational questions arising. The team met with the NIHR's project lead every 1–2 months and provided the NIHR with interim briefings in August 2024 and in February, June and September 2025.

2.3. Involvement of patients and public

The research team was helped by a dedicated group of patient/public representatives. The research is not concerned with care delivery or individuals' experience of care, but instead mainly concerns economic modelling. The main request made of the PPI Group was for advice and assistance with formulating the, sometimes technical, findings from the research in a way that would make them clear and unambiguous to interested but non-technical audiences.

The PPI Group had four members, two female and two male, recruited via the project team's professional networks. The four members represented a mix of age groups (including those of working age and those in retirement), regions in England and life experiences. As the project focused on the economic impacts of NIHR funding in general rather than effects on individual patients or members of the public, PPI members were not required to have specific health and care experience, but to be interested in publicly funded health research in the UK.

The PPI Group met with the research team three times via videoconference (MS Teams) and provided additional input via email. The first meeting discussed the scope of the research, and the second was a training session on the various types of expenditure via the NIHR, the economic principles for measuring the economic impact of research and the specific methods used by the research team. This developed a shared understanding of the goals, methods and interpretation of the project's expected results. While the group was not expected to be confident in the details of the project's methodology (particularly the CGE modelling), we sought to enable a clear understanding of its overall aims and principles, including its limitations. The training session was essential for the group to feel confident in interpreting the project's results. The final meeting between the PPI Group and the research team focused on the key messages emerging from the research and how best to describe them to non-technical audiences.

Towards the end of the research project, we shared the draft of the final report with the PPI Group members. We then asked them to email to us any reflections they might have on how best to involve patients and the public in a research project such as this, i.e. one that is economics-heavy and does not draw on their experiences of healthcare. The PPI Group's inputs and their impact on the study are discussed in Chapter 8 (Section 8.2) of this report.

2.4. Evidence review

The evidence review was undertaken to identify the current state of knowledge about empirical estimates of national and regional economic impacts of health and care research in a UK-relevant context, and about the methods used to calculate those estimates. At the outset of the study, based on the research team's previous work in this area, we knew that empirical estimates of the long-term economic rate of return to medical and health care research in the UK do exist at the national level, and for individual locations where research has taken place. However, we had not previously

come across any studies that measured how research in one region would affect the economies of other regions, accounting for the economic interrelatedness of those regions.

2.4.1. Literature review

Early in the study, in summer and autumn 2024, we conducted a rapid evidence assessment of the existing literature and empirical evidence on the economic returns to health and care research. The purpose was to establish the current state of knowledge about how economic returns on medical, health and care research expenditure are captured in practice, the extent to which these returns vary between different types or locations of expenditure, and the measurement of the extent to which public and charity research spending affects private industry R&D spending.

Full details of how the literature review has been conducted, including search terms, inclusion/exclusion criteria and databases searched, are set out in Appendix A. Building on the team's prior work and knowledge of more recent studies, a focused search strategy was developed and refined, targeting relevant health and care and economics literature databases and using inclusion criteria designed to capture English-language sources from 2008 onwards in the UK and other high-income countries. Titles and abstracts were screened, and further literature was identified through snowballing references and input from the project Steering Committee. Data were extracted on study characteristics, methods, and findings, and the quality of evidence was assessed using established criteria (Varker et al. 2015), with greater weight given to higher-quality studies in the synthesis.

2.4.2. Scoping interviews

The aim of the scoping interviews with experts and stakeholders was to capture tacit expert knowledge on the potential economic benefits of spending through the NIHR and their regional impacts that might have been missed in the literature review. Semi-structured interviews were conducted online via MS Teams with 12 senior professionals representing a range of relevant institutions and areas of expertise, including government, research funders, the life sciences industry and academic experts on the economic returns to research. Participants were selected to ensure diverse perspectives, including those from national and regional organisations across the UK. An interview topic guide was used to structure the discussions while allowing flexibility to elaborate on issues of particular importance to them. The scoping interview methods and results are described in detail in Appendix B.

2.4.3. Developing a typology of NIHR-funded activities

Funding through the NIHR contributes to a diverse range of health and care-related research activities, ranging, for example, from public health to clinical trials to policy research projects to infrastructure and researchers' career development. The literature review and scoping interviews were used to detect whether different types of spending through the NIHR might be expected to have significantly different magnitudes or timings of economic impacts. To the extent that data are available on different types of expenditure through the NIHR, this permits nuance in modelling the economic impacts of those expenditures. It also provides a steer for the range of expenditures it is desirable to include in the case studies (see below).

Building on the evidence emerging in the literature review and scoping interviews, we developed a draft typology of spending through the NIHR. This draft typology was discussed with NIHR staff to assess its compatibility with the NIHR's spending data.

This led us to aggregate some expenditure types to create a pragmatic typology. The development of the typology is described in further detail in Appendix C.

2.5. Descriptive analysis of expenditure through the NIHR

We mapped spending through the NIHR across UK nations and English regions from financial year 2013/14 to financial year 2017/18 inclusive, grouped according to the selected typology of spending categories. This pre-COVID-19 period was specified by the NIHR, being recent but long enough ago to allow at least some outcomes from the supported research activities to be observed. Regional spending was compared with demographic and socioeconomic characteristics, and trends in total annual expenditure up to 2023/24 were presented. To produce the maps and figures, we integrated two sources of spending information, providing different aspects of the required information. We used NIHR annual reports to obtain national total spending amounts and their distribution by type, and DHSC finance data (obtained via a data-sharing agreement) for the regional distribution of spending, where the region is determined by the location of the host organisation receiving the funding through the NIHR. Regional spending estimates were scaled to match national totals, ensuring consistency. All figures were adjusted for inflation and expressed in 2023/24 prices per capita within the region. Full details are given in Appendix D. As health and care are devolved in the UK, the large majority of spending through the NIHR is on health and care research in England.

2.6. Updating quantitative estimates in the literature of returns from health gains

The 2008 'Medical research: what's it worth?' study demonstrated that the monetised value of health gains achieved as a result of medical and health care research by public organisations and medical research charities forms an important part of the overall economic impact of that research. Such health gains are likely to be observed first in the locations where the research that leads to them is conducted, but they would eventually spread throughout the country, particularly when propagated through clinical guidelines, and internationally (HERG et al. 2008).

Previous studies have estimated these outcomes at the UK national level across four disease areas: musculoskeletal conditions (Glover et al. 2018), cancer (Glover et al. 2014), mental health and cardiovascular diseases (HERG et al. 2008). These studies estimated the UK public and charity research spending in the respective disease area, the elapsed time before selected consequent innovations were implemented in the UK, the extent to which that implementation could be attributed to the UK research (in the context of the wider and international research ecosystem), and the flow of health gains and implementation costs that then resulted. The health gains were expressed in QALYs and monetised by applying a range of values per QALY. The cost to the health and care system of delivering that benefit was subtracted from the value of the QALY gain, yielding the net health benefit in monetary terms.

We have updated the estimated health-gain-related rates of return to public and charity research expenditures for each disease area in the literature by applying a range of values per QALY gained and expressing all monetary values in 2023/24 price terms. Full details of the method and assumptions are provided in Appendix E. We thereby obtain a very approximate, and admittedly somewhat dated, range of estimates of the health-gain-related rates of return to expenditures through the NIHR.

2.7. Case studies

We undertook four in-depth case studies of NIHR-funded and supported research, in addition to an analysis of the impact case studies that mentioned the NIHR included in the most recent (2021) Research Excellence Framework (REF) assessment of Higher Education Institutions in England (REF 2026a).

2.7.1. In-depth case studies

The four in-depth case studies aimed to provide detailed, qualitative insights into the economic impacts of NIHR-funded research, complementing the project's broader quantitative analysis of funding distribution and returns on investment. By systematically selecting and examining diverse examples of NIHR awards – chosen for their varied impact categories, funding schemes and geographic locations – the case studies illustrate how research investments lead to tangible benefits, such as policy influence, commercialisation, health improvements and economic contributions at both regional and national levels.

The selection process used Researchfish data to identify NIHR awards with demonstrable economic impacts, focusing on policy influence, commercial spinouts, product development and licensed patents. The final list of four case studies was agreed with the NIHR. Full details of the selection process are described in Appendix F.

Each case study was developed using a mixed-methods approach, combining semi-structured online interviews (via MS Teams) with principal investigators, other key research team members and end-users, as well as desk-based review of project documents, published outputs and supplementary data on clinical and economic impacts. To analyse the pathways from research funding to economic and health outcomes, we sought information on study details (cost, dates, publications, purpose/objectives and study design), the context in which the research was conducted (including the motivation), key findings and their potential implications, and the impact of the work (citation in systematic reviews or guidelines, adoption into practice, etc.). Further details of the case study development method are in Appendix F.

2.7.2. REF 2021 impact case studies

In the second part of the case studies WP, we identified NIHR-funded case studies that featured in the impact case studies database of the 2021 REF exercise. The REF is the UK's system for assessing the quality and impact of research in UK higher education institutions. REF case studies should not, however, be considered as representative of the impact of research. These case studies are selected and developed by UK universities to showcase their strongest impact examples that best align with the REF impact assessment criteria and requirements (e.g. requirement to evidence the impact and its link to a specific university's research). Therefore, findings based on REF case studies alone should not be considered generalisable to all research in the UK. We analysed these to understand how the regional distribution of funding translates to impact across UK regions. In a recent RAND Europe analysis of the REF 2021 impact case studies (Stevenson et al. 2023), we found that around 60% of the impact from research was 'exported' to other regions of the UK. Exploring these patterns of impact 'export' across geographic regions adds to our regional analysis of impact. More detail about the method is presented in Appendix F.

2.8. CGE modelling

The economic impact of health research investment includes tangible outcomes like job creation and income generation. Research funding circulates through the economy as direct spending, including the hiring of researchers, indirect effects resulting from the purchase of supplies or the construction of new research facilities, and induced effects in which one person's consumption becomes another person's income (e.g. through the sale of goods or services). Especially in the first few years following the research expenditure, before any new health innovations have time to take effect, these so-called 'demand-side' effects represent the primary economic impacts of research funding.

To evaluate the regional economic impact of spending through the NIHR (by the DHSC and the devolved administrations) across the UK, we adopted a CGE approach, constructing a model capable of accounting for economic interactions between all regions of the UK. As explained in section 1.4, this represents a novel approach to estimating the economic impacts of research.

Previous modelling reported in the literature has applied input-output approaches to estimate the economic returns of spending through the NIHR on the regional and national economy. A notable output of the input-output model is the calculation of multiplier effects, which indicate how much additional economic activity – income and jobs – is generated by initial spending. In our research protocol, we anticipated finding, in the existing literature or from the experts we would interview, indications of whether and how different types of health and care research spending might yield different multipliers. However, this was not the case: we uncovered no such indications of differing multipliers. Consequently, we have relied on the multipliers implicit in the CGE model we built (developed primarily by two members of the research team: EY and MH), the structure, data and assumptions of which are explained in full detail in Appendix G.

Our choice of approach started from the observation that input-output models have important limitations. They assume a linear relationship between inputs and outputs and no capacity constraints in the economy. This means they implicitly suppose that resources such as labour and capital are infinitely elastic in supply, i.e. if a research project needs workers or materials, they can be drawn from an unlimited pool without affecting other sectors. However, economies have finite resources, and spending more on research or other activities can bid up wages or prices, crowd out alternative uses of resources or otherwise change the economic equilibrium. Input-output models assume that the mix of labour and capital used and relative prices do not change, and that economic agents do not change their behaviour in response to price changes. As a result, input-output-based impact estimates are likely to be overstated because they ignore opportunity costs and adjustments that occur in a real economy (Koks et al. 2016).

To overcome these limitations and capture a more realistic, system-wide impact, our study employed a regional, CGE model of the UK economy. CGE models are a standard tool in economic analysis for assessing policy impacts or exogenous shocks, widely used in fields like trade policy, taxation and environmental economics and increasingly in regional economic analysis (Giesecke & Madden 2013). A CGE model represents the economy as a whole system of interdependent markets (e.g. for goods, services, labour and capital), grounded in microeconomic theory. Rather than using fixed multipliers, a CGE model computes a new equilibrium after a shock by allowing prices, wages and the

quantities of goods, services, labour and capital to adjust so that supply and demand balance once more in all markets. In our context, this means the model can simulate how research funding through the NIHR affects not just the directly funded sectors but also related sectors, factor markets and household incomes across all regions. CGE models consider how all markets interact and capture feedback effects, such as changes in household income that lead to changes in consumption, which in turn affect demand for goods in other sectors. In the case of research funding, this allows us to capture not just the immediate ripple of spending but also second-round effects (e.g. higher incomes might increase demand in unrelated sectors). In this way, we ensure that the estimated impacts on incomes and jobs account for both positive and negative feedback loops, giving a net effect that is economically consistent.

Unlike input-output models, CGE modelling imposes budget constraints and full employment on factors, preventing unlimited expansion. If a particular region has a limited labour pool, the model will show rising wages or in-migration when that region's research sector expands, rather than assuming labour appears from nowhere. This feature prevents overestimation of impacts by accounting for opportunity costs. If some resources are diverted from other productive uses to accommodate the NIHR-funded activity, the model will net out the lost output elsewhere from the gained output in the target sector.

Crucially, our CGE model is designed to be multi-regional, disaggregating the UK into 12 regions. This feature allows us to track how investment through the NIHR impacts each region differently.

The CGE model in this study is comparative-static, comparing equilibria before and after the NIHR investment shock but not modelling the dynamic transition between those two states of the economy. Most of the adjustment between two different equilibrium positions is likely to happen in the short- to medium-term, i.e. within 5–10 years, but the full adjustment may take many years.

A final aspect of the regional and national economic impacts of research expenditure through the NIHR, in addition to the health outcomes discussed earlier and to the direct, indirect and induced impacts of the public research spending just described, is that such research funding can produce broader economic benefits often termed as 'spillovers' into the wider economy. These include benefits such as increased economic productivity due to a healthier population and the introduction of new knowledge and technologies. Quantifying such spillover effects is challenging and beyond the scope of the research reported here. However, one further spillover effect from health and medical research is very important, and we are able to include it in our modelling of economic impacts. This is the large amount of additional private industry R&D expenditure that is 'crowded-in' by taxpayer and charity-funded research activity. This significantly adds to GDP growth (Sussex et al. 2016) and has been built into our CGE modelling.

For full details and further discussion of the strengths and weaknesses of our CGE modelling approach, see Appendix G.

2.9. Synthesised findings from all WPs

Findings from the separate WPs informed each other throughout the project's progress via regular exchange and discussions within the project team. Towards the end of the project, the leaders of all WPs met with other members of the research team in a synthesis

and triangulation workshop (SG, MH, BS, JS, AU). The key results and evidence from each WP were collectively reviewed and mapped onto the project's objectives, as presented in section 1.5. The team identified, discussed and reached agreement on whether the evidence gathered is mutually reinforcing, complementary (different evidence concerns different issues) or contradictory. The results of the triangulation and synthesis are presented in Chapter 8.

This follows the presentation of the findings of each WP in successive sections. The next chapter starts that process by setting out the findings from the evidence review.

Chapter 3. **Evidence review findings**

An evidence review was conducted in the early stages of the research (summer and autumn 2024) and comprised two elements as described in Chapter 2: a review of literature from January 2008 to the end of June 2024, followed by interviews with stakeholders and experts in the field. The overall aim was to obtain a complete and up-to-date understanding of the current state of knowledge on empirical estimates and the methods used to obtain them for national and regional economic impacts of health and care research. Based on the literature and interviews, and on NIHR expenditure data available in the public domain and shared under a data-sharing agreement with the NIHR, we developed a typology of expenditures through the NIHR. The findings from each element of the evidence review and the typology development are summarised below. Full details are presented in Appendices A, B and C.

3.1. Literature review

The purpose of the literature review was to establish the current state of knowledge at the study's outset on how economic returns on medical, health and care research expenditure are captured in practice, the extent to which the magnitudes of these returns or the length of time lags before they occur vary between different types or locations of expenditure, and the measurement of the extent to which public and charity research spending affects private industry R&D spending.

Three members of the research team (SM, BS, ALT) reviewed the academic and grey literature published in English on the topic between 2008 and the first half of 2024, inclusive. The start date for the review period was set to the year in which the seminal 'Medical research: what's it worth?' study (HERG et al. 2008) was published, which included references to the key literature up to that time. Twenty-three papers were selected for full review, as described in Appendix A and listed in the table annexed to that appendix. Two researchers (BS, AU) then synthesised the data extracted from these papers into themes related to the objectives of our research. The key points we took from that literature are as follows. More details can be read in Appendix A.

3.1.1. How economic returns to research have been captured

The economic returns to research other than those consequent on health gains due to the outcomes of the research being applied (we consider health gains separately later) can be summed up as the change in the GDP of a country or region, which is roughly equivalent to the gross value added (GVA) produced by the country or region, that results from the research. GVA is typically referred to when considering economic activity in a region or sector within a national economy, while GDP is used when considering the entire national economy. For present purposes, they can be considered as the same. For brevity, we will refer only to GDP from here on, whether national or subnational. The impact of research expenditure on GDP may be due to:

- The jobs and incomes created directly by the research spending.
- Spending on suppliers of goods, services, equipment and facilities used in research (often referred to as indirect effects).

- The induced effects on the rest of the economy as those incomes are spent.
- The additional industry R&D spending that is stimulated by the public research spending.
- Effects on the rest of the economy affecting its productivity (due to knowledge gained from the research and to reduced morbidity and premature mortality resulting in a healthier and larger workforce) and its competitiveness (due to a strengthened science base and a more skilled and productive workforce).

The 'Medical research: what's it worth' study (HERG et al. 2008) estimates econometrically the relationship between public and charity research spending in different disease areas and industry R&D spending in those disease areas, combined with a review of estimates in the literature of the social rate of return to private industry R&D. The study found that the GDP gains from public and charity medical research spending in the UK had a positive internal rate of return (IRR), with a best estimate of 30% per year in real terms, although this figure is subject to considerable uncertainty. The IRR can be thought of as the (real terms) rate of interest being earned on the money spent on research. In other words, £100 of public-plus-charity medical research spending yields a flow of future positive impacts on UK GDP, estimated to be equivalent to £30 per year indefinitely. A later study by some of the same authors with more recent data found a still very positive but somewhat smaller association between public-plus-charity medical research spending and industry R&D, as a result of which the internal rate of return in GDP terms to public and charity medical research was re-estimated to be in the range 15–18%, again subject to considerable uncertainty (Sussex et al. 2016).

Other studies have proceeded by assuming the proportion of observed GDP growth that is attributable to health-related research. For example, Roback et al. (2011) studied returns on health research investment in Sweden and attributed 50% of Sweden's GDP growth over the studied period to research generally, 20% of which was health-related research. Hence, they attributed 10% of the achieved GDP growth (which had averaged 3% per annum) to health-related research.

Several studies have adopted economic modelling approaches, among which input-output approaches are the most frequently used. These are relatively simple to use, as the UK ONS publishes estimated multipliers for different sectors of the economy that describe how many additional jobs or pounds of income would be created for every pound spent in a sector (ONS 2022). One example of using this approach is Smith et al. (2019), who used input-output modelling to estimate the return on investment of the Oxford Biomedical Research Centre (funded through the NIHR), focusing on income and job creation in South East England. The authors noted that while the input-output method is useful when confined to a single region, a 'general equilibrium' approach (discussed in the next paragraph) might be more appropriate when evaluating the full national extent of funding by a specific programme or agency.

CGE modelling of health and care research's economic impacts is more advanced but more difficult to apply than input-output modelling. CGE is commonly used to estimate the effects of a public funding intervention on a (national) economy, but we found only one study applying it to estimate returns on research expenditure. The ACIL Allen study (2023) estimated the economic impact of Australian Research Council funding (including, but not limited to, health and care research) using a CGE model of the Australian economy.

Several studies identified in the review rely on a mixed-methods approach, providing both

qualitative evidence (e.g. case studies) and quantitative evidence (e.g. counts of patents and other economically relevant outputs). Common evaluation frameworks used are the payback framework (Buxton & Hanney 1996; Donovan & Hanney 2011) and the Framework to Assess the Impact from Translational health research (Searles et al. 2016). These frameworks assess the impact of research funding through indicators within domains of knowledge advancement, capacity- and capability-building, economic, policy and legislation, and infrastructure. Such studies typically do not estimate the monetised return on research expenditure but instead rely on 'cost-consequence analysis', in which the ledger of costs is presented alongside a list of attributable consequences, only some of which might be monetised, and the actual comparison and conclusion are left for the reader. Other studies only qualitatively capture and interpret economic benefits.

Overall, our literature findings on how economic impacts of health and care research on incomes and jobs might be quantified point to CGE modelling as superior to simpler input-output approaches.

3.1.2. Capturing and quantifying health gains from research

A systematic review by Raftery et al. (2016) of approaches for measuring the impact of health research included a review of studies estimating the monetary value of health gains resulting from health research. Most of the studies identified by Raftery and colleagues examine the impact of research on the health outcomes of the population in the country where the research is funded. Two broad types of approach are evident: 1) a bottom-up approach of studying a large number of research projects and linking specific health interventions achieved by these projects taken together to the expected health impacts of the constituent interventions via published evidence, such as clinical trials and cost-effectiveness studies, and 2) a top-down approach of observing lagged population-level health gains and attributing a part of them to earlier research. In either approach, the quantified health gains are typically measured as QALYs gained, disability-adjusted life years avoided or simply as improvements in life expectancy and hence life years, unadjusted for the quality of life during those years. Some studies then monetise those health gains using an assumed value per QALY, etc. The conversion rate used to monetise the quantified health gains varies across studies. Several other studies qualitatively examine health gains from research, e.g. via case studies, without estimating their monetary value.

When health gains resulting from health and care research are monetised, a useful metric for presenting their value is the IRR, mentioned earlier in the section on capturing economic impacts. Studies of health gains in the UK attributed, in part, to public and charitable UK research undertaken in the UK, report IRRs from those health gains less the costs of implementing the innovations that produce them in the range of 7–10% for four individual disease areas: cardiovascular disease, mental health, cancer and musculoskeletal disease (Glover et al. 2014; 2018; HERG et al. 2008).

In addition to how economic and health gains have been captured and quantified in the literature, we were interested in finding evidence about the extent to which these returns to research vary across different types of expenditure or geographic locations. The next paragraphs summarise the literature on this.

3.1.3. Variation in impact by type or location of research activity

Most of the studies we reviewed did not differentiate economic returns by type or

location of the research activity. However, while not providing (monetary) estimates of different returns on investment in different research activities, a few studies did offer qualitative hints. Boulding et al. (2020) used Researchfish data and nine qualitative case studies of NIHR-funded research projects in the field of public health to capture the diversity of mechanisms and pathways to impact. The interviewees in the case studies noted that, while the impact of their research on policy was usually hard to ascertain, a more immediate, but smaller-scale, impact often occurred at a local level, e.g. in health service delivery or local government. Various mechanisms, facilitators and barriers to achieving impact were mentioned, but they did not specifically explore which mechanisms and impacts were more closely related to which types of research activities.

Several studies examined specific subgroups of funding, such as health technology assessments (Guthrie, Bienkowska-Gibbs et al. 2015), Biomedical Research Centres and Units (Craig et al. 2020), cyberinfrastructure services for research, or biobanks (Marquina et al. 2025; Stewart et al. 2023). However, owing to differences in methods, settings (countries) and time periods, it is not possible to compare the results across studies to reach conclusions about variations in economic returns achieved by different research types or locations.

Most of the studies we reviewed presented findings at the national level. Few papers addressed intra-national differences in health and medical research funding, and none examined whether economic returns differ by geographic region or location. Craig et al.'s 2020 study on funding through NIHR Biomedical Research Centres and Units maps the regional distribution of this funding across England between 2007 and 2019 and notes its concentration in London, the South East and East of England (Craig et al. 2020). The authors raise a concern about potential inequality in funding distribution and state that economic returns are more likely to be realised locally (e.g. in terms of employment or health gains if innovation is more likely to be adopted in the area it is developed). However, they do not present quantitative evidence of the differential economic returns across regions.

3.1.4. Time elapsed between research spend and impact

Most of the studies we reviewed addressed the time that elapses between health and care research funding and spending and its consequent impacts, although only with respect to the delay before health gains begin. We found no literature about the timelines for impacts on GDP and employment.

The number of years used in studies to represent the time elapsed between research and consequent health gains emerging is typically assumed or based on previous research. However, a few studies empirically estimated the elapsed time directly. One of the most detailed studies to examine the elapsed time remains the 'Medical research: what's it worth' study published in 2008 (HERG et al. 2008), which uses the dates of the publication of research studies and clinical guidelines to estimate the time that elapses before research findings inform clinical practice. The study reports a 10–25-year time lag, with a midpoint of 17 years, for cardiovascular-related research and 9–14 years (midpoint 12 years) for mental-health-related research spending. Replicating this approach for cancer-related research spending, Glover and colleagues estimated lags of 10–20 years, with 15 years as the midpoint (Glover et al. 2014); and for musculoskeletal disease, the estimated lag was 16 years (Glover et al. 2018). A review by Hanney et al. (2015) reports the heterogeneity in time lags estimated across studies as depending partly on the field of research, ranging from 8.5 years for anti-infectives to 15 years for immunological

medicines. Overall, it is clear that there is a wide and variable range of time elapsed between research expenditure and consequent returns in the form of health gains.

3.1.5. The relationship between public and private research investment

The extent to which public and charity research spending affects private industry R&D spending is the focus of a small empirical literature. One of the few studies discussing the topic is the 'Medical research: what's it worth' study (HERG et al. 2008). Reviewing the literature, the authors cite papers suggesting that public spending on medical research in the UK increases industry R&D spending. The magnitude of this 'crowding-in' effect is studied in greatest detail by Sussex et al. (2016), who use an econometric 'vector error correction model' and a time series of biomedical and health R&D expenditure in the UK for ten disease areas between 1982 and 2012. The study concluded that public research investment in the UK does indeed crowd in additional private-sector R&D investments in the UK, so that £1 of public research spending is associated with an additional £0.83–1.07 of private R&D spending, with 44% of the additional expenditure occurring within one year. Sussex et al.'s approach is later replicated by Craig and colleagues (Craig et al. 2020), who updated the data with more recent inputs and concluded that the new empirical evidence broadly supports the earlier estimates by Sussex and colleagues. The crowding-in effect appears to be substantial.

3.1.6. New DHSC estimate of long-term return on investment

During the course of our research, the DHSC was developing an estimate of the long-term return on investment for spending through the NIHR. The DHSC estimate and its calculation were published on the NIHR website in October 2025 (NIHR 2025d). This estimate is based on the same empirical studies we use in the current study to estimate the rate of return from health gains from research funded through the NIHR, and the crowding-in of additional commercial R&D spending in the UK. However, the DHSC estimate is not directly comparable with the research in the present report, as we focus on regional CGE modelling to show how economic effects ripple out from any one region to all other regions, and use a shorter timescale than the 60-year horizon of the DHSC estimate.

3.2. Interviews

To supplement and update the information obtained from the literature review, we conducted 12 interviews with stakeholders and experts in the field between September 2024 and January 2025. Interviews focused on:

- How expenditure through the NIHR could most usefully be grouped into types of funded activities when investigating the expected economic impacts of that expenditure.
- Whether and how the types and magnitudes of economic impacts might be expected to vary across different types of expenditure through the NIHR.
- The expected balance of economic impacts at regional, national and international levels.

Interview participants came from diverse sectors, including the government, public and charity research funders, the life sciences industry and academic experts on the economic returns to research. Along with national-level organisations, we included perspectives from organisations coordinating health research in a UK country other than England, and one for a region of England outside London and the South East. Full details

of the interviews and the range of information and views they yielded are presented in Appendix B.

In summary, taken together, the scoping interviews suggest the following answers to the three questions they were designed to address.

How expenditure through the NIHR could most usefully be grouped into types of funded activities when investigating the expected economic impacts of that expenditure

An overriding point made by several respondents was that the boundaries between different types of expenditures through the NIHR are not clear-cut. However, with that limitation, a three-way typology using categories established by the NIHR to present its expenditure data was agreed as a relevant and helpful basis for considering economic returns: research programmes, infrastructure and research training and career development. We discuss this further in section 3.3 below. A further important dimension within each of those types of NIHR-funded activity is timescale: how soon the economic returns start to flow and for how long they continue. Whether activity funded through the NIHR is specific to a particular disease area, and whether it is focused on public health and prevention or on treatment, might also be relevant to the magnitude and timing of returns achieved.

Whether and how the types and magnitudes of economic impacts might be expected to vary across different types of expenditure through the NIHR

Interview participants did not indicate that they were aware of any additional empirical evidence beyond that in the literature we found about the magnitudes and geographies of the economic impacts of health and care research expenditure. That expenditure through the NIHR pays for jobs and hence incomes – for researchers and for suppliers of resources used by researchers – is common to all types of such expenditure. Some interviewees highlighted the economic benefits resulting from health gains or from savings in NHS costs, while others focused more on the importance of generating economic activity via spillovers to the commercial sector. All types of NIHR-funded activity are expected to contribute to all types of benefits. Several interviewees stressed that funding through the NIHR for infrastructure, including research delivery networks and data capture systems supported by the NIHR, delivers particular value by providing a necessary foundation for other types of research activity. Biomedical Research Centres are another type of infrastructure spending and were considered by interviewees to be particularly fruitful in terms of spinning out commercial businesses. Beyond that, no clearer picture emerged from the interviews of which types of economic returns are likely to be achieved to the greatest extent by which types of NIHR-funded activity.

The expected balance of economic impacts at regional, national and international levels

Interview participants did not indicate that they were aware of any additional empirical evidence beyond that in the literature we found about the magnitudes and geographies of the economic impacts of health and care research expenditure. Additional jobs and incomes created directly were agreed to be likely to be mainly local effects. Health gains and NHS cost savings are initially greater locally to the research activity that generates them but are expected to spread nationally eventually. Crowding-in of additional industry R&D expenditure occurs regionally, where research capacity is increased by expenditures through the NIHR, and nationally, to the extent that activities funded through the NIHR affect the international attractiveness of the UK as a location for commercial R&D.

3.3. Typology of NIHR expenditures

For the purposes of the research reported here, the research team wished to determine whether different types of NIHR-funded activities might be expected to have similar or substantially different economic impacts. The research team started developing a typology of expenditures through the NIHR by reviewing NIHR annual reports. These present expenditures via the NIHR under headings that refer to specific purposes or funding streams (NIHR 2025b).

Within the literature review (see section 3.1), we sought indications for how health and care research spending has been categorised in studies estimating economic impacts. The main distinction in the literature, where any was discussed, was the likely difference in elapsed times (lags) between basic and applied research expenditures and their respective economic and other impacts (HERG et al. 2008). In general, basic research takes longer to yield economic impacts than applied research. The NIHR is predominantly focused on applied research.

Most studies in the literature provide a single estimate of economic returns for a particular funding programme without differentiating between types of expenditure. Different studies examine specific sub-groups of funding, including health-technology assessments, charity versus government funding for medical research, Biomedical Research Centres and Units, clinical research networks and cyberinfrastructure services for research and biobanks (see Appendix A). However, owing to differences in methods, settings (countries) and time periods across studies, it was not possible to compare their results and reach conclusions about differences in economic returns across different types of health and care research.

During interviews with stakeholders and experts in health and care research funding in the UK (see Section 3.2), several respondents noted that the boundaries between types of NIHR-funded activity are not clear-cut. With this limitation in mind, they indicated that the NIHR's Annual Report categories made sense when thinking about economic impacts, particularly if some categories are aggregated. Thus, most often, interviewees suggested a structure of three broad types of activity:

- Research programmes
- Infrastructure
- Research training and career development.

Consistent with our literature review findings, some interviewees suggested going beyond this categorisation to take into account other dimensions, including the timescale over which economic returns could be expected to emerge and the disease area or type of health or care intervention being researched. However, expenditure data disaggregated by timescale for achieving economic returns were not available, and the majority of NIHR expenditure is not disease-specific.

Hence, the research team used the three-way typology above to inform our CGE modelling (Chapter 7). For that purpose, we analysed NIHR awards costs data for the five years between 2013/14 and 2017/18 (provided by the NIHR under a data-sharing agreement). We consider the cost categories 'NHS overheads' and 'NHS support costs' as representing Health economic sector spending ('Human health and social care activities' in the Standard Industrial Classification used by ONS). All other cost categories, such as salaries, equipment and indirect costs, are considered R&D economic sector spending under 'Scientific research and development' in the Standard Industrial Classification used by ONS (ONS 2009). The split of expenditures in Table 1 shows that 95–100% of expenditure through the NIHR falls within the R&D sector of the economy, and this is true for all three types of expenditure.

Table 1: NIHR awards split between spending in the health sector and in the R&D sector of the UK economy

Type of NIHR award	Health sector %	R&D sector %
Research programmes	0.1%	99.9%
Infrastructure	4.2%	95.8%
Research training and career development	0.0%	100.0%

Source: RAND Europe analysis of NIHR awards data 2013/14 to 2017/18.

The NIHR requested that, for the purposes of descriptive presentation of their expenditure data and in line with their Annual Reports and Accounts (NIHR 2025a), we subdivide the infrastructure 'type' into two constituent parts: research delivery infrastructure and other NIHR infrastructure. We have done so in the following chapter. However, the two sub-categories of infrastructure expenditure are modelled as having the same economic impacts.

Chapter 4. **Descriptive analysis of expenditures through the NIHR**

Our descriptive analysis examines the distribution of spending via the NIHR across UK nations and English regions in the financial years 2013/14 to 2017/18 (the period chosen by the NIHR to allow time for some of the effects of that spending to have happened), and across different types of funded activities:

- Research programmes
- Research delivery infrastructure
- Other (translational) NIHR infrastructure
- Research training and career development.

While data on Northern Ireland, Scotland and Wales are captured (due to their 'buy-in' to specific NIHR programmes), it is essential to recall, as previously explained, that NIHR spending is focused on England.

We also present the trend in total annual expenditure through the NIHR by activity type (but not region, as we do not have the necessary regional data), up to 2023/24. All monetary figures in this and later chapters are expressed in 2023/24 price terms.

For the descriptive and other quantitative analyses in this project, we analysed data from three DHSC and NIHR sources. These datasets covered different aspects of data granularity and dimensions; therefore, we combined them for the descriptive analysis. The data sources and their use in this project are summarised in Table 2, with further details provided in Appendix D. Appendix D also shows additional analysis of how far spending through the NIHR correlates with regional population characteristics, such as the proportion of population aged 65 or older, non-white population or population living in rural areas.

From 2013/14 to 2017/18, the grand total of spending through the NIHR decreased each year from £1,336m to £1,322m in 2023/24 price terms, representing an overall real-terms fall of -1.10%. Beyond the period on which we focus in this project, from 2018/19 to 2023/24, total annual spending through the NIHR grew slightly from £1,295m to £1,302m in 2023/24 price terms, representing an overall real-terms increase of 0.48%.

Table 2: Summary of the DHSC and NIHR data sources

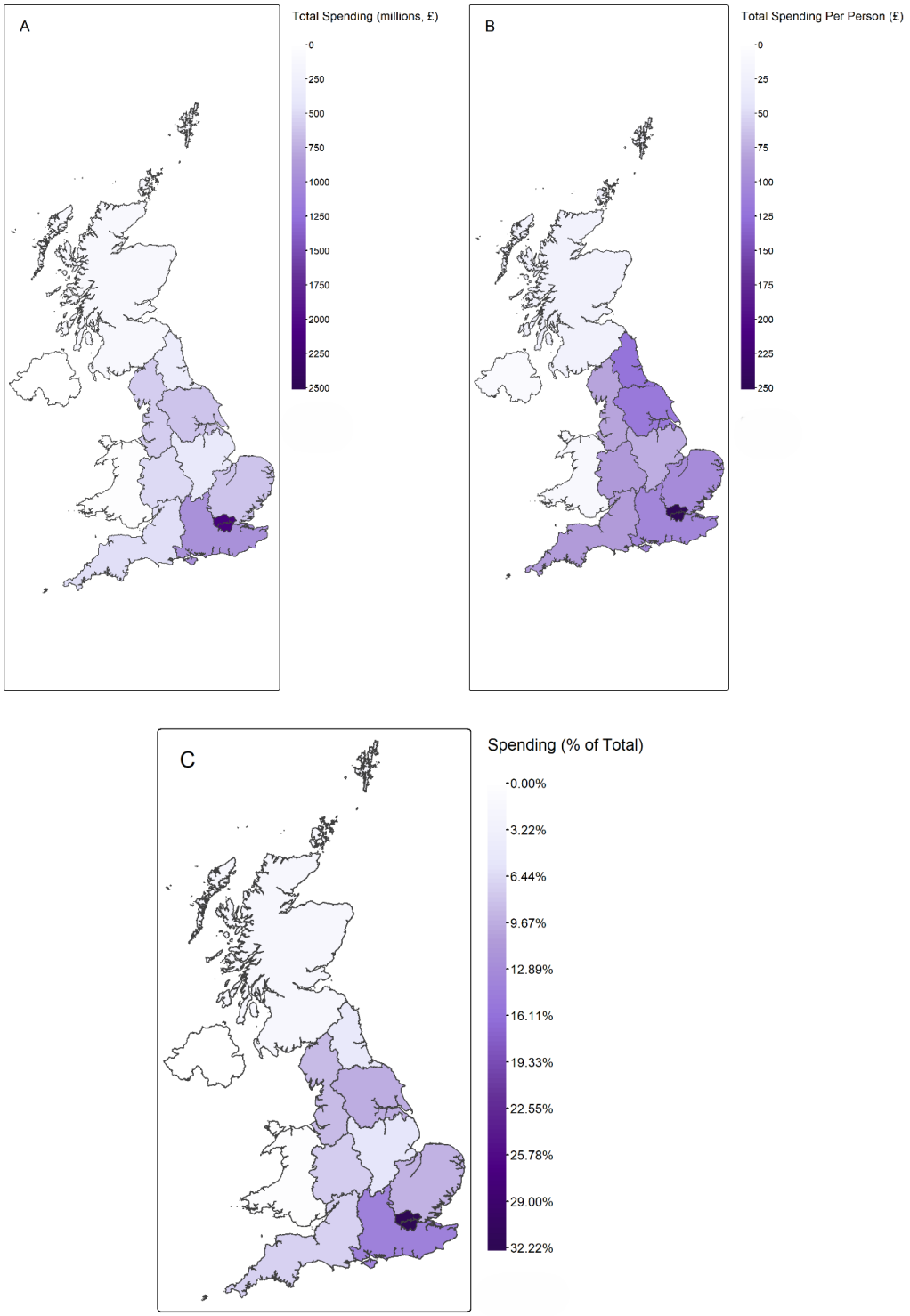
	1. NIHR expenditure data	2. DHSC finance accounting data	3. Awarded amounts for individual NIHR awards
Covered period	2013/14 to 2023/24	2013/14 to 2017/18	2013/14 to 2017/18
Aggregated by financial year	Yes	Yes	No
Regional split	No	Yes	Yes
Split by type[1]	Yes	Yes	Yes (only three types)
Split by cost category[2]	No	No	Yes
Used for annual spend through the NIHR, in total and by type	Yes	-	-
Used for regional distribution of spend through the NIHR	-	Yes	-
Used for cost category distribution, necessary for the economic modelling	-	-	Yes

Notes:
1 'Type' refers to the funding purpose: 'Research Programmes', 'Research Delivery Infrastructure', 'Other NIHR Infrastructure', 'Training and Career Development' and 'Digital and Data'.
2 'Cost category' refers to the NIHR-defined cost categories as reported by NIHR funding recipients for each NIHR award, such as salaries, indirect costs, equipment and treatment costs.

4.1. Total spending through the NIHR by region, 2013/14–2017/18

Total spending through the NIHR over the five years from 2013/14 to 2017/18 for all regions was £6,652m (in 2023/24 price terms). Among the regions, London received the highest spending through the NIHR (£2,143m), accounting for 32.2% of the total spending. In England, the North East had the lowest total spending at £316m. The region with the highest spending per person was also London, at £248.32, and within England, the East Midlands had the lowest per capita spending at £74.78. Spending per region over the five-year period is shown in Figure 3 (total spending per region (A), per person within a given region (B), and relative as a proportion of the total).

Figure 3: (A) total spending per region vs (B) total spending per person per region and (C) total relative spending

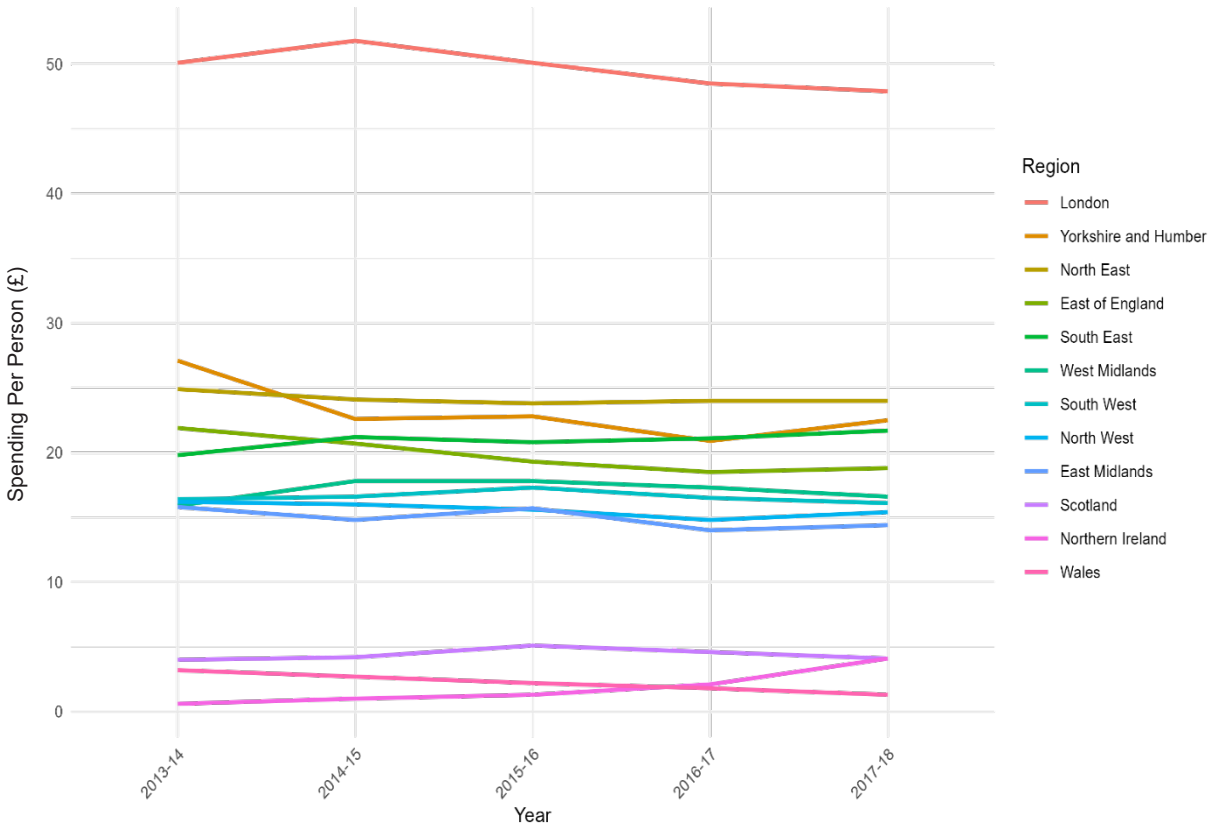


Note: Figure 3C scale considers total spending through the NIHR as 100%.

4.2. Change in spending across regions, 2013/14–2017/18

The change over time in inflation-adjusted spending through the NIHR across regions, per person, is shown in Figure 4. The average change in spending (in 2023/24 price terms) across all regions, from 2013/14 to 2017/18 was a small fall of -£0.75 per person. Throughout that period, expenditure through the NIHR per head of population was roughly twice as high in London as in the rest of England. Spending through the NIHR per head of population in Northern Ireland, Scotland and Wales was much lower than in England, reflecting that the NIHR does not have responsibility for health and care research in the devolved nations.

Figure 4: Annual per-person spending through the NIHR by region, using inflation-adjusted values (2023/24 prices)



4.3. Spending through the NIHR by type and region, 2013/14–2017/18

Figure 5 shows how spending through the NIHR is distributed across regions by spending type. London consistently had the highest spending across all expenditure types. The North East had the second-highest funding for 'Research Delivery Infrastructure', while the East of England had the second-highest spending for 'Other NIHR Infrastructure'. Yorkshire and Humber had the second-highest spending for 'Research Programmes' and 'Training and Career Development'. Figure 6 illustrates the relative regional funding distribution for the period 2013/14-2017/18 across different types, expressed as a percentage of the total funding within each type. London consistently received the highest share across all types of spending. The difference between London and other regions in expenditure received via NIHR per capita was smallest for research delivery infrastructure but substantial for all types of spending through the NIHR – further details are provided in Appendix D.

Figure 5: Total per-person spending through the NIHR by region and type, 2013/14–2017/18, using inflation-adjusted values

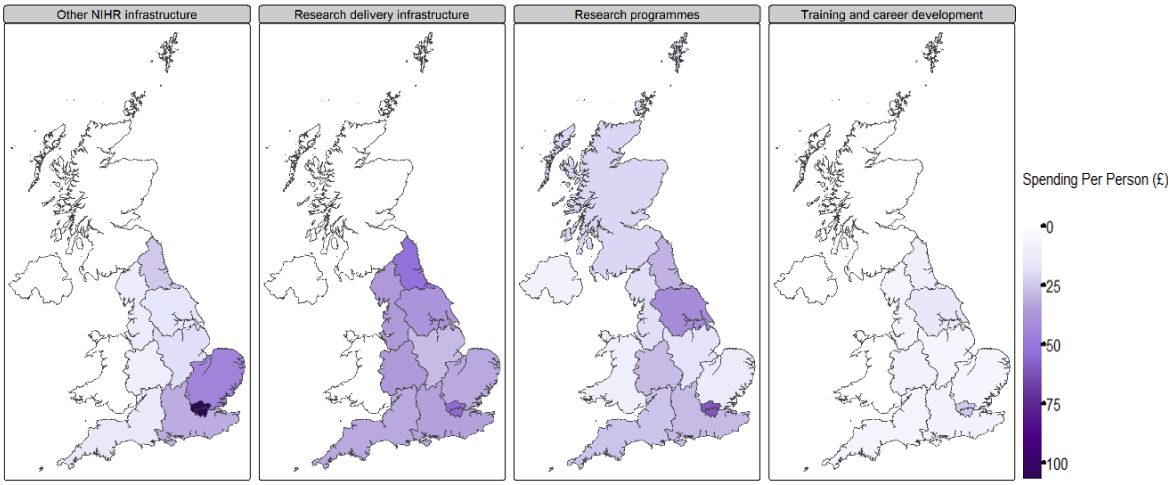
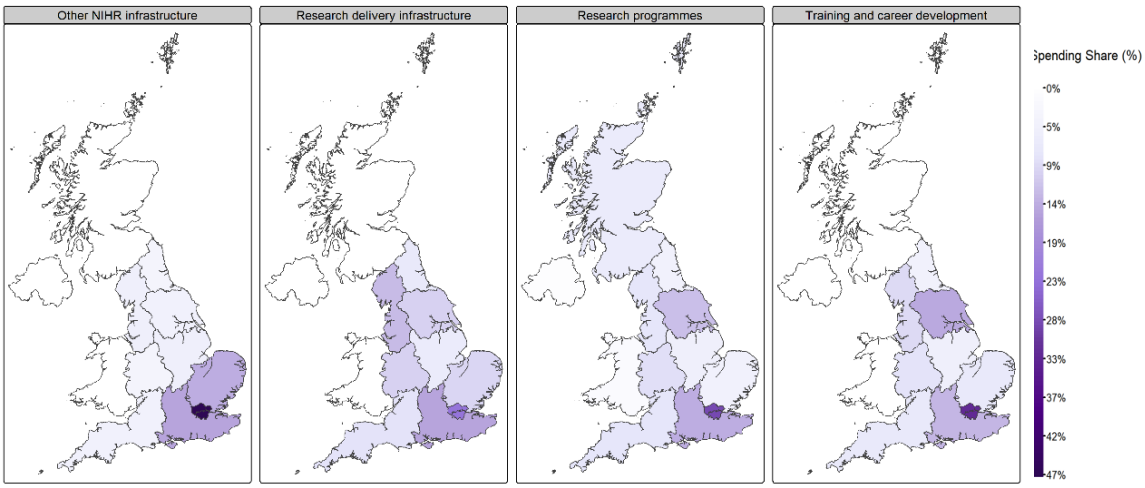


Figure 6: Total spending through the NIHR by region, 2013/14–2017/18, as a percentage of national spending within a specific funding type and using inflation-adjusted values

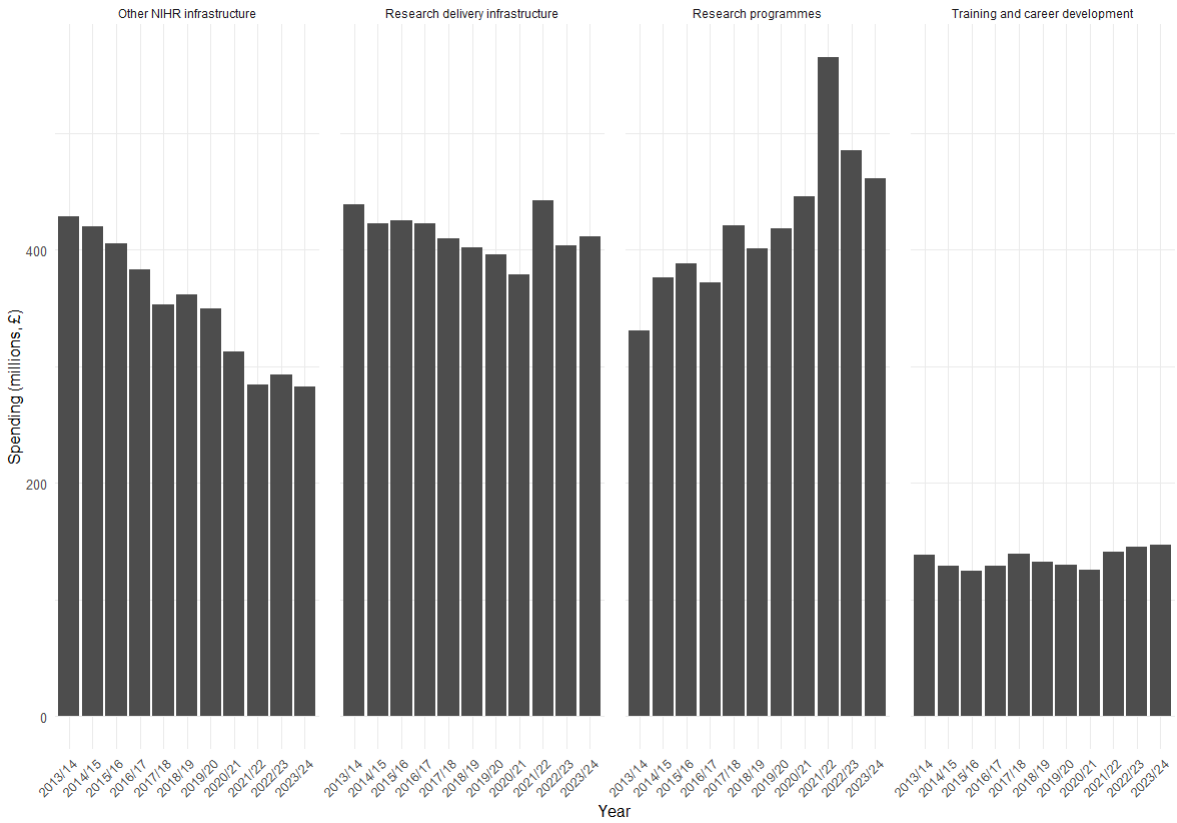


Note: Figure 6's scale considers total spending through the NIHR within a specific funding type as 100%.

4.4. Change by spending type, 2013/14–2023/24

Figure 7 illustrates spending through the NIHR per type of activity each year, adjusted for inflation. It shows a decline in 'other NIHR infrastructure' spending and a gradual decrease in 'research delivery infrastructure' over time, while spending for 'research programmes' steadily increased, with a particular jump in 2021/22 (largely attributable to COVID-19 response funding). In comparison, spending for 'training and career development' remained more stable. Thus, infrastructure expenditure declined from 68.6% of the total spend in 2013/14 to 61.5% by 2017/18, and declined further to 53.7% of the total spend through the NIHR by 2023/24. Spending on training and development rose from 9.3% to 10.8% and then to 11.1% of the total, while spending on research programmes increased from 22.1% of total expenditure through the NIHR in 2013/14 to 27.7% in 2017/18 and 35.2% in 2023/24.

Figure 7: Spending through the NIHR by type: totals in NIHR annual reports from 2013/14 to 2023/24, adjusted for inflation (2023/24 prices)



Chapter 5. **Health gain rates of return**

5.1. Scope

As well as being the principal reason for undertaking the research, the health gains that may result from research expenditures through the NIHR are also an important part of its overall economic impact. Successful research may result in more effective and cost-effective ways to deliver better health and health care. In this chapter, we present the evidence from the literature on the scale of such health gains per pound spent on health research, and how we have updated those published estimates. As described in the next sub-section of the report, there are three relevant published studies, covering four disease areas (cancer, cardiovascular, mental health and musculoskeletal). Each study entailed a major, labour-intensive search for relevant innovations contributed to by the UK public or charity-supported research, for evidence of the implementation costs and health gains in the UK from those innovations, and for how much of those gains (and implementation costs) is attributable to UK research. Future research might usefully reproduce those studies with the benefit of many more years of data and might expand the range of disease areas covered. In the present study, we have undertaken a more limited update of the published studies by revising the costs they report for inflation and applying a new monetary value per QALY of health gain.

Health gains from research outcomes are a national (and international) benefit for the patient groups or population subgroups served by the resulting innovations. The regional spread of these health gains is likely to reflect, eventually and at least approximately, the regional spread of the health care need addressed by the innovation. In the shorter term, however, it is likely that patients in the location where the funded research is conducted will benefit sooner than those in the rest of the country. Our literature review and consultations with expert researchers in the field imply that there is no empirical evidence relevant to the UK on the speed with which such health gains spread from one region to the rest of the country. Consequently, in our research, we have focused on quantified estimates of health gains at the UK national level.

There is accumulating evidence that populations served by research-active healthcare professionals receive higher quality care than those served by non-research-active healthcare professionals (Boaz et al. 2024). However, we have not found any quantification of this type of benefit, and so do not consider it further in this report. The interregional speed of spread of health benefits from research could be a fruitful area for future research.

Improving the health of the working-age population can also be expected to reduce premature mortality, to reduce time off work due to illness ('absenteeism'), and potentially to increase the productivity of people who are at work, but who would otherwise be performing less well due to health challenges (so-called 'presenteeism'). Taken together, these potential work-related economic benefits of health and care research are referred to as productivity impacts. Estimating the productivity impacts of health gains is beyond the scope of the present study, but would be another useful topic for future research.

The focus of the research presented in this report is on modelling the impact of expenditure through the NIHR on the GDP of the countries and regions of the UK. We add to that an estimate of the health-gain-related rate of return at the UK national level, based on a review of the empirical literature and an update of the health-gain IRRs reported there. An IRR is a measure of the rate of return that can be thought of as equivalent to the interest earned on the initial research investment. Thus, for example, a 10% IRR would mean that the returns earned on each £1 of investment are equivalent to earning £0.10 in interest each year thereafter. How we updated the IRR estimates from the literature, and the resulting estimates themselves, are reported in the following paragraphs and in more detail in Appendix E.

5.2. Findings

Studies in the literature have estimated medical research health gain outcomes from government (including NIHR) and charity-funded research at the UK national level for four disease areas: cancer (Glover et al. 2014), cardiovascular disease (HERG et al. 2008), mental health (HERG et al. 2008) and musculoskeletal conditions (Glover et al. 2018). In all these studies, the health gains from research expenditure are expressed as the IRR in real terms (i.e. after adjusting for inflation). The IRRs are calculated by comparing the initial UK public and charity research investment in a disease area with the consequent health gains in the UK population, expressed in monetary terms, minus the cost of delivering those benefits, for a prioritised list of health interventions over a period of time. This list does not represent all health innovations over the respective period and therefore implicitly assumes that any other innovations attributable to UK public and charity research had a net benefit of zero. Based on their reviews of the evidence about individual innovations in the respective disease areas, the authors of these studies made assumptions (see Appendix E for details) about:

- The elapsed time between research funding and the consequent health gain
- The duration and time profile over which health gains would be realised
- The percentage of the overall UK health gains and implementation costs that can reasonably be attributed to UK research.

These studies estimated IRRs from the value of UK health gains associated with UK public and charity investment in medical and health research by first identifying the consequent health gains expressed as QALYs. The number of years over which health gains were estimated varied between the individual studies: 20 years for both musculoskeletal conditions and cancer, 18 years for mental health and 14 years for cardiovascular diseases. In each study, the authors then assumed a central value per QALY of £25,000 in money of the day at the time of the study, and conducted sensitivity analyses using ranges of values either side of £25,000. At the time the studies were conducted, this value was the midpoint of the £20,000–30,000 per QALY threshold range used by NICE when determining whether a new treatment should be offered by the NHS. On this basis, the studies yielded estimated health-gain IRRs ranging from 7–10% in real terms, depending on disease area. The weighted average of the four disease-specific internal rates of return (using as weights the relative expenditures through the NIHR on research in those disease areas in 2014) is an IRR of a little over 8%, as shown in the second column of Table 3.

For the purposes of the current research, we assumed that spending through the NIHR in the four disease areas for which health-gain IRR estimates already exist will continue to

yield health gains at the rates implied by those studies, and that the costs of delivering those health gains will have increased to 2023/24 financial year price terms at the general rate of inflation (measured by the GDP deflator at market prices) since those studies were undertaken. We then applied a value per QALY gained of £70,000 in 2023/24 price terms. This is HM Treasury's suggested value of the UK population's average willingness to pay for a QALY, which is the appropriate value to use when adopting a UK societal perspective on the value of health gains (HM Treasury 2022).

The third column of Table 3 reports the estimated health-gain IRRs for each of the four disease areas, with costs updated to 2023/24 price terms and health gains valued at £70,000/QALY in those terms. These updated estimates range from 11–15%, with a weighted average of 13%. If we assume that overall research expenditure through the NIHR achieves the same health gains and impacts on health care costs as past UK research in these disease areas on average, then the national IRR from health gains if QALYs are valued at £70,000 in 2023/24 price terms is 13% in real terms.

Table 3: Internal rates of return (IRRs) from the value of QALY gains net of delivery costs

Disease area	Reported in source study using £25,000/QALY in money of the day (various years' price terms)	Updated to 2023/24 price terms and using £70,000/QALY
Cancer (Glover et al. 2014)	**10.05%**	**15.22%**
Cardiovascular disease (HERG et al. 2008)	**9.20%**	**13.77%**
Mental health (HERG et al. 2008)	**7.04%**	**10.90%**
Musculoskeletal disease (Glover et al. 2018)	**6.76%**	**12.04%**
Weighted average IRR	**8.43%**	**13.00%**

Notes: Sources underlying these RAND Europe calculations are referenced in the table. Weighted average IRR is weighted by 2014 research expenditure through the NIHR per disease area (UK Clinical Research Collaboration 2015).

Chapter 6. **Case studies**

As part of this study, the research team conducted four qualitative case studies. The objective of the case studies was to provide in-depth insights into the economic impacts of activities funded through the NIHE, complementing the broader quantitative analysis of expenditure distribution and returns on investment across the UK. By examining specific examples of NIHR awards, the case studies illustrate how research investments translate into tangible benefits, such as policy influence, commercial outcomes, health improvements and other economic contributions at both regional and national levels. This qualitative component highlights the mechanisms through which NIHR funding generates value, including spillover effects across regions, while capturing variations in impact based on award type, location and research focus.

In this section, we set out key findings regarding the economic (and wider) impacts observed across these four case examples. This is followed by an analysis of cross-cutting findings, particularly regarding the mechanisms through which these impacts are generated, which can inform our understanding of the NIHR's economic impact more widely. Full case study write-ups and details of the methods used to conduct them are provided in Appendix F.

6.1. Overview of the case studies and their impact

The selected cases were chosen in discussion with NIHR staff to represent diversity in impact categories (policy influence, commercial spinouts and practice changes), funding schemes (research awards and fellowships), and geographic distribution, ensuring a balanced view of the NIHR's contributions to health and wealth. Given the small sample, the four case studies cannot be representative of the NIHR portfolio as a whole. Considering this and to ensure a more informative analysis, we selected case studies anticipated to have a demonstrable impact. The four case studies are summarised in Table 4.

Table 4: Overview of case studies

	Project title	Research organisation	Timeframe	Key type of impact expected	Award type and value (GBP)
1	REMAP-CAP: Randomised, Embedded, Multifactorial Adaptive Platform trial for Community-Acquired Pneumonia (COVID-19)	Imperial College London	01/04/2020 - 31/03/2023	Policy and practice influence	Research award; £1,249,630

	Project title	Research organisation	Timeframe	Key type of impact expected	Award type and value (GBP)
2	Clinical development and evaluation of an advanced prototype for in situ microbial sensing, providing early antibiotic susceptibility data for organisms colonising chronic wounds	University of Manchester	01/04/2015 - 30/06/2017	Spin-out	Research award; £552,945
3	A randomised placebo-controlled trial of mifepristone and misoprostol versus misoprostol alone in the medical management of missed miscarriage: the MifeMiso trial	University of Birmingham	01/02/2017 - 31/07/2020	Policy influence	Research award; £1,715,379
4	Improving the management of children with respiratory and urinary tract infection in primary care	University of Bristol	01/01/2010 - 31/12/2013	Policy influence	Fellowship; £420,688

6.2. Economic and other impacts from the case studies

Reviewing these four case studies, we found a diverse and significant set of impacts across different dimensions, as summarised in Table 5.

Table 5: Summary of impacts from the case studies

Impact category	Case Study 1: REMAP-CAP	Case Study 2: Microbial sensing	Case Study 3: MifeMiso trial	Case Study 4: Fellowship on children's primary care
Knowledge production	Generated definitive evidence on 14 different COVID-19 treatments within a rapid timeframe.	Accelerated the processing of information on the level and type of bacteria present and which antibiotic to use for treatment from 4 days to 10 hours.	Produced definitive evidence regarding the effectiveness of combination therapy for missed miscarriage management.	Provided core funding which enabled studies such as TARGET, which supported the development of the STARWAVe clinical rule, a seven-point tool designed to help GPs classify a child's risk of hospitalisation and support more informed, targeted decisions around antibiotic prescribing.
Benefits to future research	Demonstrated the transformative potential of adaptive platform trial methodology, including statistical and data-management innovations.	The research-informed applications of technology in other settings, particularly in the area of peritoneal dialysis for kidney patients.	Transferable learning on rapid translation from research completion to guideline implementation (within three years).	The Fellowship played a key role in building long-term research capacity for the Fellow and his wider team, spanning the set-up and running of cohort and diagnostic studies and statistical modelling, for example.
Informing policy and product development	Informing policy: Hydrocortisone was recommended by the UK Chief Medical Officer with immediate action (2020); the UK Medicines and Healthcare products Regulatory Agency supported access to hydrocortisone, tocilizumab or sarilumab for eligible COVID-positive patients (2020, 2021). In 2020 and 2022, the World Health Organization incorporated the results into international treatment guidelines. National health authorities worldwide updated their treatment protocols based on REMAP-CAP evidence, and medical societies incorporated the findings into clinical practice guidelines.	Product development: UK and international patent applications filed for a microbial sensing device that builds on the work funded by this award.	Informing policy: NICE guideline NG126 '*Ectopic pregnancy and miscarriage: diagnosis and initial management*' updated to include guidance to prescribe both mifepristone and misoprostol for the medical management of miscarriage rather than misoprostol alone, citing this trial.	Informing policy: Results from broader research funded by the NIHR and involving the Fellowship recipient directly informed Public Health England's (now UK Health Security Agency) antimicrobial stewardship policy and led to changes in recommendations in five NICE clinical guidelines. Findings also informed large-scale public health initiatives, including the 2017 '*Keep Antibiotics Working*' campaign.

Impact category	Case Study 1: REMAP-CAP	Case Study 2: Microbial sensing	Case Study 3: MifeMiso trial	Case Study 4: Fellowship on children's primary care
Health and care impacts	Findings directly influenced the treatment of millions of patients worldwide. An estimated 25,000 patients received IL-6 receptor antagonists in the UK during 2021 based on REMAP-CAP evidence, resulting in approximately 2,000 lives saved in the UK alone during that single year. Intensive care unit (ICU) stay durations were reduced by more than one week per patient treated, and effective therapies freed up critical care capacity for additional patients during surge periods. The study findings also prevented harm from inappropriate treatment, identifying no benefit in critically ill patients from hydroxychloroquine, lopinavir-ritonavir, and convalescent plasma. The trial prevented the continued use of ineffective treatments that carried risks of adverse effects and consumed healthcare resources.	The device has been rolled out to and used in around 10% of UK nephrology clinics.	Early evidence suggests widespread adoption of the new protocol across NHS trusts. Based on the trial findings, this could result in 2,800 fewer surgical procedures per year, calculated by applying the 8% reduction in surgical intervention rates observed in the trial to the estimated 35,000 women who choose medical management annually. As well as cost savings, this leads to improved patient care through reduced psychological distress, improved treatment success and enhanced patient autonomy.	Together, the wider set of (NIHR-funded) studies this award enabled have contributed to real-world benefits, most notably a 12% reduction in primary care prescriptions (four million fewer prescriptions/year) between 2018 and 2022.
Other economic benefits	Pharmaceutical industry impacts, particularly for companies whose products demonstrated efficacy in the trial. Also, cost savings due to reduced hospital stays (e.g. reduction in ICU length of stay by more than one week per patient treated with effective therapies) and significant QALY benefits (e.g. improved quality of life, reduced disability and better functional outcomes at six months post-discharge).	The i4i award supported the spin-out MicroBioSensor and contributed to it employing approximately 12 full-time equivalents (FTEs) each year between 2018 and 2023.	Combination therapy resulted in a cost saving of £182 per successfully managed miscarriage, largely through reduced surgical intervention costs. Higher treatment resolution rates and reduced need for unplanned surgery enable more women to return to work in a timely manner.	Indirect contribution to the Otigo product, which is now prescribed across the UK, with average sales of approximately 15,000 packs per month. Potential NHS cost saving due to reduced antibiotic prescribing (but no estimate available).

6.2.1. Impacts on the economy

Even focusing specifically on economic impact, we see a range of impact types illustrated in just these four examples. In some cases, economic impact is generated through the commercialisation of research findings, supporting further (non-NIHR) investment, job creation and product commercialisation. For example, the REMAP-CAP study's pharmaceutical-industry impacts (Case Study 1) were both immediate and substantial, particularly for companies whose products demonstrated efficacy in the trial. Roche's tocilizumab sales to healthcare systems treating over one million COVID-19 patients globally represented several hundred million pounds in additional revenue. However, the commercial value extended beyond direct sales to include enhanced market position, regulatory advantages and strengthened relationships with healthcare systems worldwide. On a smaller scale, the microbial sensing work made important contributions to the spin-out company MicroBioSensor (Case Study 2), playing a role in supporting employment of around 12 FTEs, and contributing to the development of UK and international patent filings as well as further investment in the company (for example, £1.4m in equity finance secured in November 2017).

There is also reason to believe that the REMAP-CAP study had longer-term implications for the UK economy. The trial's success enhanced the UK's reputation as a location for international clinical research, positioning the country as a leader in innovative trial methodology. The UK contributed 5,568 of the total 10,000 COVID-19 patients recruited worldwide, representing the majority of global recruitment, despite the UK accounting for a much smaller fraction of the global population affected by COVID-19 (NIHR 2023a).

The REMAP-CAP study also complements other innovative platform studies. One example is the RECOVERY trial, which was funded by UKRI, the Medical Research Council (MRC), Wellcome and the NIHR, and supported by the NIHR Research Design Network, as a multi-arm, multi-stage (MAMS) platform trial that recruited 47,000 patients in just two years to identify potential therapies for COVID-19. Another example is the STAMPEDE MAMS trial, which received funding from MRC and Cancer Research UK, as well as further support from Prostate Cancer UK, NIHR infrastructure and industry. The STAMPEDE trial aimed to lengthen the life expectancy of advanced prostate cancer patients by giving additional out-of-patent treatments alongside standard-of-care hormone therapy early on, rather than waiting until hormone therapy had stopped working. The STAMPEDE trial won a 2025 NIHR Impact Prize and has led to a second wave, the STAMPEDE 2 trial.

In other cases, we see economic benefits in the form of cost savings to the NHS. For example, the MifeMiso trial (Case Study 3) led to the implementation and cross-UK roll-out of combination therapy for the management of miscarriage, which resulted in a cost saving of £182 per miscarriage (Okeke Ogwulu et al. 2021). The REMAP-CAP trial led to changes in COVID-19 treatment that significantly reduced the typical length of stay in hospital for patients by around one week, which results in significant cost savings of around £2,730 per patient in 2023/24 price terms, assuming £390 per day for a standard bed day (GOV.UK 2024; REMAP-CAP Investigators et al. 2021; Writing Committee for the REMAP-CAP Investigators et al. 2023; UK Parliament 2023). Similarly, work following on from the fellowship award (Case Study 4), largely through further project awards funded by the NIHR, led to guideline changes and changes in the UK Health Security Agency's antimicrobial

stewardship policy, which contributed to a 12% reduction in primary care prescriptions (four million fewer prescriptions per year) between 2018 and 2022, a significant cost reduction (NIHR 2023d).

Economic benefits can also accrue through health improvements resulting from these investments. For example, in the case of the MifeMiso trial, the more effective treatment is suggested to provide economic benefits as women who benefit from improved treatment may be able to return to work more quickly (source: research interviews 'RC_1', 2025; 'RC_2', 2025). Similarly, the significant reductions in mortality and morbidity resulting from more effective COVID-19 treatment based on the REMAP-CAP study can be assumed to have had important impacts on productivity in the UK and beyond.

Most of the case studies include more than one of these pathways, with economic impacts accruing through several different routes. There are also benefits to future research and through gains in knowledge, as well as an intrinsic value to new knowledge, though this is not readily monetised. The more tangible benefits are those that reduce the costs of future research (e.g. through methodological developments, by making processes more efficient and by sharing knowledge to pool resources) or increase the skills of researchers.

6.2.2. Impact mechanisms

The case studies illuminate the mechanisms by which funding through the NIHR can impact the UK's health and wealth.

First, it is important to emphasise that **impacts primarily result from an ecosystem of funding rather than any one award**. It is the combination of funding from different sources that is often critical in driving impacts, and it is hard to disentangle the impacts of one award in isolation. This is clearly demonstrated in Case Study 4, which focuses on a fellowship award. The fellowship provided base funding to enable the principal investigator (PI) to conduct research funded through a range of further NIHR awards, which led to a range of impacts on policy and practice. Although the PI's research led to multiple changes in NICE guidelines, this policy change occurred gradually, with individual studies designed to address clearly defined clinical uncertainties. Through the PI's journey, we see that each piece of research has contributed to a broader agenda, such as strengthening diagnostic confidence, informing national messaging and supporting antimicrobial stewardship at scale. In the MifeMiso example, while the important findings detailed are funded through an NIHR award, the researchers leading on the work were based at a research centre that is core-funded by the pregnancy and miscarriage charity Tommy's. Both funding sources were crucial to the delivery of that work, illustrating the potential complementary and reinforcing roles of NIHR and charitable research funding.

Second, these examples demonstrate how **infrastructure and fellowship funding provide an underpinning basis for individual projects and enable them to have impacts.** The critical role of infrastructure support by the NIHR was noted in three of the four case studies, except for the i4i award. The fellowship in Case Study 4 illustrates one aspect of this, namely support for individuals. However, there is also clear evidence about the value of wider infrastructure investment. In particular, the NIHR's former Clinical Research Network (CRN – renamed the NIHR Research Delivery Network (RDN) in November 2024) was key to the rapid and effective delivery of the REMAP-CAP trial. Initially supporting research nurses at a dozen hospitals during the inter-pandemic phase, the CRN's established relationships and embedded research capacity allowed for rapid expansion to 143 hospitals when COVID-19 emerged. The

CRN was the crucial infrastructure that enabled the UK to make such a significant contribution to the global trial. Networks – particularly the NIHR-supported Birmingham Clinical Trials Unit and its network – were also important to the delivery of the MifeMiso trial. This mature infrastructure enabled the trial to take place across a network of 28 UK healthcare institutions, intended to cover a mix of urban and rural settings across England, Scotland and Wales to ensure the trial's findings would be broadly applicable to diverse NHS contexts and patient populations.

6.2.3. Regional vs national impacts

As part of these case studies, we aimed to identify and explore any regional impacts they had in the area where the work took place. To this end, we conducted case studies based in different regions. Interestingly, we did not identify significant localised impacts in these cases. In most cases, the impacts of the work occurred at the national (or in some cases international) level. The reason for this was the national-level infrastructure (e.g. national-level guideline bodies and CRNs) through which research is both conducted and implemented in practice. These national-level mechanisms mean that large-scale trials typically take place across a range of locations rather than just the primary funding location and are relevant and implemented across a diversity of settings as a result.

Our additional analysis of NIHR-funded studies in the REF 2021 database supports the view that the impacts of research are spread across regions (REF 2026b). Studies conducted in one region typically report multiple instances of impacts in other regions as well (see Appendix F for details).

6.2.4. Timescales of impacts

It is also important to note that **impacts, particularly economic impacts, emerge and evolve in different ways over time.** Typically, we assume that the impact of research can be slow to emerge and builds up over time (Lane 2009; Morris et al. 2011; Salter & Martin 2001). However, these case study examples illustrate how heterogeneous that picture can be. For example, the fellowship case study provides a classic example of the expected pathway, in which multiple awards over time slowly build a picture that leads to layers of new information and evidence, resulting in important and significant changes in policy and healthcare delivery in the longer term. However, REMAP-CAP provides a contrasting example, in which a novel trial design (and indeed a significant concentration of resources at the national level) resulted in rapid policy change and healthcare impact within short timeframes. Interestingly, shortly after these events, the expectation was that the experience from REMAP-CAP would lead to changes in trial designs, potentially yielding a further significant impact, but we now see that this has not materialised as expected. This highlights the importance of the timing in evaluating research impact: if the anticipated impact on future clinical practice had been assessed immediately after the award, it would have been higher than the realised impact that we might attribute now.

This illustrates that **the understanding of impact from research investments can change over time.** Indeed, while we might expect the impact from awards to grow over time, this may not necessarily be the case. Whether qualitative or quantitative, any assessment we make of research impact is a snapshot at a particular time. An assessment at a different time point may yield a different result.

Similarly, any estimate of the time lag from research to impact can only be considered as a proxy for a wide range of possible values. In the case of the REMAP-CAP study, although the time lag from the specific award to impact was

short, the work was also crucially underpinned by the former NIHR Clinical Research Network, which was established over decades. Similarly, the MifeMiso trial was highlighted as delivering rapid impact on policy and practice, with the findings of the award (which ran from 2017 to 2019) published in 2020, included in guidelines in 2023 and rapidly implemented in practice thereafter. However, the impact was also underpinned by the funding from the charity Tommy's since 2016 and from the NIHR-supported Birmingham Clinical Trials Unit for almost 20 years. This shows that, even beyond differences in time to impact between awards and within a single case study, the time lag is difficult to define since multiple, layered investments contribute to a particular impact.

6.3. Implications for our analysis of the NIHR's economic impact

Overall, these case studies have a range of implications for our understanding of the NIHR's economic impacts. **First, it is important to consider the impact as emerging from a complex, layered and interacting network of funding sources.** Specific pieces of research may appear to have high impact but often build on a foundation of other underpinning work, which may include translational and delivery infrastructure support, fellowship awards and methodological development. Our four case studies featured examples of all this underpinning, for which funding may have come from the NIHR or other sources, such as medical research charities. Measuring the impact of awards in isolation, or without considering the underpinning investments, may lead to unrealistic estimates of economic returns. It may also undervalue other types of funding and investment that provide those underpinnings within a complex research ecosystem.

Second, the time point of analysis will have a material impact on the nature and extent of the impact attributed to the research. A nuanced view of the impact is needed that considers how the picture may change and evolve over time.

Finally, focusing on the location of funding – particularly the primary award holder's location – as the region that benefits exclusively from research investment may be oversimplistic. As illustrated in these examples, many large-scale studies, particularly trials, are multi-site and include healthcare settings across a wide range of areas. Similarly, due to the distributed networks for trial implementation and national-level infrastructure for policy and practice change and roll-out, and based on these case examples, impacts can – and often do – happen at the national rather than the regional level.

Chapter 7. **Findings from the CGE model of regional and national economic impact**

In this chapter, we explain:

- The expected direct, indirect and induced economic activity impacts of research spending through the NIHR.
- How these impacts have typically been estimated using simple input/output multipliers, which may be sufficient to model the impact in one region, but which do not take into account economic interactions between regions.
- The strengths of our CGE modelling approach, how it overcomes some of the limitations of existing analyses, and how it enables (for the first time) regional economic impacts to be estimated that take into account the interrelated nature of regional economies within the UK.
- Key points about our model, how it is structured, where the data came from, assumptions made and the limitations of our approach.
- The scenarios modelled and their rationales.
- The modelling results for the different scenarios, presented in turn.

We then finish with a concise summary of the chapter.

7.1. The macroeconomic impact of health research investments

An important channel through which health research investment contributes to the wider economy is via its short- and medium-term macroeconomic effects, including job creation, income generation and regional economic development. When research funding enters the economy, it first manifests as direct expenditure, e.g. through the employment of researchers and technical staff, the procurement of equipment and laboratory materials or the construction and maintenance of research facilities. These direct activities, in turn, generate further economic interactions. For example, firms supplying goods and services to the research sector experience additional demand, stimulating activity across upstream industries – so-called indirect effects. Moreover, as income generated by increased demand circulates through households, the resulting consumption of goods and services generates further rounds of spending across the economy, creating additional employment and income – called induced effects. In the short term, before any new scientific or health innovations can influence population health, these direct, indirect and induced demand-side mechanisms constitute the principal macroeconomic impacts of health research funding.

7.1.1. How these macroeconomic impacts are estimated

Past studies have used a range of analytical methods to estimate the economic returns on research investment. One of the most widely applied tools for assessing the macroeconomic impacts is input-output modelling. This approach traces how spending in one part of the economy, such as a research investment used to hire staff or purchase equipment, stimulates further activity across other sectors. The input-output framework relies on

inter-industry transaction tables that describe how industries buy from and sell to each other. Using these data, economic multipliers are then applied to estimate how an initial investment translates into broader changes in output or employment through direct, indirect and induced effects. The appeal of input-output modelling lies in its simplicity and its ability to provide quantitative estimates of short-run economic impacts.

However, input-output models are built on simplifying assumptions that do not hold in most situations. Crucially, they assume that there are no capacity constraints, meaning that labour, capital and other resources are assumed to be available at any time in unlimited supply at constant prices. In practice, economies operate with limited resources. When large research investments are made, they can draw workers and materials away from other sectors or regions, thereby putting upward pressure on wages or prices or crowding out alternative uses of these funds. Moreover, input-output models treat technology as fixed, do not allow substitution between factor inputs such as labour and capital, and do not account for the behavioural responses of firms or households to changes in prices or the availability of goods.

While the aggregate national benefits of UK publicly funded health research have already been documented, as described in Chapter 3, much less is known about the regional distribution of economic impacts. Existing studies focus on national impacts or isolated individual regional cases, leaving a need for a system-wide analysis of regional and national effects. Where input-output modelling has been applied previously at the regional level, its limitations become even more restrictive, as they do not account for how regions interact within the broader national economy. For instance, when one region experiences an increase in economic activity following new research investment, part of this growth reflects new economic activity created locally, but may also involve the movement of workers, capital and other resources from neighbouring regions. In other words, some of the apparent regional gains may come at the expense of reduced activity elsewhere. At the same time, the increased demand for intermediate goods or higher household consumption is not limited to one geographical area. These effects tend to spread across regions, as supply chains and consumption patterns link local economies together. As a result, input-output-based impact estimates tend to capture the mechanical demand-side effects of spending but overestimate total economic gains, because they exclude supply-side constraints and opportunity costs that exist in a real economy.

7.1.2. Strengths of our approach

To address the limitations of the existing input-output analyses and capture a more realistic, system-wide picture of economic impacts, our study employs a CGE model of the UK economy. CGE models are increasingly applied to assess the economy-wide implications of policy changes in areas such as trade, taxation, climate change and, increasingly, regional development. We are aware from our literature review (Chapter 3.1) of one study that uses CGE at the national level and across all areas of research, not just health and care (ACIL Allen 2023), to assess the impact of research investments.

The CGE approach can also be developed to enable the estimation of direct, indirect and induced economic impacts at the regional level (Brandsma et al. 2015; Christensen 2022). However, to our knowledge, no UK-wide regional CGE model exists to assess the economic impact of health research. The CGE model developed for this study is multi-regional, disaggregating the UK into 12 regions. This enables us, for the first time, to examine how expenditures through the NIHR affect

different parts of the country, identifying both regional and national economic impacts.

In essence, a CGE model represents the economy as an interconnected system of markets for goods, services, labour and capital, all grounded in microeconomic theory. Unlike input-output models, which rely on fixed multipliers, a CGE model computes a new equilibrium after an external shock by allowing prices, wages and quantities to adjust so that supply and demand balance across all markets. In this context, the model enables us to examine how research funding through the NIHR influences not only the sectors directly receiving the investment but also related industries, factor markets and household incomes across all regions of the UK. Several features make the CGE framework particularly well-suited to the objectives of this study.

First, CGE models capture the interdependence of all markets within the economy. They trace how a change in one sector of economic activity, such as higher research spending, affects household incomes, consumption and demand in other sectors. This allows the analysis to capture both the immediate spending effects and the second-order ripple effects in other parts of the economy.

Second, CGE models explicitly incorporate the supply side of the economy, recognising that factor inputs such as labour and capital are limited and that increased demand for these inputs can raise costs or reallocate resources from other sectors or regions. For instance, if research spending increases in a region with a tight labour market, the model will show rising wages, which may also lead workers to relocate to that region. This prevents the overestimation of impacts by incorporating opportunity costs that occur when resources are diverted from other productive uses to accommodate NIHR-funded activity, as the model accounts for the lost output elsewhere.

Third, unlike in input-output models, prices and wages in CGE models are not fixed, which allows us to observe the impact of research expenditure not only on output changes but also on how real household incomes change. This is essential for a comprehensive assessment, as the value of research funding lies not only in the gross increase in overall production but also in the net welfare gains once price and distributional effects are considered.

Full details of our modelling, including the model's structure, data and assumptions, are explained in Appendix G. The key points of the CGE model are summarised here, before we present the modelling results.

7.2. Summary of the CGE model structure, data, assumptions and limitations

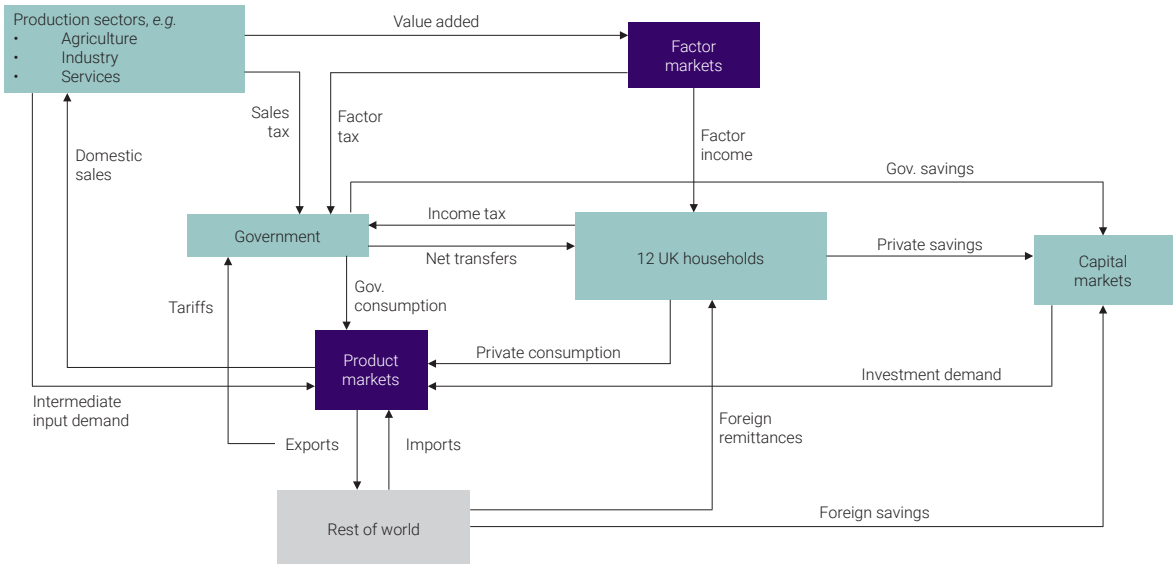
Our multi-regional CGE model disaggregates the UK into 12 regions: the nine ONS English regions plus the devolved nations of Scotland, Northern Ireland and Wales. This enables us to examine heterogeneous regional outcomes while summing to a coherent national picture. The model is comparative-static, meaning it compares two steady-state equilibria, for example, before and after the NIHR investment. This setup enables us to capture both demand-driven and supply-side adjustments within a tractable yet comprehensive framework.

7.2.1. Model structure

The model represents the economy as a system of interacting agents, including households, firms, the government and the rest of the world, interconnected through markets for goods, services, labour and capital. Households supply labour and capital to factor markets and allocate income between consumption and savings. Firms use capital, labour and intermediate inputs to produce

goods and services , which are consumed by households and the government. In the model, 12 region-specific 'science and R&D' sectors are distinguished alongside other key sectors, including human health services, pharmaceuticals, residential and social care, and a composite 'all-other' sector. The government collects taxes, purchases goods to provide public services and transfers income to households. The rest of the world interacts through trade in goods and services, with the UK modelled as a small, open economy that takes world prices as given. The model structure is depicted in Figure 8.

Figure 8: A depiction of the model



Note: The figure shows the linkages between various agents (households, the government and the rest of the world), various markets for goods and inputs, and the flow of money.

Source: The research team.

7.2.2. Data inputs and construction of the Social Accounting Matrix

The backbone of the CGE analysis is a newly constructed UK Social Accounting Matrix, developed to provide a coherent, internally consistent snapshot of the national and regional economy. The construction of the Social Accounting Matrix represents a major analytical contribution of this study. It integrates multiple ONS data sources into a unified, regionally disaggregated framework that connects production, factor income, household consumption, government finances and external trade. This comprehensive database allows the CGE model to simulate how research funding through the NIHR circulates through the UK economy across industries, households and regions, capturing the channels through which research investment generates economic value. The Social Accounting Matrix represents the circular flow of income through the economy in a single, balanced framework and serves as the empirical foundation of the model, recording all monetary transactions between the model's economic actors and ensuring that every income has a corresponding expenditure.

The data input to the Social Accounting Matrix are drawn from the ONS Supply and Use Tables for 2022 (ONS 2025a), which describe how industries purchase inputs from one another ('use' table) and supply their outputs to final users ('supply' table). These data establish the structure of inter-industry relationships and the value-added generated by each sector of the economy. To extend this to incorporate additional accounts, we integrated the Supply and Use Tables with additional data information from:

- Gross Disposable Household Income (GDHI) (ONS 2024) and Institutional Sector Accounts (ONS 2023b), which provide income and transfer flows between households, government and non-profit institutions.
- Regional Household Final Consumption Expenditure (RHFCE), which details consumption patterns across UK regions (ONS 2020).
- Public Sector Finances, to ensure consistency between fiscal flows, government spending and taxation (ONS 2026).

The Social Accounting Matrix is structured to reflect key accounts representing:

1. Production activities, including six aggregated sectors:
    a. All other industries (non-health)
    b. Basic pharmaceutical products and preparations
    c. Scientific research and development services
    d. Other professional, scientific and technical services
    e. Human health services
    f. Residential care and social work activities.
2. Commodities, capturing the flow of goods and services from domestic producers and imports to final demand categories (household, government, investment and exports).
3. Factors of production, representing the payments to labour and capital and their allocation to regional households.
4. Institutions detailing income and transfers between households, government and non-profit organisations.
5. The rest of the world, recording international trade and transfer flows.

The ONS Supply and Use Tables only capture UK aggregate economic activities at the national level. Therefore, to evaluate regional impacts – a key feature of the model – the aggregate UK household accounts were disaggregated into 12 regional household

groups, corresponding to the UK's main regions. This was conducted through a multi-step procedure:

1. Income disaggregation: Using GDHI data, we calculated regional shares of labour income (wages and mixed income) and capital income (operating surplus and property income).
2. Expenditure disaggregation: RHFCE data were used to allocate household consumption across sectors for each region. Where direct data were not available (e.g. for professional services), expenditure was imputed using regional income shares from GDHI.
3. Transfers and taxes: Government–household transfers, social contributions and taxes were also allocated regionally based on these datasets, ensuring consistency between income sources and uses.

Furthermore, to incorporate the regional disaggregation of funding through the NIHR, the scientific R&D sector was further broken down into 12 regional sub-sectors using regional GVA data provided by the ONS (2025b). To capture interregional labour linkages, the wage bill was disaggregated using ONS commuting data (ONS 2023a), which maps where workers live and work. Although this dataset does not distinguish between industries, it provides a reasonable proxy for regional labour supply mobility. Adjustments were made to ensure that total labour income in each region matched the factor payments in the Social Accounting Matrix, maintaining overall balance.

Lastly, to capture crowded-in private research investment induced by funding through the NIHR, we drew on empirical estimates from Sussex et al. (2016), who found that every £1 of public medical research funding generates between £0.83 and £1.07 of additional private R&D expenditure, with around 44% realised within the first year. To be conservative, we have used the lower-bound elasticity (0.83) and the one-year realisation rate, and estimated that the NIHR's £6.7bn investment between 2013/14 and 2017/18 crowded in approximately £2.4bn of additional private R&D in the short term. To distribute these spillover effects regionally, we used data from the Association of the British Pharmaceutical Industry (ABPI) on the location of pharmaceutical research sites and clinical trial enrolments. Each region's weighted share of these indicators determined its share of the total additional private R&D investment, reflecting where industry R&D activity is most likely to respond to public funding.

7.2.3. Key modelling assumptions

The CGE modelling framework used in this study rests on a set of important assumptions that define how the economy responds to a funding shock such as NIHR investment.

First, the model is comparative-static, meaning it compares two equilibrium states of the economy (*before* versus *after* the NIHR funding injection), without explicitly tracing the adjustment path between them. In practice, this means that results capture the short- to medium-term economic effects of spending through the NIHR once markets have re-balanced, which can be assumed to occur within the first 5–10 years.

Second, expenditure through the NIHR is modelled as an exogenous output subsidy to the scientific R&D and human health services sectors. This is a common way to model R&D investments (Brandsma et al. 2015; Christensen 2022). The subsidy effectively stimulates demand for labour and capital by firms in industries that receive the funding, thereby also stimulating demand from other industries and households, and triggers broader economy-wide impacts.

Third, the model assumes that all markets clear, meaning that prices, wages and returns to capital adjust until supply equals demand across all markets. The model does not assume fixed multipliers, as input-output models do, but instead computes a new equilibrium that reflects behavioural adjustments by all modelled economic agents.

Fourth, the model divides the UK into 12 regions, each with its own household, labour market and R&D sector. In the model, labour can work in one region while residing in another, reflecting commuting patterns observed in ONS data. However, the overall number of workers in the economy is fixed, so expansion in one region's R&D sector may draw labour from neighbouring regions. This allows the model to reflect that one region's economic gains may partly result from resource reallocation away from other regions rather than additional economic activity alone. In reality, an economy might adjust to some extent by hiring labour from abroad.

Fifth, the UK is modelled as a small, open economy, meaning that it trades with the rest of the world but cannot itself influence global market prices. Export and import prices are taken as given and remain constant throughout the model simulations. This means that changes in economic output in UK sectors, specifically R&D sectors, do not affect global market prices.

Sixth, the government collects revenue through income and commodity taxes and uses it to finance public services and transfers to households. In our modelling, public service provision is held constant, meaning that any fiscal surplus or deficit arising from NIHR investment is offset through adjustments in net government–household transfers. As such, any government surplus is allocated to household welfare rather than spent on additional government expenses.

7.2.4. Model limitations

While the CGE model offers a novel and improved approach to estimate the regional effects of investments through the NIHR, several limitations must be acknowledged.

First, as the model is comparative-static, comparing two equilibria, before and after the NIHR expenditure happened, it only captures the short- to medium-term equilibrium effects of research spending and the potential effects of additional crowded-in private research investments. However, additional potential effects arising from the NIHR funding are not represented in the analysis, such as technological innovations or health gains, and their consequent productivity improvements, and other longer-term economic impacts identified through our literature review and case studies. Our modelling results should therefore be interpreted as the short- to medium-term (5–10-year), economy-wide effects of expenditures through the NIHR rather than the full economic return to society.

Second, the model treats expenditure through the NIHR as an exogenous inflow of funds into the economy, rather than as spending financed through taxation from households, firms or through government budget reallocation. In essence, it assumes that expenditures through the NIHR drop into the UK economy like 'manna from heaven'. This approach to modelling is predominant in the literature as a way of isolating the effect of the expenditure of interest. However, public investment in research may crowd out other forms of government spending or require additional tax revenue, which could alter household consumption. As research investment decisions are likely based on already collected government revenues, a scenario where money gets paid back to households is unlikely, and the scenario analysis (described later in this chapter) considers a counterfactual scenario where the funds allocated to the NIHR

would have been spent on other government services instead.

Third, due to data limitations, the regional disaggregation of R&D sectors relies on proxy measures, specifically regional research expenditures, to approximate regional gross value added. While this approach aligns with Organisation for Economic Cooperation and Development (OECD) and Eurostat practices for constructing regional Social Accounting Matrices when regionally disaggregated output data are unavailable, it may not perfectly reflect true variations in local research productivity, absorptive capacity or the rate at which R&D benefits other parts of the region's economy. Similarly, the allocation to regions of industry R&D that is crowded in by research spending is based on indicators such as clinical trial enrolment and pharmaceutical industry research site locations. While plausible, these proxies cannot capture the full complexity of industrial clustering or collaborative networks when funding through the NIHR enters the economy.

Fourth, due to a lack of granularity in the available sectors in the ONS supply and use tables, the economic impacts are applied at highly aggregated sector levels. In particular, the data only distinguishes one large R&D sector; it does not disaggregate health research sectors from other non-health research sectors, for example.

Fifth, due to how the underlying Social Accounting Matrix (SAM) is derived, employment effects can only be assessed through changes in the overall wage bill. Employment can be measured as the number of people employed or through the wage bill (the total income received by the production factor labour). The headcount captures the quantity of labour, but it does not reflect changes in wages. By contrast, the wage bill measure captures the value of labour employed, considering both the number of workers and changes in wages, and therefore represents the total income accruing to labour as a production factor. In a general equilibrium model setting where wages adjust to clear labour markets, and where capital intensity and regional factor mobility all change simultaneously, the wage-bill indicator provides a more economically meaningful measure of labour-market impacts.

7.3. Scenarios modelled

To assess the economic impact of funding through the NIHR, we simulated a series of counterfactual scenarios using the multi-regional CGE model. All the results are expressed relative to a (hypothetical) baseline scenario in which no such funding occurs. The baseline represents a counterfactual economy in which spending through the NIHR is set to zero, and no equivalent public investment is made elsewhere. This allows us to isolate the effects of funding through the NIHR on national and regional economic outcomes. This scenario is then compared against several counterfactual scenarios. Each of the counterfactual scenarios is applied with: (a) no industry R&D crowded in, and (b) with industry R&D crowded in.

Scenario 1 captures the aggregate effect of actual spending through the NIHR across the UK over the five-year period from 2013/14 to 2017/18. The total public investment of approximately £6.7bn is entered into the model based on the observed regional and sectoral distribution of NIHR funds, predominantly to scientific R&D services and, to a lesser extent, to human health services. In essence, this scenario quantifies the aggregate national impact of funding through the NIHR and its regional distribution as it actually occurred.

To explore the potential spatial dynamics of public R&D investment, we then simulated 12 regional counterfactual scenarios, one for each region in turn (Scenarios 2–13). For each of

these regional scenarios, expenditure through the NIHR is modelled as occurring only in a single region, with expenditure in the 11 other regions set to zero. These regional simulations highlight how investment concentrated in any one region ripples through national supply chains and factor markets, thereby generating economic activity in all other regions.

Scenario 14 simulates an alternative government spending counterfactual. That is, in scenarios 1–13, funding through the NIHR is introduced as an additional inflow into the economy without displacing other public spending. This approach to modelling is predominant in the literature. However, to recognise that expenditure through the NIHR comes from the UK government's overall resources, we modelled a scenario where there is no expenditure through the NIHR, but the same total amount is assumed to be spent by the general government services sector in line with the actual regional distribution of that expenditure (a similar approach was used by ACIL Allen in their 2023 report estimating the impact of Australian Research Council expenditure). In essence, this scenario enables an assessment of whether spending via the NIHR yields higher returns than equivalent government outlays elsewhere over the short- to medium-term, which is the assumed time horizon for equilibrium to re-establish within the CGE model.

Finally, to address uncertainty about model parameter inputs, we conducted a sensitivity analysis to provide a range of estimates around our base-case findings. The sensitivity analysis assigns probability distributions to each selected parameter based on plausible ranges. We then simulated 500 independent iterations, in each of which the parameter values are randomly chosen from their assumed distributions. We then derived the lower and upper bounds of the 95% confidence interval from these distributions to provide a range for the counterfactual scenario results. The applied uncertainty ranges for the key model input parameters are outlined in Appendix G.

7.3.1. Scenario 1: Total expenditure through the NIHR, 2013/14–2017/18

Table 6 reports the results for Scenario 1. Total expenditure via the NIHR over the five-year period from 2013/14 to 2017/18 amounted to about £6.7bn, expressed in 2023/24 price terms. Compared with a baseline scenario of zero funding through the NIHR, the model estimates that this investment increased UK GDP by £7.3bn when only public research spending effects are considered, ranging from £6.9–8.6bn across the applied uncertainty bounds of model input parameters. When the crowded-in private R&D activity is included, total GDP rises to £9.6bn in the base case, ranging from £9.1–11.5bn.

At the national level, this corresponds to a GDP multiplier of 1.09 (range = 1.04–1.29) without private spillovers and 1.45 (range = 1.37–1.73) with them. In other words, every £100 of expenditure through the NIHR generates, over the short- to medium-term, around £109 (range = £104–120) in return and £145 (range = £137–173) once the additional private-sector research it stimulates is taken into account.

Table 6: Scenario 1: Total expenditure through the NIHR, 2013/14–2017/18; change in GDP (2023/24 prices)

Private R&D crowding-in:		Scenario 1					
		No			Yes		
	NIHR Funding (£m)	Base	Low	High	Base	Low	High
Region							
North East	315.6	**256.9**	*250.0*	*302.9*	**335.6**	*325.0*	*399.1*
North West	561.1	**737.2**	*705.9*	*870.9*	**979.7**	*935.3*	*1,173.9*
Yorkshire and the Humber	623.4	**584.0**	*564.3*	*694.9*	**749.6**	*717.9*	*899.6*
East Midlands	350.4	**491.6**	*467.2*	*574.1*	**646.3**	*610.5*	*768.1*
West Midlands	492.1	**597.8**	*573.3*	*710.2*	**772.1**	*734.4*	*927.4*
East of England	603.3	**766.3**	*731.7*	*913.0*	**1,030.1**	*982.7*	*1,246.1*
London	2,143.2	**1,212.2**	*1,188.5*	*1,440.9*	**1,519.7**	*1,472.7*	*1,818.7*
South East	939.3	**1,025.9**	*961.8*	*1,147.0*	**1,368.0**	*1,274.4*	*1,586.3*
South West	453.5	**827.8**	*782.5*	*966.2*	**1,094.8**	*1,029.8*	*1,304.3*
Wales	34.7	**304.0**	*273.4*	*374.3*	**442.8**	*408.3*	*543.5*
Scotland	118.3	**324.8**	*276.0*	*409.0*	**544.0**	*497.7*	*671.1*
Northern Ireland	17.0	**130.3**	*114.4*	*161.9*	**162.7**	*141.2*	*197.3*
Total funding	**6,651.8**						
Change GDP (£m)		**7,259.0**	6,889.0	8,565.3	**9,645.4**	9,129.9	11,535.4
GDP multiplier		**1.09**	1.04	1.29	**1.45**	1.37	1.73

Note: All monetary values are expressed in 2023/24 price terms. 'Base' refers to the central (base case) estimate, while 'Low' and 'High' denote the lower- and upper-bound results, respectively, derived from the probabilistic sensitivity analysis. Data on Wales, Scotland and Northern Ireland capture the extent to which the devolved administrations 'buy-in' to specific NIHR programmes.

The economic gains are observed across all UK regions, though their magnitude broadly reflects where research funding is concentrated. London, the South East and the East of England, which together received 55% of spending through the NIHR between 2013/14 and 2017/18, are estimated to have experienced the largest absolute increases in regional GDP. For example, London's GDP rises by roughly £1.21bn (£1.19–1.44bn) without additional crowded-in private R&D, and by £1.52bn (£1.47–1.82bn) with additional private R&D being crowded in. Other regions are also estimated to experience sizeable GDP gains. Regions that have received relatively small levels of funding through the NIHR, such as Wales, Scotland and Northern Ireland, are estimated to experience GDP gains that are much larger than the direct NIHR investment received.

Taken together, the UK outside London, the South East and the East of England received 45% of expenditure through the NIHR in the five years between 2013/14 and 2017/18, but a rather larger proportion (59%) of the modelled consequent increase in GDP in the UK (including crowded-in industry R&D). We note that, according to high-level, percentage data for England shared by the DHSC in April 2026, the proportion of NIHR funding in England that is outside London, the East of England and the South East has been increasing since the period of the study considered in this report: from 43% in 2013/14 to 50% in 2024/25.

These results highlight a key feature from the applied CGE modelling analysis: expenditure through the NIHR, even before accounting for its potential long-term health benefits, generates a UK-wide economic return that is composed of economic activity in the region where the R&D expenditure initially took place, but also GDP created in other regions through integrated supply chains and household spending effects.

Table 7 summarises the estimated employment impact, expressed as the per cent change in the (real) wage bill by region, resulting from total expenditure through the NIHR over the five-year period between 2013/14 and 2017/18. Results are shown for the base case as well as the lower and upper bounds from the sensitivity analysis, both with and without private R&D crowding-in effects. The UK national-level values represent the weighted average across regions, reflecting the national aggregate change in labour demand, measured by total labour income. Unlike input-output models, which rely on fixed employment multipliers, the CGE framework does not generate a unique full-time-equivalent employment figure. This is because labour markets in the model adjust through wages and sectoral reallocation of labour inputs rather than through mechanical changes in headcount. Instead, the model reports changes in total labour income (wage bill), which provides a more economically meaningful and general-equilibrium-consistent measure of employment impacts. Increases in the wage bill reflect stronger labour demand and higher employment, capturing both job creation and wage effects, and therefore represent the appropriate measure in a CGE setting.

Table 7: Scenario 1: Total expenditure through the NIHR, 2013/14–2017/18; employment impact (% change in labour income)

Private R&D crowding-in:	Scenario 1					
	No			Yes		
	Base	Low	High	Base	Low	High
Region						
North East	**0.61%**	*0.61%*	*0.69%*	**0.81%**	*0.80%*	*0.90%*
North West	**0.55%**	*0.54%*	*0.61%*	**0.74%**	*0.73%*	*0.83%*
Yorkshire and the Humber	**0.61%**	*0.61%*	*0.68%*	**0.77%**	*0.76%*	*0.87%*
East Midlands	**0.50%**	*0.49%*	*0.54%*	**0.67%**	*0.65%*	*0.72%*
West Midlands	**0.56%**	*0.56%*	*0.63%*	**0.73%**	*0.71%*	*0.81%*
East of England	**0.55%**	*0.54%*	*0.61%*	**0.76%**	*0.75%*	*0.86%*
London	**0.60%**	*0.61%*	*0.68%*	**0.77%**	*0.77%*	*0.86%*
South East	**0.41%**	*0.40%*	*0.38%*	**0.57%**	*0.54%*	*0.56%*
South West	**0.48%**	*0.47%*	*0.49%*	**0.64%**	*0.62%*	*0.68%*
Wales	**0.32%**	*0.27%*	*0.39%*	**0.57%**	*0.52%*	*0.67%*
Scotland	**0.31%**	*0.25%*	*0.36%*	**0.59%**	*0.55%*	*0.68%*
Northern Ireland	**0.30%**	*0.25%*	*0.36%*	**0.35%**	*0.28%*	*0.37%*
UK	**0.50%**	**0.49%**	**0.55%**	**0.68%**	**0.66%**	**0.75%**

Note: Entries show the change in the wage bill, a measure of the total income received by the production factor labour. 'Base' refers to the central (base case) estimate, while 'Low' and 'High' denote the lower- and upper-bound results, respectively, derived from the probabilistic sensitivity analysis. The national (UK) figures are calculated as a weighted average, using regional GDP shares as weights. Data on Wales, Scotland and Northern Ireland capture the extent to which the devolved administrations 'buy-in' to specific NIHR programmes.

Across the UK as a whole, investment through the NIHR is estimated to have increased the total labour income, a measure of the value of labour employed in the economy, by around 0.50% in the base case without private R&D spillovers, with a range of 0.49% to 0.55% across the sensitivity bounds. In absolute terms, this corresponds to an increase in total UK labour income by about £6.3bn (range = £6.1–6.9bn). When the effects of crowded-in private R&D investment are incorporated, the national labour income rises by 0.68% in the base case (£8.5bn), with results spanning 0.66–0.75% (£8.3–9.4bn).

The regional results show that the positive employment impacts are widespread but vary regionally in magnitude. It is estimated that with an increase of about 0.6%, the North East, Yorkshire and the Humber, and London are expected to experience some of the more significant increases in employment. Most other regions are estimated to experience an

increase in total labour income of 0.30–0.55% before crowded-in private R&D is taken into account. Once crowded-in private R&D is included, the percentage increase in total labour income ranges between 0.35% in Northern Ireland, reflecting the devolved administration's relatively small investment via the NIHR, and 0.81% in the North East of England. Approximately 52% of the total UK change in labour income occurs outside London, the South East and the East of England when industry R&D crowding-in is taken into account.

7.3.2. Scenarios 2–13: Regional analyses

To explore how expenditure through the NIHR affects different parts of the economy, Scenarios 2–13 simulated the effect of spending through the NIHR in each UK region in turn while holding all other regions' spending through the NIHR at zero. This allowed us to trace not only the effect of health research funding within the region that receives it, but also the regional spillover effects transmitted from each region to all the other regions. Table 8 summarises these economic flows based on the base-case model parameterisation, focusing on results without private R&D crowding-in effects to illustrate within- and between-region economic interactions.

Across the 12 columns of Table 8 (labelled Scenarios 2–13), each scenario isolates the impact of spending through the NIHR in a specific region. The figures under each column show how much additional GDP is generated in the region that received the funding and in every other region as a result of that recipient region's funding. For example, column 2 represents spending through the NIHR in the North East alone, column 3 in the North West, and so on. The row values within each column show where the resulting GDP effects occur across the 12 UK regions, and the column sums show the total national effect of the NIHR investment in each region. For example, the £315.6m expenditure through the NIHR in the North East over the five years between 2013/14 and 2017/18 (in 2023/2024 price terms) is estimated to have created £80.6m of additional GDP in this region, but also £24.4m in the North West and £27.1m in London and so on across all the other regions, resulting in a total national GDP increase of £299.1m.

The national GDP multipliers for Scenarios 2–13 range from 0.94 to 1.18. The findings may suggest that certain regions where funding through the NIHR represents a relatively large share of the total regional GDP economic output (e.g. the North East, Yorkshire and the Humber, and London) exhibit slightly lower multipliers, below 1.0. This likely reflects the existence of some capacity constraints captured in the modelling approach. For example, if the research investment is large relative to the size of the regional economy, that region might have to draw resources like labour and materials from elsewhere, reducing the marginal return per pound of spending received through the NIHR, which may raise local costs and redistribute some of the economic effects to other regions. Note that the effects captured by the CGE model also explain a few negative effects visible in Table 8 for Wales, Scotland and Northern Ireland. When a funding inflow occurs, resources such as labour or intermediate goods may be drawn away from other regions to meet increased demand. In these cases, the model shows a modest reduction in regional GDP in one or two regions because some factors of production reallocate toward regions where the funding investment occurred.

Each row in Table 8 presents complementary findings, with the figures indicating the amount of GDP each region gains from its own NIHR funding and from spending through the NIHR in all other regions. For example, Northern Ireland saw £17.0m in spending through the NIHR,

from which a £14.7m GDP gain is estimated; however, the total GDP increase for Northern Ireland, accounting for all NIHR investments across Scenarios 2–13, is about £118.9m.

Summing across all 12 regional scenarios in Table 8, spending through the NIHR generates a UK-wide GDP increase of £6.65bn, equivalent to an average multiplier of 1.01, which is below the 1.09 obtained when all funding occurs simultaneously, as reported in Table 6 for Scenario 1. This difference is expected because the region-specific simulations for Scenarios 2–13 emphasise the impact of individual funding flows, whereas Scenario 1 allows them to interact and reinforce each other simultaneously across the different regions.

For the base case without private R&D crowding-in effects, Table 9 shows the estimated employment impacts as per cent changes in overall compensation for the production factor labour by region for Scenarios 2–13 associated with the modelled NIHR investment. Similar to the GDP effects, it demonstrates that investment via the NIHR increases the total labour income in the region that received the funding, with regional spillovers to all other regions. For example, in Scenario 2, the increase in the North East is 0.27%, and all other regions are estimated to also experience modest increases in their regional labour income.

Table 10 summarises how much of the GDP generated remains within the region that initially received the NIHR funding and how much spills over to the rest of the UK. Results are reported for the base-case parameterisation as well as the lower and upper bounds from the sensitivity analysis, both with and without private R&D crowding-in effects. All values represent the proportion of total GDP gains attributable to each region's own spending through the NIHR. The results suggest some regional variation in how the economic gains are distributed. In the base case without private spillovers, the share of GDP retained locally ranges from about 25% in the East Midlands and East of England to 33% in London and 34% in Scotland. For larger English regions such as the North West, West Midlands and South East, roughly 30% to 32% of the economic effect remains within the region. Northern Ireland is a notable outlier, likely due to its geographic location and its smaller economy. For this region, we estimate that a much larger share of its GDP gain stays within the region, around 78% in the base case.

Including private R&D crowding-in has little effect on the proportion of GDP gains that stay within the region that received the funding through the NIHR, as the intra-regional shares remain almost identical, confirming that while crowding-in increases total GDP, the spatial distribution of gains is largely unchanged. When results are weighted by regional GDP to provide a UK-wide average, between 32% and 44% of the total GDP increase remains within the regions initially receiving the funding, while the remaining 56% to 68% arises in other regions. Put differently, for every £100 of economic benefit created by spending through the NIHR, roughly £32–44 stays local and £56–68 materialises elsewhere in the UK. These results highlight the interconnected nature of the UK economy. This implies that health and care research spending concentrated in specific locations also delivers broader national economic returns.

Table 8: Scenarios 2–13: Change in GDP without private R&D crowding-in (base case)

	North East	North West	Yorkshire & Humber	East Midlands	West Midlands	East	London	South East	South West	Wales	Scotland	Northern Ireland			
NIHR funding 2013/14 –2017/18 (£2023/24m)	**315.6**	**561.1**	**623.4**	**350.4**	**492.1**	**603.3**	**2,143.2**	**939.3**	**453.5**	**34.7**	**118.3**	**17.0**	**GDP received**		
Share NIHR funding regional GDP	**0.36%**	**0.21%**	**0.35%**	**0.24%**	**0.25%**	**0.28%**	**0.49%**	**0.25%**	**0.15%**	**0.02%**	**0.07%**	**0.03%**	**Regional change GDP (£2023/24m)**	**Intra-regional (%)**	**Extra-regional (%)**
Scenario	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
North East	**80.6**	13.5	15.3	9.4	11.6	14.9	51.2	26.8	12.2	0.8	2.9	0.4	***239.6***	**33.63%**	**66.37%**
North West	24.4	**174.1**	49.8	31.8	39.1	49.2	169.1	89.5	40.6	2.8	9.2	1.4	***681.1***	**25.57%**	**74.43%**
Yorkshire and the Humber	19.1	34.0	**163.9**	24.7	28.9	36.7	126.9	67.0	30.5	2.1	7.4	1.1	***542.2***	**36.49%**	**63.51%**
East Midlands	16.6	30.7	34.6	**91.0**	27.7	33.8	115.9	61.1	27.7	2.0	7.0	1.1	***449.3***	**20.25%**	**79.75%**
West Midlands	19.8	36.9	39.9	26.9	**134.9**	39.9	138.2	73.1	33.4	2.3	7.6	1.2	***554.1***	**24.35%**	**75.65%**
East	26.2	48.3	52.5	34.4	41.4	**162.9**	189.3	97.5	43.8	3.0	10.4	1.5	***711.1***	**22.91%**	**77.09%**
London	27.1	49.9	54.6	35.0	42.8	59.1	**686.7**	111.9	45.0	2.8	9.3	1.3	***1,125.5***	**61.02%**	**38.98%**
South East	29.6	54.8	60.2	39.2	47.3	61.5	219.5	**320.5**	51.3	4.4	15.2	2.3	***905.8***	**35.38%**	**64.62%**
South West	27.9	51.8	57.7	37.7	45.5	58.4	191.2	107.4	**154.1**	3.8	12.9	2.2	***750.6***	**20.54%**	**79.46%**
Wales	11.4	22.0	23.1	15.1	18.5	23.2	76.9	42.8	19.8	**12.1**	15.4	-1.7	***278.6***	**4.36%**	**95.64%**
Scotland	11.3	21.6	21.9	14.3	17.8	21.9	77.4	41.7	19.1	3.7	**47.8**	-6.5	***292.0***	**16.35%**	**83.65%**
Northern Ireland	5.0	9.3	10.0	6.5	7.9	10.0	35.0	18.8	8.6	-1.5	-5.3	**14.7**	***118.9***	**12.35%**	**87.65%**
UK change GDP (£2023/24m)	**299.1**	**546.9**	**583.5**	**366.0**	**463.4**	**571.6**	**2,077.3**	**1,057.9**	**486.1**	**38.3**	**139.7**	**18.9**	***6,648.6***		

	North East	North West	Yorkshire & Humber	East Midlands	West Midlands	East	London	South East	South West	Wales	Scotland	Northern Ireland	GDP received		
Scenario	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**Regional change GDP (£2023/24m)**	**Intra-regional (%)**	**Extra-regional (%)**
GDP multiplier	*0.95*	*0.97*	*0.94*	*1.04*	*0.94*	*0.95*	*0.97*	*1.13*	*1.07*	*1.10*	*1.18*	*1.11*			
Intra-regional (%)	*26.94%*	*31.84%*	*28.09%*	*24.86%*	*29.11%*	*28.50%*	*33.06%*	*30.29%*	*31.71%*	*31.70%*	*34.19%*	*77.70%*			
Extra-regional (%)	*73.06%*	*68.16%*	*71.91%*	*75.14%*	*70.89%*	*71.50%*	*66.94%*	*69.71%*	*68.29%*	*68.30%*	*65.81%*	*22.30%*			

Table 9: Scenarios 2–13: Regional expenditure through the NIHR, 2013/14–2017/18; employment impact (% change in labour income)

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East	London	South East	South West	Wales	Scotland	Northern Ireland
Scenario	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Region												
North East	**0.27%**	0.03%	0.03%	0.02%	0.02%	0.03%	0.11%	0.05%	0.02%	0.00%	0.00%	0.00%
North West	0.02%	**0.18%**	0.03%	0.02%	0.03%	0.03%	0.12%	0.05%	0.03%	0.00%	0.00%	0.00%
Yorkshire and the Humber	0.02%	0.03%	**0.26%**	0.02%	0.03%	0.03%	0.12%	0.05%	0.02%	0.00%	0.00%	0.00%
East Midlands	0.02%	0.03%	0.03%	**0.16%**	0.03%	0.03%	0.11%	0.05%	0.02%	0.00%	0.00%	0.00%
West Midlands	0.02%	0.03%	0.03%	0.02%	**0.19%**	0.03%	0.12%	0.06%	0.03%	0.00%	0.00%	0.00%
East	0.02%	0.03%	0.03%	0.02%	0.03%	**0.18%**	0.13%	0.06%	0.03%	0.00%	0.00%	0.00%
London	0.02%	0.03%	0.03%	0.02%	0.02%	0.03%	**0.36%**	0.05%	0.02%	0.00%	0.00%	0.00%
South East	0.01%	0.02%	0.02%	0.01%	0.01%	0.02%	0.07%	**0.19%**	0.01%	0.00%	0.00%	0.00%
South West	0.01%	0.02%	0.03%	0.01%	0.02%	0.02%	0.09%	0.04%	**0.18%**	0.00%	0.00%	0.00%
Wales	0.01%	0.02%	0.02%	0.01%	0.02%	0.02%	0.08%	0.04%	0.02%	**0.04%**	0.04%	-0.01%
Scotland	0.01%	0.02%	0.02%	0.01%	0.02%	0.02%	0.07%	0.03%	0.02%	0.00%	**0.07%**	-0.01%
Northern Ireland	0.01%	0.02%	0.02%	0.01%	0.02%	0.02%	0.08%	0.04%	0.02%	-0.01%	-0.04%	**0.08%**

Table 10: Scenarios 2–13: Total expenditure through the NIHR 2013/14–2017/18; change in GDP that stays within the region receiving the funding

Private R&D crowding-in:	Intra-regional GDP (%)					
	No			Yes		
	Base	*Low*	*High*	Base	*Low*	*High*
Region						
North East	**26.9%**	*29.9%*	*42.1%*	**27.1%**	*30.1%*	*41.9%*
North West	**31.8%**	*34.6%*	*45.7%*	**32.0%**	*34.8%*	*45.2%*
Yorkshire and the Humber	**28.1%**	*30.7%*	*40.8%*	**28.1%**	*30.8%*	*40.6%*
East Midlands	**24.9%**	*27.0%*	*36.6%*	**24.9%**	*27.1%*	*36.4%*
West Midlands	**29.1%**	*31.8%*	*42.5%*	**29.2%**	*31.9%*	*42.3%*
East of England	**28.5%**	*30.8%*	*39.9%*	**28.6%**	*31.0%*	*39.3%*
London	**33.1%**	*35.7%*	*42.6%*	**33.0%**	*35.8%*	*42.1%*
South East	**30.3%**	*32.2%*	*37.4%*	**30.3%**	*32.2%*	*37.7%*
South West	**31.7%**	*34.1%*	*44.4%*	**31.7%**	*34.2%*	*44.1%*
Wales	**31.7%**	*35.7%*	*44.6%*	**32.0%**	*36.2%*	*44.0%*
Scotland	**34.2%**	*40.0%*	*37.3%*	**34.2%**	*40.3%*	*65.4%*
Northern Ireland	**77.7%**	*77.5%*	*77.8%*	**78.0%**	*87.1%*	*89.5%*
UK	**31.6%**	**34.5%**	**42.2%**	**31.7%**	**34.7%**	**44.0%**

Note: Entries show the proportion of GDP generated by regional NIHR spending that remains within the region receiving the funding. 'Base' refers to the central (base case) estimate, while 'Low' and 'High' denote the lower- and upper-bound results, respectively, derived from the probabilistic sensitivity analysis. The national (UK) figures are calculated as a weighted average, using regional GDP shares as weights. Data on Wales, Scotland and Northern Ireland capture the extent to which the devolved administrations 'buy-in' to specific NIHR programmes.

7.3.3. Scenario 14: Counterfactual

In Scenario 14, £6.7bn is hypothetically allocated to general government services, in line with existing government expenditure allocations across regions, rather than to research through the NIHR. For example, if the government spent 15% of its budget on education, then 15% of the additional £6.7bn will now go to education, and so on. This provides a counterfactual that helps answer a key policy question about opportunity costs: how would the short- to medium-term economic effects have differed if the government had spent the same money on its portfolio of other services rather than on health research?

The third column of Table 11 shows the estimated change in national and regional GDP resulting from the additional £6.7bn of general government spending. The next two columns show the range from the sensitivity analysis, whereas the remaining columns reproduce for comparison purposes the corresponding results for the NIHR investment from Scenario 1, first without crowded-in private R&D and then with it.

Table 11: Scenario 14: Alternative expenditures effects; change in GDP

Scenario		14			1					
Private R&D crowding-in:		No			No			Yes		
	NIHR funding (£m)	Base	*Low*	*High*	Base	*Low*	*High*	Base	*Low*	*High*
Region										
North East	315.6	**276.3**	*276.1*	*277.0*	**256.9**	*250.0*	*302.9*	**335.6**	*325.0*	*399.1*
North West	561.1	**806.6**	*805.9*	*809.1*	**737.2**	*705.9*	*870.9*	**979.7**	*935.3*	*1,173.9*
Yorkshire and the Humber	623.4	**498.6**	*498.1*	*500.6*	**584.0**	*564.3*	*694.9*	**749.6**	*717.9*	*899.6*
East Midlands	350.4	**395.2**	*394.7*	*397.0*	**491.6**	*467.2*	*574.1*	**646.3**	*610.5*	*768.1*
West Midlands	492.1	**576.6**	*576.2*	*578.6*	**597.8**	*573.3*	*710.2*	**772.1**	*734.4*	*927.4*
East of England	603.3	**592.0**	*591.3*	*594.8*	**766.3**	*731.7*	*913.0*	**1,030.1**	*982.7*	*1,246.1*
London	2,143.2	**1,602.4**	*1,601.6*	*1,606.0*	**1,212.2**	*1,188.5*	*1,440.9*	**1,519.7**	*1,472.7*	*1,818.7*
South East	939.3	**1,043.4**	*1,042.4*	*1,047.7*	**1,025.9**	*961.8*	*1,147.0*	**1,368.0**	*1,274.4*	*1,586.3*
South West	453.5	**772.9**	*771.8*	*776.2*	**827.8**	*782.5*	*966.2*	**1,094.8**	*1,029.8*	*1,304.3*
Wales	34.7	**321.9**	*321.1*	*323.4*	**304.0**	*273.4*	*374.3*	**442.8**	*408.3*	*543.5*
Scotland	118.3	**532.6**	*531.5*	*534.7*	**324.8**	*276.0*	*409.0*	**544.0**	*497.7*	*671.1*
Northern Ireland	17.0	**134.2**	*133.7*	*135.0*	**130.3**	*114.4*	*161.9*	**162.7**	*141.2*	*197.3*
Total funding	6,651.8									
Change GDP (£m)		**7,552.7**	*7,544.3*	*7,580.3*	**7,259.0**	*6,889.0*	*8,565.3*	**9,645.4**	*9,129.9*	*11,535.4*
GDP multiplier		**1.14**	*1.13*	*1.14*	**1.09**	*1.04*	*1.29*	**1.45**	*1.37*	*1.73*

Note: All monetary values are expressed in 2023/24 price terms. 'Base' refers to the central (base case) estimate, while 'Low' and 'High' denote the lower- and upper-bound results, respectively, derived from the probabilistic sensitivity analysis. Scenario 1 data on Wales, Scotland and Northern Ireland capture the extent to which the devolved administrations 'buy-in' to specific NIHR programmes.

At the UK national level, the additional £6.65bn of government spending in Scenario 14 raises UK GDP by £7.55bn (£7.54–7.58bn), corresponding to a GDP multiplier of 1.14 (1.13–1.14). This modelled result is close to the 1.09 multiplier estimated for NIHR investment without crowded-in private R&D spillovers (Scenario 1) and well within the sensitivity range of 1.04–1.29. It is also below the 1.45 (1.37–1.73) multiplier when the private R&D crowded-in for the base case is accounted for. In other words, when considering only the immediate demand-side effects, spending on health research activities has a similar short-term macroeconomic impact as an equivalent expansion of general government services. However, once the private R&D crowding-in effect is incorporated, the multiplier for NIHR investment rises to 1.45, meaning that every £100 of funding through the NIHR generates £145 of additional GDP. If we assume that typical government services do not, on average, crowd in additional private sector spending, then investment via the NIHR clearly delivers a higher macroeconomic return per pound of spending.

It is important to highlight that these CGE modelling results capture short- to medium-term macroeconomic effects. Over a longer time horizon, spending on health and care research can not only generate income and jobs through increased economic activity but also improve population health and, hence, productivity. This long-term productivity benefit has not been captured by the CGE model but would further strengthen the economic returns from expenditure through the NIHR. It is worth noting, however, that other parts of government spending, such as education or skills programmes, can also generate long-term economic benefits by building human capital and raising productivity levels over time, which have not been assessed or considered in this analysis but would increase the economic returns of general government spending over the long term.

Table 12 compares the estimated impact on employment, measured as the change in the total compensation of the production factor labour, resulting from the £6.7bn investment (Scenario 1) through the NIHR with an equivalent increase in general government spending (Scenario 14). Across all regions, general government spending (Scenario 14) is estimated to generate a uniform increase in total labour income of around 0.27%, with little regional variation because the additional expenditure is spread proportionally across existing public-sector activity. By contrast, investment through the NIHR (Scenario 1) is estimated to yield substantially larger labour-market effects. Without private spillovers, the national labour income rises by 0.50% in the base case (ranging from 0.49% to 0.55%), and with private R&D crowding-in, the increase reaches 0.68% (ranging from 0.66% to 0.75%). That is, the employment impact of the investment via the NIHR is estimated to be nearly double (without private crowding-in effects) compared to general government spending, and possibly more than when private R&D crowding-in is taken into account.

Table 12: Scenario 14: Alternative expenditure effects; employment impact (% change in labour income)

	Scenario 14			Scenario 1					
Private R&D crowding-in:	**No**			**No**			**Yes**		
	Base	***Low***	***High***	**Base**	***Low***	***High***	**Base**	***Low***	***High***
Region									
North East	**0.27%**	*0.27%*	*0.27%*	**0.61%**	*0.61%*	*0.69%*	**0.81%**	*0.80%*	*0.90%*
North West	**0.27%**	*0.27%*	*0.27%*	**0.55%**	*0.54%*	*0.61%*	**0.74%**	*0.73%*	*0.83%*
Yorkshire and the Humber	**0.27%**	*0.27%*	*0.27%*	**0.61%**	*0.61%*	*0.68%*	**0.77%**	*0.76%*	*0.87%*
East Midlands	**0.27%**	*0.27%*	*0.27%*	**0.50%**	*0.49%*	*0.54%*	**0.67%**	*0.65%*	*0.72%*
West Midlands	**0.27%**	*0.27%*	*0.27%*	**0.56%**	*0.56%*	*0.63%*	**0.73%**	*0.71%*	*0.81%*
East of England	**0.27%**	*0.27%*	*0.27%*	**0.55%**	*0.54%*	*0.61%*	**0.76%**	*0.75%*	*0.86%*
London	**0.27%**	*0.27%*	*0.27%*	**0.60%**	*0.61%*	*0.68%*	**0.77%**	*0.77%*	*0.86%*
South East	**0.27%**	*0.27%*	*0.27%*	**0.41%**	*0.40%*	*0.38%*	**0.57%**	*0.54%*	*0.56%*
South West	**0.27%**	*0.27%*	*0.27%*	**0.48%**	*0.47%*	*0.49%*	**0.64%**	*0.62%*	*0.68%*
Wales	**0.27%**	*0.26%*	*0.27%*	**0.32%**	*0.27%*	*0.39%*	**0.57%**	*0.52%*	*0.67%*
Scotland	**0.27%**	*0.27%*	*0.27%*	**0.31%**	*0.25%*	*0.36%*	**0.59%**	*0.55%*	*0.68%*
Northern Ireland	**0.26%**	*0.26%*	*0.26%*	**0.30%**	*0.25%*	*0.36%*	**0.35%**	*0.28%*	*0.37%*
UK	**0.27%**	**0.27%**	**0.27%**	**0.50%**	**0.49%**	**0.55%**	**0.68%**	**0.66%**	**0.75%**

Note: Entries show the change in the wage bill, a measure of the value of labour. 'Base' refers to the central (base case) estimate, while 'Low' and 'High' denote the lower- and upper-bound results, respectively, derived from the probabilistic sensitivity analysis. The national (UK) figures are calculated as a weighted average, using regional GDP shares as weights. Scenario 1 data on Wales, Scotland and Northern Ireland capture the extent to which the devolved administrations 'buy-in' to specific NIHR programmes.

While Scenario 14 is estimated to produce a slightly higher GDP multiplier than Scenario 1 without private R&D spillovers, the increase in the wage bill is noticeably smaller, even without private crowding-in effects. Some explanatory factors for this might be that general government services are comparatively less labour-intensive per unit of output than R&D activities, and a significant share of additional spending in this sector leaks into intermediate consumption rather than directly into wages. In contrast, R&D investment might have a higher labour share of value added, employing a mix of skilled researchers and support staff whose wages contribute directly to the total real wage bill. As a result, funding via the NIHR, especially once crowded-in private R&D is included, may generate a stronger aggregate rise in labour income and a more pronounced expansion in labour demand than an equivalent increase in general government expenditure.

7.4. Chapter summary

The findings presented in this chapter demonstrate the short- to medium-term macroeconomic effects of research spending through the NIHR. Using a novel macroeconomic modelling approach that overcomes some methodological limitations of existing analyses, we estimate that, at the national level, the £6.7bn (in 2023/24 price terms) spending through the NIHR between 2013/14 and 2017/18 increased UK GDP by about £7.3bn (range = £6.9–8.6bn), suggesting that £100 invested in health and care research creates about £109 (range = £104–129) in economic activity over the 5–10-year time horizon considered. This rises to an increase of £9.6bn (range = £9.1–11.5bn), or about £145 (£137–173) per £100 invested if the likely crowding-in of private industry R&D spending is also considered.

Furthermore, our modelling results suggest that expenditure through the NIHR delivers positive labour market effects, with an estimated 0.50% (range = 0.49–0.55%) increase in the total income of the production factor labour across the UK without crowding-in of private R&D, and an estimated 0.68% (range = 0.66%–0.75%) increase when crowding-in of private R&D is included. This reflects a nationwide rise in labour demand, capturing both additional employment and higher wages generated by the expansion of research-related economic activity.

A key finding of the analysis is that, while the whole UK benefits from the expenditures through the NIHR, there are also regional implications. Even when expenditure is directed to a single region, other regions also benefit, because regional economies are interconnected. We find that 56–68% of the macroeconomic benefit created from the increased demand effect associated with the expenditures through the NIHR in any single region arises in the other regions.

Lastly, our findings suggest that from a macroeconomic perspective, considering the counterfactual is important. Allocating the same £6.7bn across general government services instead of health and care research investments yields a similar GDP benefit to the investment via the NIHR. However, once potential private-sector R&D crowding-in effects are considered, the NIHR investment produces higher macroeconomic returns in terms of GDP, without including any potential long-term health or productivity benefits linked to the outcomes of the research. With regard to labour market effects, we estimate that investment through the NIHR generates roughly double the uplift in total national labour income compared with an equivalent rise in general government services spending. This finding underscores that health and care research funding not only supports economic output but also has the potential to deliver positive regional and national earnings effects even in the short- to medium-term.

Chapter 8. **Evidence synthesis and discussion**

In this chapter, we first synthesise the evidence gathered and created by the research team, as described in the preceding chapters, discussing the extent to which that evidence is mutually consistent and addresses the research aims, taking each one in turn. We then reflect on the contribution of the PPI Group and on the strengths and weaknesses of the research undertaken.

8.1. Synthesis

As described in Chapter 2, the research team brought together the evidence from all parts of the study and discussed it in three online, external workshop meetings in September 2025 with, respectively:

- Our project Steering Committee of external advisors, supplemented by external advisors to the NIHR.
- The project PPI Group.
- Stakeholders from the DHSC, the NIHR and senior academics working for NIHR research streams.

The senior researchers leading the various elements of our research met in an internal online workshop in late September 2025 to discuss and agree how the evidence produced by the different WPs contributes to the overall findings from our study. We looked for any apparent contradictions but concluded that none had arisen. Rather, the different WPs produced either mutually reinforcing or complementary findings. See Table 13 for a summary of this triangulation of evidence compared with the research aims specified at the outset by the NIHR (O'Cathain et al. 2010). Shaded cells in the table indicate which WPs (table columns) contribute to which research aims (table rows).

The pattern of NIHR-funded activities

The expenditure data provided by the NIHR and described in Chapter 4 of this report are the main source of information on the pattern of activity funded through the NIHR in the UK by type, over time and across regions. In the main five-year study period, 2013/14–2017/18, total expenditure through the NIHR was roughly constant in real terms (i.e. after removing the effect of general price inflation). However, there was a change in the balance between types, with infrastructure expenditure declining from 68.6% to 61.5% as a share of the total over that period, spending on training and development rising from 9.3% to 10.8% of the total and spending on research programmes increasing from 22.1% to 27.7%. Throughout that period, expenditure via the NIHR per head of population was roughly twice as high in London as in the rest of England. Spending through the NIHR per head of population in Northern Ireland, Scotland and Wales was much lower than in England, reflecting that health and care research is devolved and the devolved nations have their own health budgets, priorities and research institutions, and they only buy into a limited number of NIHR programmes. Interview participants were aware of the regional variations in expenditure through the NIHR.

Short- and medium-term regional and national effects, including multipliers and spillovers

The literature review yielded a number of estimates of multiplier effects of health and care research on incomes and employment.

For the most part, these estimates are based on simple input-output multipliers that may be adequate for a single region but ignore the interactions between regions and, hence, probably overestimate the impact at the national level. The literature also yields estimates of the rate at which private industry R&D is crowded in by public- and charity-funded research, making the UK an attractive location for this kind of activity, which we have added to our CGE model of the UK economy. The case studies illustrate mechanisms by which industry R&D can be crowded in, e.g. through commercial activities spun out from funded research, thereby creating new jobs. The case studies also make clear how the economic impact of research spending through the NIHR contributes to, as well as being dependent on, the overall research infrastructure in the UK, which spans regions.

The CGE modelling captured short- and medium-term economic impacts of expenditures through the NIHR for each region, in effect generating estimates of income and employment multipliers. The CGE model is based on an underlying input-output matrix. However, as discussed earlier, it goes beyond that by allowing labour and capital markets and all sectors of the economy to adjust and reach equilibrium via wage/price changes. Most importantly, the CGE modelling allows us to model the interactions between regional economies within the UK, so that we take into account, for example, that increased research activity in one region may affect patterns of employment and wages not only there but in all other regions.

Thus, we find that the short- and medium-term economic effects of spending through the NIHR are to increase incomes and jobs in all regions. Furthermore, the majority of the economic impact from money spent in one region is likely to arise outside that region and be spread across all other regions of the UK.

At the national level, before allowing for extra industry R&D spending being crowded into the UK, incomes eventually increase by an expected £109 (range = £104–129) for every £100 of expenditure through the NIHR. This is similar to the modelled £114 (range = £113–114) in eventual income increase for every £100 spent on other government services generally, rather than on health and care research. But once the crowding-in of additional industry R&D is also taken into account, which is well-evidenced in the existing literature, our modelling shows that the UK national impact is an estimated increase in income of £145 (range = £137–173) for every £100 spent through the NIHR. We do not know whether other government expenditures have net crowding-in or crowding-out effects, let alone the magnitudes of any such effects in either direction, but it is reasonable to expect that, in total, they would be much smaller in magnitude than the measured crowding-in effect of public spending on healthcare research. These numbers also do not include the impact of improved health outcomes and their consequences.

Our modelling results suggest that spending through the NIHR delivers positive labour-market effects, with an estimated 0.50% (range = 0.49–0.55%) increase in the UK-wide wage bill without crowding in private R&D, and an estimated 0.68% (range = 0.66–0.75%) increase when crowding-in is included. This reflects a nationwide rise in labour demand, capturing both additional employment and higher wages generated by the expansion of research-related economic activity.

Long-term national and regional economic returns

The literature offers estimates of the long-term rate of return to public and charity-funded medical and health research in the UK at the national level, but not for regions. These estimates include impacts on incomes (GDP),

including via additional private industry R&D that is crowded in over the longer term, and the monetised value of health gains attributed to the UK public and charity research. The most recent estimate is an overall IRR of 29% per annum, specifically for DHSC investment in NIHR Biomedical Research Centres (Craig et al. 2020). This is broadly similar in magnitude to earlier IRR estimates of 24–28% per annum (Sussex et al. 2016) and 37–39% per annum (HERG et al. 2008) for returns in the UK to public and charity medical research in general. All these estimates include the crowding-in of additional industry R&D spending in the UK and the monetised health gains from the outcomes of public and charity research funded in the UK.

The case studies illustrate how research funded through the NIHR, interacting with the wider health and care research ecosystem in the UK, can generate innovation and how this, in turn, can save lives and improve patients' quality of life. The studies also indicate that some innovations may save health service costs, e.g. by preventing avoidable interventions, but in all cases will necessarily entail costs of implementation if they are to be made available to the UK population. We note that in general, technical progress is a net contributor to increasing health care expenditures rather than reducing them, in essence by making it possible to do more for more people (see, for example, Feng et al. 2017). The increased costs are netted off the value of the health gains in our calculations, just as they are in the source literature. Another consideration when estimating economic returns to health and care research expenditure is the timescale over which the returns arise. Taken together, the case studies illustrate how varied such timescales can be and reinforce the point that any such analysis is a snapshot at one moment in time.

Our CGE modelling includes the short- and medium-term effects of crowded-in industry R&D in each region, but not the long-term national IRRs from health gains due to research funded through the NIHR. A major benefit of the CGE model we have constructed is that it allows us to model the interactions among the subnational regions of the UK. We found that the beneficial impact of research funding through the NIHR on incomes and jobs occurs in all regions of the UK. Money spent on researchers in one region generates economic activity throughout the UK when they spend their incomes, and suppliers of goods and services to the research activity are spread throughout the UK. By modelling the effects on all regions of expenditure in each region in turn, we see that most of the total income and employment effects of spending through the NIHR in one region are generally felt outside that region, in the rest of the UK.

Our regional CGE model does not yet include the likely effects on workforce productivity from improved health outcomes due to health and care research. Extending the CGE regional model to accommodate such productivity effects would be a worthwhile focus for future research.

Return on investment in terms of health gain

As mentioned above, monetised health gains attributed to the outcomes of public and charity-funded research in the UK have been included within the estimates in the literature of total IRR to medical and health research (Craig et al. 2020; HERG et al. 2008; Sussex et al. 2016). These estimates are at the national level. It would require a model of disease prevalence for all diseases by region, and data on uptake of innovations by region to determine sub-national IRRs. However, the absence of such regional data precludes that. Other literature provides estimates of only

that part of the overall long-term returns at the national level that is due to monetised health gains from research in particular disease areas (Glover et al. 2014; 2018). We have updated the estimates of national-level IRRs due to monetised health gains, to take into account cost inflation since the original studies in the literature, and to apply the current HM Treasury - advised estimate of the societal (so-called 'willingness to pay') value of a QALY in the UK, namely £70,000 per QALY. These updates imply an overall average IRR from health gains of 13% per annum in real terms. This rough estimate is very sensitive to assumptions about the scale and timing of health benefits, their attribution to research funded through the NIHR and the value of the QALYs generated. For example, our estimate is higher than the average IRR of around 8% per annum in the original studies in the literature, due to their use of lower values for each QALY gained. No region-specific health-gain IRRs are available from the literature to update.

Case studies note examples of health gains and NHS cost savings or increases, but none provide sufficient information to permit calculation of a health-gain-related IRR to the public and charity research expenditures that ultimately yielded those health gains and cost changes.

The remaining two study aims have been fulfilled in the first instance by the case studies as described in Chapter 6 and Appendix F, and in the second instance by all the WPs taken together in the synthesis process described in the current chapter.

Table 13: NIHR economic impacts: triangulation of findings across all WPs

Research objective	Evidence review	Descriptive analysis of expenditure through the NIHR	Health-gain IRRs	Case studies	CGE modelling
1. Describe the overall patterns of NIHR-funded activities in the UK by type, over time and across regions.	Interviewees were aware that NIHR spending was not spread evenly between regions.	The main source of evidence, showing variation by type and region over time.	Not relevant	Not relevant	Not relevant
2. Estimate short-term direct economic effects of these activities with input-output modelling, including spillover and multiplier effects, and capturing workforce and employment.	Literature provides existing input-output-based estimates of local income and jobs impacts, and estimates of crowded-in industry R&D. Interviews yielded no additional estimates but confirmed what is in the literature.	Shows the regional distribution of NIHR expenditures by type of expenditure, which are inputs into the CGE model.	Not relevant	Include examples of mechanisms via which some crowding-in of industry R&D can happen.	The CGE model has an input-output matrix as its starting point, but goes beyond that approach. CGE estimates of multipliers are lower than input-output multipliers because CGE allows for interaction with labour and other markets in other regions, which input-output modelling ignores. CGE modelling estimates mainly short- and medium-term impacts (income and employment multipliers), but includes crowding-in industry R&D, which happens over the longer term.

Research objective	Evidence review	Descriptive analysis of expenditure through the NIHR	Health-gain IRRs	Case studies	CGE modelling
3. Estimate short- and long-term return on NIHR investment in the period from 2013/14 to 2017/18, nationally and in separate regions, and extrapolate the expected return on investment to the future.	The 'What's it worth?' and crowding-in literature show national long-term returns as IRRs, including industry crowding-in and health gains. The literature shows returns increase and spread over time, but offers no evidence on different returns by type of NIHR spend or region. Interviewees knew of no evidence about returns by type of spend or about regional interactions.	Shows the regional distribution of expenditures through the NIHR by type of expenditure, which are inputs into the CGE model.	The health-gain IRRs, net of implementation costs, contribute to long-term national returns. Health-gain IRRs at the regional level cannot be estimated due to a lack of regional data on health gains and innovation uptake.	Case studies show how health and care research can yield long-term health gains and either reduce or increase the costs of providing health and care services, depending on the specific innovation. Case studies also indicate how returns can emerge over prolonged timescales and eventually be superseded by further innovations.	The CGE model shows economic returns that are consistent at the national level with those in the literature. However, the CGE model focuses on regional analysis. CGE model outcomes arise over the short- and medium-term.
4. Estimate the return on investment on health, using multipliers derived from literature, data, and expert inputs.	The literature provides source material for the calculation of updated health-gain-related IRRs.	Not relevant	These updates to estimates in the literature are the main source of information on health-gain-related IRRs.	Case studies note health gains and NHS cost savings or increases, but none permit the calculation of a health-gain-related IRR.	Not relevant

Research objective	Evidence review	Descriptive analysis of expenditure through the NIHR	Health-gain IRRs	Case studies	CGE modelling
5. Analyse four qualitative case studies with respect to the benefits to health and wealth on regional and national levels.	Not relevant	Not relevant	Not relevant	Provides evidence for this objective as summarised in the preceding rows of the table.	Not relevant
6. Synthesise economic modelling and case study findings together to provide an overall picture and insights into the economic effects of NIHR activities regionally and nationally.	All WPs contribute.	All WPs contribute.	All WPs contribute.	All WPs contribute.	All WPs contribute.

8.2. Patient and public involvement

As described in Chapter 2.3, the research team has been advised by a four-member group of patient and public representatives, one of whom helped to draft the plain language summary in the bid for funding for the research reported here and participated in the project Steering Committee throughout the study. The PPI Group's members spanned a mix of age groups (including working-age and retired), regions in England and life experiences.

The research is not about care delivery or individuals' experiences of care but mainly concerns economic modelling and the nature of regional economic impacts, as distinct from national ones. In that context, the PPI Group's inputs have focused on how we might formulate the research findings to make them clear to interested but non-technical audiences. The research team greatly appreciates the time taken and advice given by the group, including their review of the present report. Their inputs have demonstrated the benefit of having diverse public contributors by providing clear steers at key points, particularly those outlined below.

As the research proceeded, the members of the PPI Group provided advice on how best to work with them and on improving the clarity of the final report and other deliverables. Ideas that the research team has implemented and which are reflected in the present report are:

- Providing a glossary of terms that not only spells out acronyms in full but also explains them and some other economic terminology. The glossary has been updated as the project has developed.
- Being open about the limitations of our methods and the assumptions they entail, set alongside the limitations and assumptions of other approaches that are described in the literature we refer to.
- A plain language summary that retains detail.
- Being clear that we are researching the economic effects that are consequent on the regional distribution of expenditures through the NIHR, and not the reasons for that regional spread of spending.

To further capture the insights of PPI Group members, we asked them, after we had shared the draft final report with them, to reflect on how best to obtain patient and public involvement in an economics-heavy project such as this (in contrast to more typical NIHR projects focusing on health and care) and other general recommendations based on their overall PPI experience. Three of the four members provided written input, which is summarised below.

Good practices in this project

Holding a training session on the concepts and methods relevant to the project, including simple worked examples, was welcomed. For example, one PPI member commented that this helped them to understand the concept of economic effects spilling over from one geographic area to another or from one organisation to another, and also helped them to link this specific project to their broader experience. The training resources produced by the research team were well received by our PPI Group and by the NIHR's project steering group. These materials could be reused with other PPI and non-economist groups.

There was early involvement of a PPI participant in writing the lay summary of the proposal. This early experience encouraged this participant to engage with the project even though it was outside their usual topic preference, by allowing them an opportunity to incorporate their perspective.

The PPI Group was actively engaged in identifying key messages from the project and communicating them in the lay language

summary. In particular, as proposed by one PPI member, the research team has attempted to ensure that the lay summary of the final report matches the questions raised in the lay summary of the original research application to the NIHR, its structure and the language used.

The project lead and other research team members have actively engaged with the PPI Group's questions and concerns, dedicating significant time to them, which has been recognised and welcomed by the Group's members.

Areas for improvement

One of the four PPI Group members thought that there had been fewer opportunities to shape the project than they would have wished. This was understood to be due in part to the original research specification received from the NIHR. We understand from the NIHR that they did involve public contributors in the design and commissioning of the research project. The suggestion was made that there could additionally have been PPI input into the selection of the case study sites. While not all PPI Group members might have the expertise and knowledge to contribute to all aspects of the project's methodology, not all opportunities to tap into this expertise have been exhausted.

The training session referred to earlier was considered by one participant to have included too much economic terminology, rather than relying throughout on plain-language explanations. Another PPI participant commented that they considered it essential that PPI participants understood the main economic terms being referred to, so as to be able to understand any write-up of the research and challenge it when appropriate. On reflection, the research team would, in future, focus initially on plain-language explanations and introduce the main economic terms later in the session, for the benefit of interested participants who might encounter them in future reading.

General recommendations from PPI Group members

One member of the Group proposed that the NIHR should involve PPI members at the outset in designing the project brief that is then published to attract applications. Such input could check the brief's aims and requirements against real-world experience outside the research community. For example, during the specification of this project, one member of the PPI Group suggested that PPI could have contributed to the consideration of what counts as an economic benefit. Allowing a longer period between the call and the bid submission deadline would have permitted better PPI involvement in developing the research proposal.

Regular communication from the research team is needed to keep PPI members actively interested and engaged. In this project, the research team shared interim findings and held three meetings with the PPI Group between autumn 2024 and autumn 2025. However, one PPI Group member suggested that more frequent meetings would have been helpful for keeping in touch. An important point is that providing short refreshers at the start of each meeting on the project's structure and aims enables PPI participants to contribute. PPI representatives are often involved in multiple research projects at once, which can make it hard to keep track.

Different individuals have different experiences and knowledge to call on. Taking the time to understand the range of contributions different PPI Group members could bring to a project can add value. However, care is needed to avoid creating any sense of unequal involvement and contribution by different PPI participants.

PPI can be used as a 'sounding board' for outputs aimed at both the general public and non-technical policy audiences, as in the present project. For example, PPI participants could reflect on whether the language used

in the project's outputs is sufficiently clear to be understandable by a wide range of audiences, including policymakers. To that end, PPI participants can be actively involved in creating content rather than merely responding reactively in meetings or commenting on existing drafts of project documents.

8.3. Strengths and weaknesses of the research

The approach we have taken in the research reported here was designed to significantly advance previous work on the economic impacts of health and care research, while remaining feasible within an 18-month timeframe and within budget constraints. To that end, our focus has been on investigating regional economic effects, taking into account the high degree of interaction between regional economies within the UK. Hence, the core of our research is the regional CGE modelling. However, this has been reinforced and complemented by the other WPs described above. It is inevitably the case that more could be done, with more time and resources, to more fully and confidently answer the question of what the regional and national impacts of expenditures through the NIHR are. In the next chapter, we highlight our recommendations for future research directions. First, however, we consider the strengths and weaknesses of the research reported here.

Our literature review was a rapid evidence assessment. Through the exclusion criteria adopted, this runs the risk of missing some potentially relevant literature. We did not search for non-English language literature, which is a weakness. But given our focus on economic returns in the UK to expenditure through the NIHR in the UK, the likelihood of having missed directly relevant sources seems low. We found relevant grey literature through snowballing from references in the academic literature and by seeking the advice of our Steering Committee and of interviewees. This is not a guarantee that all relevant grey literature will have been found. However, members of the research team have been active in the (relatively small) field of economic returns to medical and health research for 20 years and so were already familiar with much of the most relevant literature, including grey literature, before the current review was undertaken. Our Steering Committee members were invited because of their active presence in this particular research field, and they added much depth and breadth to the knowledge base we could draw on. Their contributions, including challenges and validation at different times, have been invaluable to ensuring thorough consideration of relevant issues. Our programme of interviews with stakeholders and experts has given the team confidence that all, or at least the most relevant literature available at the time of the study, has been identified.

Determining the health gains (and associated health and care system costs) that can reasonably be attributed to research supported by NIHR is a major undertaking. There are three sources in the literature that do this (Glover et al. 2014; 2018; HERG et al. 2008), all in the UK, and between them they cover four disease areas, which, as described in Chapter 5, represented around 35% of disease-specific research expenditure through the NIHR in the time period investigated. However, 90% of expenditure through the NIHR in that period was not recorded as allocated to a specific disease area (UK Clinical Research Collaboration 2015). As a result, our estimates of health-gain related IRRs achieved by expenditure through the NIHR, which have simply updated the estimates in the literature to allow for cost inflation since they were done and applied a different value per QALY gained, cannot, with any great confidence, be applied to the totality of spending through the NIHR.

Furthermore, these studies are now somewhat out of date, and we do not know whether the previous rate at which research spending translated into health gains has changed (improved or worsened). Our approach is no substitute for new work to update such studies to reflect more recent NIHR and other public and charity-supported research, and the outcomes of that research would be a major exercise for each disease area covered. That would be a major undertaking, but it could be very informative.

We have included four case studies in our research to illustrate some of the forms and mechanisms of economic impacts regionally and nationally. Inevitably, four case studies cannot represent the thousands of research studies that have been supported by the NIHR. More case studies could have provided more illustrations, but, within the bounds of reasonable cost and timescale to undertake, they would still not, in any sense, have been representative. The case studies we undertook were of three research projects and of support for career development via a fellowship. They do not explicitly include an example of an overarching investment in infrastructure, but all are likely to have benefited from infrastructure funded through the NIHR. The omission was deliberate owing to the difficulty and scale of work involved in tracking all the research that any research infrastructure investment may have contributed to. Our four case studies did provide an illuminating variety of impacts, but they have weaknesses. In particular, we obtained access to only a small number of, albeit key, interviewees in each case (usually three, but two in one case), and we were asking them to recall periods several years ago as well as more recently.

The main novel element of our research is the development of a regional CGE model of the UK economy to measure the expected regional impact of expenditure through the NIHR. We are not aware of any previous research modelling all regions simultaneously. As explained earlier in the report, the CGE approach is less restrictive in its assumptions than simple input-output derived multiplier approaches. Input-output-based impact estimates of economic impacts are likely to be overstated because they ignore adjustments that occur in a real economy. Our CGE model allows for capacity constraints (i.e. that there is not an unrestricted supply of labour and capital) that are an important feature of any economy. It not only allows demand in a market (e.g. for research) to change and, hence, supply, but also allows prices to adjust across all markets (including labour and capital markets) and for producers and consumers in the economy to adjust accordingly. This feature prevents overestimation of impacts by accounting for opportunity costs. If some resources are diverted from other productive uses to accommodate the activity that is funded through the NIHR, the model will net out the lost output elsewhere from the gained output in the target sector.

Like any other model, a CGE model depends on many assumptions. The principal assumption is that via changes in prices, all markets would eventually return to equilibrium (supply equalling demand in all markets and regions) following a perturbation (such as an increase in spending on research via the NIHR), provided there are no further perturbations. Thus, our use of CGE modelling means that we are comparing the expected settled-down economy after a variety of changes specified in the various modelled scenarios. This has the disadvantage that the model is essentially 'timeless': we compare different equilibrium positions, but we cannot map how the economy looks one year after a perturbation, two years after, three years after, and so on. An interesting line of future research would be to develop a dynamic version of the model that

provides a pathway for regional incomes and employment annually in the coming years.

Our regional model does not include allowance for the potential for health gains resulting from NIHR-supported research to increase labour productivity in the economy. This lack also applies to input-output models. At the national level, it would be possible to include such a productivity effect. Data are currently lacking to permit that effect to be modelled at a regional level, however. Future research might usefully focus on productivity impacts in different regions, e.g. due to their differing demographic, economic activity and employment profiles.

We have included in the regional CGE model the effect of research expenditure through the NIHR, which crowds in additional R&D activity by industry. A weakness of our approach is that we do not know whether general government services expenditure other than research crowds in additional activity or crowds it out overall, let alone the magnitude of any such effect. Therefore, we have assumed that for other general government service expenditures, there is no net crowding-out or crowding-in.

The existence of substantial crowding-in of industry R&D spending by public spending on healthcare research is, however, well established in the literature. The crowding in of R&D from across the global life sciences industry is a strong indicator of how the research base that the NIHR contributes to enhances the competitiveness of the UK economy as a location for commercial life sciences research. The magnitude of the crowding-in effect at the national level is taken from the literature (Craig et al. 2020; Sussex et al. 2016). Those studies are based on econometric analyses and necessarily have their own limitations, as explained in the respective papers, but they reach similar conclusions about the magnitude of crowding-in. To split the national effect across the regions of the UK, we have used ABPI data on recruitment to clinical trials and the number of industry research sites in each region (ABPI 2025). These are reasonable proxies for the regional split of crowded-in industry R&D, but they are only proxies. If different regional weights were applied rather than these, then the modelled regional spread of income and employment would look different.

Chapter 9. **Conclusions and recommendations for future research**

Expenditure through the NIHR (by DHSC and the devolved administrations) makes an economic contribution to all parts of the UK. That expenditure occurs in all regions of the UK but has been higher in London and other parts of South East England than in other regions of the UK, relative to their population sizes. The present study has reviewed the literature and obtained the views of stakeholders and experts about the economic impact of health and care research. The analysis includes four selected in-depth case studies that illustrate how such impacts can arise, and estimates of the rates of return to be expected as a result of health gains attributable to NIHR research.

The single most important contribution of the work reported here is the development of a novel modelling approach using a CGE model of all parts of the UK to estimate how spending through the NIHR has affected incomes and employment in each region (or devolved nation). This model takes into account how any region's economy interacts with all other regions' economies and explicitly allows that increased demand for labour and capital in one region will affect the supply of labour and capital in other regions. This means that the estimated combined effect on incomes and employment across the country as a whole is more modest and more realistic than would be implied by a simple input-output approach to modelling that ignores the regional interrelatedness of the economy.

We conclude that all regions have benefited from expenditure through the NIHR through short- and medium-term increases in regional income and employment. The overall economic returns achieved at the national level are likely to exceed those achieved by general government expenditure in the UK when account is taken of the additional industry R&D stimulated by research spending through the NIHR. The majority of the economic impact from money spent in one region looks likely to materialise outside that region and be spread across all other regions of the UK. In other words, a substantial part of the economic benefit from research spending through the NIHR in any one region is 'exported' beyond that region to the rest of the UK.

In addition to the direct, indirect and induced effects on incomes and employment in each region of the UK, we have estimated that, at the national level, the health gains from research funded through the NIHR, assuming that each QALY gained is valued at £70,000 (in line with HM Treasury guidance), are equivalent to an IRR of 13.0% per annum in real terms. This figure is highly sensitive to the assumptions made when calculating it and should not be interpreted as other than a rough estimate. We have not conducted any new studies of particular health-improving innovations that can be traced back in part to activities funded through the NIHR, so this figure is subject to considerable uncertainty. Our research has not taken into account the extent to which health gains may have fed into improved productivity in the UK economy by reducing time off work and increasing productivity while at work.

Based on our work in the present study, we have identified the following areas where further

research would be useful in improving the regional and national estimation of the economic impacts of spending through the NIHR:

- Analysis of the economic impacts of different types of research activity and whether some types yield higher returns than others.
- New studies of the health gains and cost impacts of the adoption of outcomes from research to which funding through the NIHR contributed. New studies in the disease areas already in the literature (cancer, cardiovascular disease, mental health and musculoskeletal disease) would be valuable, as would studies of disease areas not yet investigated in this way (e.g. infectious, respiratory and metabolic diseases).
- Measuring the inter-regional speed of spread of health benefits from research and understanding the factors determining that speed. Different regions may absorb research outcomes more quickly than others.
- Estimating productivity impacts from health gains and building them into the regional CGE model of the economy.
- Developing a dynamic version of the regional CGE model, to permit greater understanding of the time profile of economic impacts regionally and nationally.

However, even with the current level of knowledge, it is possible to be confident that research expenditures through the NIHR have had beneficial effects in all regions as well as nationally and, indeed, internationally. Furthermore, the economic returns from this expenditure compare favourably to those that might be expected from other government spending taken together.

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Appendix A. **Rapid evidence assessment**

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1. Introduction

The National Institute for Health and Care Research (NIHR) aims to create a health and care research system in which the NHS supports leading-edge research focused on the needs of patients and the public. Under its mission to 'improve the health and wealth of the nation through research', it spends its budget on a wide range of funded activities. These can be seen as an investment in the UK's health and care research system. RAND Europe has been commissioned to evaluate the economic impact of NIHR-funded activities and their Return On Investment (ROI) at regional and national levels within the UK, capturing all activities and the full range of economic effects, and providing insights into the distribution of funding by region and type.

At the start of this study, we reviewed published evidence on methods for evaluating the economic returns from research funding and the resulting empirical estimates, with particular focus on health and care research. As per the study protocol, we have followed a Rapid Evidence Assessment (REA) (Varker et al. 2015) methodology to:

1. Review and synthesise the existing literature and establish the current state of knowledge about measurement of the economic returns to the types of health and care research activities funded by the NIHR. This includes examining the methodologies used and identifying any gaps or differences in the existing body of work.
2. Identify the range of peer-reviewed, empirical estimates of such returns published since 2008 that are either in or applicable to the UK context.

This document describes our REA's methods and results and presents a discussion of the findings.

2. Methodology

We developed a systematic, focused literature search strategy building on our knowledge of previous relevant papers co-authored by the researchers in our team (Glover et al. 2014 & 2018; HERG et al. 2008; Sussex et al. 2016) as starting places for deriving search terms and then refining them in the light of initial search results. Following the REA methods, we single-screened the identified titles and abstracts and discussed any uncertainties within the research team. We validated our screening process using a sample of titles and abstracts that were double-screened. We extracted the relevant information from the selected full texts using a standard form and manually screened the references of the included and other relevant papers to snowball additional literature. We also sought input from our Steering Committee on additional literature.

The following sections describe the methods in greater detail.

2.1. Inclusion and exclusion criteria

We commenced the literature review with publications from 2008 onwards, as that was the publication year of the seminal UK study: 'Medical research: what's it worth? Estimating the economic benefits from medical research in the UK' (HERG et al. 2008) (referred to hereafter as 'Medical research: what's it worth?' 2008). That study included all health and care research spending by the NIHR's predecessor organisations as well as other organisations' medical research spending, which is beyond the scope of our study.

Inclusion and exclusion criteria are listed in Table 14 below.

Table 14: Inclusion and exclusion criteria for identified literature

Criteria	Scope of inclusion	Exclusion
Topic Relevance	Articles and documents focused on economic returns to health and care research expenditure and activity, including direct economic impacts on jobs, incomes, gross value added, Gross Domestic Product (GDP) and quantified health gains, e.g. expressed as Quality-Adjusted Life Years (QALYs)	-
Scale and Spread	Any scale and geographical level, ranging from individual sites to regions to national coverage	Solely global focus with nothing at or below the national level
Countries	Research conducted in the UK and other high-income countries (Organisation for Economic Co-operation and Development [OECD] countries)	Solely focused on low and middle-income countries
Years	Published in 2008 or later	Publications earlier than 2008
Study Characteristics	Empirical studies	Solely theoretical studies
Language	English language	Other languages

2.2. Search strategy

We worked with RAND Knowledge Services to derive initial search terms for economic returns to health and care research and refine the search strategy. We included databases covering health research (Embase, PubMed, Scopus and Web of Science) and specifically economics (EconLit) research literature. We broadly constructed the search strategy to capture terms in titles and abstracts related to:

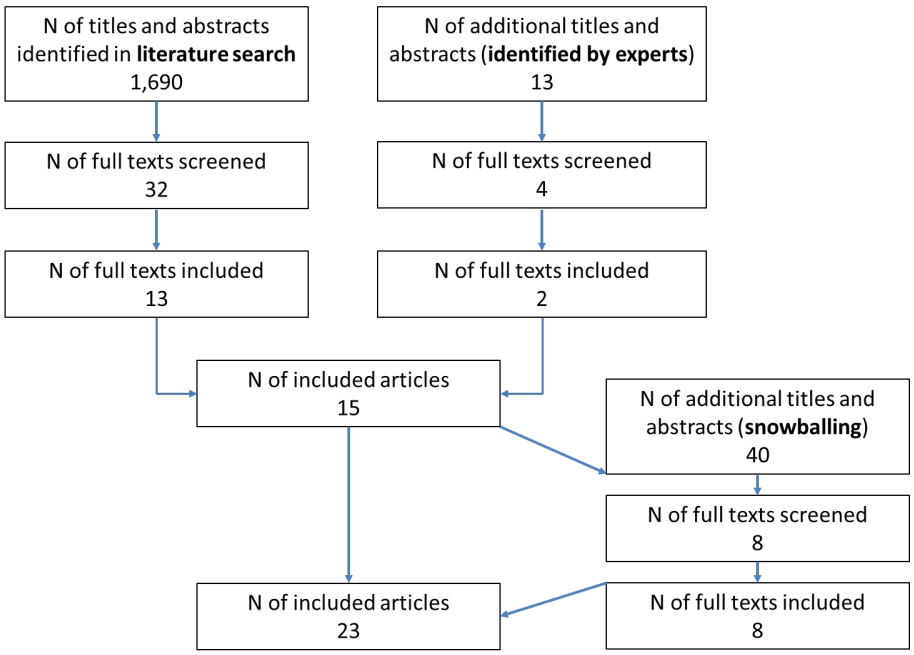
- Health and care (e.g. health, nursing, social care, medical and various disease categories)
- Research (e.g. research and evaluation)
- Economic returns and quantified health gains (e.g. economic return, ROI and impact assessment)
- Countries of interest (OECD countries).

Annex A1 details our precise search strategy. We undertook the initial searches on 1 and 2 July 2024.

2.3. Title and abstract screening, and snowballing of references

Figure 9 shows a flow diagram of the number of screened titles, abstracts and full texts, alongside the final included articles.

Figure 9: Flow diagram of articles included in the review



After deduplication, we identified 1,690 titles in the initial literature search. We copied information on these titles, including abstracts when available, into a spreadsheet for screening. Two members of the research team (BS, ALT) screened a sample of 100 titles and abstracts. They discussed discrepancies with the wider research team (BS, JS, ALT, AU and SM) to reach consensus and improve shared understanding of the inclusion/exclusion criteria. All remaining titles and abstracts were subsequently single-screened (BS, ALT) against the inclusion and exclusion criteria, resulting in 32 papers selected for full-text review.

In addition to the systematic literature search, we asked our project Steering Committee to provide additional references that were not already included but were potentially relevant. They suggested 13 titles, of which we selected 4 for full-text screening after title and abstract review. We also manually searched the references of the selected full texts and identified 40 additional titles of potentially relevant articles. After screening their titles and abstracts, we selected eight of these for full-text review.

2.4. Full text screening, data extraction and narrative synthesis

We conducted a detailed screening of 44 full-text articles for inclusion, resulting in 23 for data extraction. At the full-text screening stage, we excluded studies that either 1) focused on optimal (rather than actual) research spending and defining research priorities, 2) did not report economic benefits of research or its costs, 3) focused solely on the impact of a single intervention; concerned spending on health and care rather than on research on health and care, or 4) did not include empirical research (e.g. protocols and commentaries).

Extracted data from each included full text covered:

- **Bibliographic information**: Authors, publication year and title.
- **Study characteristics**: Country in which the research was funded, funding time period, research scope and paper type.
- **Quality of evidence:** According to Varker et al.'s (2015) criteria.
- **Evidence on**:
    - Returns on investment in research: methods of estimating and estimates
    - Economic impacts captured
    - Health gains captured
    - Variation in economic returns by type and location of funded research
    - Time lags between research and economic impact
    - Spillovers.

Four members of the research team extracted data, initially by a single reviewer in each case (AU, BS, SM, ALT). They then compared, discussed and in some cases clarified the resulting data extraction table in a workshop meeting. We iteratively reviewed the extracted data and synthesised it into a narrative to describe and compare the methodologies used, and to reflect on the reasons for the variation in observed results.

2.5. Assessment of the quality of included studies

Our experience of published studies is that there are examples that have generated large estimates of returns to research investment due to questionable assumptions, e.g. the

'exceptional returns' literature discussed in 'Medical research: what's it worth?' (HERG et al. 2008). We therefore assessed the quality of the empirical literature based on Varker and colleagues' approach, which comprises five components (Varker et al. 2015):

1. Strength of the evidence base
2. Direction of study results (positive/negative/null)
3. Consistency of study results (compared to other included studies)
4. Generalisability
5. Applicability to the NIHR and UK contexts.

Reviewers evaluated the quality of the study when extracting information from the included articles. We did not exclude any articles based on their quality but lent more weight in the narrative synthesis to those that the research team considered to be of higher quality.

3. Results

Of the 23 studies ultimately included (see Figure 9), one was a systematic review (Raftery et al. 2016) and the others were empirical, original research. Most of the included studies focused on research funding in a single country (nine in the UK or England, six in Australia, three in the US and one each in Ireland, Sweden and Canada), and one in the EU. The remaining paper was an international systematic review.

We used keywords related to 'health' and 'care' in our search to capture studies focused on the relevant research funding sectors. We included additional studies that considered, included or impacted health-and-care research funding, spending or investment (e.g. national agencies covering health and/or care and other research funding). The majority of studies focused on funding for a specific disease area, such as cancer (Glover et al. 2014; Jakovljevic et al. 2024; Lakdawalla et al. 2010; Marquina et al. 2025; Oliveira et al. 2013; Paul et al. 2024) cardiovascular disease (HERG et al. 2008), musculoskeletal conditions (Glover et al. 2018), mental health (HERG et al. 2008), strokes (Ramanathan et al. 2023) and Alzheimer's disease (Jakovljevic et al. 2024). Several studies focused on funding for specific infrastructure or programmes of research, e.g. funding for IT support for all science and engineering disciplines in the US (Stewart et al. 2023), funding through the NIHR for Biomedical Research Centres and Biomedical Research Units (Craig et al. 2020) and the NIHR's Health Technology Assessment programme (Guthrie et al. 2015, 2016)

Two researchers (BS, AU) synthesised the extracted data into several themes related to our study's research questions and discussed them with the principal investigator (JS). We present these results in the following pages, starting with how economic returns and health gains from research are captured, moving on to variation in impacts across different types of research and geographies, and finally considering time lags, research spillovers and the quality of the evidence.

3.1. Capturing economic returns on investment in research

The identified studies employed a broad range of methods to capture the economic returns to research. No single method emerged as the standard, dominant method, and the economic benefits were themselves defined in multiple ways. In the following subsections we consider the different approaches to estimating economic returns other than health gains. In a later section we examine the estimation of health gains from research, first using bottom-up methods and then using top-down methods.

We can summarise the economic returns to research beyond those consequent on health gains that are due to the application of the research findings as the change in the GDP of a country or region, in other words to the 'gross value added' (GVA) produced by the country or region, that results from the research (we consider health gains separately later in this Appendix). The impact on GDP or GVA may be due to:

- Jobs and incomes that are created directly by the research spending.
- Jobs and incomes that are indirectly generated via spending on suppliers of goods and services, equipment and facilities used in research.
- The induced effects on the rest of the economy as those incomes are spent.
- Additional industry research and development (R&D) spending that is stimulated by the public research spending.
- Effects on the rest of the economy, including productivity (due to a healthier workforce and knowledge gained from the research) and competitiveness (due to a strengthened science base and a more skilled, more productive workforce).

The 'Medical research: what's it worth' study (HERG et al. 2008) describes these economic returns and presents a top-down estimation method that relies on an econometric analysis of the (lagged) relationship between public and charity research spending in different disease areas and subsequent private (pharmaceutical) industry R&D spending in those disease areas, alongside a review of estimates in the literature of the social rate of return to private industry R&D. This study found that the GDP gains from public and charity medical research spending in the UK have a positive Internal Rate of Return (IRR) with a best estimate of 30% per annum, although this figure is subject to considerable uncertainty. In other words, £100 of public-plus-charity medical research spending yields a flow of future positive impacts on UK GDP, estimated to be equivalent to £30 per year indefinitely. A later study by some of the same authors with more recent data found a comparably positive but somewhat smaller association between public-plus-charity medical research spending and consequent commercial private sector R&D spending, as a result of which the internal rate of return in GDP terms (excluding the value of health gains) to medical research was re-estimated to have an IRR of 15–18% per annum, this range being itself subject to considerable uncertainty (Sussex et al. 2016.)

Some studies in the literature that estimate the economic returns to research, in addition to health gains, have proceeded by assuming that a proportion of observed GDP growth or other economic variables is attributable to health-related research. Roback et al. (2011) studied returns on health research investment in Sweden, attributing 50% of Sweden's GDP growth over the studied period to research, of which 20% was health related. Hence, they attributed 10% of the achieved GDP growth (which averaged 3% per annum) to health-related research. Deloitte Access Economics' (2011) study used the number of life years saved, estimated using a top-down approach, to estimate productivity and indirect economic gains using values derived from cost of illness studies, and then added the estimated value of commercialisations, linking the value of biotech companies with the research, via a series of simple proportions and assumptions.

Other studies have adopted economic modelling approaches, as described in the following subsections.

3.1.1. Input-output modelling

Input-output modelling is a standard way to assess economic returns of public spending interventions, and we have found a few studies using this method for health research funding. Smith et al. (2019) used input-output modelling to estimate the ROI of the Oxford Biomedical Research Centre (funded by the NIHR), focusing on income and job creation in South East England. One key feature of this method, as the authors highlighted, is that it is not specific to a disease area or research type. The authors also noted that, while this method is useful when confined to a single region, Social Accounting Matrix or General Equilibrium Modelling might be more appropriate when evaluating the full extent of funding by a specific programme or agency.

Craig et al. (2020) used input-output modelling as an adjunct to bottom-up methods of estimating economic impact via health gains and spillovers. The authors argued that a strength of this method, compared to other approaches for measuring spillovers, is that it uses established model inputs specific to the UK and to non-profit scientific research. However, they also highlighted several limitations.

3.1.2. Computable General Equilibrium (CGE) modelling

While more advanced modelling, such as CGE, is commonly used to estimate the effects of a public funding intervention on a (national) economy, we found only one study that applied it to estimate returns on investment in research. ACIL Allen's (2023) study estimated the economic impact of Australian Research Council funding using whole-economy modelling, impact case studies and qualitative and quantitative research. Using a CGE model of the Australian economy, the authors estimated that every $1 spent on research in 2002/2021 generated $3.32 in additional GDP over the 20 years post-expenditure.

3.1.3. Mixed and qualitative approaches

Several studies identified in our review used a mixed-methods approach, providing both qualitative evidence (e.g. case studies) and discrete quantitative evidence (e.g. counts of patents and other economically relevant outputs), including in some cases the monetary value of further public grants and other leveraged funding. Common evaluation frameworks used are the payback framework (Buxton & Hanney 1996; Donovan & Hanney 2011) and the Framework to Assess the Impact from Translational Health Research (FAIT) (Searles et al. 2016). These frameworks assess the impact of research funding through indicators across domains of knowledge advancement, capacity- and capability-building, economics, policy and legislation, and infrastructure.

Such studies typically do not estimate the complete monetised ROI but instead rely on 'cost-consequence analysis' that presents the ledger of costs against a list of attributable consequences, only some of which might be monetised; the actual comparison and conclusion is left to the reader. For example, the monetised consequences of funded research listed by Paul et al. (2024) and Ramanathan et al. (2023) were primarily presented as leveraged further funding and the increased lifetime earnings of the funded PhD students.

Several other studies interpret and capture the economic benefits more qualitatively. Nason et al. (2008) use the payback framework and eight case studies of funded research to capture benefits (including, economic) for Ireland. Boulding et al. (2020) provided a broad overview of research types and their potential impacts,

focusing on NIHR-funded public health research between 2000 and 2016, and nine case studies in particular. Jakovljevic et al. (2024) used a broadly descriptive narrative to illustrate the impacts of European Commission funding on several health research areas. Guthrie et al. (2015) examined the impacts of the NIHR Health Technology Assessment programme, drawing on qualitative case studies.

Other economic impacts considered qualitatively but not captured in monetary terms in the identified studies include (1) health service delivery productivity, process improvements and reduced absenteeism from work (Roback et al. 2011), (2) impact through refining products or markets, increased sales and more efficient allocation of NHS resources (Guthrie et al. 2015), (3) savings from negative study results preventing the cost of larger, expensive follow-up trials (Boulding et al. 2020), and (4) improving research efficiency by minimising the costs and time needed for participant recruitment or obtaining samples (Ramanathan et al. 2023).

3.1.4. Other noteworthy approaches

Some studies using payback or FAIT frameworks directly consider the number of patents or start-ups/spin-offs originating from research. However, their economic value is rarely directly estimated. Using a top-down approach to capturing the commercial value of research funding, Access Economics (Deloitte Access Economics 2011) attributed a proportion of all biotech companies' value in Australia to public research funding, equal to the proportion of companies that received such funding, and assumed that 50% of their value is due to research and development activities.

Although they do not capture the overall economic impact of research funding, two other studies are noteworthy. Stewart et al. (2023) compared the costs of running a publicly funded IT support service for the US national research community with the estimated market value of such services to arrive at a (hypothetical) return to the investment. Roth et al. (2014) examined the returns to funding a single trial rather than a programme of research, looking at the then largest clinical trial funded by the US National Institutes of Health. Focusing on how the trial's results affected a single health intervention (combined hormone therapy among postmenopausal women), the authors modelled a counterfactual scenario in which the trial was not funded, and treatment guidelines did not change. While the study comes close to generating causal evidence on the impact of research funding, the approach is unlikely to be scalable to whole research programmes, particularly research beyond direct clinical applications.

Innovation often means that additional services are provided, or that the cost of existing services might change. Thus, research can lead to additional or reduced health and care service delivery costs. For example, employing a bottom-up approach, the 2008 'Medical research: what's it worth' study (HERG et al. 2008) identified healthcare interventions associated with research, gathered estimates of their cost to the NHS from the literature, estimated the number of patients utilising these interventions during the study period and calculated the resulting change in healthcare costs. In contrast, Roback et al. (2011) estimated the increased healthcare costs due to research via a top-down method, by assuming that half of the total expected annual increase in costs is due to research and development, of which 3% is specifically related to research funded in Sweden (the study's regional focus).

3.2. Capturing health gains

A systematic review by Raftery et al. (2016) of approaches to measuring the impact of health research included studies estimating the monetary value of health gains resulting from health research. Most of the studies they identified examined the impact of research on the health outcomes of the population in the country where the research is funded. Two broad approaches were evident: (1) a bottom-up approach examining a large number of research projects and linking health interventions achieved by these projects to the expected health impacts of each constituent intervention via published evidence, such as clinical trials and cost-effectiveness studies, and (2) a top-down approach observing lagged population-level health gains and attributing part of them to research. We have adopted this categorisation to present the studies we identified that quantify overall health gains from health and care research (excluding those that quantify health gains only from individual research projects, clinical trials and evaluations).

When the economic impacts of research on improved health are captured, the change in life expectancy and health-related quality of life must first be quantified and then converted into a monetary value using both bottom-up and top-down approaches. Quantified health gains are typically measured as quality-adjusted life years (QALYs) gained, disability-adjusted life years (DALYs) avoided, or simply as improvements in life expectancy and hence life years, unadjusted for the quality of life during those years. The nature of the conversion rate used to monetise the quantified health gains differs across studies. For example, Access Economics (2008) uses the value of a statistical life year estimated in willingness-to-pay studies for this conversion. In contrast, the 'Medical research: what's it worth' study (HERG et al. 2008) used the opportunity cost to the NHS of one QALY, as assumed by the National Institute for Health and Care Excellence (NICE).

3.2.1. Bottom-up approach: health benefits aggregated from individual interventions

The bottom-up approach starts by identifying the health interventions arising from the funded research, estimating the expected health gains from implementing them (through published empirical analyses) and valuing these gains in monetary terms to derive the economic return (from health gains) on investment. Starting with the 'Medical research: what's it worth' report on public and charity medical research funding in the UK (HERG et al. 2008), a set of studies used a bottom-up approach to capture the health gains resulting from specific research-based health interventions in cardiovascular and mental health research. Later studies using this approach focused on limited but quite broad clinical areas, such as cancer (Glover et al. 2014) or musculoskeletal research (Glover et al. 2018).

These studies used a bibliometric analysis of condition- and period-specific clinical practice guidelines to estimate the proportion of benefits attributable to research in the country of interest. This approach was developed by the 'Medical research: what's it worth' (HERG et al. 2008) study for research and health gains specific to cardiovascular diseases and mental health in the UK, and was later applied to cancer (Glover et al. 2014) and musculoskeletal diseases (Glover et al. 2018).

A similar approach has been applied to cardiovascular diseases and research in Canada (Oliveira et al. 2013). Guthrie et al. (2016) also use a similar approach to calculate the health gains (measured in QALYs) associated with a selection of ten health technology assessment (HTA) studies funded through the NIHR. This study used a simplified approach to provide a conservative estimate;

it also relied on additional assumptions. For example, the full health benefit observed is assumed to be reliant on the relevant HTA study being conducted, rather than relying on bibliometric analysis to estimate the proportion of benefit attributable to the NIHR's HTA programme. Craig et al. (2020) used the same methodology but applied a different monetary value for a QALY; therefore, they estimated different monetary values for health gains and a different IRR.

3.2.2. Top-down approach: changes in life expectancy, quality and disability

A different approach is to link the costs of funding health research with empirically observed changes in population health outcomes via a chain of assumptions, including the time lag between research and health impact, the proportion of health gains linked to research activity and the contribution of research funded by a specific funder in the studied country to the global pool of health research. Examples of such studies include Access Economics' 2008 study of returns on health research investment in Australia and Marquina et al's 2024 study of returns on investment in a cancer biobank in Australia (Marquina et al. 2025). While some of the individual assumptions in such studies linking the inputs (funding costs) to outputs (health gains) are based on empirical methods and reasoning (e.g. bibliographic analysis of publications), others are untestable. For example, one study assumed that 50% of the observed health gains over time are attributable to research, without empirically quantifying this key assumption (Deloitte Access Economics 2011).

The top-down approach starts by identifying improvements in life expectancy, QALYs or DALYs in the country compared to a historical reference. For example, Access Economics (2008) estimated projected gains in well-being between 2033 and 2045 relative to 1993. The gains in years and quality of life are then converted to a monetary equivalent using a reference value. Next, the proportion of health gains attributable to research activities is determined using an assumed value, based on literature or reasoning (e.g. Access Economics 2008 estimated that 50% of health gains are attributable to research). Then, the country's share in global research is estimated, e.g. Access Economics (2008) used bibliometric analysis of scientific references to Australian studies, attributing 3.04% of the well-being gains from research specifically to research in Australia. Finally, if relevant, the contribution of the specific funding stream studied is evaluated relative to all research in the country. For example, Deloitte Access Economics (2011) examined the proportion of Australian publications in clinical sciences that were funded by the Australian National Health and Medical Research Council.

Lakdawalla et al. (2010) applied a related, although more complex, approach in the United States to compare cancer R&D costs with the increased life expectancy of cancer patients. The authors estimated the proportion of the increase in life expectancy due to earlier diagnosis and improved treatment, then calculated the (observed) value of the life gains using models of individual willingness-to-pay. However, they made no explicit assumptions about the relationship between R&D costs and benefits.

3.2.3. Qualitative assessment of impacts on health

Several studies qualitatively examine the health gains of research via case studies, without estimating their monetary value. For example, Nason et al. (2008) highlighted case studies of research that contributed to improved acute myocardial infarction survival, improved health outcomes for patients with psychosis, dental practice and other outcomes in Ireland. Guthrie et al. (2015) used qualitative case studies of NIHR-funded research to describe the positive impact of NIHR Health Technology Assessment projects on patients and healthcare quality.

3.3. Variation in economic impact by type of research activity

We were interested to find studies that would provide differential estimates of economic returns based on what types of research activities (e.g. focused on staff vs institutional development; early vs late stage of health research) are funded. However, most of the identified studies provided a single estimate of economic returns for a funding programme without differentiating between funding categories/types.

While not providing quantitative estimates of different returns on investment by research activity, several studies offer qualitative insights. Boulding et al. (2020) used Researchfish data and nine qualitative case studies of NIHR-funded research projects to capture the diversity of mechanisms and pathways to impact. The interviewees in these case studies noted that while the impact of their research on policy was usually hard to ascertain, often a more immediate but smaller in scale impact occurred at local level, e.g. in health service delivery or local government. Although they mentioned various mechanisms, facilitators and barriers to achieving impact, they did not specifically explore the mechanisms and impacts most relevant to specific types of research activities.

Ramanathan et al. (2023) examined the impact of funding the Centre for Research Excellence in Stroke Rehabilitation and Brain Recovery in Australia using the FAIT framework. While funding such a centre arguably represents a single 'research activity', they provided a breakdown of the costs, in terms of researcher and other staff salaries, infrastructure and supporting services (e.g. capacity-building events and supporting a biobank/register), indirect and implementation costs. While the study was unable to link each of these cost categories to specific economic impacts, the authors discuss the specific impacts observed from capacity-building events, clinical stipends, knowledge-transfer events, infrastructure (such as biobanks and registers) and clinical research.

Paul et al. (2024) examined the impacts of funding a translational cancer research collaborative in Australia, providing a breakdown of costs and comparing them to various impacts captured via the FAIT framework. They concluded that the most significant benefit of the funding was capacity building, particularly in supporting early and mid-career researchers to leverage additional funding for career development.

Several studies examined different specific subgroups of funding, such as health-technology assessments (Guthrie et al. 2015), charity vs government funding on medical research (Sussex et al. 2016), Biomedical Research Centres and Biomedical Research Units (Craig et al. 2020), cyberinfrastructure services for research (Stewart et al. 2023) or a biobank (Marquina et al. 2025). However, due to differences in methods, settings (countries), and studied time periods, it is not possible to compare results across studies to conclude variations in economic returns.

A few studies with similar methodologies provided estimates of returns on investment from health gains by disease area:

- A set of UK studies evaluated the economic returns on cardiovascular (HERG et al. 2008), mental health (HERG et al. 2008), cancer (Glover et al. 2014) and musculoskeletal (Glover et al. 2018) research.
- An Australian study estimated returns on investment separately for cardiovascular disease, cancer, sudden infant death syndrome, asthma and muscular dystrophy (Deloitte Access Economics 2011).
- A US study estimated the health gains for cancer patients against the R&D costs for different cancer types, including breast, colorectal, lung, non-Hodgkin's lymphoma and pancreatic (Lakdawalla et al. 2010).
- A study of European Commission-funded research (Jakovljevic et al. 2024) compared the value of funding and the outputs and outcomes of the funded research on Alzheimer's disease, breast cancer and prostate cancer. Compared outputs included the number of publications, patents, diagnostic tools and initiated clinical trials, among others, but the study did not translate these into economic returns on investment.

3.4. Variation in economic impact by geographic location of research activity

We checked if each study reported whether research funded in different geographic locations (e.g. regions within a country) yields different economic returns on investment. However, most of the identified studies were at the national level. We found that few studies addressed intra-national differences in funding, and none examined different economic returns by geographic region or location.

Based on nine qualitative case studies of public health research projects funded through the NIHR, Boulding et al. (2020) found that while the impact of individual research projects on policy was usually hard to ascertain, a more immediate but smaller-scale impact often occurred at a local level, e.g. in health service delivery or local government. Craig et al.'s (2020) study on the NIHR's funding of Biomedical Research Centres and Units mapped the regional distribution of this funding across England between 2007 and 2019, noting a high concentration of funding in London, the South East (including Oxford) and the East of England (including Cambridge). The authors expressed concern about potential inequality of funding distribution and state a view that economic returns are more likely to be realised locally (e.g. in terms of employment or health gains if innovation is more likely to be adopted in the area it is developed) and therefore are likewise probably unevenly spread. However, they did not present quantitative evidence of differential economic returns across regions. A study based in Australia showed how research funding can generate benefits for the specific region where the research is conducted (e.g. by increasing skilled jobs, boosting economic activity and attracting additional regional research funding). However, it did not examine regional differences in economic returns (Paul et al. 2024).

3.5. Time lags between research spending and consequent impacts

Most of the studies we reviewed do address the issue of the time lag between research spending and the consequent (economic) impacts. The exact number of years used in the models to capture this time lag is typically either assumed or based on previous research. For example, some studies assume a lag of 10–15 years, relying on previous research but not discussing their sources (Nason et al. 2008; Roback et al. 2011). Drawing on research by

Contopoulos-Ioannidis et al. (2008), another study used a lag of 12.8 years (Oliveira et al. 2013), while Lakdawalla et al. (2010) extended this to 18 years as a conservative estimate based on the typical 10–15 years it takes for drug development from inception to launch.

Few studies have empirically estimated the time lag directly. One of the most detailed studies to examine time lags is the 2008 'What's it worth?' study (HERG et al.), which uses the publication dates of research studies and clinical guidelines to estimate the lag between research findings and their impact on clinical practice. The study reports a 10–25-year time lag (midpoint = 17 years) for cardiovascular research spending, and a 9–14-year time lag (midpoint = 12 years) for mental health research spending. Replicating this approach, Glover et al. (2014) estimated a lag of 10–20 years for cancer research spending (midpoint = 15 years), and Glover et al. (2018) estimated a lag of 16 years for musculoskeletal disease.

More recently, ACIL Allen (2023) surveyed 3,631 researchers in Australia (with a 13% participation rate among all invited Chief Investigators and Partner Investigators of National Competitive Grants Program funding recipients) to subjectively estimate the time lag to generate returns on the research investment. The weighted averages of the reported time lags were six years for Discovery (funding basic and fundamental blue-sky research) and four years for Linkage projects (focused on collaborative research linking universities, industry and other research users). However, this report examined all research, not just health- or care-specific research, and did not look at heterogeneity in the timing of research impact across fields. It is unclear whether health and care research is subject to the same time lags as other research.

A review by Hanney et al. (2015) reported the heterogeneity in time lags estimated across studies as depending partly on the field of research (ranging from 8.5 years for anti-infectives to 15 years for immunological medicines). As a result, Hanney et al. proposed a framework with research translation milestones or events and different tracks to structure the expected lags. As part of the economic evaluation of the NIHR's Biomedical Research Centres and Biomedical Research Units, Craig et al. (2020) updated Hanney et al.'s (2015) systematic review on time lags between investment and new therapies. The review included 15 studies on drug and medical-device development and reported widely varying estimates, partly because the dates for the start (of investment) and end (of therapy) of the time lag are defined differently across studies. Two of the biggest reported studies estimated 14 years from patent date to NICE final appraisal determination in the UK and 9.1 years from Phase 1 trial launch to European Medicines Agency authorisation between 2009 and 2016 for cancer drugs (Sharpe et al. 2020), and 13.5 years from patent to launch for new drugs coming to the US market in 2018 (IQVIA 2019).

3.6. Research funding spillovers: the relationship between public and private research investment

Overall, the authors of most of the studies express a view that public and private research spending support (or can support) each other. One set of studies (Glover et al. 2014 & 2018; HERG et al. 2008; Oliveira et al. 2013; Sussex et al. 2016) uses the concept of spillovers from public research funding to capture the overall effect on national GDP. Others rely on qualitative evidence and examples to show that public research spending can lead to a virtuous cycle and complement and stimulate private research (Access Economics 2008; Nason et al. 2008).

One of the few studies to discuss the topic is HERG et al.'s (2008) 'Medical research: what's

it worth?' study. Based on a review of the literature, they estimate that an extra £1 spent on public medical research in the UK leads to a total eventual additional £2.2–5.1 in private R&D spending in the UK. The authors combine this with an estimate from the literature of the social rate of return to private investment on R&D (total, rather than the private, returns of such investment), and arrive at the total social rate of return 'to the marginal "investment project" that commences with £1 extra of UK public medical research spending is estimated to lie in the range 26–34%, i.e. of the order of 30%.' Some subsequent studies have also used this approach (Oliveira et al. 2013).

Sussex et al. (2016) studied spillovers from public and charitable research to private industry R&D in detail using an econometric 'vector error correction model' and a time series of biomedical and health R&D expenditure in the UK for ten disease areas between 1982 and 2012. The study concluded that public research investment 'crowds in' additional private-sector R&D investment, so that £1 of public research spending is associated with an additional £0.83–1.07 of private R&D spend, with 44% of the additional expenditure occurring within one year. Thus, the spillover effect is estimated to imply a real terms IRR in the UK of 15–18%. Craig et al. (2020) later replicated Sussex et al.'s approach, updating the time-series data with more recent inputs and identifying three additional papers that measured spillover (two of them not specific to health research). Their review concluded that the new empirical evidence supports the presence of positive spillovers from public research funding.

A study in Australia took a different approach, comparing the value of public medical R&D investment with the value of commercialisation estimated to result from it (Deloitte Access Economics 2011). However, this calculation relied on strong assumptions, e.g. that 50% value of the commercial products stems from R&D spending and 50% from other factors, and that the proportion of companies that received public medical funding (33%) equals the proportion of the value of all Australian biotech companies attributable to this funding. The authors thus arrive at a commercialisation benefit-to-cost ratio of 0.72:1 (i.e. $1 of research funding yields $0.72 in commercial value). The added benefits of the commercialisation of products developed with public research investment have also been noted more generally in other studies (e.g. Guthrie et al. 2015).

Some spillover effects are also indirectly captured in studies using input-output models to capture the diffusion and spillovers between industries (Smith et al. 2019). However, such studies do not capture spillovers; instead, they rely on economic assumptions that are not specific to research funding.

Several other studies provide qualitative evidence of spillovers, including examples of public research funding fostering partnerships between public and private research partners, enhancing private-sector capabilities and laying the foundations for innovations that are further developed and commercialised by private companies (Jakovljevic et al. 2024; Paul et al. 2024).

Some studies report the amount of leveraged (research) funding following an initial research expenditure as an economic output. In the paragraphs above, we discussed how public research stimulates additional private-sector R&D, which, in turn, generates economic impacts. Where public research stimulates further public research, we do not consider this an economic return, as we view the further public research as a publicly funded input rather than an output. For example, Ramanathan et al. (2023) based the total ROI for a research centre in Australia on a comparison of the associated value of grants, fellowships, scholarships, awards and

increases in lifetime earnings (of completed PhDs) with the centre's research costs. Another study compares leveraged funding with the costs of a translational cancer research collaborative in Australia (Paul et al. 2024). However, it is unclear how much of this additional funding originates from public and how much from private sources, and thus whether it should be considered a further input of public spending or an output of the original research.

3.7. Quality of evidence from the identified studies

We have evaluated the quality of evidence for the studies included in this review using the criteria developed by Varker et al. (2015). These criteria were primarily designed to evaluate a set of (rather than individual) studies; therefore, we describe the overall quality of the evidence in our literature review results here. The **strength of each study's evidence base** ranges widely. Some relied on extensive assumptions (such as time lags and the contribution of a specific country's research to improving its population's health), making their results and conclusions sensitive to changes in modelling inputs. Others triangulated their results using multiple methods, including both quantitative and qualitative data collection.

The **direction of economic impacts** of (health and care) research captured was primarily positive. The few partial exceptions were research in specific clinical areas, including Alzheimer's disease (Jakovljevic et al. 2024) and muscular dystrophy (Deloitte Access Economics 2011), where research has not led to expected health gains. However, these specific studies did not comprehensively consider all economic benefits.

The overall results of the studies reviewed were broadly **consistent**, despite a wide range of methods and settings.

We found that the **generalisability** of study estimates, e.g. the reported overall returns on investment or health gains from health and care research, was limited by their variability. Direct generalisations from studies focused on specific clinical areas (e.g. cancer) or research funding types (e.g. translational research) should be made with great caution, particularly in relation to the broad portfolio of research that is funded through the NIHR.

We considered studies conducted in the United States to have limited applicability to the UK and NIHR funding, as their research and healthcare contexts differ from those in the UK. Studies conducted in other countries mentioned in the literature, including Australia, Canada, Ireland and Sweden, are likely to be more applicable to the UK context. UK-based studies should, by definition, be applicable.

4. Discussion

The research literature on measuring the economic returns to health and care research is diverse. In this review of 23 studies evaluating the economic impact of (health) research funding, no single method emerged as the dominant or 'gold standard' technique. Methods for capturing the overall economic impact build on techniques such as input-output and CGE models. Health gains are often considered when estimating the impact of this research, using top-down deductive reasoning or bottom-up estimates based on specific health interventions. Accurately capturing spillovers and time lags between research spend and economic benefits is key, as models are sensitive to these inputs. We did not find quantified evidence of variation in economic returns by (intra-national) region or by type of research activity, beyond some evidence of differences between disease areas funded. A proportion of identified studies are based in the UK and are thus directly

relevant to the evaluation of economic returns to NIHR activities, although not necessarily generalisable to the whole portfolio of NIHR research, as they focused on specific diseases or research programmes.

Most studies of economic returns were top-down, with notable exceptions that estimated health gains. Estimates of the monetary value of health gains were also sometimes top-down, but several used a bottom-up approach. While authors highlighted various strengths and limitations of both top-down and bottom-up approaches, one major trade-off between them was the practical effort required to gather the necessary model inputs. While top-down studies rely primarily on aggregated statistics (e.g. overall national changes in life expectancy for specific patient groups), bottom-up studies require an extensive literature review of the health gains and costs associated with specific medical interventions and, as a result, necessarily focus on narrower areas of research.

We note that the body of literature building on the payback framework and other approaches to (partly) quantify but not monetise research funding impacts provides a rich picture of how research funding translates into benefits to society and the economy. However, this literature typically does not provide the information necessary to monetise such benefits.

Even within studies using apparently comparable methods, reporting of economic impacts varies, complicating comparisons across studies. Most studies reporting quantified impacts presented them as an IRR or ROI. These estimates are not directly comparable, as an IRR expresses returns equivalent to a stream of net benefits continuing in perpetuity, whereas a ROI uses a lump sum of benefits over a specified number of years – typically assumed rather than estimated empirically. Complicating the comparison further, yet other methods are used to estimate instantaneous one-off benefits to the economy without time lag, such as input-output modelling that captures immediate gains to the local economy. While attempts have been made to combine several of these (Craig et al. 2020), this increases the risk of double-counting.

While we have identified some studies that estimated the overall economic impact of research, few discussed how this impact varies by region (within a country), and none provided different estimates for different regions. Taking the studies we reviewed as a whole suggests that economic returns may vary by disease area, but differences in methods across some papers warrant caution. A recent report by Grant et al. (2024) reviewed methods to capture regional economic impact (in the context of public spending rather than research-specific funding), and listed input-output models, CGE models, dynamic CGE models and Social Accounting Matrices as approaches used. We note that input-output data and social accounting matrices are inputs to CGE models. One of the studies we reviewed applied a CGE model (ACIL Allen 2023).

5. Limitations

Our review of the literature is subject to limitations. Firstly, due to the project timeline and the broad range of literature available, we used focused, REA methods and a scoping approach to collect and synthesise the relevant studies. We acknowledge that we may have missed some relevant studies due to this approach. However, we conducted a broad search and screened a large number of apparently relevant papers (n=1,690 after deduplication). We also drew on the expertise of our project steering committee and the background knowledge of the research team – some of whose members have been active in this research field for nearly 20 years.

That, and the snowball search (of references) we undertook, gives us confidence that we have covered the most relevant studies and methods for evaluating the economic returns to the NIHR's activity.

Secondly, we restricted our search to OECD countries and focused on empirical studies to narrow the scope to the inputs most valuable to our overall research project. Thirdly, while we systematically extracted information from the included studies using a template, most quantitative estimates are not directly comparable or applicable to our project due to the heterogeneity of methods and settings. We have focused on methods and lessons that could inform our own study design.

6. Annex A1. Detailed literature search strategy

Databases:

- EconLit
- Embase
- PubMed
- Scopus
- Web of Science.

Limiters:

- Language: English
- Date Range: 2008 to July 2024
- Geographic: UK and other high-income countries.

Results:

- Total number imported to EndNote Library: 2,527
- Total number for review post-deduplication of EndNote Library: **1,690**.

EconLit
1 JUL 2024

Set #	Search	# results
1 HEALTH AND CARE	**TI**(health* OR nursing OR "social care" OR medical OR biomedical OR clinical OR "patient care" OR "quality of care" OR "preventive care" OR alzheimer* OR cancer OR cardiovascular OR "chronic obstructive pulmonary disease" OR diabetes OR obesity OR "mental disorder*" OR "kidney disease" OR Arthritis OR asthma OR dementia OR hypertension OR epilepsy OR influenza OR pneumonia OR "AIDS" OR "HIV" OR coronavirus OR "COVID-19" OR "COVID 19" OR "multiple sclerosis" OR Parkinson* OR liver) OR **AB**(health* OR nursing OR "social care" OR medical OR biomedical OR clinical OR "patient care" OR "quality of care" OR "preventive care" OR alzheimer* OR cancer OR cardiovascular OR "chronic obstructive pulmonary disease" OR diabetes OR obesity OR "mental disorder*" OR "kidney disease" OR Arthritis OR asthma OR dementia OR hypertension OR epilepsy OR influenza OR pneumonia OR "AIDS" OR "HIV" OR coronavirus OR "COVID-19" OR "COVID 19" OR "multiple sclerosis" OR Parkinson* OR liver)	94,642

Set #	Search	# results
2 RESEARCH	**TI**(research OR evaluation* OR "R&D" OR "trials" OR "health technology assessment*" OR "HTA" OR appraisal OR intervention*) OR **AB**(research OR evaluation* OR "R&D" OR "trials" OR "health technology assessment*" OR "HTA" OR appraisal OR intervention*)	234,641
3 ECONOMIC RETURNS AND HEALTH GAINS	**TI**("economic return*" OR "return on investment*" OR "ROI" OR "rate of return*" OR "impact assessment*" OR "value assessment*" OR externalities OR synergies OR "general equilibrium model*" OR "social accounting matrix" OR "input-output model*" OR "health gain*" OR "net health benefit*" OR spillover* OR "economic gain*" OR "multiplier effects" OR "economic multipliers" OR "direct economic impact*" OR "indirect economic impact*" OR "capacity impact*" OR "crowding-in" OR "crowding in" OR "crowding-out" OR "crowding out") OR **AB**("economic return*" OR "return on investment*" OR "ROI" OR "rate of return*" OR "impact assessment*" OR "value assessment*" OR externalities OR synergies OR "general equilibrium model*" OR "social accounting matrix" OR "input-output model*" OR "health gain*" OR "net health benefit*" OR spillover* OR "economic gain*" OR "multiplier effects" OR "economic multipliers" OR "direct economic impact*" OR "indirect economic impact*" OR "capacity impact*" OR "crowding-in" OR "crowding in" OR "crowding-out" OR "crowding out")	59,976
4 OECD COUNTRIES	**TI**("United States" OR USA OR "U.S.A." OR "U.S." OR Canada OR "British Columbia" OR Europe* OR Austria OR Belgium OR "Czech Republic" OR France OR Germany OR "Great Britain" OR Ireland OR England OR Scotland OR Wales OR "United Kingdom" OR UK OR "U.K." OR Greece OR Hungary OR Italy OR Netherlands OR Luxembourg OR Poland OR Portugal OR Scandinav* OR Denmark OR Estonia OR Finland OR Iceland OR Norway OR Sweden OR "Slovak Republic*" OR Slovenia OR Spain OR Switzerland OR Israel OR Australia OR "New Zealand" OR Japan OR Korea* OR Lithuania OR Latvia OR Cyprus OR Liechtenstein OR Slovakia) OR **AB**("United States" OR USA OR "U.S.A." OR "U.S." OR Canada OR "British Columbia" OR Europe* OR Austria OR Belgium OR "Czech Republic" OR France OR Germany OR "Great Britain" OR Ireland OR England OR Scotland OR Wales OR "United Kingdom" OR UK OR "U.K." OR Greece OR Hungary OR Italy OR Netherlands OR Luxembourg OR Poland OR Portugal OR Scandinav* OR Denmark OR Estonia OR Finland OR Iceland OR Norway OR Sweden OR "Slovak Republic*" OR Slovenia OR Spain OR Switzerland OR Israel OR Australia OR "New Zealand" OR Japan OR Korea* OR Lithuania OR Latvia OR Cyprus OR Liechtenstein OR Slovakia)	377,166
5	**#1** AND **#2** AND **#3** AND **#4**	257
6	**#5** AND **Limiters**: - **Date of Publication**: 20080101-; **Language**: English	218
7	**#6** AND **Limiters: - Source Types:** Academic Journals	**126**

Embase
2 JUL 2024

Set #	Search	# results
1	'health research':ti,ab OR 'medical research':ti,ab OR 'biomedical research':ti,ab OR 'translational research':ti,ab OR 'clinical research':ti,ab OR 'healthcare research':ti,ab OR 'disease research':ti,ab OR 'health care delivery research':ti,ab OR 'healthcare delivery research':ti,ab OR 'research support':ti,ab OR 'research investing':ti,ab OR 'research investment':ti,ab OR 'research investments':ti,ab OR 'health investment':ti,ab OR 'health investments':ti,ab OR 'health investing':ti,ab OR 'medical research'/exp OR 'health services research'/exp OR (('cardiovascular disease'/exp OR 'hypertension'/exp OR 'endocrine disease'/exp OR 'diabetes mellitus'/exp OR 'obesity'/exp OR 'hematologic disease'/exp OR 'chronic disease'/exp OR 'liver disease'/exp OR 'kidney disease'/exp OR 'degenerative disease'/exp OR 'multiple sclerosis'/exp OR 'dementia'/exp OR 'Parkinson disease'/exp OR 'brain disease'/exp OR 'epilepsy'/exp OR 'respiratory tract disease'/exp OR 'pneumonia'/exp OR 'neoplasm'/exp OR 'mental disease'/exp OR 'asthma'/exp OR 'acquired immune deficiency syndrome'/exp OR 'Human immunodeficiency virus'/exp OR 'arthritis'/exp OR 'Alzheimer disease'/exp OR 'coronavirus disease 2019'/exp OR 'population health'/exp) AND research:ti,ab)	1,797,036
2	research:ti,ab OR evaluation*:ti,ab OR R&D:ti,ab OR 'research development':ti,ab OR trials:ti,ab OR 'health technology assessment*':ti,ab OR HTA:ti,ab OR appraisal:ti,ab OR intervention*:ti,ab	7,166,091
3	'economic return*':ti,ab OR 'return on investment*':ti,ab OR ROI:ti,ab OR 'rate of return*':ti,ab OR 'impact assessment*':ti,ab OR 'value assessment*':ti,ab OR externalities:ti,ab OR synergies:ti,ab OR 'general equilibrium model*':ti,ab OR 'social accounting matrix':ti,ab OR 'input-output model*':ti,ab OR 'health gain*':ti,ab OR 'net health benefit*':ti,ab OR spillover*:ti,ab OR 'economic gain*':ti,ab OR 'multiplier effects':ti,ab OR 'economic multiplier*':ti,ab OR 'direct economic impact*':ti,ab OR 'indirect economic impact*':ti,ab OR 'capacity impact*':ti,ab OR crowding-in:ti,ab OR 'crowding in':ti,ab OR crowding-out:ti,ab OR 'crowding out':ti,ab	65,729
4	Australia:ti,ab OR Austria:ti,ab OR 'British Columbia':ti,ab OR Belgium:ti,ab OR Canada:ti,ab OR 'Czech Republic':ti,ab OR Denmark:ti,ab OR Estonia:ti,ab OR England:ti,ab OR France:ti,ab OR Finland:ti,ab OR Germany:ti,ab OR 'Great Britain':ti,ab OR Greece:ti,ab OR Hungary:ti,ab OR Iceland:ti,ab OR Ireland:ti,ab OR Israel:ti,ab OR Italy:ti,ab OR Japan:ti,ab OR Latvia:ti,ab OR Lithuania:ti,ab OR Luxembourg:ti,ab OR Netherlands:ti,ab OR 'New Zealand':ti,ab OR Norway:ti,ab OR Poland:ti,ab OR Portugal:ti,ab OR Scandinavia*:ti,ab OR Scotland:ti,ab OR 'Slovak Republic':ti,ab OR Slovenia:ti,ab OR Spain:ti,ab OR 'South Korea*':ti,ab OR Sweden:ti,ab OR Switzerland:ti,ab OR Wales:ti,ab OR 'United Kingdom':ti,ab OR UK:ti,ab OR U.K.:ti,ab OR 'United States':ti,ab OR USA:ti,ab OR U.S.A.:ti,ab OR U.S.:ti,ab OR US:ti,ab	3,496,650
5	**#1** AND **#2** AND **#3** AND **#4**	1,026
6	**#5** AND ([article]/lim OR [article in press]/lim OR [data papers]/lim OR [review]/lim) AND [english]/lim AND [embase]/lim AND [2008-2024]/py	**385**

PubMed
2 JUL 2024

Set #	Search	# results
1	"health research"[tiab:~1] OR "medical research"[tiab] OR "biomedical research"[tiab] OR "translational research"[tiab] OR "clinical research"[tiab] OR "healthcare research"[tiab:~1] OR "disease research"[tiab] OR "health care delivery research"[tiab:~1] OR "healthcare delivery research"[tiab:~1] OR "research support"[tiab] OR "research investing"[tiab:~2] OR "research investment"[tiab:~2] OR "research investments"[tiab:~2] OR "Biomedical Research"[MAJR] OR "Health Services Research"[MAJR] OR "Research Support as Topic"[Mesh] OR (("Cardiovascular Diseases"[Mesh] OR "Hypertension"[Mesh] OR "Endocrine System Diseases"[Mesh] OR "Diabetes Mellitus"[Mesh] OR "Hematologic Diseases"[Mesh] OR "Chronic Disease"[Mesh] OR "Hematologic Diseases"[Mesh] OR "Liver Diseases"[Mesh] OR "Kidney Diseases"[Mesh] OR "Neurodegenerative Diseases "[Mesh] OR "Multiple Sclerosis"[Mesh] OR "Dementia"[Mesh] OR "Parkinson Disease"[Mesh] OR "Brain Diseases"[Mesh] OR "Epilepsy"[Mesh] OR "Obesity"[Mesh] OR "Respiratory Tract Diseases"[Mesh] OR "Pneumonia"[Mesh] OR "Neoplasms"[Mesh] OR "Mental Disorders"[Mesh] OR "Asthma"[Mesh] OR "Acquired Immunodeficiency Syndrome"[Mesh] OR "HIV"[Mesh] OR "Arthritis"[Mesh] OR "Alzheimer Disease"[Mesh] OR "COVID-19"[Mesh] OR "Coronavirus Infections"[Mesh]) AND research[tiab])	966,757
2	research[tiab] OR evaluation*[tiab] OR "R&D"[tiab] OR "research development"[tiab:~1] OR "trials"[tiab] OR "health technology assessment*"[tiab] OR "HTA"[tiab] OR appraisal[tiab] OR intervention*[tiab]	5,361,185
3	"economic return*"[tiab] OR "return on investment*"[tiab] OR "ROI"[tiab] OR "rate of return*"[tiab] OR "impact assessment*"[tiab] OR "value assessment*"[tiab] OR externalities[tiab] OR synergies[tiab] OR "general equilibrium model*"[tiab] OR "social accounting matrix"[tiab] OR "input-output model*"[tiab] OR "health gain*"[tiab] OR "net health benefit*"[tiab] OR spillover*[tiab] OR "economic gain*"[tiab] OR "multiplier effects"[tiab] OR "economic multiplier*"[tiab] OR "direct economic impact*"[tiab] OR "indirect economic impact*"[tiab] OR "capacity impact*"[tiab] OR "crowding-in"[tiab] OR "crowding in"[tiab] OR "crowding-out"[tiab] OR "crowding out"[tiab]	48,812

Set #	Search	# results
4	Australia[tiab] OR Austria[tiab] OR "British Columbia"[tiab] OR Belgium[tiab] OR Canada[tiab] OR "Czech Republic"[tiab] OR Denmark[tiab] OR Estonia[tiab] OR England[tiab] OR France[tiab] OR Finland[tiab] OR Germany[tiab] OR "Great Britain"[tiab] OR Greece[tiab] OR Hungary[tiab] OR Iceland[tiab] OR Ireland[tiab] OR Israel[tiab] OR Italy[tiab] OR Japan[tiab] OR Latvia[tiab] OR Lithuania[tiab] OR Luxembourg[tiab] OR Netherlands[tiab] OR "New Zealand"[tiab] OR Norway[tiab] OR Poland[tiab] OR Portugal[tiab] OR Scandinavia*[tiab] OR Scotland[tiab] OR "Slovak Republic"[tiab] OR Slovenia[tiab] OR Spain[tiab] OR "South Korea*"[tiab] OR Sweden[tiab] OR Switzerland[tiab] OR Wales[tiab] OR "United Kingdom"[tiab] OR "UK"[tiab] OR U.K. [tiab] OR "United States"[tiab] OR USA[tiab] OR U.S.A. [tiab] OR "U.S." [tiab] OR "US"[tiab] OR "Australia"[Mesh] OR "Austria"[Mesh] OR "Belgium"[Mesh] OR "Canada"[Mesh] OR "Czech Republic"[Mesh] OR "Denmark"[Mesh] OR "Estonia"[Mesh] OR "England"[Mesh] OR "Finland"[Mesh] OR "France"[Mesh] OR "Germany"[Mesh] OR "Greece"[Mesh] OR "Hungary"[Mesh] OR "Iceland"[Mesh] OR "Ireland"[Mesh] OR "Israel"[Mesh] OR "Italy"[Mesh] OR "Japan"[Mesh] OR "Latvia"[Mesh] OR "Lithuania"[Mesh] OR "Liechtenstein"[Mesh] OR "Luxembourg"[Mesh] OR "Netherlands"[Mesh] OR "New Zealand"[Mesh] OR "Norway"[Mesh] OR "Poland"[Mesh] OR "Portugal"[Mesh] OR "Republic of Korea"[Mesh] OR "Scandinavian and Nordic Countries"[Mesh] OR "Scotland"[Mesh] OR "Slovenia"[Mesh] OR "Spain"[Mesh] OR "Sweden"[Mesh] OR "Switzerland"[Mesh] OR "Wales"[Mesh] OR "United Kingdom"[Mesh]	3,522,664
5	**#1** AND **#2** AND **#3** AND **#4**	731
6 PUBLICATION TYPES TO BE EXCLUDED	Address[pt] OR Autobiography[pt] OR Bibliography[pt] OR Biography[pt] OR "Clinical Trial Protocol"[pt] OR "Clinical Trial, Veterinary"[pt] OR "Collected Work"[pt] OR Comment[pt] OR Congress[pt] OR "Consensus Development Conference"[pt] OR "Consensus Development Conference, NIH"[pt] OR Dataset[pt] OR Dictionary[pt] OR Directory[pt] OR "Duplicate Publication"[pt] OR Editorial[pt] OR "Electronic Supplementary Materials"[pt] OR "Equivalence Trial"[pt] OR "Expression of Concern"[pt] OR Festschrift[pt] OR "Historical Article"[pt] OR "Interactive Tutorial"[pt] OR Interview[pt] OR "Introductory Journal Article"[pt] OR Lecture[pt] OR "Legal Case"[pt] OR Legislation[pt] OR Letter[pt] OR News[pt] OR "Newspaper Article"[pt] OR "Observational Study, Veterinary"[pt] OR Overall[pt] OR "Patient Education Handout"[pt] OR "Periodical Index"[pt] OR "Personal Narrative"[pt] OR Portrait[pt] OR Preprint[pt] OR "Published Erratum"[pt] OR "Randomized Controlled Trial, Veterinary"[pt] OR "Retracted Publication"[pt] OR "Retraction of Publication"[pt] OR "Twin Study"[pt] OR "Video-Audio Media"[pt] OR Webcast[pt] OR proceeding*[ti]	3,350,123
7	(**#5** NOT **#6**) AND (2008/1/1:2024/12/31[pdat]) AND (english[Filter])	**569**

Scopus
1 JUL 2024

Set #	Search	# results
1	**TITLE-ABS**((health* OR nursing OR "social care" OR medical OR biomedical OR clinical OR "patient care" OR "quality of care" OR "preventive care" OR alzheimer* OR cancer OR cardiovascular OR "chronic obstructive pulmonary disease" OR diabetes OR obesity OR "mental disorder*" OR "kidney disease" OR Arthritis OR asthma OR dementia OR hypertension OR epilepsy OR influenza OR pneumonia OR "AIDS" OR "HIV" OR coronavirus OR "COVID-19" OR "COVID 19" OR "multiple sclerosis" OR Parkinson* OR liver))	17,393,427
2	**TITLE-ABS**((research OR evaluation* OR "R&D" OR "trials" OR "health technology assessment*" OR "HTA" OR appraisal OR intervention*))	14,095,106
3	**TITLE-ABS**(("economic return*" OR "return on investment*" OR "ROI" OR "rate of return*" OR "impact assessment*" OR "value assessment*" OR externalities OR synergies OR "general equilibrium model*" OR "social accounting matrix" OR "input-output model*" OR "health gain*" OR "net health benefit*" OR spillover* OR "economic gain*" OR "multiplier effects" OR "economic multipliers" OR "direct economic impact*" OR "indirect economic impact*" OR "capacity impact*" OR "crowding-in" OR "crowding in" OR "crowding-out" OR "crowding out"))	312,799
4	**TITLE-ABS**(("United States" OR USA OR "U.S.A." OR "U.S." OR Canada OR "British Columbia" OR Europe* OR Austria OR Belgium OR "Czech Republic" OR France OR Germany OR "Great Britain" OR Ireland OR England OR Scotland OR Wales OR "United Kingdom" OR UK OR "U.K." OR Greece OR Hungary OR Italy OR Netherlands OR Luxembourg OR Poland OR Portugal OR Scandinav* OR Denmark OR Estonia OR Finland OR Iceland OR Norway OR Sweden OR "Slovak Republic*" OR Slovenia OR Spain OR Switzerland OR Israel OR Australia OR "New Zealand" OR Japan OR Korea* OR Lithuania OR Latvia OR Cyprus OR Liechtenstein OR Slovakia))	7,476,436
5	**#1** AND **#2** AND **#3** AND **#4**	4,288
6	**#5** AND **PUBYEAR** > 2007 AND **PUBYEAR** < 2025	3,650
7	**#6** AND (**LIMIT-TO** (**LANGUAGE**, "English"))	3,456
8	**#7** AND (**LIMIT-TO** (**DOCTYPE**, "ar" OR "re" OR "cp"))	3,259
9	**#8** AND (**LIMIT-TO** (**SRCTYPE**, "j"))	3,085
10	**#9** AND (**LIMIT-TO** (**SUBJAREA**, "SOCI" OR "MULTI" OR "BUSI" OR "ECON" OR "MEDI"))	2,581
11	**#10** AND (**LIMIT-TO** (**AFFILCOUNTRY**, "United Kingdom" OR "United States" OR "Australia" OR "Netherlands" OR "Canada" OR "Germany" OR "Italy" OR "Spain" OR "France" OR "Sweden" OR "New Zealand" OR "Ireland" OR "Switzerland" OR "Denmark" OR "Belgium" OR "Norway" OR "South Korea" OR "Japan" OR "Finland" OR "Poland" OR "Portugal" OR "Greece" OR "Hungary" OR "Austria" OR "Undefined" OR "Israel" OR "Czech Republic" OR "Slovakia" OR "Slovenia" OR "Lithuania" OR "Iceland" OR "Cyprus" OR "Luxembourg" OR "Estonia" OR "Latvia"))	2,475
12	**#11** AND (**LIMIT-TO** (**EXACTKEYWORD**, "Economics" OR "Economic Model" OR "Economic Evaluation" OR "Health Economics" OR "Health Impact Assessment" OR "Health Impact" OR "Medical Research" OR "Quality-Adjusted Life Years" OR "Quality Adjusted Life Year" OR "Quality Of Life"))	**879**

Web of Science
2 JUL 2024

Set #	Search	# results
1	**TI=**((health* OR nursing OR "social care" OR medical OR biomedical OR clinical OR "patient care" OR "quality of care" OR "preventive care" OR alzheimer* OR cancer OR cardiovascular OR "chronic obstructive pulmonary disease" OR diabetes OR obesity OR "mental disorder*" OR "kidney disease" OR Arthritis OR asthma OR dementia OR hypertension OR epilepsy OR influenza OR pneumonia OR "AIDS" OR "HIV" OR coronavirus OR "COVID-19" OR "COVID 19" OR "multiple sclerosis" OR Parkinson* OR liver)) OR **AB=**((health* OR nursing OR "social care" OR medical OR biomedical OR clinical OR "patient care" OR "quality of care" OR "preventive care" OR alzheimer* OR cancer OR cardiovascular OR "chronic obstructive pulmonary disease" OR diabetes OR obesity OR "mental disorder*" OR "kidney disease" OR Arthritis OR asthma OR dementia OR hypertension OR epilepsy OR influenza OR pneumonia OR "AIDS" OR "HIV" OR coronavirus OR "COVID-19" OR "COVID 19" OR "multiple sclerosis" OR Parkinson* OR liver))	13,682,927
2	**TI=**((research OR evaluation* OR "R&D" OR "trials" OR "health technology assessment*" OR "HTA" OR appraisal OR intervention*)) OR **AB=**((research OR evaluation* OR "R&D" OR "trials" OR "health technology assessment*" OR "HTA" OR appraisal OR intervention*))	9,474,579
3	**TI=**(("economic return*" OR "return on investment*" OR "ROI" OR "rate of return*" OR "impact assessment*" OR "value assessment*" OR externalities OR synergies OR "general equilibrium model*" OR "social accounting matrix" OR "input-output model*" OR "health gain*" OR "net health benefit*" OR spillover* OR "economic gain*" OR "multiplier effects" OR "economic multipliers" OR "direct economic impact*" OR "indirect economic impact*" OR "capacity impact*" OR "crowding-in" OR "crowding in" OR "crowding-out" OR "crowding out")) OR **AB=**(("economic return*" OR "return on investment*" OR "ROI" OR "rate of return*" OR "impact assessment*" OR "value assessment*" OR externalities OR synergies OR "general equilibrium model*" OR "social accounting matrix" OR "input-output model*" OR "health gain*" OR "net health benefit*" OR spillover* OR "economic gain*" OR "multiplier effects" OR "economic multipliers" OR "direct economic impact*" OR "indirect economic impact*" OR "capacity impact*" OR "crowding-in" OR "crowding in" OR "crowding-out" OR "crowding out"))	229,321

Set #	Search	# results
4	**TI=**((“United States” OR USA OR “U.S.A.” OR “U.S.” OR Canada OR “British Columbia” OR Europe* OR Austria OR Belgium OR “Czech Republic” OR France OR Germany OR “Great Britain” OR Ireland OR England OR Scotland OR Wales OR “United Kingdom” OR UK OR “U.K.” OR Greece OR Hungary OR Italy OR Netherlands OR Luxembourg OR Poland OR Portugal OR Scandinav* OR Denmark OR Estonia OR Finland OR Iceland OR Norway OR Sweden OR “Slovak Republic*” OR Slovenia OR Spain OR Switzerland OR Israel OR Australia OR “New Zealand” OR Japan OR Korea* OR Lithuania OR Latvia OR Cyprus OR Liechtenstein OR Slovakia)) OR **AB=**((“United States” OR USA OR “U.S.A.” OR “U.S.” OR Canada OR “British Columbia” OR Europe* OR Austria OR Belgium OR “Czech Republic” OR France OR Germany OR “Great Britain” OR Ireland OR England OR Scotland OR Wales OR “United Kingdom” OR UK OR “U.K.” OR Greece OR Hungary OR Italy OR Netherlands OR Luxembourg OR Poland OR Portugal OR Scandinav* OR Denmark OR Estonia OR Finland OR Iceland OR Norway OR Sweden OR “Slovak Republic*” OR Slovenia OR Spain OR Switzerland OR Israel OR Australia OR “New Zealand” OR Japan OR Korea* OR Lithuania OR Latvia OR Cyprus OR Liechtenstein OR Slovakia))	5,116,293
5	**#1** AND **#2** AND **#3** AND **#4**	3,148
6	**#5** AND (2008-01-01 to 2024-12-31 (**Publication Date**))	2,806
7	**#6** AND (English (**Languages**))	2,709
8	**#7** AND (Article OR Review Article OR Proceeding Paper OR Early Access (**Document Types**))	2,651
9	**#8** AND (SCI OR SSCI OR ESCI (**Web of Science Index**))	2,500
10	**#9** AND (Business Economics OR Health Care Sciences Services OR Science Technology Other Topics OR General Internal Medicine OR Social Sciences Other Topics (**Research Areas**) NOT (Public Environmental Occupational Health OR Environmental Sciences Ecology OR Pharmacology Pharmacy OR Medical Informatics OR Engineering or Agriculture OR Computer Science OR Biomedical Social Sciences OR Education Educational Research OR Psychology OR Sociology OR Medical Ethics OR Nursing OR Emergency Medicine OR Information Science Library Science OR Mathematical Methods In Social Sciences OR Public Administration OR Research Experimental Medicine OR Energy Fuels OR Food Science Technology OR Government Law OR Nutrition Dietetics OR Operations Research Management Science OR Social Issues OR Transportation or Rehabilitation OR Respiratory System OR Surgery or Urban Studies OR Chemistry OR Construction Building Technology OR Legal Medicine OR Neurosciences Neurology OR Oncology OR Psychiatry OR Anesthesiology OR Dermatology OR Geography OR History Philosophy Of Science OR International Relations OR Mathematics OR Gynecology OR Orthopedics OR Physical Geography OR Sport Sciences OR Substance Abuse OR Women’s Studies (**Research Areas**))	**574**

DATABASE SEARCH TOTALS

DATABASE	FINAL #
EconLit	39
Embase	102
PubMed	319
Scopus	876
Web of Science	354
TOTAL	1,690

NOTES

1	Was this search based on a previous search, such as one used in a prior review?	No.
2	Process for removing duplicates:	De-duplicated using EndNote Desktop and Excel.
3	Additional Information:	Embase and PubMed database searches include controlled vocabulary MESH keywords.

Appendix B. **Interviews**

Jon Sussex and Agnė Ulytė (RAND Europe)

1. Introduction

As part of the project's second work package (WP2) Evidence Review, we gathered existing evidence on economic returns (and methods for capturing them) from health and care research funding. We completed an REA of the existing literature, as described separately, and conducted 12 interviews with key stakeholders and informants. The interviews were designed to capture up-to-date, informed views on aspects of national and regional economic returns to the activities funded through the NIHR that the REA could have missed, including the extent to which different types of investment may yield different types and scales of economic returns.

Specifically, the interviews focused on the questions:

- How can NIHR research funding activities be grouped into funding 'types' based on the expected economic impacts and returns?
- What economic impacts and returns can be expected for each relevant funding type, and which types are most significant for achieving economic returns?
- How much of the economic returns are expected to remain local, and how much will be national and international?

2. Methods

The interviews were semi-structured, combining specific questions with the opportunity for interviewees to develop the conversation in directions they deemed appropriate and/or add any emphasis or nuance they wished. We developed an interview topic guide (provided in Annex B1), which the RAND Human Subjects Protection Committee reviewed and approved on 21 August 2024.

We selected interview participants based on their professional role to represent relevant institutions or specific areas of expertise (e.g. economics, policy and operations). These covered diverse sectors, including the government, public and charity research funders, the life sciences industry and academic experts on the economic returns to research. Along with national-level organisations, we included perspectives from organisations coordinating health research in a UK country other than England, and from another coordinating research in a region of England outside London and the South-East. We identified interviewees through the research team's professional networks, publicly available information on organisations' websites, and recommendations and introductions from members of the project Steering Committee and NIHR staff. We prioritised professionals in senior roles with knowledge of the NIHR and/or other UK health and care research funders.

All participants we approached consented, via an online consent form, to being interviewed, to the interview being recorded and to the data obtained in the interview being used in the project. We conducted interviews between September 2024 and January 2025. Each interview lasted 30–60 minutes and was conducted by AU or JS over MS Teams. All interviews were recorded, automatically transcribed and pseudonymised. The interviewing researcher in each case recorded

the main points from each interview, including answers to the interview questions (see Annex B1) and additional relevant information, in a summary note. Two researchers (AU and JS) deductively analysed the notes separately, then met to compare, discuss and agree on a synthesis of the findings.

3. Results

We interviewed 12 stakeholders and key informants. Table 15 indicates the perspective each participant represented.

Table 15: Interview participants

Interview number	Perspective (UK unless otherwise stated)
Int1	Public sector research funder (England)
Int2	Industry association
Int3	Industry association
Int4	Public sector – government department (England)
Int5	Charity sector research funder
Int6	Researcher of research impact
Int7	Public sector – government department (England)
Int8	Regional research association (England, outside London and South-East)
Int9	Charity sector research funder
Int10	Public sector – government department (England)
Int11	Public sector research funder
Int12	Devolved nations' research association

In the following pages we synthetise interview data into four themes, aligned with our interview questions (Annex B1): (1) types of activity funded through the NIHR, (2) economic returns from these types of NIHR-funded activity, (3) spillovers from NIHR-funded activity to research funded by other organisations (which, as explained below, are an important contributor to economic returns) and (4) local versus national and international economic returns on NIHR-funded activity.

3.1. Types of activity funded through the NIHR

The interviewer explained during each interview that, as of September 2024, the NIHR categorised its funded activities under five main headings:

- Research centres
- Programmes of research
- Individual research projects
- Research staff development, e.g. fellowships
- Research infrastructure.

They then asked the interviewee whether they would recommend additional categories or alternative approaches to classifying activities funded through the NIHR.

Several respondents suggested that the boundaries between types of NIHR-funded activity are not clear cut, and that any given expenditure category might include elements of many, or even all, of the above. For example, the NIHR categorises its Biomedical Research Centres as infrastructure spending in its financial reporting (NIHR 2025) but the Centres spend some of those funds on research projects and staff development (Int4).

Two of the interviewees did not have specific views about how NIHR research funding activities should be grouped in terms of their expected economic returns (Int2, Int12). Across the other ten interviewees there was a lot of agreement that these categories were reasonable, and that for the purpose of thinking about types and magnitudes of economic returns the first three of the categories listed above could be aggregated together these are activities that make use of the research capacity that exists partly as a consequence of the other two types of activity: staff development and research infrastructure. Thus, interviewees most frequently suggested categorising the NIHR-funded activities into three broad types:

1. **Research programmes**, also referred to as 'research', 'activities' or 'projects'
2. **Infrastructure**, also referred to as 'kit' or 'places'
3. **Staff development**, also referred to as 'academy', 'faculty', 'fellowships' or 'people'.

However, some interviewees across a variety of perspectives suggested going beyond this categorisation to account for other dimensions, including the timeframe during which economic returns could be expected and the disease area, health, or care intervention being researched, as shown in Figure 10.

Figure 10: Schematic representation of suggested dimensions of a typology of NIHR-funded activity

Interview number	Three-way split: Research programmes, Infrastructure, Staff development	Timescale of returns	Disease area or prevention vs treatment
Int1			
Int2			
Int3			
Int4			
Int5			
Int6			
Int7			
Int8			
Int9			
Int10			
Int11			
Int12			

Note: Solid shading indicates the respondent's suggestion.

Some research activities are likely to achieve economic returns sooner than others. Thus, spending might be categorised according to whether its expected economic returns are primarily in the short, medium, or long term (Int6, Int7, Int9, Int10 and Int11). The duration of returns (i.e. the number of years they persist) is as significant as how quickly they commence. For example, while investing in staff development for early- and mid-career researchers might take a long time to generate economic returns, the benefits would likely continue for a significant period thereafter, i.e. for the remainder of the researchers' careers. In contrast, spending on a research project evaluating a healthcare innovation might yield more rapid consequences (a decision on whether to spread the intervention more widely or to discourage its further use), but in some cases that might in turn be superseded by a further innovation a few years later, rendering the benefit relatively short-lived. Where the main expected eventual benefit is health gain for patients, the temporal proximity to those health benefits depends on the innovation's development stage:

> There's basic fundamental discovery science, and then that moves into more transitional work such as experimental medicine. And then there's more applied things, such as late-phase trials and so on. So you can sort of see, you might, by looking at stage of development or technology readiness sort of approach […]. And the discovery science, you know, that's going to take a long time to get into application. (Int11).

Another respondent expected that, despite their importance, policy research impacts could take the longest to produce economic returns:

> Informing policy more broadly, […] efficiency of care […]. But, you know, that's when you get to the time lags. I guess the Policy Research is the longest one, but I think, still, it's a very important one. (Int9)

In addition to timescale, two interviewees highlighted that economic returns arising from research-generated health gains or cost savings will likely vary by disease area (Int9) or by whether the research focuses on prevention and public health measures rather than treatment (Int11). Prevention and public health innovations tend to have longer-term returns than treatment innovations.

3.2. Economic returns from different types of NIHR-funded activity

None of the interviewees pointed to any empirical estimates of the magnitudes of economic returns to different types of research such as that funded by the NIHR. However, all but two interviewees commented that returns are likely to differ between activity types (Int1, Int2, Int3, Int4, Int5, Int6, Int8, Int9, Int10 and Int11). For example, one interviewee expected economic returns to differ by funding category but was unaware of any empirical estimates by type (Int4).

Several interviewees stressed that NIHR funding for infrastructure delivers special value, as it supplies a necessary foundation for other types of research activity, 'enabling others to do R&D even by providing the infrastructure for grants' (Int3).

Interviewees in Int2 and Int3 stressed that such infrastructure is crucial for enabling industry-funded research, e.g. research delivery networks and data capture systems supported by the NIHR (we return to this point in the discussion of spillovers below). Infrastructure investment includes investment in data science, which can have a large impact: 'data science is an area that the impacts of shouldn't be underestimated' (Int11).

Two interviewees mentioned Biomedical Research Centres as being exceptionally good at leveraging additional funding, with one suggesting that 'BRCs will be brilliant at the discovery and probably leveraging a lot of investment in partnership funding, I imagine' (Int2), and another that they spin out start-up companies that create commercial value (Int3). Conversely, a lack of infrastructure funding limits the leverage for additional funding:

> I think the infrastructure funding is particularly important in the north of England because one of the things that we know when we talk to industry partners is that, because of historic underfunding in the region, the infrastructure doesn't exist. When, for example, they want to put in place large clinical trials, there isn't developed infrastructure. […] It's a self-perpetuating circle of under-investment. (Int8)

During the interviews, the researcher prompted the participant with the following list of economic return types and asked whether they would expect different types of NIHR-funded research to generate different mixes or magnitudes of these (see Annex B1):

- Health gains for patients/ the population.
- Improved experiences of care for service users.
- Greater efficiency in the provision of care, e.g. cost savings.
- Stimulation of other research activity funded by charities or industry (including commercial spin-outs).
- Economic activity, including jobs and incomes.
- Longer-term strengthening of the UK's competitiveness in health and care research.

Three of the twelve interviewees considered health gains, including consequent improvements in economic productivity, as likely to be the single most important source of economic returns to NIHR spending (Int1, Int7 and Int9). Health benefits are likely to vary according to disease area (Int9). Two interviewees (Int1 and Int10) indicated that spending on research programmes, rather than on infrastructure or staff development, could be expected to yield the greatest health gains. Other interviewees did not distinguish across spending types in terms of expected health gains, and no interviewees commented on improved service user experiences in this context.

Some innovations resulting from activity funded through the NIHR can be expected to yield economic benefits by reducing the costs of care provision. Also, some NHS costs are covered by commercially funded clinical trials, which may, in turn, be facilitated by NIHR investment (Int1). One interviewee considered cost savings to the NHS and social care a particularly important benefit (Int10). Most interviewees did not identify any one type of NIHR-funded activity as more likely to generate such savings. However, the three who did all suggested that some funding under the heading of research programmes (e.g. health technology assessment) would be more likely to produce cost savings than infrastructure or staff development (Int1, Int2 and Int10).

The stimulation of research activity funded by others, which is a type of 'spillover', is discussed in the next subsection. This effect includes the consequences of strengthening the UK's international competitiveness as a location for health and care research.

One participant noted that funding through the NIHR directly supports employment and income for both researchers and suppliers of research resources, and that this pattern is consistent across all categories of such expenditure (Int6). However, two interviewees (Int1 and Int10) observed that Biomedical Research Centres, as components of the NIHR's infrastructure expenditure, are especially effective in facilitating the creation of commercial enterprises. These enterprises subsequently create employment opportunities and generate income by producing innovative goods and services.

3.3. Spillovers

Several interviewees mentioned that funding through the NIHR stimulates increased industry R&D spending in the UK by increasing the capacity to conduct research (more trained researchers and more research facilities) and by making the UK a more competitive location for the international life science industry's R&D (Int1, Int2, Int3, Int4, Int8, Int10 and Int11). Specifically, one participant expected infrastructure funding, such as Clinical Research Networks (CRNs) supporting clinical trials, to have the greatest impact on the life science industry (Int1). Another suggested that privately funded clinical

trials would not happen in the UK without infrastructure funding from the government, including via the NIHR (Int2). A third interviewee commented that the NIHR is particularly well placed for funding infrastructure to support further research investment:

> The NIHR [is] better placed […] to make, for example, easier access to data. […] It is very difficult to measure the value of accessing [data] to research, but without data, but without access to data, no research can be done. (Int9)

A fourth interviewee specifically mentioned that the number of clinical research staff and their training is a bottleneck for greater industry R&D investment in the UK, but further funding through the NIHR would boost both:

> Workforce is one of the key barriers to delivery of any clinical research in the UK, not just industry, but any. So there needs to be more staff training. (Int2)

Several interviewees suggested that funding through the NIHR might result in increased research funding from charities, not just more industry R&D (Int1, Int2, Int3, Int5 and Int9). Funding infrastructure, staff development and other NIHR initiatives not only establishes frameworks to facilitate industry- and charity-funded research, but also acts as a signal to commercial investors and charities of the UK's high-quality research capabilities (Int5 and Int8):

> I think having that reassurance that the government thinks it's worthwhile, that this research is recognised as being good, definitely enhances industry confidence and there's a spiralling effect. (Int8)

3.4. Local versus national economic returns

Interviewees expected both local and national economic returns from expenditure through the NIHR, which is spread across England and, to a lesser extent, the other countries of the UK. Typically, they expected local economic returns to materialise via funded employment (Int1, Int6 and Int10):

> funding […] makes its way into people's pockets that then gets spent in local economies. (Int1)

While many interviewees noted the regional funding distribution as an important objective, others highlighted the benefits of concentrating some funding in fewer locations (Int2, Int3, Int6 and Int10), i.e. in clusters or centres of excellence. Two interviewees considered such clusters to be well placed to contribute to the UK's international reputation in health research (Int3 and Int6). Conversely, they suggested that spreading funding to regions with poorer absorptive capacity could be at the cost of lower benefits to the UK overall:

> We shouldn't just be putting money into the ground in an area that's got no capacity to properly gain and build on that. (Int3)

However, interviewees indicated that clustering is not desirable for all types of NIHR-funded activities. Instead, they

suggested that clinical trials should be conducted in locations where the relevant condition is most prevalent, which would necessitate distribution across all regions:

> locations where there just is a higher prevalence of that particular condition because it's often linked to ethnicity, for example, so you're not going to find them in Cambridge. (Int2)

One interviewee argued that not fully using the assets and talent available in all regions would be inefficient (Int8). They also considered that returns would be more impactful in areas where the NHS and universities are among the largest employers locally (e.g. the North of England), as funds spent there would directly affect a larger proportion of the local workforce.

Interviewees expected health gains from research to follow the disease prevalence pattern and have an impact according to disease geographic distribution and local population health needs (Int10):

> People are unwell everywhere, and so if you're finding ways to improve people's health, then the whole UK population benefits. (Int11)

Economic returns of all kinds were expected to arise first locally, and to take time to spread geographically but that they would do so eventually (Int5 and Int6), including health gains from better and more efficient provision of patient care (Int6 and Int11):

> It's been shown that you don't even have to be a patient enrolled in one of their clinical studies to get better care in hospitals that are research active. […] Clinicians are better carers and clinicians if they're doing research. (Int11)

4. Conclusions

The research team discussed the interview findings internally in December 2024 and with the project Steering Committee in February 2025, and shared them with the NIHR in an interim briefing submitted in February 2025. Interview participants were drawn from all stakeholder perspectives including: government and public funders of research, research charities and industry, nationally and regionally. The findings described above indicate the range of views elicited. Many of the points made by interviewees are followed up in more depth in the case studies (written up elsewhere). In summary, the interviews suggest the following overall answers to the three questions they aimed to address.

How can NIHR research funding activities be grouped into funding 'types' based on the expected economic impacts and returns?
Based on the NIHR's categories for presenting expenditure data, a three-way typology – research programmes, infrastructure and staff development – was agreed as a relevant and helpful basis for considering economic returns. Timescale was another important dimension within each activity type, i.e. how quickly economic returns commence and for how long they continue. Whether the NIHR activity is specific to a particular disease area and focused on public health/prevention or treatment might

also be relevant to the magnitude and timing of subsequent economic returns.

What economic impacts and returns can be expected for each relevant funding type, and which types are most significant for achieving economic returns? Expenditure through the NIHR supports employment and income generation for both researchers and suppliers of research resources, and this feature is consistent across all NIHR funding types. While some interviewees emphasised the economic benefits arising from health improvements or NHS cost savings, others highlighted the significance of stimulating economic activity through spillovers to the commercial sector. Interviewees expected all types of research activity funded through the NIHR to contribute to all these benefit types. Although they did not provide a definitive understanding of which specific types of economic returns are most likely to be achieved by particular research activities, Biomedical Research Centres were considered especially effective in generating commercial spin-out businesses. No empirical evidence was identified regarding how the magnitude of economic returns varies across types of NIHR-funded activities.

How much of the economic returns are expected to remain local, and how much will be national and international? Directly created jobs and incomes are expected to be predominantly local effects. Health gains and NHS cost savings initially accrue more significantly in the regions where research activities occur, but these benefits are expected to spread nationally over time. Spillover effects are expected to arise when expenditure through the NIHR increases research capacity, both locally and nationally, to the extent that such investments enhance the UK's attractiveness as a site for international commercial R&D.

Annex B1. Topic guide for interviews

Introduction

Please see the participant information sheet dated 2024.08.14, consent form and privacy notice which we sent to you.

Background

- I am a member of the research team at RAND Europe, a not-for-profit research organisation.
- We have been commissioned by the National Institute for Health and Care Research (NIHR) to carry out a mixed-methods evaluation of the economic impact of NIHR-funded activities and their return on investment at national and regional levels within the UK in 2024-25.
- This interview contributes to the evidence review work package (WP2) of the evaluation.
- The interview will last around 45–60 minutes. The interview will be conducted online using teleconferencing software.

Consent

If the consent form has already been signed and returned before the interview, thank the interviewee and commence the interview.

If the consent form has not yet been signed and returned, proceed as follows:

- Read out all the questions from the consent form and complete it on the basis of the answers given. If consent is not given, end the interview.

Interview protocol

We are running a set of scoping interviews with experts and stakeholders to capture further knowledge on the return on investment in health and care research in the UK. We are inviting representatives at national (e.g. NIHR experts) and local levels (e.g. NIHR funding recipients). The scoping interviews aim to capture views on aspects that could have been missed in the Rapid Evidence Assessment – including the extent to which different types of NIHR investment may yield different types and scales of returns – and inputs for selecting the case studies for in-depth analysis.

Questions

Introductory questions

1. Please tell us about your professional role and organisation.
2. How long have you been in that role / at that organisation, and are any of your previous roles/organisations relevant to discussing the returns achieved by NIHR-funded activity?
3. Could you briefly describe how you and your current organisation (and, if relevant, previous roles/organisations) are concerned with NIHR-funded activity?

Types of activity that NIHR funds and their expected impacts

4. The NIHR funds different types of activities related to health and care research, such as:

    a. Research centres

    b. Programmes of research

    c. Individual research projects

    d. Supporting research staff development, e.g. fellowships

    e. Research infrastructure.

    In that list, have we missed any types of activities that NIHR funds? Or would it be clear to split any of these types of activities into sub-categories? Alternatively, could any of the above types of activities be grouped together as likely to have very similar economic impacts?

5. Would you expect different mixes or magnitudes of impacts to result from different types of NIHR activities? Please explain what differences and why you expect them or do not expect them. Relevant types of benefits broadly include:

    a. Health gains for patients/population.

    b. Improved experiences of care for service users.

    c. Greater efficiency in provision of care, e.g. cost savings.

    d. Stimulation of other research activity funded by charities or industry (including commercial spin-outs).

    e. Economic activity, including jobs and incomes.

    f. Longer-term strengthening of the UK's competitiveness in health and care research.

    g. Local impacts vs elsewhere in the UK.

6. Would you expect the balance of benefits between local/national/international to be different from different kinds of NIHR-funded activities?

Other questions

7. Are you aware of any key papers/ documents we should include in our evidence review?
8. Would you recommend any other individuals that we should speak to as part of the scoping interviews?

Wrap up

9. Thank you for your time. If we have any additional follow-up questions, are you happy for us to contact you via email?

Appendix C. **Typology of expenditures through the NIHR**

Jon Sussex and Agnė Ulytė (RAND Europe)

Our focus in this study is on whether we might reasonably expect different types of activities funded through the NIHR to have substantially different economic impacts. We began developing a typology by reviewing NIHR annual reports. These present expenditures under numerous headings that refer to specific purposes or funding streams (NIHR 2025a & 2025c). This system for reporting expenditures through the NIHR distinguishes five types:

- Research funding (programmes)
- Research delivery infrastructure
- Other NIHR infrastructure
- Research training and career development (faculty)
- Digital and data (systems).

The 'digital and data' category (also referred to as 'systems' by the NIHR) typically represents less than 1% of total expenditure through the NIHR. For the purposes of estimating total economic returns from spending through the NIHR, this category is too small to warrant analysis as a separate expenditure type. Instead, we have divided this category of spending into four equal parts and added them to the other four spending types listed above.

In our initial thinking, we considered disaggregating the first of the above-listed categories into three subcategories – research centres, research programmes and individual research projects – in case that would be clearer than a single composite 'research funding' category.

Within the literature review (see Appendix A for details), we sought indications for how authors categorised health and care research spending in studies estimating economic impacts. Where discussed, the main distinction in the literature was based on the likely differences in the elapsed times (lags) between basic and applied research expenditures and their respective economic and other impacts (HERG et al. 2008). Basic research takes longer to yield economic impacts than applied research. However, the NIHR focuses predominantly on applied research. Most studies in the literature provide a single estimate of economic returns for a particular funding programme, without differentiating between expenditure categories. Different studies examine specific subgroups of funding, including health technology assessments, charity versus government funding for medical research, Biomedical Research Centres and Biomedical Research Units, clinical research networks, cyberinfrastructure services for research and a biobank (see Appendix A). However, owing to differences in methods, settings (countries), and time periods, cross-study comparisons were not possible, preventing conclusions about differences in economic returns across types of health and care research.

During the scoping interviews with stakeholders in health and care research

funding in the UK (see Appendix B for details), research team interviewers asked participants for their views on how best to categorise NIHR expenditure and invited their opinion on the following five categories:

- Research centres
- Programmes of research
- Individual research projects
- Research infrastructure
- Research staff development.

Several respondents noted that the boundaries between NIHR-funded activities are not clear-cut, so that any given expenditure category might include elements of many, or even all, of the above. For example, while NIHR, in its financial reporting, categorises its Biomedical Research Centres as infrastructure spending, some of those funds are spent by the Centres on research projects, infrastructure used across multiple research projects, and staff training and development (see Appendix B for a full synthesis of the interview findings).

The interviewees generally agreed that the categories listed above were reasonable. However, for the analysis of the types and magnitudes of economic returns, they suggested combining the first three categories. These activities draw on research capacity that has developed, in part, through staff development initiatives and the creation of research infrastructure. Consequently, interviewees most often suggested three primary categories of NIHR-funded activity: research programmes, infrastructure and staff training/development.

Some interviewees from diverse stakeholder perspectives recommended considering additional dimensions, such as the expected timescale for economic returns and the specific disease area or type of health or care intervention under investigation. Some research activities will likely achieve economic returns sooner than others, and some research will yield returns that persist for longer. For example, while investing in staff development for early- and mid-career researchers might take time to generate economic returns, the benefits would likely persist for a considerable time thereafter, i.e. the remainder of the researchers' careers. In contrast, spending on a research project evaluating a healthcare innovation might yield more rapid consequences (e.g. a decision to spread the intervention more widely or to discourage its further use). However, it might be quickly superseded by a further innovation, rendering the benefits relatively short-lived. Two interviewees also highlighted that economic returns arising from health gains or cost savings in health and care generated by research are likely to vary by disease area or by whether the research focuses on prevention and public health measures rather than treatment. Prevention and public health innovations tend to have longer-term returns than treatment innovations. However, data limitations preclude analysis of expenditure through the NIHR by economic impact timescales or disease areas.

The NIHR provided a dataset detailing its funding awards between 2013 and 2018, reflecting new funding commitments rather than actual expenditures, with many awards spanning multiple financial years. The data are organised into three expenditure types and further subdivided by the cost headings that NIHR funding applicants must use to justify their requested funding levels. These cost headings include salaries, equipment, consumables, overheads and NHS support costs, among others. Based on the economic activity sectors into which our CGE model was disaggregated, which in turn was determined by the sectoral data available from ONS (see Appendix G), we then estimated from the NIHR awards data what percentage of spending through the NIHR in each of the three

categories would be on the "Research" sector of the economy and how much on the "Health services" sector (these being the two Office for National Statistics (ONS)-defined sectors of relevance to expenditures through the NIHR).

Although we used the three-way typology to inform our CGE modelling, the NIHR requested that we subdivide the infrastructure 'type' into two constituent parts to descriptively present their expenditure: research delivery infrastructure and other NIHR infrastructure.

Hence, we refer to four types of NHS expenditure in Chapter 4's descriptive analysis in this report, as presented in NIHR Annual Reports in recent years (NIHR 2025a & 2025c):

- Research programmes
- Research delivery infrastructure
- Other NIHR infrastructure
- Research training and career development.

Appendix D. **Descriptive analysis of expenditure through the NIHR**

Bhavya Singh and Agnė Ulytė (RAND Europe)

1. Introduction

This descriptive analysis examines the distribution of NIHR spending across UK nations and English regions in financial years 2013/14 to 2017/18, as required by the NIHR, and across different types of funded activities. We use the typology of expenditures agreed earlier in the project, as used by the NIHR:

- Research Programmes
- Research Delivery Infrastructure[1]
- Other NIHR Infrastructure[2]
- Research Training and Career Development.

The NIHR also refers to a fifth expenditure type, 'Digital and Data', but since this is relatively small, we distributed it across the four expenditure types above. We also compared regional spending through the NIHR with regional demographic, socioeconomic and geographic characteristics.

At the NIHR's request, we also present the trend in total annual NIHR expenditure up to 2023/24. The focus of the overall research project, however, remains the impact of NIHR's expenditure over the five years from 2013/14 to 2017/18.

We begin this section by outlining the methods used to process and analyse the expenditure data received from the NIHR, including details of the data sources for demographic, socioeconomic and geographic information. We then present the findings from the analysis, followed by an annex containing the data tables used to plot the graphs and a detailed explanation of the methodology used to adjust spending figures for general price inflation.

2. Methods

We received data on spending from the NIHR via three sources that were not entirely congruent. We explain below the differences between these data sources and how we have combined them to enable the research specified in the registered protocol:

1. **Annual NIHR spend figures** are taken from NIHR annual reports, which reflect spend by type and capture research

1 **Research Delivery Infrastructure:**
Clinical Research Facilities, CRNs, Patient Recruitment Centres, Research Recovery and Reset incentive (with RCF payments), Networks (Topic Specific Networks and Comprehensive Network).

2 **Other NIHR Infrastructure:**
Applied Research Collaborations, BRCs, BRUs, BioResource, Clinical Trials Unit Support Funding, Collaborations for Leadership in Applied Health Research and Care, Diagnostic Evidence Co-operatives, Excess treatment cost funding (part-funded by NHS England), Excess Treatment Costs, Experimental Cancer Medicine Centres, Flexibility and Capability Funding, Health Informatics Collaboration, Health Technology Co-operatives, Healthcare Technology Co-operatives, Infrastructure equipment call, Medtech and In vitro Diagnostics Cooperatives, Medtech and In vitro Diagnostics Co-operatives, Medtech and In-vitro Diagnostics Cooperatives, MRC/NIHR National Phenome Centre, Other (including Athena Swan and dementia, clinical academics, dementia and Child Prosthetics, and management), Patient Safety Translational Research Centres, Research Capability Funding, Research Design Service, Translational Research Collaborations.

management costs alongside the typical research spending and support. Figures exclude Official Development Assistance. The specific wording for spending types has evolved; for consistency, we use the wording taken from the NIHR 2023/24 Annual Report and apply it retrospectively. These spending types are as described earlier: 'Research Programmes', 'Research Delivery Infrastructure', 'Other NIHR Infrastructure', 'Research Training and Career Development' and 'Digital and Data'. The NIHR explained that the distinction between 'Research Delivery Infrastructure' and 'Other NIHR Infrastructure' was not made in previous annual reports and is instead applied retrospectively.

2. **Department of Health and Social Care (DHSC) Finance accounting data** provide insight into the regional distribution of NIHR spending. Where information is available on the recipient region for a specific transaction, spend is totalled by spend type (as specified above) and year. While the accounting data do not give the full regional picture of all NIHR spend, they do account for 94% of the total spend so are deemed to provide a good insight into regional distribution of spend by type and year.
3. **Amounts for individual grants awarded** from 2013/14 to 2017/18 by cost category, together with information on the region and type of the grant. We did not use this data source in the geographic mapping analysis, but we used it as input to the modelling in WP6 of the project.

Table 16 summarises the data sources, shows the differences between them in how the spending data are disaggregated, and explains how we have used the data sources in our analyses.

Table 16: Summary of the NIHR data sources

	1. Annual NIHR spend figures	2. DHSC Finance accounting data	3. Awarded amounts for individual grants
Covered period	*2013/14 to 2017/18 (extended to 2018/19 to 2023/24)*	*2013/14 to 2017/18*	*2013/14 to 2017/18*
Aggregated by financial year	Yes	Yes	No
Regional split	No	Yes	Yes
Split by type[1]	Yes	Yes	Yes (only three types)
Split by cost category[2]	No	No	Yes
Used for annual NIHR spend in total and by type	Yes	-	-
Used for the regional distribution of NIHR spending	-	Yes	-
Used for cost category distribution, necessary for the economic modelling	-	-	Yes

Notes:

1 – **'Type'** *refers to NIHR spending types by funding purpose: Research Programmes, Research Delivery Infrastructure, Other NIHR Infrastructure, Research Training and Career Development and 'Digital and Data'. On rare occasions, yearly spending figures for a given subtype suggested a negative total for NIHR spending in Wales, presumed to be a result of accounting adjustments made between years. These figures are set to a value of zero before proceeding.*

2 – **'Cost category'** *refers to the NIHR-defined cost categories as reported by NIHR funding recipients for each NIHR award, such as salaries, indirect costs, equipment and treatment costs.*

Scaling regional spending to the reference total annual amount by type. We applied the yearly regional distributions (Source 2 in Table 16) for each research spending type to the known annual totals by expenditure type (Source 1) to estimate spending through the NIHR by type, region and year. The scaled totals are calculated by first deriving a scaling factor for each spending type and year. This factor is obtained by dividing the reported national expenditure by type in Source 1 by the total expenditure across all regions shown in Source 2 for the corresponding type and year. The scaling factor is then applied to each region's observed spending (Source 2), thereby ensuring that the adjusted regional totals align with the national figures in the NIHR Annual Reports (Source 1), while maintaining the proportional distribution of spending across regions. This approach ensures that the annual totals match the reference expenditure amount (as shown in NIHR Annual Reports) in all our analyses.

Processing 'Digital and Data' type of spending. One of the spending types, 'Digital and Data' (earlier referred to as 'systems' by the NIHR), accounts for only around 1% of NIHR spending over the five years. We agreed with the NIHR that it is too small for analysis as a separate type and instead distributed this spending type equally across the other four types analysed.

Adjusting for inflation. We analysed values for NIHR spending from financial years 2013/14, 2014/15, 2015/16, 2016/17 and 2017/18, after adjusting for inflation and population using ONS GDP deflators (GOV.UK 2025). Unless otherwise specified, all numbers are adjusted for inflation and expressed per capita. We sourced population estimates from the Nomis official census and labour market statistics database (ONS 2025) for all years of interest.

Other data sources. We visualised the geographic distribution of NIHR spending using boundaries defined by the Nomenclature of Territorial Units for Statistics, level 1 (NUTS1) regions in the UK. We sourced these boundaries from the ONS Open Geography Portal (ONS Geography 2018). We used Nomis to collect data on populations aged 65+ (ONS 2025), ethnicity statistics (ONS 2025a), and rural population data (available only for 2011, as the ONS does not publish rural estimates for non-census years). We obtained rural population data directly from the ONS.

Descriptive analysis. For mapping purposes, we totalled spending through the NIHR across all five financial years from 2013/14 to 2017/18, adjusted for inflation. We calculated spending per person by dividing total spending in a region by the average population in that region over the financial years 2013/14 to 2017/18. We calculated the absolute value of the change in spending over time by subtracting the spending in the first year observed (2013/14) from that in the last year (2017/18), and the percentage change by expressing this difference as a proportion of the amount spent in 2013/14. In the scatterplots shown below, which compare regional spending and regional population characteristics, inflation-adjusted spending values have been adjusted for population size and expressed per head to aid comparability across regions.

3. Results

3.1. Total spending through the NIHR across regions from 2013/14 to 2017/18

We analysed aggregate data over five years (Table 17 and Figure 11) and, for each financial year, examined changes over time (Table 18).

The total spending through the NIHR during 2013/14–2017/18 for all regions was £6,651.80m. London received the highest spending (£2,143.16m), accounting for 32.2% of the total. The region with the lowest spending through the NIHR was Northern Ireland, with £17.03m, accounting for 0.3% of total. Within England, the North East region received the lowest total spending at £315.61m. Figure 11(C) shows the relative total regional spending as a percentage of the national spending, with London having the highest share.

Between 2013/14 and 2017/18, the total spending through the NIHR per person amounted to £87.70 in the UK, and across England it was £112.20 per person. The region receiving the highest spending per person was London, with £248.32 per person. Northern Ireland received the lowest spending through the NIHR per person at £9.14. Within England, the East Midlands received the lowest per capita spending at £74.78.

Spending per region over the period is reported in Table 17 and visualised in Figure 11 (total spending per region (A) and per person within a given region (B), as well as total spending per region expressed as a percentage of total UK spending through the NIHR (C)).

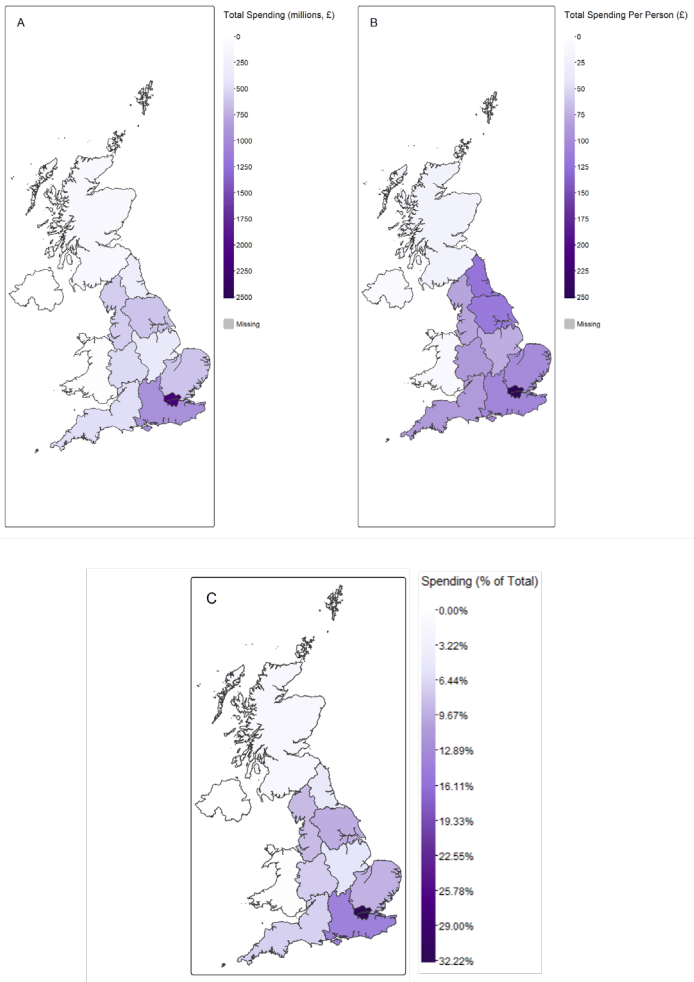
Table 17: Total spending through the NIHR from 2013/14 to 2017/18, inclusive, after adjusting for inflation (2023/24 prices)[3,4]

Region	Spending (£m)	Percentage of National Spending	Average Population (millions)	Spending Per Person (£)
England				
East Midlands	350.37	5.3	4.69	74.78
East of England	603.26	9.1	6.09	99.07
London	2,143.16	32.2	8.63	248.32
North East	315.61	4.7	2.61	120.76
North West	561.08	8.4	7.19	78.08
South East	939.32	14.1	8.97	104.73
South West	453.52	6.8	5.47	82.86
West Midlands	492.06	7.4	5.76	85.37
Yorkshire and Humber	623.44	9.4	5.38	115.91
Northern Ireland	17.03	0.3	1.85	9.14
Scotland	118.29	1.8	5.35	22.1
Wales	34.66	0.5	3.08	11.28

3 Total spending was divided by each region's average population from 2013 to 2018 to determine its per capita spending.

4 The totals before and after adjustment for inflation can be found in Annex D1.

Figure 11: (A) Total spending per region[5] vs (B) vs total spending per person per region[6] and (C) total relative spending



Note: Figure 11(C)'s scale takes total NIHR spending as 100%.

The change over time in inflation-adjusted spending through the NIHR across regions is shown in Table 18. In 2023/24 price terms, the average change in spending across all regions from 2013/14 to 2017/18, was a small fall of -£0.75 per person. The biggest spending change across English regions was in Yorkshire and Humber with a decrease of -£4.60 per person. The English region with the smallest change was the South West, at -£0.30 per person. Figure 12 plots annual per-person spending in each region for 2013/14 – 2017/18, adjusted for inflation.

5 Total spending from 2013/2014 to 2017/2018 was aggregated and adjusted for inflation.

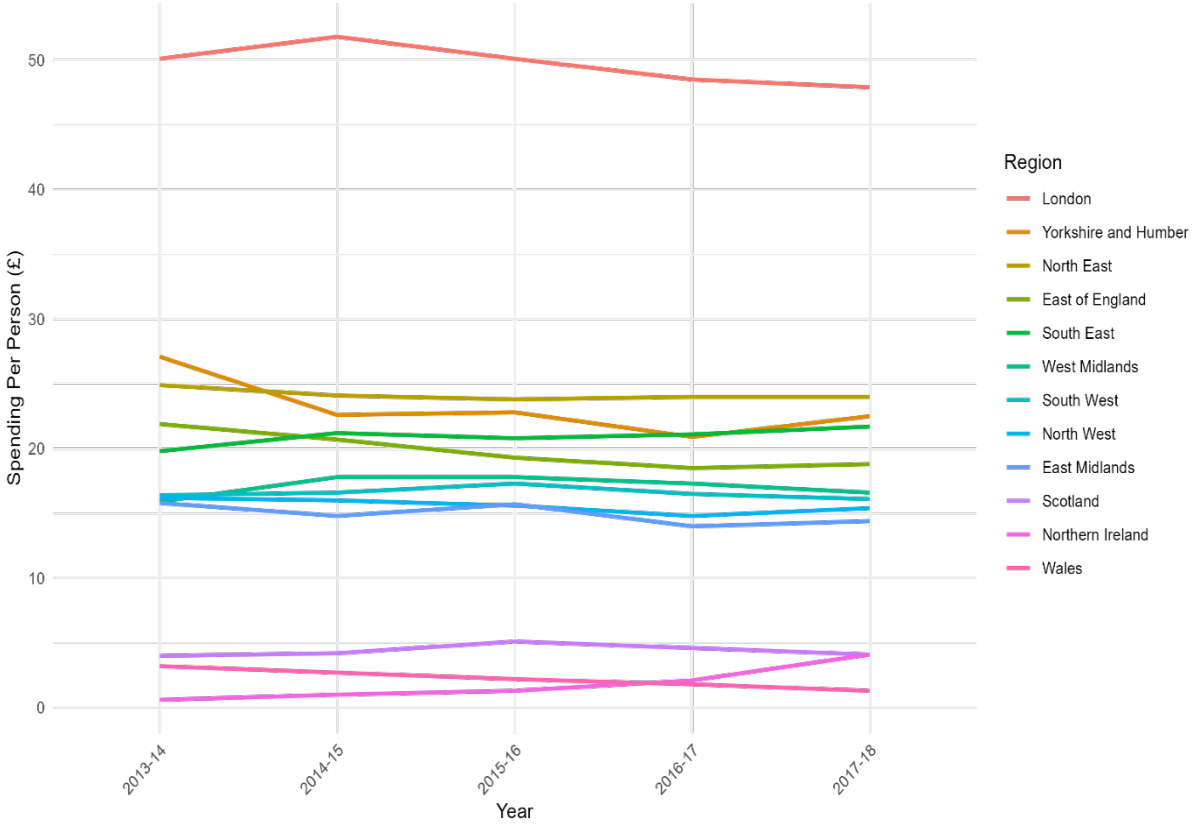
6 Per capita spending was determined by dividing total regional spending by the average population in that region from 2013 to 2018.

Table 18: Regional spending through the NIHR per person per year for 2013/14 – 2017/18, adjusted for inflation (2023/24 prices)

Region	Annual Spending (£)					Change
	2013-14	2014-15	2015-16	2016-17	2017-18	
England						
East Midlands	£15.80	£14.80	£15.70	£14.00	£14.40	-£1.40
East of England	£21.90	£20.70	£19.30	£18.50	£18.80	-£3.10
London	£50.10	£51.80	£50.10	£48.50	£47.90	-£2.20
North East	£24.90	£24.10	£23.80	£24.00	£24.00	-£0.90
North West	£16.20	£16.00	£15.60	£14.80	£15.40	-£0.80
South East	£19.80	£21.20	£20.80	£21.10	£21.70	£1.90
South West	£16.40	£16.60	£17.30	£16.50	£16.10	-£0.30
West Midlands	£15.90	£17.80	£17.80	£17.30	£16.60	£0.70
Yorkshire and Humber	£27.10	£22.60	£22.80	£20.90	£22.50	-£4.60
Northern Ireland	£0.60	£1.00	£1.30	£2.10	£4.10	£3.50
Scotland	£4.00	£4.20	£5.10	£4.60	£4.10	£0.10
Wales	£3.20	£2.70	£2.20	£1.80	£1.30	-£1.90

Note: negative change over time is shown in red.

Figure 12: Annual spending through the NIHR per person in each region, using inflation-adjusted values (2023/24 prices)



3.2. Spending through the NIHR by type across regions, 2013/14–2017/18

Figure 13 provides a visualisation of how spending through the NIHR is distributed across regions by spending type. London consistently received the highest spending across all expenditure types. Specifically, spending on 'Other NIHR Infrastructure' and 'Research Delivery Infrastructure' in London amounted to £925.71m and £476.70m, respectively, equating to £107.35 and £55.10 per person. 'Research Programmes' spending for London totalled £526.80m, corresponding to £60.96 per person, while 'Research Training and Career Development' spending was £213.94m, translating to £24.80 per person. The North East received the second-highest funding for 'Research Delivery Infrastructure' at £138.82m and £53.12 per person. The East of England had the second-highest spending for 'Other NIHR Infrastructure' at £274.99m and £45.20 per person. The Yorkshire and Humber region had the second-highest spending on 'Research Programmes' (£227.60m) and 'Research Training and Career Development' (£92.02m), after London. Figure 14 illustrates the relative regional funding distribution across different types, expressed as a percentage of the total funding within each type, with London consistently receiving the highest share across all types of spending.

Figure 13: Total spending through the NIHR in each region per person by type, for 2013/14-2017/18, using inflation-adjusted values[7]

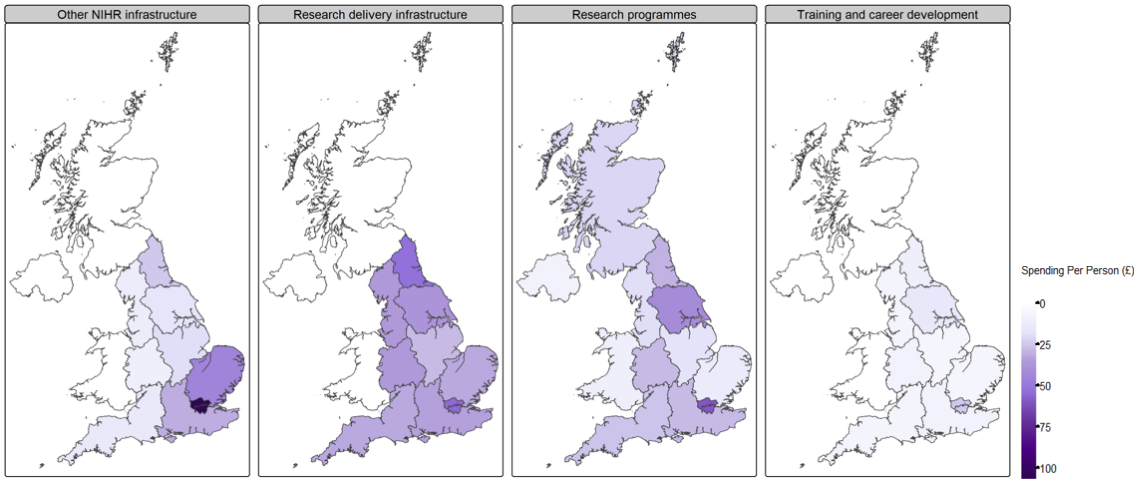
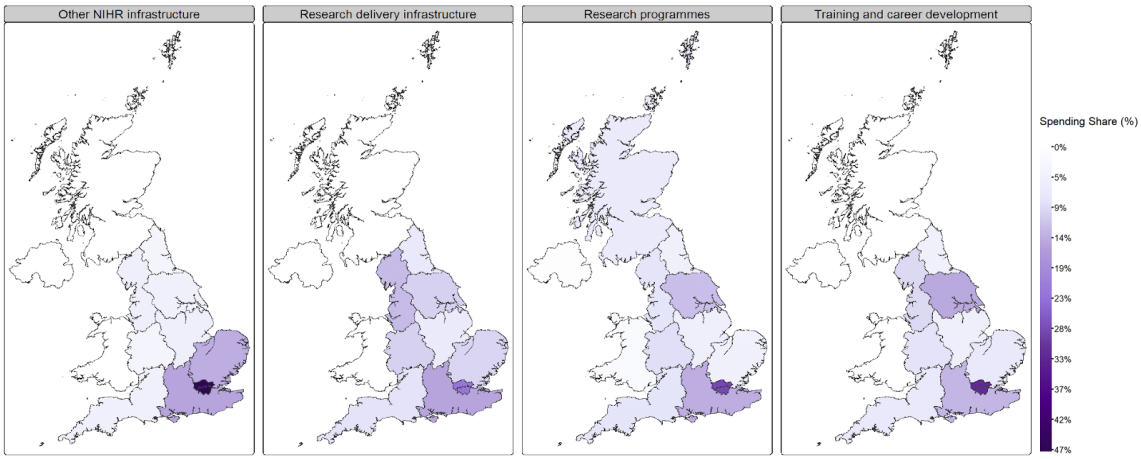


Figure 14: Total spending through the NIHR in each region as a percentage of national spending in a specific funding type, 2013/14-2017/18, using inflation-adjusted values



Note: Figure 14's scale assumes total NIHR spending within a specific funding type as 100%.

7 The table used to visualise Figure 13(A) can be found in Annex D1.

Figures 15 and 16 illustrate annual spending by activity type, adjusted for inflation. The figures show a decline in 'Other NIHR Infrastructure' and 'Research Delivery Infrastructure' spending over the years. Spending for 'Research Programmes' has steadily increased. Additionally, spending on 'Research Training and Career Development' initially declined but subsequently increased from 2016/17. From 2013/14 to 2017/18, total NIHR spending decreased each year from £1,336.2m to £1,321.51m in 2023/24 price terms, representing an overall real-terms decrease of -1.10%. The highest annual percentage increase during this period was for 'Research Programmes' between 2013/14 to 2014/15, with a change of 13.82%. The largest percentage decrease was for 'Other NIHR Infrastructure' between 2016/17 and 2017/18, with a change of -7.86%.

Figure 15: Spending through the NIHR by type between 2013/14 and 2017/18, adjusted for inflation (2023/24 prices)

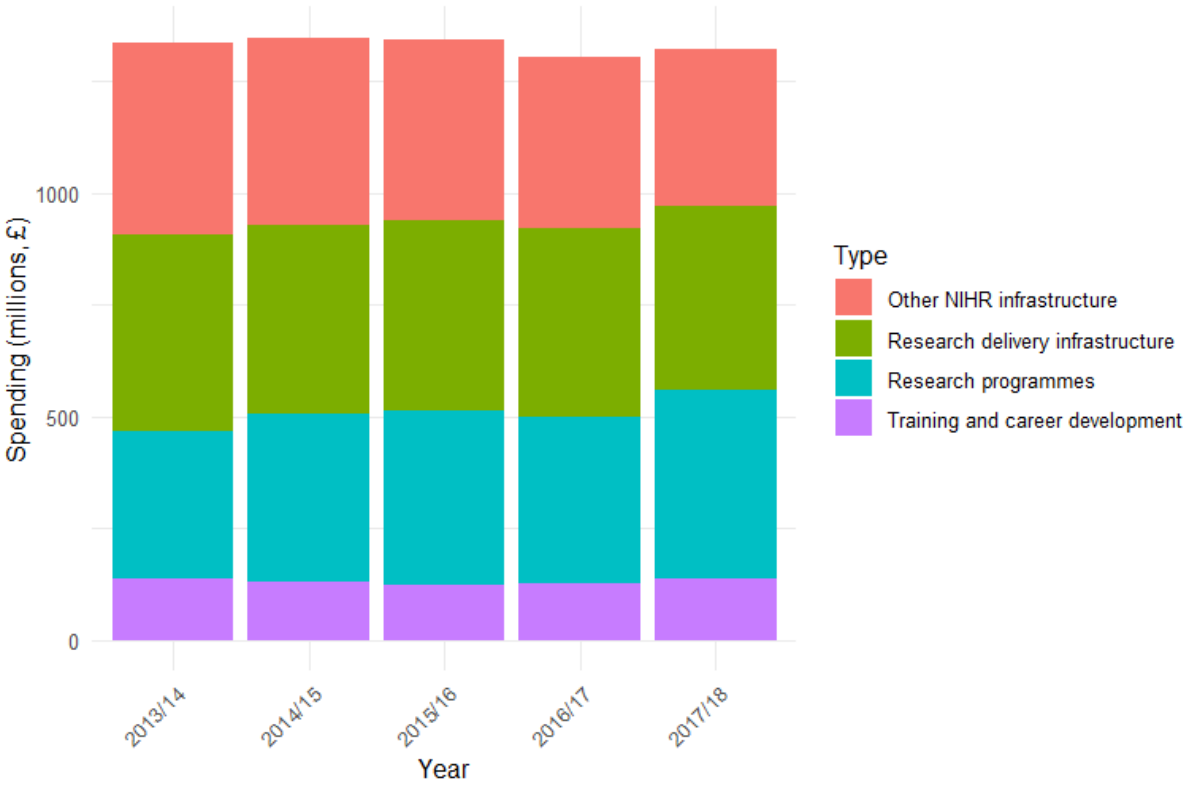
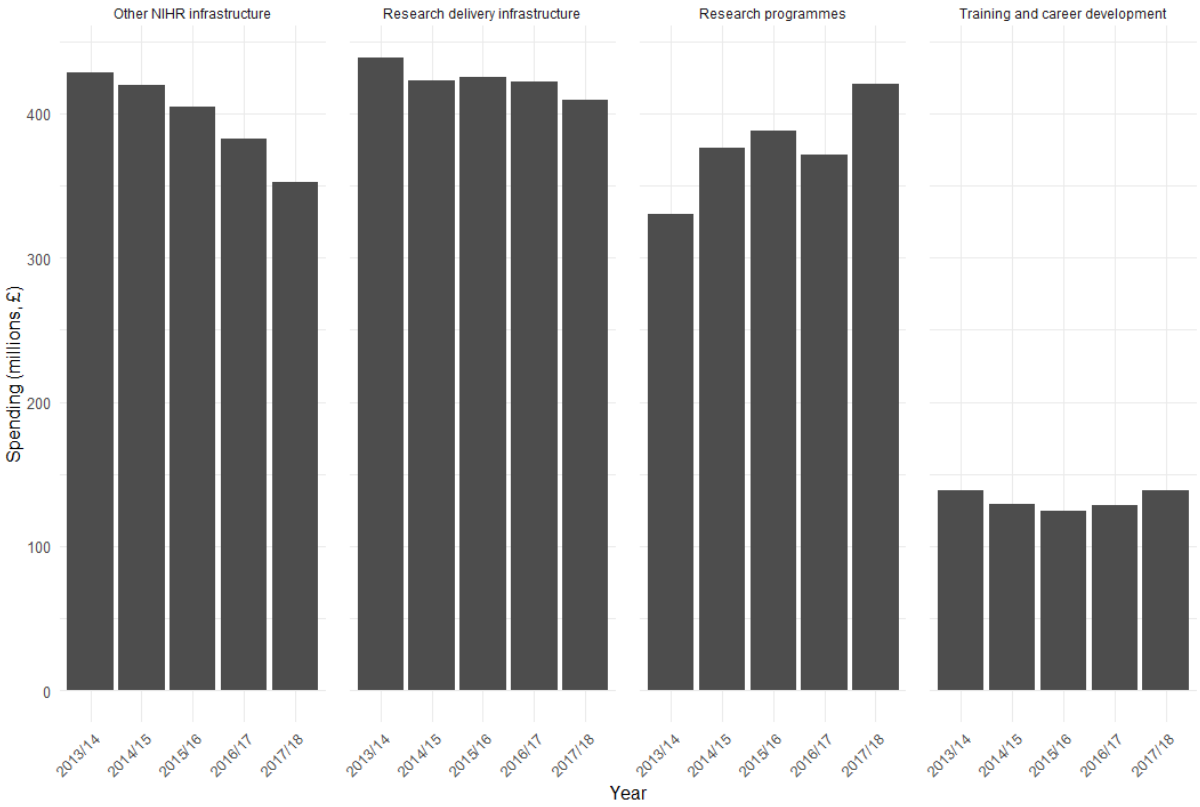


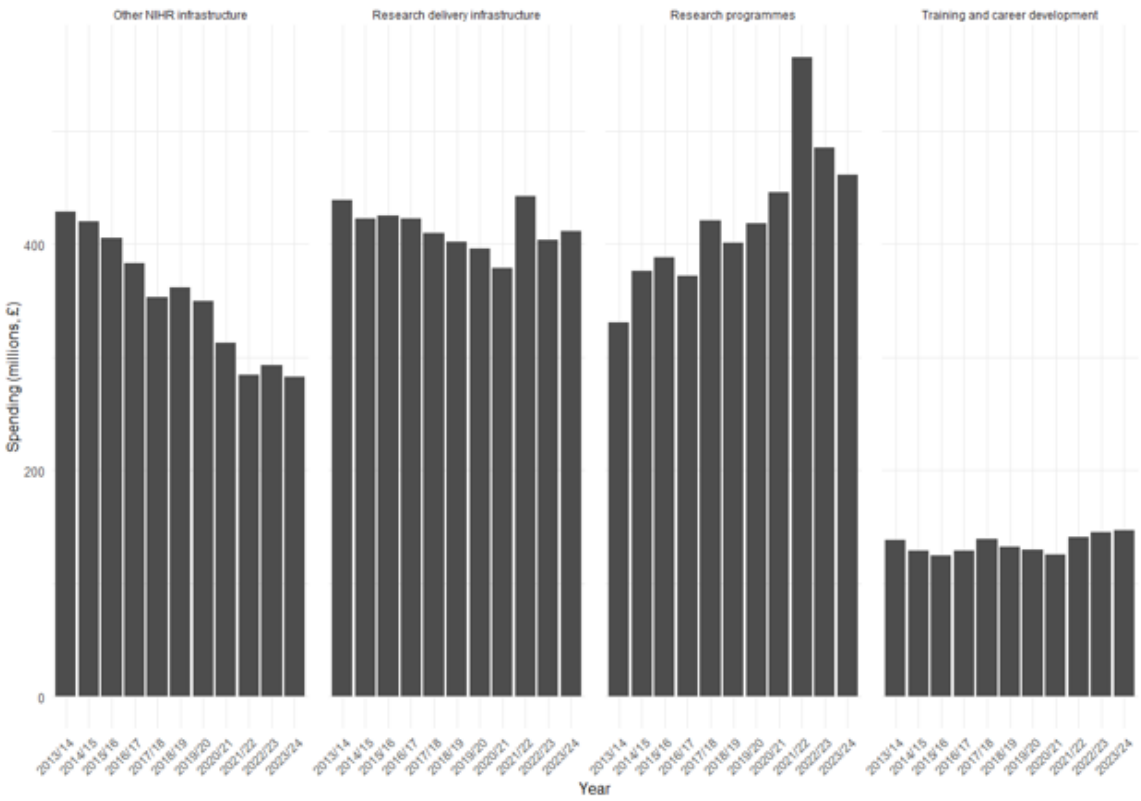
Figure 16: Spending through the NIHR by type between 2013/14 and 2017/18, adjusted for inflation (2023/24 prices)



Since the NIHR provided additional years of Annual Report data, it is possible to show the annual spending trend to 2023/24 across the four activity types.[8] From 2018/19 to 2023/24, total annual spending through the NIHR increased slightly from £1,295.34m to £1,301.60m in 2023/24 prices, representing an overall real-terms increase of 0.48% and a decrease of 2.59% compared to the £1,336.20m in 2013/14. The highest percentage increase during this period was for 'Research Programmes' between 2020/21 and 2021/22, with a change of 26.84%. The largest percentage decrease was for 'Research Programmes' between 2021/22 and 2022/23, with a change of -14.13%.

8 Note that we do not have data on the regional distribution of NIHR spending for 2018/19–2023/24. These years are also outside the project's main focus and are not considered in the modelling work.

Figure 17: Spending through the NIHR by type; NIHR annual report totals for 2013/14–2023/24, adjusted for inflation (2023/24 prices)



3.3. NIHR regional spending and regional population characteristics

Figures 18–20 explore the relationship between each region's average spending through the NIHR per person and its population characteristics. The latter include the percentage of the population aged 65 or above (Figure 18), the percentage of the population that is non-white (Figure 19) and the percentage of the population living in rural areas (Figure 20). Each analysis is based on a limited number of data points, each representing a UK nation or English region; hence, we have not applied regression analysis to study the statistical relationship between expenditure through the NIHR and these variables, which could lead to over-interpretation. As the NIHR is responsible for health and care research in England, its expenditure in the rest of the UK is well below the expenditure in any region of England.

Across England's regions, London consistently emerged as an outlier, with the highest spending and distinct regional characteristics: a lower proportion of older adults, a higher proportion of non-white residents and a minimal rural population.

Figure 18 shows no obvious relationship between annual NIHR spending per person and the percentage of the population aged 65 and above, once London is excluded. Regions with higher proportions of older adults, such as the South West, tended to receive lower per-person spending. In contrast, London, with the lowest percentage of older adults, received the highest spending per person.

Figure 18: Average annual spending through the NIHR per person (2023/24 price terms) within UK regions for 2013/14–2017/18 compared to the percentage of the region's population aged over 65

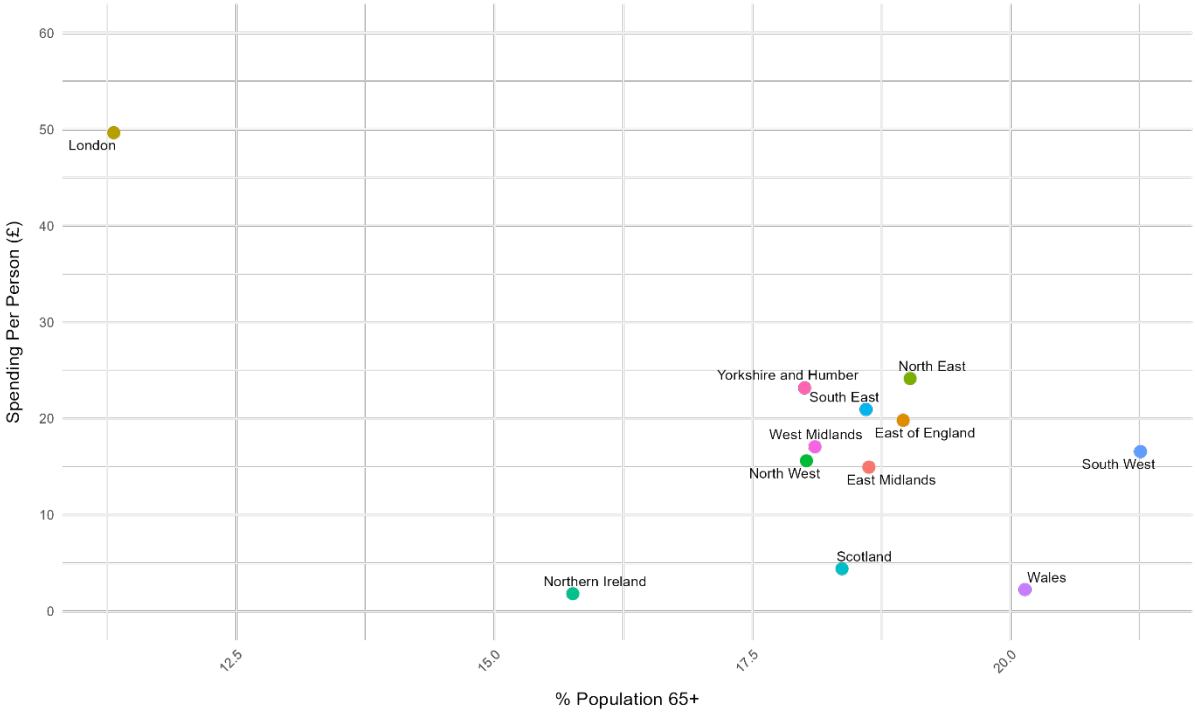


Figure 19 shows that London, which has a much higher proportion of non-white residents than other regions, received greater spending through the NIHR per person. However, after excluding London and non-English regions, there is no clear relationship between the proportion of non-white populations and spending through the NIHR per person across the remaining regions.

Figure 19: Average annual spending through the NIHR per person (2023/24 price terms) in UK regions for 2013/14–2017/18 compared to the percentage of the population that is non-white

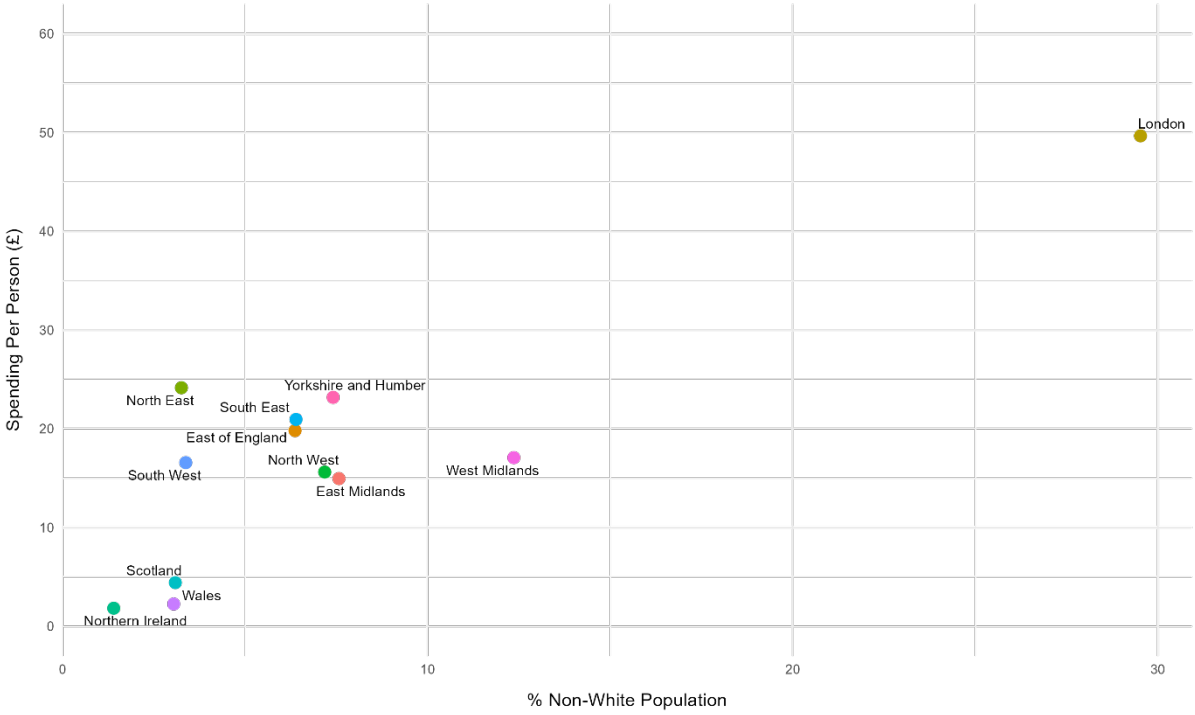
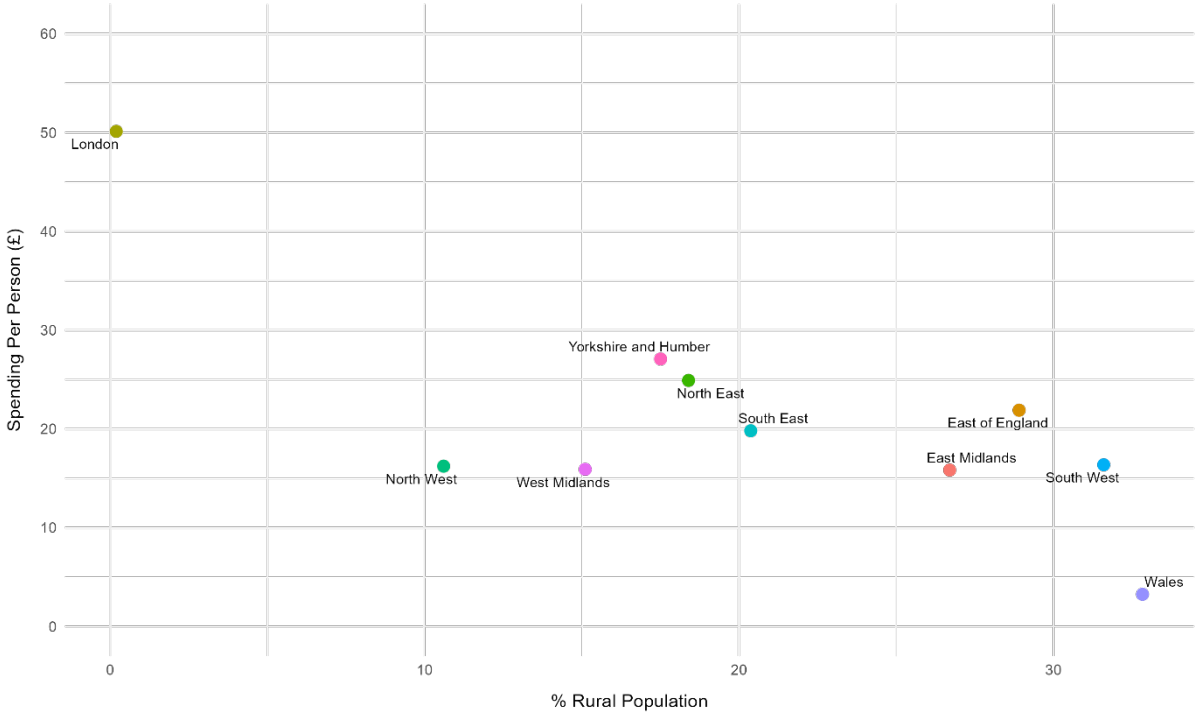


Figure 20 highlights a potential trend, suggesting that regions with a higher percentage of rural population received, on average, slightly lower per-person spending. London is again an outlier, receiving the most spending through the NIHR per head and having almost no rural population.

Figure 20: Average annual spending through the NIHR per person (2023/24 price terms) within UK regions for 2013/14–2017/18 compared to the percentage of the population living in rural areas in 2011



Note: Equivalent data on the percentage of the population living in rural areas is not available for Northern Ireland and Scotland.

Annex D1.

Adjusting Spending for Inflation

Table D1.1: Deflators used to adjust for general price inflation

Financial Year	GDP deflator at market prices, index
2013/14	75.8566
2014/15	76.7835
2015/16	77.3347
2016/17	79.0813
2017/18	80.3254
2018/19	82.017
2019/20	83.961
2020/21	88.466
2021/22	87.949
2022/23	94.218
2023/24	100.000

Formula: Original spending amount * (100/ GDP deflator at market prices for that financial year)

By applying this formula, the spending amount is effectively adjusted to show its real value, expressed in 2023/24 price terms. This is what we refer to as 'inflation-adjusted values' throughout the report.

Total spending through the NIHR by region, year and type

Table D1.2: Total spending through the NIHR (£) 2013/14–2017/18, before adjusting for inflation

Region	2013/14	2014/15	2015/16	2016/17	2017/18
London	320,870,459	339,720,084	335,387,061	335,346,883	337,361,931
East of England	99,133,578	95,984,604	90,817,735	89,969,630	93,467,274
South East	132,352,651	144,938,161	144,587,702	151,234,088	158,947,585
East Midlands	55,280,025	52,738,777	56,693,932	52,557,001	55,460,455
North East	49,183,333	48,393,818	48,051,657	49,623,666	50,494,873
North West	87,429,026	87,959,592	86,779,339	84,708,901	89,919,838
South West	66,707,394	69,080,561	73,181,010	72,026,623	72,217,505
West Midlands	68,466,142	77,992,621	79,090,370	79,517,572	78,241,295
Yorkshire and Humber	109,560,552	92,922,789	94,780,624	89,533,656	98,172,336
Scotland	16,182,550	17,399,206	21,210,351	19,643,415	17,698,639
Wales	7,568,766	6,292,623	5,200,497	4,435,467	3,339,916
Northern Ireland	865,523	1,377,162	1,919,722	3,103,097	6,178,353

Table D1.3: Total spending through the NIHR (£) 2013/14–2017/18, after adjusting for inflation (2023/24 price terms)

Region	2013/14	2014/15	2015/16	2016/17	2017/18
London	422,996,099	442,438,915	433,682,500	424,053,325	419,994,087
East of England	130,685,503	125,006,811	117,434,651	113,768,527	116,360,795
South East	174,477,437	188,762,118	186,963,552	191,238,746	197,879,607
East Midlands	72,874,378	68,685,039	73,309,824	66,459,455	69,044,730
North East	64,837,250	63,026,324	62,134,666	62,750,190	62,862,896
North West	115,255,661	114,555,331	112,212,679	107,116,222	111,944,463
South West	87,938,814	89,967,976	94,628,944	91,079,211	89,906,187

Region	2013/14	2014/15	2015/16	2016/17	2017/18
West Midlands	90,257,328	101,574,716	102,270,223	100,551,676	97,405,422
Yorkshire and Humber	144,431,140	121,019,216	122,558,986	113,217,229	122,218,299
Scotland	21,333,080	22,660,085	27,426,694	24,839,520	22,033,677
Wales	9,977,730	8,195,280	6,724,661	5,608,743	4,157,982
Northern Ireland	1,140,999	1,793,565	2,482,355	3,923,933	7,691,655

Table D1.4: Total spending through the NIHR by type for the five years 2013/14–2017/18 combined, adjusted for inflation (2023/24 price terms)

Region	Type of spending (£)	Spending per person (£)	Spending (£m)
East Midlands	Other NIHR Infrastructure	20.26	94.83
East of England	Other NIHR Infrastructure	45.20	274.99
London	Other NIHR Infrastructure	107.35	925.71
North East	Other NIHR Infrastructure	25.76	67.27
North West	Other NIHR Infrastructure	13.25	95.22
Northern Ireland	Other NIHR Infrastructure	0.00	0.00
Scotland	Other NIHR Infrastructure	0.00	0.00
South East	Other NIHR Infrastructure	32.02	286.98
South West	Other NIHR Infrastructure	15.66	85.77
Wales	Other NIHR Infrastructure	0.00	0.01
West Midlands	Other NIHR Infrastructure	11.39	65.64
Yorkshire and Humber	Other NIHR Infrastructure	17.20	92.45
East Midlands	Research Delivery Infrastructure	28.32	132.68
East of England	Research Delivery Infrastructure	32.56	198.42
London	Research Delivery Infrastructure	55.21	476.71
North East	Research Delivery Infrastructure	53.12	138.82
North West	Research Delivery Infrastructure	36.58	262.73
Northern Ireland	Research Delivery Infrastructure	0.00	0.00
Scotland	Research Delivery Infrastructure	0.00	0.00
South East	Research Delivery Infrastructure	34.57	309.95
South West	Research Delivery Infrastructure	32.29	176.62
Wales	Research Delivery Infrastructure	0.00	0.00

Region	Type of spending (£)	Spending per person (£)	Spending (£m)
West Midlands	Research Delivery Infrastructure	36.52	210.46
Yorkshire and Humber	Research Delivery Infrastructure	39.30	211.38
East Midlands	Research Programmes	19.09	89.56
East of England	Research Programmes	14.03	85.51
London	Research Programmes	60.96	526.80
North East	Research Programmes	30.22	79.04
North West	Research Programmes	19.93	143.32
Northern Ireland	Research Programmes	9.14	17.03
Scotland	Research Programmes	22.10	118.29
South East	Research Programmes	28.72	257.78
South West	Research Programmes	26.61	145.74
Wales	Research Programmes	11.27	34.66
West Midlands	Research Programmes	27.92	160.95
Yorkshire and Humber	Research Programmes	42.30	227.60
East Midlands	Research Training and Career Development	7.10	33.30
East of England	Research Training and Career Development	7.28	44.33
London	Research Training and Career Development	24.80	213.94
North East	Research Training and Career Development	11.66	30.48
North West	Research Training and Career Development	8.32	59.80
Northern Ireland	Research Training and Career Development	0.00	0.00
Scotland	Research Training and Career Development	0.00	0.00
South East	Research Training and Career Development	9.42	84.61
South West	Research Training and Career Development	8.30	45.39
Wales	Research Training and Career Development	0.00	0.00
West Midlands	Research Training and Career Development	9.54	55.01
Yorkshire and Humber	Research Training and Career Development	17.11	92.02

Appendix E. **Updated estimates of health-gain-related IRRs**

Jon Sussex (RAND Europe)

1. Introduction

The health gains ultimately resulting from NIHR research expenditures constitute not only the principal reason for conducting such research but also represent an important part of the overall economic impact of expenditure through the NIHR. Successful research may yield more effective and cost-effective ways to deliver better health and healthcare. NIHR-funded research may yield health improvements directly. They may also do so indirectly by enabling cost savings in parts of healthcare provision, meaning that the resources thereby released can then be re-allocated to provide more care to more people.

Improving the health of the working-age population can also be expected to reduce time off work due to illness ('absenteeism') and potentially to increase the productivity of people who are at work but who would otherwise be performing less well due to health challenges (so-called 'presenteeism'). Together, these potential work-related economic benefits from health and care research are referred to as productivity impacts.

Health gains are a benefit felt nationally by all populations served by the NHS (and potentially internationally too), and specifically by the patient groups or population subgroups served by the innovations resulting from spending through the NIHR. Eventually, the regional spread of these health gains is likely to reflect, at least approximately, the regional spread of the healthcare need addressed by the innovation. In the shorter term, however, there is evidence that patients in the location where the funded research takes place are likely to benefit earlier than in the rest of the country (Boaz et al. 2024).

The research presented in this report focuses on modelling the impact of expenditure through the NIHR on the GDP of the UK's countries and regions. We add to that an estimate of the health-gain-related rate of return to the NIHR's expenditure, based on a review of the relevant empirical literature and updating the health gain 'internal rates of return (IRRs)' reported there. We report our methods and the resulting health gain IRR estimates in the following sections. Estimating productivity impacts from health gains is beyond the scope of the present study.

Existing studies in the literature have estimated medical research health gain outcomes from government (including through the NIHR) and charity-funded research at the UK national level for four disease areas: cancer (Glover et al. 2014), cardiovascular disease (HERG et al. 2008), mental health (HERG et al. 2008) and musculoskeletal conditions (Glover et al. 2018).

In all these studies the net monetary benefit (NMB) from the health gain in the UK population was estimated as the monetary value of the QALYs minus the cost of delivering these health benefits for a prioritised list of health interventions over a defined period. Based on systematic reviews of the available evidence, the authors of those studies made assumptions about the following variables:

- The elapsed time between research funding and the health gain
- The duration and time profile over which the health gains are realised
- The percentage of the overall UK NMB that can reasonably be attributed to UK research.

Table 19 summarises the key assumptions in those published studies.

Table 19: Key assumptions in studies estimating IRRs on UK health gains from UK research

	Cancer	Cardiovascular	Mental health	Musculoskeletal
Time lag between research spend and consequent UK health gain (years)	15	17	12	16
Duration of UK health gain (years)	20	14	18	20
Percentage of UK health gains attributed to UK research	17%	17%	28%	30%

Note: These assumptions underlie the authors' 'best estimates' in the studies in the following areas: cancer (Glover et al. 2014), cardiovascular disease (HERG et al. 2008), mental health (HERG et al. 2008) and musculoskeletal conditions (Glover et al. 2018).

The above studies estimated IRRs from the value of UK health gains associated with UK investment in medical research, applying a value per QALY of £25,000 in money of the day at the time of analysis. This was the middle of the £20,000–30,000 per QALY threshold range used by the National Institute for Health and Care Research (NICE 2025) to assess whether the NHS should offer a new treatment. On this basis, the studies yielded estimated health gain IRRs of 7–10% in real terms, depending on the disease area.

For the purposes of the current research, we assume that spending through the NIHR in the four disease areas with existing health gain IRR estimates will continue to yield health gains at the rates indicated by those studies. We have adjusted the costs of delivering those health gains to FY 2023/24 price terms using the general rate of inflation, as measured by the GDP deflator at market prices. We then applied a value per QALY gained of £70,000 in 2023/24 price terms, following HM Treasury's suggested value for the UK population's average willingness to pay for a QALY. This value is appropriate when adopting a UK societal perspective on the value of health gains (HM Treasury 2022).

2. Method

We obtained the discounted cash flow calculation spreadsheet data used to estimate the original health gain IRRs for the four published studies as follows:

1. **Cancer**: Correspondence with the lead author of Glover et al. (2014), who provided a copy of the original spreadsheet. The research and annual implementation costs have been inflated from 2011 price terms to 2023/24 financial year prices using the GDP deflator at market (GOV.UK 2025).
2. **Cardiovascular disease**: The relevant cost and QALY flows over time are presented in HERG et al. (2008), expressed in 2005 price terms. These have been inflated to 2023/24 prices using the GDP deflator at market prices.
3. **Mental health**: HERG et al. (2008) report some (but not all) of the research costs, implementation costs and QALYs gained data used by its authors to estimate the health gain IRR for mental health conditions. Although we approached the original authors, they no longer had the spreadsheets they had used to calculate the IRR for mental health research. JS constructed a discounted cash flow

spreadsheet consistent with the cost (in 2005 price terms) and QALY information and their temporal patterns available in HERG et al. (2008), which yielded the IRRs reported for the central estimate using £25,000/QALY and for the two sensitivities estimated, namely for £20,000/QALY and £30,000/QALY. We then inflated the costs in this constructed spreadsheet from 2005 price terms to 2023/24 prices using the GDP deflator at market prices.

4. **Musculoskeletal conditions**: Correspondence with the lead author of Glover et al. (2018), who provided a copy of the original spreadsheet. We inflated the research and annual implementation costs from 2013 price terms to 2023/24 prices using the GDP deflator at market prices.

All spreadsheets used in the updated health gain IRR calculations are available on request from the corresponding author (JS).

Data on expenditure through the NIHR by disease area for 2014 are available in UK Health Research Analysis 2014 (UKCRC 2015). The year 2014 is the only period within 2013/14–2017/18 for which we could find NIHR expenditure data by disease area. Table 20 shows that, collectively, the four disease areas represented 35.0% of total expenditure through the NIHR attributed to specific disease areas in that year. In 2014, research expenditures through the NIHR identified to specific disease areas totalled £285.9m (money of the day), compared to total spending through the NIHR of £1,034.8m (money of the day) in the 2014/15 financial year (2015). Thus 72% of NIHR expenditure was not attributed to a specific disease area but likely relates to health and care more generally. Consequently, the four disease areas constitute just under 10% of total expenditure through the NIHR. While this limitation significantly affects the generalisability of the health gain IRRs reported in the published literature, we have not identified any alternative data sources.

Table 20: Expenditure through the NIHR by disease area, 2014 (£m in 2014 prices)

	£m (2014 prices)	% of disease-specific NIHR expenditure	% of total NIHR expenditure
Cancer	32.1	11.2%	3.1%
Cardiovascular	21.0	7.4%	2.0%
Mental health	37.1	13.0%	3.6%
Musculoskeletal	9.8	3.4%	0.9%
Total for 4 diseases	*100.0*	*35.0%*	*9.7%*
Other disease areas	185.9	65.0%	18.0%
Total identified by disease area	285.9	100.0%	27.6%
Total NIHR expenditure overall	1,034.8		100.0%

Sources: UKCRC (2015) NIHR (2015).

3. Findings

Table 21 reports the estimated health gain IRRs for research expenditure through the NIHR across the four disease areas for which earlier estimates are available in the literature. The original papers report health gain IRRs (net of implementation costs) for public (government plus charity) research expenditure assuming that each QALY gained is valued at £25,000 in money of the day at the time of the study. These reported IRRs range from approximately 7% per annum in real terms for mental health and musculoskeletal research to 9% per annum for cardiovascular research and 10% for cancer. The weighted average of the four disease-specific internal rates of return (using relative research expenditures through the NIHR in those disease areas in 2014 as weights) is a little over 8%.

However, HM Treasury proposes that a 'willingness to pay' value of a QALY of at least £70,000 be used in NHS and other government investment appraisals (HM Treasury 2022). Valuing QALYs at £70,000 in 2023/24 price terms would increase the estimated IRR due to health gains from NIHR expenditure to around 13% per annum in real terms (see Table 21), assuming that spending overall through the NIHR achieves the same average IRR as spending in the four evidenced disease areas.

Table 21: IRRs to research expenditures through the NIHR, from the value of QALY gains net of incremental costs

	Reported in source using £25,000/QALY in money of the day (various years)	Estimated using £70,000/QALY value in 2023/2024 price terms*
Cancer (Glover et al. 2014)	10.05%	15.22%
Cardiovascular (HERG et al. 2008)	9.20%	13.77%
Mental health (HERG et al. 2008)	7.04%	10.90%
Musculoskeletal (Glover et al. 2018)	6.76%	12.04%
Weighted average IRR of the four disease areas	**8.43%**	**13.00%**

*Notes: Underlying sources for these RAND Europe calculations are referenced in the table. *GDP deflator at market prices from HM Treasury 2024.*

4. Conclusions

Based on the existing empirical literature, we have estimated the IRR of research expenditure through the NIHR in terms of the value of QALYs gained as a consequence of that expenditure net of the costs of implementing the research findings that yield those QALYs. Our main estimate is that the health gain IRR to expenditure through the NIHR is around 13% per annum in real terms, assuming QALYs valued at £70,000 (in 2023/24 price terms). As the original studies made clear, any estimated IRR figure is highly sensitive to numerous assumptions, including the value of a QALY applied, the time profile of health gains consequent on research, and the proportion of those gains attributed to public research in the UK. Furthermore, other factors besides inflation will have changed since, e.g. new research outputs and changes in the pattern of spending through the NIHR, which will add significant uncertainty to the estimates. The true IRR from health gains could be considerably higher or lower than 13%, but that value is a reasonable estimate based on the available information.

Appendix F. **Case studies**

Devika Kapoor, Imogen Wade, Bhavya Singh and Sue Guthrie (RAND Europe)

1. Introduction

This appendix presents the full write-ups of the four case studies examining the economic impacts of activities funded through the NIHR, as well as the REF 2021 case study database analysis of the regional impacts of research funded through the NIHR.

1.1. Introduction to case studies

The objective of the case studies was to provide in-depth insights into the economic impacts of NIHR-funded activities, complementing the broader quantitative analysis of funding distribution and investment returns across the UK. By examining specific examples of NIHR awards, the case studies illustrate how research investments translate into tangible benefits, such as policy influence, commercial outcomes, health improvements and economic contributions at both regional and national levels. This qualitative component highlights the mechanisms by which NIHR funding generates value, including spillover effects across regions, while capturing variations in impact by award type, location and research focus. We chose the selected cases to represent diversity in impact categories (policy influence, commercial spinouts and practice changes), funding schemes (research grants and fellowships), and geographic distribution, ensuring a balanced view of NIHR's contributions to health and wealth.

1.2. Methods

The approach involved a systematic selection process using Researchfish data, which contains self-reported impact information from NIHR award holders. We identified awards demonstrating economic impacts in the UK, focusing on four key criteria: policy influence, spinouts with UK-based employees, products or interventions under active development with wider achievements, and granted patents licensed by companies. We excluded awards for artistic or creative products because the evaluation's emphasis is on economic effects.

From an initial long list of 173 awards, we developed a shorter list of 24 potential case study sites by randomly selecting four case studies for 'fellowship' and four for 'research grant' within each of the three broad categories of impact: policy influence, commercial and practice. We then mapped these against characteristics such as funding scheme, location and typology to select four diverse case studies, in consultation with NIHR. Using additional filtering, we created a shortlist of eight possible case studies (four first-choice case studies and four back-up options), with a geographic spread across regions. We shared this shortlist with the NIHR in January 2025 and received the final confirmation for all four case studies in April 2025.

We did not select case studies for 'infrastructure' for two reasons. First, NIHR infrastructure awards typically do not report in Researchfish. However, infrastructure

spending underpinned other awards, and we reflected on this in our write-ups. Second, it is hard to measure the impacts of infrastructure spending because it is context-specific and contributes to a multitude of further research, making it impractical to track all impacts.

We used the 'Payback Framework' theoretical approach (Buxton & Hanney 1998) to structure our case study analysis. This approach is commonly used to tease out impacts or 'paybacks' of health services research. Each case study was developed through a mixed-methods process, including semi-structured interviews with principal investigators (PIs), key research team members and end-users, as well as desk-based review of project documents, published outputs and supplementary data on clinical and economic impacts.

We used a protocol to ensure we asked the same questions in all interviews, while remaining semi-structured to allow flexibility. We first contacted the PI for each award, then used a snowballing approach to reach out to others involved in the award or its end users. Challenges we faced included a low response rate to our initial email invitations to interview, possibly due to the significant time since the award ended in some cases.

In total, we conducted 11 interviews to support the case studies between the first week of April 2025 and mid-August 2025. For three of the case studies, we interviewed three people; for the fourth, we interviewed two.

Overall, our mixed-methods process for developing the case studies enabled a comprehensive analysis of inputs, processes, outputs and outcomes, with findings synthesised across interviews and documentary sources to inform the in-depth case studies. We used the interviews to validate, clarify or refute information collected from documentary sources and vice versa. As a final step in July 2025, we shared the final draft write-ups with the award holders for validation, which, in some cases, enabled us to correct or edit key details.

Table 22: Details of the four case studies

Key type of impact	Project title	Research organisation	NUTS1 Region[9]	Project start	Project end	Award type and value (GBP)
Policy and practice influence	'REMAP-CAP: Randomized, Embedded, Multifactorial Adaptive Platform trial for Community-Acquired Pneumonia (COVID-19)'	Imperial College London	London	1 April 2020	31 March 2023	Research award; £1,249,630

9 The Nomenclature des Unités Territoriales Statistiques (NUTS), or Nomenclature of Territorial Units for Statistical Purposes, is a geographic classification developed by Eurostat to ensure that territorial units are comparable in terms of area and population size for collecting and collating regional statistics. Following the UK's withdrawal from the European Union on 31 December 2020, the Office for National Statistics introduced International Territorial Levels (ITLs) as a parallel classification to NUTS. ITLs have since been used in the UK. For further details, International geographies - ONS. As of 30 November 2025: https://www.ons.gov.uk/methodology/geography/ukgeographies/eurostat.

Key type of impact	Project title	Research organisation	NUTS1 Region[9]	Project start	Project end	Award type and value (GBP)
Spin-Out	Clinical development and evaluation of an advanced prototype for in situ microbial sensing, providing early antibiotic susceptibility data for organisms colonising chronic wounds	University of Manchester	North West	1 April 2015	30 June 2017	Research award; £552,945
Policy influence	A randomised placebo-controlled trial of mifepristone and misoprostol versus misoprostol alone in the medical management of missed miscarriage: The MIFEMISO trial	University of Birmingham	West Midlands	1 February 2017	31 July 2020	Research award; £1,715,379
Policy influence	Improving the management of children with respiratory and urinary tract infection in primary care	University of Bristol	South West	1 January 2010	31 December 2013	Fellowship; £420,688

2. Case Study 1: Randomised, Embedded, Multifactorial, Adaptive Platform trial for Community-Acquired Pneumonia (REMAP-CAP)

2.1. Summary

The Randomised, Embedded, Multifactorial, Adaptive Platform trial for Community-Acquired Pneumonia (award ID COVID-19 - REMAP-CAP) represents a novel and award-winning approach to clinical research that delivered critical evidence during the COVID-19 pandemic. NIHR's investment of £1.25m between 2020 and 2023 enabled the UK to become the largest contributor to this international adaptive platform trial, recruiting 5,568 of over 10,000 patients globally from the general ward and intensive care unit (ICU) during COVID-19 (NIHR 2023a). The trial identified life-saving treatments, including tocilizumab and sarilumab (IL-6 receptor antagonists), which reduced mortality by 24% in critically ill patients and enabled the treatment of over 1 million patients globally, saving an estimated 100,000 lives (NIHR 2023a). This case study examines how NIHR's strategic funding of adaptive platform trial infrastructure generated health and economic returns through rapid evidence generation, international collaboration, and transformative changes in healthcare practice.

Key Facts About the Funding:

NIHR award type: Research award (ID COVID-19 - REMAP-CAP)

Study Period: March 2020 to June 2023 (COVID-19 phase)

Principal Investigator: Professor Anthony Gordon, Imperial College London

Total NIHR Funding: £1,249,630 (2020–2023)

UK Contribution: 5,568 patients recruited

This case study draws on a range of evidence sources, including:

- Three semi-structured interviews (conducted via Teams video) with the PI, a senior trial manager and a local site PI to understand NIHR's role and impact mechanisms.
- Research documentation, including the final project report submitted to the NIHR (NIHR 2023a) and the original application form.
- An analysis of project documentation, published trial results, and supplementary research on adaptive platform trial efficiency.

2.2. Introduction

REMAP-CAP represents an innovative trial methodology that proved crucial during the COVID-19 pandemic. It was one of five winners of the NIHR impact prize in 2025, in the early-career researcher category (NIHR 2025b). The study utilised an adaptive platform design that enabled simultaneous evaluation of multiple treatments while adapting to emerging evidence through pre-specified statistical triggers (REMAP-CAP Trial 2025). The trial investigated treatments for severe community-acquired pneumonia (CAP) and was specifically designed to adapt rapidly to pandemic scenarios.

We selected this case to illustrate how expenditure through the NIHR has impacted global health. REMAP-CAP exemplifies how strategic investment in research infrastructure can enable rapid, high-quality evidence generation during health crises.

2.3. Background

Scientific/Health System Context

The genesis of REMAP-CAP can be traced to lessons learned during the 2009 swine flu outbreak (caused by the influenza A virus subtype H1N1 strain), which exposed critical weaknesses in the global research response to health emergencies. During that pandemic, it became starkly apparent how difficult it was to initiate and conduct meaningful clinical research during a rapidly evolving health crisis. The traditional approach to clinical trials, with its lengthy set-up periods, complex regulatory approvals and sequential design, proved inadequate when faced with the urgent need for evidence-based treatment guidance during a pandemic (REMAP-CAP 2025). As the PI reflected in their interview, the idea of REMAP-CAP was born from the realisation that research infrastructure must be established before a pandemic strikes, not afterwards (interviewee RC_1 2025).

The challenge was not merely logistical but fundamentally methodological. While providing the gold standard for clinical evidence, traditional randomised controlled trials can take months or even years to design, approve, and implement. During a pandemic, when thousands of lives hang in the balance daily, such timeframes become not just impractical

but ethically problematic. The 2009 experience demonstrated that by the time traditional trials could get underway and begin recruiting patients, the pandemic wave might have already passed, leaving critical treatment questions unanswered for future outbreaks (Angus et al. 2020).

The European Union's PREPARE FP7 grant provided initial seed funding for trial development from 2014, while Australian, New Zealand, Canadian and US funding supported respective national components.[10]

CAP represented the ideal focus for this preparedness effort, given its position as one of the most significant infectious disease threats globally. CAP stands as a leading cause of death from infection worldwide, with lower respiratory tract infections responsible for approximately 2.53 million deaths in 2021, according to WHO (2024), making it the fifth most common cause of death globally[11] and the leading cause of death in developing countries (REMAP-CAP Trial, 2025). More crucially for pandemic preparedness, the majority of people requiring intensive care during respiratory pandemics are admitted because of severe community-acquired pneumonia, making CAP the common pathway through which pandemic threats manifest in critically ill patients (Angus et al. 2020).

The evidence base for treating severe CAP was fragmented and incomplete, particularly regarding optimal treatment combinations and their effectiveness across different patient populations. Traditional clinical practice relied heavily on individual clinician judgment when selecting treatment options, often without definitive evidence about which treatments worked best for specific patient populations. This uncertainty was compounded during pandemics when novel pathogens with unknown characteristics suddenly emerged, rendering existing treatment protocols potentially obsolete overnight.

The healthcare system context in 2009 and 2010 also revealed structural limitations in research capacity during emergencies. Healthcare systems overwhelmed by patient care demands struggled to maintain research activities, creating tension between providing immediate care and generating evidence to improve it. This tension highlighted the need for research approaches that could be seamlessly embedded within routine clinical practice, rather than requiring additional resources that might be unavailable during crisis periods (REMAP-CAP 2025).

Key Individuals/Organisations

The PI of the NIHR-funded project became involved in the REMAP-CAP trial's UK segment in 2016 upon receiving an NIHR Research Professorship award, which provided funding to pursue a comprehensive programme of work investigating adaptive and novel trial designs (RC_1 2025; RC_2 2025). This initial investment through the NIHR proved prescient, as it was through this research that the PI became involved in the international REMAP-CAP collaboration.

The PI's institutional base at Imperial College London and the Imperial Biomedical Research Centre provided crucial infrastructure and

10 The full list of funders is available in the case study annex.

11 This does not include deaths linked to COVID-19, accounting for around 8.8 million deaths in 2021 – making it the second leading cause of deaths globally.

expertise.[12] However, one interviewee noted that the Biomedical Research Centre's contribution was relatively minor, as Biomedical Research Centres typically focus on earlier-phase translational research rather than the later-stage platform trials that REMAP-CAP represented (RC_1 2025).

The international collaborative structure of REMAP-CAP reflected the global nature of pandemic threats and the need for coordinated research responses. The trial's leadership was distributed across multiple continents, with coordinating centres in the Netherlands (University Medical Centre Utrecht), Australia, New Zealand, Canada and the United States. This geographic distribution ensured that the platform could capture diverse patient populations and healthcare system contexts while building resilience against regional disruptions that might affect any single coordinating centre (REMAP-CAP 2025).

A critical component was the innovation by a US-based private company, Berry Consultants, which developed the novel Bayesian statistical methods underlying the adaptive platform design.

As industry partners, Roche and Sanofi provided tocilizumab and sarilumab, respectively, for the platform, enabling head-to-head comparisons that would have been impossible in separate, company-sponsored trials (REMAP-CAP 2025). This collaborative approach proved mutually beneficial, reducing individual company costs while providing more robust evidence than any single-company study could have generated.

The NIHR CRN[13] represented the crucial infrastructure that enabled the UK's meaningful contribution to the global trial. Initially supporting research nurses at a dozen hospitals during the inter-pandemic phase, the CRN's established relationships and embedded research capacity allowed for rapid expansion to 143 hospitals when COVID-19 emerged (RC_1 2025; RC_2 2025).

2.4. Research input and processes

Funding and Resources

The evolution of support through the NIHR for REMAP-CAP illustrates the complex, multi-layered nature of research investment and how strategic early funding can yield transformative results during health emergencies. The funding trajectory began in 2016, through NIHR's broader investment in research excellence via a Research Professorship award to the PI, whose involvement in REMAP-CAP from 2016 onwards was sustained through this personal NIHR funding, allowing the development of expertise and relationships within the international consortium before the pandemic created urgent demand for the platform's capabilities.

The infrastructure support provided by the NIHR CRN between 2016 and 2020 represented another crucial investment. While the trial did not receive direct NIHR funding during this period, the CRN's embedded research nurses at a dozen hospitals across

12 The infrastructure centres supporting this project included NIHR Guy's and St Thomas' Clinical Research Facility, NIHR Sheffield Clinical Research Facility, NIHR Wellcome Trust Newcastle Clinical Research Facility, NIHR Nottingham Biomedical Research Centre, NIHR University College London Hospitals Biomedical Research Centre, NIHR Wellcome Trust Southampton Clinical Research Facility, NIHR Alder Hey Clinical Research Facility, NIHR Bristol Biomedical Research Centre, NIHR Cambridge Biomedical Research Centre, NIHR Southampton Biomedical Research Centre, NIHR Leicester Clinical Research Facility, NIHR Nottingham Clinical Research Facility and NIHR Wellcome Trust Birmingham Clinical Research Facility.

13 The NIHR's CRN transitioned to the Research Delivery Network (RDN) on 1 October 2024.

the UK provided the foundation for patient recruitment and trial delivery (RC_1 2025; RC_2 2025). This infrastructure investment created the capacity for rapid scaling when direct COVID-19 funding became available in 2020.

When COVID-19 emerged in early 2020, NIHR stepped in by providing crucial funding to carry out the trial in the UK. In addition to the funding infusion, NIHR's response also demonstrated the value of having established research infrastructure and relationships. The direct COVID-19 grant of £1,249,630 covering the 2020–2023 period enabled the UK to become the largest single contributor to the global trial (NIHR 2023a). The funding covered not just direct trial costs but also the coordination activities necessary to scale from a dozen to 143 participating hospitals within a matter of weeks.

Research activities

The methodological innovation underlying REMAP-CAP reimagined how clinical trials could be designed and conducted, particularly during health emergencies. At its core, the platform employed a Bayesian adaptive design that enabled continuous learning and optimisation throughout the trial, rather than waiting until the end of a fixed study period to analyse results. This approach allowed the trial to allocate more patients to treatments showing early promise while reducing allocation to those showing signs of futility or harm, thereby maximising both the scientific value and ethical appropriateness of patient participation (Angus et al. 2020).

The multi-factorial design represented another crucial innovation, enabling simultaneous evaluation of multiple treatment domains rather than the traditional approach of testing single interventions in isolation. Patients could be randomised to receive interventions across multiple domains simultaneously – for example, receiving both an immunomodulatory agent and a specific anticoagulation strategy – allowing investigators to assess not just individual treatment effects but also potential interactions between treatments (NIHR 2023a). This approach more closely reflects real-world clinical practice, where severely ill patients typically receive multiple concurrent therapies.

The response-adaptive randomisation component ensured that as evidence on treatment effectiveness accumulated, the likelihood of assignment to more effective treatments increased. At the same time, the likelihood of assignment to less effective treatments decreased. This change created an ethical advantage over traditional trials, as patients entering the study later had a higher likelihood of receiving beneficial treatments, while still maintaining the scientific rigour necessary for definitive conclusions about treatment effects.

The platform's perpetual design enabled the addition of new treatments and removal of ineffective ones without stopping the entire trial, creating a continuously learning research system. When COVID-19 emerged, this flexibility proved crucial, as new domains specific to COVID-19 treatments could be rapidly incorporated into the existing platform infrastructure. The trial's timeline demonstrates this adaptability: the first COVID-19 patient was enrolled on 9 March 2020, less than six weeks after the WHO declared COVID-19 a Public Health Emergency and just two days before it was declared a pandemic (REMAP-CAP 2025). REMAP-CAP achieved rapid ethics approval and patient recruitment within weeks in the UK, contrasting with a mean of three months across EU countries and delays in the US and Europe, which proved challenging for trial leaders. The UK's pace can be attributed to its integrated health research system features, such as NIHR governance embedded in the NHS, which accelerated processes and data access, allowing the trial to mobilise quickly (Hanney et al. 2022).

The trial's embedded nature represented one of the most significant operational innovations. Rather than creating parallel research processes that competed with clinical care for healthcare workers' attention and institutional resources, REMAP-CAP was designed to integrate seamlessly with routine clinical practice. Eligibility screening, consent processes and treatment allocation were embedded within intensive care unit (ICU) admission procedures, meaning that research participation became part of standard care rather than an additional burden during crisis periods (RC_3 2025; RC_2 2025).

UK regulatory approval processes that typically took months were compressed into weeks through coordination between the Health Research Authority, ethics committees and the Medicines and Healthcare Products Regulatory Agency (MHRA). The designation of REMAP-CAP as an Urgent Public Health priority study by the Chief Medical Officer unlocked access to the full NIHR CRN, enabling rapid expansion from 12 to 143 participating hospitals (RC_2 2025; RC_1 2025; NIHR 2023a).

Site activation and training represented another major challenge, as the complexity of the adaptive platform design required healthcare teams to understand multiple treatment domains, randomisation procedures and data collection requirements. The CRN's established relationships and embedded research infrastructure proved crucial here, enabling existing research teams to be rapidly trained and deployed rather than requiring entirely new personnel and systems at each site.

Maintaining trial quality and scientific integrity during the COVID-19 pandemic's early chaos required a careful balance between speed and rigour. The trial's adaptive design included pre-specified statistical stopping rules that enabled rapid decision-making about treatment effectiveness while maintaining appropriate safeguards against false conclusions. The international coordination required daily communication between coordinating centres to ensure consistent protocol implementation across different healthcare systems and regulatory environments.

2.5. Research outputs and outcomes

Knowledge production

REMAP-CAP's knowledge production represents a significant achievement in pandemic clinical research, generating definitive evidence on 14 different COVID-19 treatments within a rapid timeframe. The trial's success in rapidly producing actionable clinical evidence altered the global response to COVID-19 and demonstrated the transformative potential of adaptive platform trial methodology (NIHR 2023a).

The breakthrough findings regarding IL-6 receptor antagonists, tocilizumab and sarilumab, exemplify the trial's impact. Originally developed for rheumatoid arthritis, these drugs were shown to reduce mortality by 24% in critically ill COVID-19 patients, decreasing deaths from 35.8% to 27.3% compared with standard care (REMAP-CAP Investigators, Gordon et al. 2021). This finding represented the first major breakthrough in reducing COVID-19 mortality beyond corticosteroids and emerged from the trial's ability to simultaneously evaluate multiple immunomodulatory approaches rather than testing each in isolation.

The clinical significance extended beyond simple mortality reduction. The corticosteroid findings provided crucial confirmation and refinement of earlier results from other trials. REMAP-CAP demonstrated a 93% probability of superiority for hydrocortisone in improving organ support-free days among patients with severe COVID-19, contributing to a growing

body of evidence that led to corticosteroids becoming standard care globally (Angus et al. 2020). The trial's contribution was particularly valuable because it provided evidence for specific corticosteroid regimens and patient populations, rather than generic recommendations about steroid use.

The trial demonstrated that IL-6 receptor antagonists shortened ICU stays by more than one week on average and reduced total hospital length of stay by approximately two weeks. During a pandemic in which healthcare systems worldwide were overwhelmed, and ICU capacity was the primary constraint on healthcare delivery, these findings had immediate practical implications not only for healthcare cost savings but also for resource allocation and patient flow management. The long-term follow-up at six months revealed sustained benefits, with improved survival, better quality of life and reduced disability among survivors, suggesting that the treatments provided lasting rather than merely temporary benefits (Writing Committee for the REMAP-CAP Investigators et al. 2023).

Perhaps equally important were the trial's negative findings, which prevented potentially harmful treatments from becoming standard practice. The definitive demonstration that hydroxychloroquine and lopinavir-ritonavir provided no benefit and potentially caused harm in critically ill COVID-19 patients helped end widespread off-label use of these treatments worldwide (Arabi et al. 2021). Similarly, the finding that convalescent plasma showed no benefit in critically ill patients helped save costs and redirect scarce blood bank resources away from an ineffective intervention (Writing Committee for the REMAP-CAP Investigators et al. 2021).

The therapeutic anticoagulation results revealed the sophistication possible through adaptive platform designs. Rather than providing simple positive or negative results, the trial demonstrated that anticoagulation benefits varied by disease severity, helping moderately ill patients (ATTACC Investigators et al. 2021) but potentially harmful in the most critically ill (REMAP-CAP Investigators, ACTIV-4a Investigators et al. 2021). This nuanced finding would have been impossible to detect in traditional single-population trials and provided crucial guidance for personalised treatment approaches.

The academic impact of these findings was immediate and substantial, with results published in the world's leading medical journals, including the New England Journal of Medicine and JAMA. The speed of publication, often within weeks of reaching statistical significance thresholds, enabled rapid clinical translation that would have been impossible with traditional trial designs that require complete enrolment before analysis (RC_1 2025).

Benefits to future research

REMAP-CAP's methodological contributions extend beyond its specific findings about COVID-19 treatments, establishing new paradigms for clinical research that are being adopted across therapeutic areas. The trial demonstrated that adaptive platform trials can maintain scientific rigour while improving efficiency and responsiveness to urgent health crises.

The trial's statistical innovations, particularly the development of response-adaptive randomisation algorithms that can operate in real time across multiple international sites, have been shared openly and are being implemented in new platform trials for sepsis, acute respiratory distress syndrome and other critical care conditions (Bos et al. 2024).

The trial demonstrated that effective scientific collaboration could transcend national boundaries, regulatory differences and healthcare system variations while maintaining consistent quality standards.

The trial's data management and statistical analysis platforms have become resources for the broader research community. The open sharing of statistical code, trial protocols and operational procedures has enabled other research groups to build upon REMAP-CAP's innovations rather than starting from scratch. This knowledge transfer has accelerated the development of additional platform trials and reduced barriers to implementing adaptive designs.

REMAP-CAP's success in minimising research waste through adaptive platforms that avoided underpowered duplicates was notable. In the UK, this success was reinforced by the NIHR's comprehensive health research system strategy and NHS integration, which facilitated the efficient production of evidence despite global challenges, such as small, uncoordinated trials elsewhere (Hanney et al. 2022).

In 2022, REMAP CAP was designated as the UK National platform trial to evaluate treatments for influenza and was awarded another NIHR HTA grant (NIHR 2024).

Health and care impacts

The health impacts of REMAP-CAP were substantial. The trial's findings directly influenced the treatment of millions of patients worldwide and generated health benefits that continue to accrue years after the initial results were published.

The global impact of the IL-6 receptor antagonist findings illustrates the reach of evidence generated through NIHR investment. More than one million people hospitalised with COVID-19 worldwide have been treated with tocilizumab based on REMAP-CAP evidence, with Roche/Genentech specifically acknowledging this figure in their public communications (Genentech 2022). Using the trial's demonstrated 24% relative risk reduction in mortality, this translates to an estimated 100,000 lives saved globally from tocilizumab treatment alone (NIHR 2023a).

Within the UK, the impact was both immediate and substantial. An estimated 25,000 patients received IL-6 receptor antagonists in the UK during 2021 based on REMAP-CAP evidence, resulting in approximately 2,000 lives saved in the UK alone during that single year (REMAP-CAP Trial 2025). These figures represent direct, attributable lives saved that can be traced specifically to the research investment through the NIHR.

The healthcare system efficiency gains were particularly crucial during the pandemic's peak periods when hospital capacity was severely constrained. The demonstrated reduction in ICU length of stay by more than one week per patient treated with effective therapies freed up critical care capacity for additional patients during surge periods.

The QALY gains extended well beyond immediate survival benefits. Long-term follow-up demonstrated that patients treated with effective therapies had improved quality of life, reduced disability and better functional outcomes at six months post-discharge. This meant that survivors were more likely to return to work, require less ongoing healthcare support and maintain independence, generating broader economic and social benefits that extended to families and communities (RC_1 2025; RC_2 2025).

The prevention of harm through negative findings represented another crucial health impact. By definitively demonstrating that hydroxychloroquine, lopinavir-ritonavir and convalescent plasma provided no benefit in critically ill patients, the trial prevented the continued use of ineffective treatments that posed risks of adverse effects and consumed healthcare resources. The rapid dissemination of these negative findings prevented thousands of patients from receiving potentially harmful treatments.

The translation of research findings into clinical practice occurred rapidly, largely due

to the NIHR's embedded relationship with the NHS and established pathways for evidence implementation. Results were communicated to clinicians, policymakers and regulators even before formal publication, enabling immediate incorporation into treatment guidelines and protocols. This rapid translation meant that the benefits of research discoveries reached patients within days and weeks.

The global influence of REMAP-CAP findings extended through multiple channels. The World Health Organization (WHO) incorporated the trial's results into international treatment guidelines, stating: 'In this update, the panel makes a strong recommendation to use IL-6 receptor blockers (tocilizumab or sarilumab) in patients with severe or critical COVID-19' (WHO Rapid Evidence Appraisal for COVID-19 Therapies (REACT) Working Group et al. 2021). National health authorities worldwide updated their treatment protocols based on REMAP-CAP evidence, and medical societies incorporated the findings into clinical practice guidelines.

Demonstrating treatment effectiveness across diverse patient populations enhanced the generalisability and global applicability of the findings. Unlike trials conducted in single countries or healthcare systems, REMAP-CAP's international scope ensured that results applied across different demographic groups, healthcare delivery models and resource settings, increasing confidence in implementing the findings worldwide.

Commercial impacts

The impacts on the pharmaceutical industry were both immediate and substantial, particularly for companies whose products demonstrated efficacy in the trial. Roche's tocilizumab sales to over one million COVID-19 patients globally represented several hundred million pounds in additional revenue, although it was subsidised during the pandemic. However, the commercial value extended beyond direct sales to include enhanced market position, regulatory advantages and strengthened relationships with healthcare systems worldwide.

The head-to-head comparison within REMAP-CAP provided more robust evidence than either company could have generated independently, while sharing the costs and risks of clinical development during a health emergency. We should note that both Roche and Sanofi are based outside the UK, headquartered in Basel and Paris, respectively; therefore, these commercial benefits did not necessarily accrue within the UK's economic system.

The broader impacts extended across multiple sectors of the UK economy. The trial's success enhanced the UK's reputation as a location for international clinical research, positioning the country as a leader in innovative trial methodology.

Regional impacts

REMAP-CAP's regional impact positioned the UK as a leader in pandemic clinical research, with the UK contributing 5,568 of the total 10,000 COVID-19 patients recruited worldwide, representing a majority of global recruitment despite the UK accounting for a much smaller fraction of the global population affected by COVID-19 (NIHR 2023a).

The achievement was particularly remarkable given the competing demands on healthcare systems during the pandemic's most severe phases. While hospitals worldwide struggled to maintain basic clinical services, the UK's research infrastructure enabled the simultaneous delivery of high-quality patient care and cutting-edge clinical research. This capability demonstrated the maturity of NIHR's investment in embedded research infrastructure and validated the strategic decision to build research capacity within the NHS rather than in separate academic institutions.

The regional health system benefits extended throughout England and into Scotland, Wales and Northern Ireland, where sites also participated in the trial.

Impact on the public

The trial's embedded design meant that critically ill patients and their families experienced research participation not as an additional burden during medical crises but as access to potentially life-saving treatments that might not otherwise be available.

The ethical advantages of the adaptive design proved particularly important for public acceptance and trust. Unlike traditional trials, where patients might be randomised to treatments that early data suggested were less effective, REMAP-CAP's response-adaptive randomisation ensured that later participants had a higher probability of receiving beneficial treatments. This approach aligned research participation with patients' and families' hopes for the best possible care, reducing the perceived conflict between research objectives and individual patient welfare.

The rapid translation of research findings into clinical practice provided immediate, visible benefits, enhancing public confidence in clinical research.

The educational impact extended to healthcare professionals, patients and the general public through widespread dissemination activities. The PI and other investigators provided presentations to medical societies, policy groups, and public forums, explaining both the specific findings and the broader methodological innovations (RC_1 2025; RC_3 2025). These educational activities helped build an understanding of adaptive trial methods and their potential applications beyond pandemic response.

2.6. Conclusions and lessons learned

REMAP-CAP stands as an example of how strategic investment in innovative research methodology can generate transformative returns during health emergencies, demonstrating that investments in research infrastructure and methodological innovation can yield extraordinary benefits when health crises demand rapid, evidence-based responses. The trial's success depended on several critical factors that provide important lessons for future research investment and pandemic preparedness strategies.

The foundation of REMAP-CAP's success lay in NIHR's long-term investment in research infrastructure through the CRN, which provided the embedded research capacity necessary for rapid scaling during the COVID-19 emergency. This infrastructure investment, sustained over many years before the pandemic, created the relationships, expertise and operational capabilities that enabled the UK to contribute so effectively to the global recruitment for an international trial.

The strategic value of investing in methodological innovation, rather than attempting to predict specific future health threats, proved crucial to the trial's success. The PI's NIHR Research Professorship enabled their involvement in adaptive trial design research years before COVID-19 emerged, positioning the UK to lead when the methodology became urgently needed.

The UK's focused prioritisation of REMAP-CAP as an Urgent Public Health study concentrated NIHR resources and embedded CRN infrastructure (mirroring the prioritisation of other COVID-19-related studies), enabling over 50% of global patient recruitment and

key contributions to global evidence on therapies like corticosteroids and IL-6 receptor antagonists. As a result, patient recruitment at study sites was significantly higher in the UK than in other participating nations, including in Europe and globally (Goossens 2024). However, this intense focus on a few priority COVID studies had trade-offs, negatively impacting non-prioritised research topics, with many researchers having to wait to resume or begin research within the NIHR or NHS (Hanney et al. 2022).

The integration of research with clinical practice, facilitated by the NHS's structure and NIHR's embedded relationship with healthcare delivery, enabled research to continue during crisis periods when healthcare systems worldwide struggled to maintain basic services. The embedded trial design meant that research participation became part of standard care rather than an additional burden, allowing the generation of evidence without compromising patient care during resource-constrained periods.

The broader implications extend to research investment, demonstrating that funding innovative methodologies, building research infrastructure and supporting international collaboration can generate extraordinary returns when health emergencies create urgent demand for rapid evidence generation.

Annex to Case Study 1

External funding and support received: In addition to NIHR funding, the REMAP-CAP trial and its associated studies received funds and support from the following sources (REMAP-CAP Investigators, Gordon, et al. 2021):

- The Platform for European Preparedness Against (Re-)emerging Epidemics (PREPARE) consortium by the EU [FP7-HEALTH-2013-INNOVATION-1 number 602525].
- EU Horizon 2020 Rapid European CoVid-19 Emergency response Research (RECoVER) [grant number 101003589].
- EU H2020 European Clinical Research Alliance for Infectious Diseases – Base funding [ECRAID-Base grant number 965313].
- Australian National Health and Medical Research Council [#APP1101719], the New Zealand Health Research Council [#16/631].
- Canadian Institute of Health Research Strategy for Patient-Oriented Research Innovative Clinical Trials Program Grant [#158584].
- Health Research Board of Ireland [CTN 2014-012].
- French Ministry of Health [PHRC-20-0147].
- National University Health System [NUHSRO/2021/002/RO5 + 6/adhoc/02/LOA].
- National Research Foundation Singapore under its Open Fund-Large Collaborative Grant [NMRC/oflcg19May—0034] and administered by the Singapore Ministry of Health's National Medical Research Council.
- UPMC Learning While Doing Program, the Breast Cancer Research Foundation and the Minderoo Foundation.

3. Case Study 2: Clinical development and evaluation of an advanced prototype for in situ microbial sensing, providing early antibiotic susceptibility data for organisms colonising chronic wounds

3.1. Summary

This Invention for Innovation (i4i) award (ID II-LB-0214-20004) was for a project titled 'Clinical development and evaluation of an advanced prototype for in situ microbial sensing, providing early antibiotic susceptibility data for organisms colonising chronic wounds.' The i4i award from the NIHR totalled £552,945 between March 2015 and June 2017. It was awarded to the University of Manchester, in collaboration with the University Spin Out MicroBioSensor Limited. The aim of the case study is to evaluate the economic impacts of this NIHR i4i award in the short-, medium- and long-term.

This case study draws on a range of evidence sources, including:

- Three semi-structured interviews, conducted via Teams video with the PI, project manager and a clinician.[14]
- Research documentation – the final project report submitted to the NIHR (NIHR 2017) and the original application form (NIHR 2014).
- The Crunchbase database (Crunchbase 2026).
- Publicly available online documentary sources (Companies House [GOV.UK 2025] and various news articles, blog posts, etc., which are referenced in footnotes in the corresponding places).

Key facts about the funding:

NIHR award type: i4i research grant award (ID II-LB-0214-20004)

Study period: March 2015 – June 2017

Principal investigator: Professor Curtis Dobson, University of Manchester and Microbiosensor Ltd.

Total NIHR funding: £552,945 (2015–2017)

14 To preserve the confidentiality of interviewees and ensure that their statements are reported in a way that cannot identify them, the identities and roles of interviewees are not revealed in this write up. They are referred to as II_1, II_2 and II_3. II_1 and II_2 were interviewed together on 7 April 2025 and II_3 was interviewed on 12 June 2025.

The i4i award has had medical and economic impacts. The medical impact of the award lies in speeding up the detection of bacteria in foot ulcer wounds of people with diabetes, as well as in its later impacts by assessing whether peritoneal dialysis (PD) patients will respond to antibiotics and which antibiotic in particular. The award enabled the pre-existing spin-out company MicroBioSensor Ltd to develop, refine and test the commercial potential of a **QuickCheck diagnostic device** in different medical areas, first for the benefit of diabetic patients with infected foot ulcers and later for the benefit of PD patients to detect peritonitis, a potentially serious complication of PD, more quickly. In the latter medical area, this diagnostic device provides an instant count of leukocytes (white blood cells) in PD effluent and has been **rolled out to and used in around 10% of UK nephrology clinics** (Reynolds 2022).

In addition, Researchfish reports that the i4i award has had economic impacts, including the generation of economic activities by a spin-out company (see Box 1) (GOV.UK 2025).[15] According to the data reported in ResearchFish (data entered on 11 February 2022), MicroBioSensor was established in 2013, prior to the i4i award, and has secured around £8m in additional funding to develop its technology since the award ended in 2017. This **additional funding** is in the form of venture capital and research grants to develop disposable, affordable point-of-care safety monitors for detecting microbial infections. The grants that MicroBioSensor has received total approximately £564,000 from the Biotechnology and Biological Sciences Research Council (BBSRC), £2.1m from Innovate UK, £900,000 from the Small Business Research Initiative (SBRI) Healthcare, £125,000 from a division of the University of Manchester's intellectual property commercialisation agent UMI3 Ltd (UMIP) and £50,000 from Health Innovation Manchester (see Annex for a full list of additional funding secured).

The **main impact** of this award is the company's **success in developing and commercialising a new technology to more quickly detect infection levels in diabetic patients' foot ulcers and in PD patients.** This new technology takes the form of a colour-change device, enabling results within ten hours. This device is much quicker than the existing system, in which clinicians wait up to four days for results from hospital microbiology laboratories. The spin-out company has developed several versions of this device, building on the work they did with the i4i award funding. The device MicroBioSensor tested with PD patients was a 15 x 10cm, three-chambered cassette that incubated PD effluent. Moreover, it is important to emphasise that it was developed *after* the i4i project was completed and was a very different physical device from the device they developed for foot ulcer wound dressings. The latter contained the same chemistry that they tested in the i4i award.

The i4i award enabled the spin-out company to test its pre-award platform technology (a colour-change sensor device for detecting microbes on medical device surfaces) across different medical areas and benchmark it against alternatives. The company hoped that this testing would help them determine the most commercially viable medical areas in which the technology can be applied.

The company initially tested the device on wound fluids from diabetic patients' foot ulcers before pivoting to testing the device

15 The company was called Microsensor Limited from 14 December 2012 to 20 July 2015 (company number 08332089). It was re-named as MicroBioSensor Ltd on July 2015.

on PD patients. Peritoneal dialysis is one of the two main treatments for kidney failure and can be carried out by patients at home, unlike haemodialysis, which requires hospital treatment (Natl. Kidney Fed. 2019). In the UK, about 4,000 patients use PD. Informed by the work funded by the NIHR's i4i award, the company developed a new optical product for PD. The company CE marked its PD optical product in May 2022 because they found it had technical advantages over the original colour change device developed using the i4i award. This product has been rolled out to around 10% of nephrology clinics in the UK. An interviewee proposed that without the i4i award, this would have been less likely to have happened:

> 'I think it's less likely to have happened… because we had the i4i award, we certainly perfected the vancomycin colour change technology, which we then used and then clearly was exciting for PD' (II_2 2025).

Box 1: Overview of the spin-out company MicroBioSensor Ltd

'MicroBioSensor is a medical device company developing disposable point-of-care safety monitors for detecting microbial infection. Microbiological monitoring is especially important for long-term users of medical devices. Medical device use is one of the highest risk factors for nosocomial infection, affecting nearly 2 million patients and killing approximately 90,000 annually in the US alone. At-risk groups include patients with chronic wounds, such as diabetic leg ulcers, or those requiring long-term invasive medical device intervention, such as kidney dialysis patients.' (Researchfish 2025)

The company has three products, according to data from Crunchbase (the online database about companies and start-ups) (Crunchbase 2026). QuickCheck, a device for instant measurement of leukocyte levels in peritoneal effluent that aids in the diagnosis of peritonitis, is directly attributable to the i4i award. The other two products are STAR System, a prototype technology for rapidly determining antibiotic resistance in urinary tract infections, and QuickCheck SBP, a development project aimed at creating a device for instant diagnosis of Spontaneous Bacterial Peritonitis in patients with advanced liver disease.

3.2. Introduction

This award aimed to develop a microbial sensing device to sample wound fluid from used wound dressings, swabs taken from the wound surface and wound tissue of diabetic foot ulcers (DFUs). The device aims to detect bacteria and change colour when in contact with infected wound exudate and tissue. Chronic foot ulcers among diabetic patients are ulcers that are unlikely to heal within a relatively short period of time; diabetic patients are particularly susceptible for developing ulcers in their extremities due to poor blood supply. Some 2.9 million people in the UK have diabetes, with this number forecast to rise to more than 5.5 million by 2030 (NICE 2019). Approximately 15–25% of diabetic patients in the UK will get a DFU at some point in their lives. Of these, 10–15% will develop a chronic infection in the DFU (Price et al. 2016). High infection rates are associated with amputation. Globally, amputation rates in diabetic patients are high: one amputation is carried out every 20 seconds in the world because of diabetes in the lower limb (II_3 2025). Hence, there is a real clinical need to accelerate the detection and treatment of infections in diabetic patients' foot ulcers.

While the i4i award focused on helping the spin-out company develop a device to sample wound fluid from used wound dressings and wound tissue in diabetic patients' foot ulcers, the spin-out did not pursue commercialisation of this device for diabetic patients. Instead, the award was instrumental in helping the spin-out learn that their device lacked commercial potential in the above medical area due to relatively low sensitivity and specificity values obtained in testing (II_1 2025). The spin-out then developed, refined and tested the commercial potential of a QuickCheck diagnostic device in different medical areas. As a result, the spin-out modified the device for the benefit of PD patients to more quickly detect peritonitis, a potentially serious complication of PD.

In this way, the i4i award had significant yet indirect medical and commercial impacts. It enabled the spin-out company to test a new technology they developed and benchmark it against alternatives, one of which they later took forward commercially. In 2020, the same research team began a clinical trial to assess the effectiveness of a medical device that used similar technology to that which they developed using the i4i award, but in kidney dialysis patients, i.e. a different medical area. The study team were doing a research programme on PD patients in parallel with the research on ulcers in diabetic patients. This device uses analogous technologies and chemistry to detect bacteria and leukocytes in effluent from PD patients. Peritoneal dialysis can be performed at home by the patient, making it more user-friendly than repeatedly visiting a hospital-based dialysis unit, but it involves risks, such as the development of peritonitis, an infection treatable with antibiotics.

Ultimately, the study team decided against commercialising any method using any of the technology supported by the i4i grant funding. Instead, they commercialised a leukocyte detection method via CE marking. The closest the technology supported by the i4i funding came to market was its use in a different application (for peritoneal kidney dialysis patients). The i4i funding enabled the study team to test and benchmark it against alternatives; the scientists decided to take forward one of the alternatives. Thus, this i4i award had significant but only indirect impacts.

3.3. Background

Scientific/health system context

Before the study team first applied for funding from the NIHR in 2013 (they were successful in receiving funding in late 2014/early 2015), clinicians in the UK had to wait 2–4 days to receive detailed results of wound fluid sample tests from a hospital microbiology laboratory. This delay meant that clinicians needed to rely on their judgement and experience, without access to test results, to determine the wound infection status and which antibiotic treatment to start. These results told the clinicians the levels and types of bacteria present in the wounds, which are important for prescribing appropriate antibiotics. If the clinician prescribed the wrong antibiotics to treat the infection, the infection could worsen, potentially increasing antimicrobial resistance (NIHR 2017).

The research project funded by the i4i award aimed to address the above problem by making the test information available much more quickly, within ten hours rather than up to four days. This shorter time-to-results means clinicians can make an informed decision on the best treatment much more quickly, improving patient health outcomes and reducing the use of inappropriate antibiotics.

The i4i award addressed three main issues:

1. Growing antimicrobial and antibiotic resistance is reducing the effectiveness of the antibiotics clinicians currently use.
2. The global incidence of diabetes is growing due to ageing populations and increasing obesity levels.
3. Diabetic patients who develop foot ulcers often see them become infected. Globally, 15% of diabetic patients are likely to get a foot ulcer. These ulcers are at high risk of infection and worsening infection, which can lead to amputation.

Key individuals/organisations

Key investigators in this award were the PI, a professor at the University of Manchester and co-founder of Microbiosensor Ltd. (PI), the CEO and co-founder of Microbiosensor Ltd., a director and then-Chief Scientific Officer at Microbiosensor Ltd., who worked on the i4i project, and a Professor and Podiatric Surgeon at the Manchester Diabetes Centre, Manchester University NHS Foundation Trust who was a clinician closely involved in the i4i project.

Other involved people included a research technician and commercial and regulatory consultants. The contracting organisation was the University of Manchester, and the award's activities were physically located in the city of Manchester. The pre-existing spin-out company, Microbiosensor Ltd., was the award's recipient.

3.4. Research Input and Processes

Funding and resources

According to the project's final report, the total contracted value of the award was £558,269.00. The actual spend at the end of the award was £552,945, according to Researchfish data.

The project utilised the facilities and infrastructure of both MicroBioSensor and the University of Manchester. While the application form did not list any other funding sources from other bodies, one interviewee felt it was likely that MicroBioSensor contributed to the project's commercialisation elements. For example, it may have covered the costs of patent filings, since those applied to the technology and related technologies they were developing. In other words, the spin-out company would not have been NIHR-funded for all the work it was doing between 2015 and 2017.

The PI of the i4i award and co-founder of MicroBioSensor received two BBSRC awards in the same medical area as the i4i award (plus two other BBSRC awards unrelated to the i4i award). The spin-out company has also received a large award from Small Business Research Initiative (SBRI) Healthcare, three large awards from Innovate UK and small awards from the University of Manchester and Health Innovation Manchester. They have not received other awards from the NIHR (see Annex).

Another leading academic involved in the work that built on the i4i award, yet not directly involved in the i4i award-funded project, was Professor Martin Wilkie, a consultant nephrologist at Sheffield Teaching Hospitals NHS Foundation Trust. For example, Professor Wilkie participated in Innovate UK-funded projects and led the clinical trial, which began in March 2020, to assess the efficacy of the QuickCheck device for detecting antibiotic susceptibility in PD patients. His group published a conference poster on their experiences with QuickCheck in their PD clinic, which was presented at a meeting in Belgium in November 2023 (clarifications by II_1 by email, 2025).

Research activities

The research funded by the i4i award to develop a device to detect bacterial presence

in DFUs was designed and implemented in two parts. Part 1 lasted 14 months and involved developing a sensor and testing prototype sensors in a lab to assess their performance. Part 2 was a nine-month clinical study that tested the prototype sensor on 85 patients to determine the levels of bacteria in wounds, the types of bacteria present and which antibiotic to use.

For the work on developing a device for DFUs in diabetic patients funded by the i4i award, MicroBioSensor established partnerships with two companies: SWM International Ltd (formerly Smith & Nephew Extruded Films Ltd) and BDK Industrial Products Ltd. These two companies helped with R&D to stop the dye spreading between the beads in the device when in the presence of wound fluid, which would give a false reading. They are both located in the UK and have significant experience and access to the materials, technology and manufacture of wound dressings and diagnostic test equipment (NIHR 2017).

Challenges encountered and how they were addressed:

- **Difficulties engaging with the clinical team** to understand their views on the device. Since the clinicians were busy with their clinical work, the study team found it difficult to engage them effectively. They overcame this challenge by meeting with clinicians one-to-one and asking a small, manageable number of questions per meeting, a process the clinicians were willing to engage with (NIHR 2017).
- **The long time required to obtain the positive samples needed**, as negative results were more common, i.e. no or low levels of bacteria present (II_2 2025).
- **The NHS bureaucracy's lack of distinction** between big, complex new technologies and small, simple ones when introducing them into clinical use. Point-of-care teams in hospitals are responsible for managing the introduction of new technologies. They assess a new technology against a checklist, e.g. whether the new device connects to the hospital record system or can be regularly calibrated. The checklist that point-of-care teams apply is primarily aimed at very large and complex diagnostic systems to ensure they are safe before they are used in hospitals. One interviewee felt that some point-of-care teams sometimes showed resistance to assessing MicroBioSensor's relatively simple testing device due to their rigid, lengthy assessment procedure, which could have been faster and simpler for new, smaller-scale technologies. The interviewee only faced this relatively slow technological assessment process in the UK and hence associated it with NHS bureaucracy. The interviewee said that this caused the slow adoption of their PD device by the NHS: the device has been rolled out to around 10% of UK nephrology clinics (II_1 2025; II_2 2025).

3.5. Research outputs and outcomes

Knowledge production

For the work funded by the i4i award (developing a diagnostic device for diabetic patients with infected foot ulcers), the achieved sensitivity and specificity were at expected levels, albeit at the lower end of the hoped-for ranges. If these values had been higher, the technology's commercial viability would have been greater (II_1 2025). The clinical study found that the sensors had an average accuracy of 86% for detecting the number of bacteria (high/medium/low levels) in wound dressings and 84% when used with swabs/tissue. The sensors detecting the **type** of bacteria were on average 64% accurate in

wound fluid from dressings and 74% accurate in swab/tissue samples.

The technology developed with the i4i award enabled results on the level and type of bacteria present, as well as information on which antibiotic would be best for treatment, to be obtained much more quickly than with the older technology. Results could be received **within ten hours,** compared with up to four days with the existing system, in which clinicians wait for results from hospital microbiology laboratories (NIHR 2017).

A device for detecting leukocytes was CE-marked by MicroBioSensor in 2022.

Although this was a different device from the one they had developed using the i4i award, the i4i award nevertheless contributed to the later development of the CE-marked device. CE marking is required for many products and shows consumers and regulators that the product meets EU safety requirements, complies with EU legislation, and is permitted to move freely within the European Economic Area single market. Getting a CE mark is an important step for launching a product on the EEA market.

An interviewee elaborated on how the i4i award helped the spin-out company get this CE mark:

> And as it turns out, that wasn't the one that we eventually CE marked. But nonetheless, you know, it allowed us to build on the success of the previous project … and get more funding to move on to the next one and eventually funding to develop the alternative technology that has worked so, so you know it certainly isn't, it's not a waste you know it's important to make sure that we've got the best technology to take forward but I think it's given confidence to investors that, you know, we're evaluating this properly and that the way that we've selected is … worth pursuing. So I think… it would have been certainly less likely to have happened. (II_1 2025)

While the final report of the i4i award listed no publications, presentations or other intellectual assets, our desk research found three publications published after the award commenced (in 2016, 2020 and 2024, respectively) that were co-authored by the PI of the i4i award and were relevant to the i4i award. A paper published in 2024 presents the MicroBioSensor technology developed after the project, which uses a similar approach and a newer light-scattering approach for peritonitis detection (see Annex below for full details) (Govindji-Bhatt et al. 2024).

Benefits to future research

Although the collaborations between the spin-out, the university and the local NHS trust predate the NIHR i4i award, they were strengthened by it. A leading clinician whose main research area is bacteriology and who runs a clinic in the local NHS trust that treats diabetic patients with infections in their lower limbs, such as foot ulcers, was approached by the i4i award's PI to join the research team and help write the grant application. This clinician continued their involvement in both phases of the award's activities.

Geographic proximity enabled the network and collaboration between the spin-out and local NHS trust to be strengthened, as one interviewee noted:

> There's a real network of quite translationally focused clinicians in the hospital next door. So who are really, you know, interested in, you know, trying to find ways of improving processes and providing new devices and techniques for patients. (II_2 2025; bold added)

The company has secured substantial follow-on funding since the award ended in 2017, in the form of venture capital and research grants totalling £8m to develop its disposable, affordable point-of-care safety monitors for detecting microbial infection. It is worth noting that the online database Crunchbase records only £3.3m in funding; the difference between £8 million and £3.3m is likely because Crunchbase captures only venture capital and investment, not grants. MicroBioSensor won the Bionow award in 2017 for the investment deal of the year, a £1.4m investment deal completed in November 2017 (part of the £3.3m that the spin-out has raised to date) with the Northern Powerhouse Investment Fund and the Greater Manchester and Cheshire Life Sciences Fund made through private equity firms Maven Capital Partners and Catapult Ventures respectively (Barker 2017a). This additional funding is proof that the spin-out company has developed a potentially commercially viable technology.

In addition, the company received an investment from Kidney Research UK, the UK's leading kidney research charity, in 2024 (Kidney Research UK 2025). Although the value of this investment is unknown, it enabled MicroBioSensor to further develop and refine its QuickCheck device as a point-of-care device to help patients with PD manage their treatment more effectively at home.

Direct health impacts

As mentioned above, significant time savings have been made possible by the i4i award. With the sensor developed by the team using the NIHR i4i award, the time to obtain results has reduced from four days to less than ten hours (NIHR 2017).

In the medical area of PD for kidney patients, the spin-out company's diagnostic device provides an instant leukocyte count in PD effluent. This device has been rolled out to and used in around 10% of UK nephrology clinics (Reynolds 2022).

The spin-out's technology has other potential impacts, freeing up biomedical research lab technicians' time and potentially increasing efficiency. One interviewee pointed to potential applications of the company's technology outside of healthcare, for example, using the same cell-counting device to count cells in biomedical research labs. This technology takes 7 seconds to count cell samples, potentially freeing research staff from spending a couple of hours a week on cell counting. MicroBioSensor made its first sale of a device for such use early in 2025. They plan to expand this commercial phase as part of the company's development, and there are additional applications in pharmaceutical manufacturing and monitoring. Thus, although the original technology developed using the i4i award did not progress to commercialisation, it led to an alternative technology which had a niche application and broader applications as well (II_1 2025).

Indirect health impacts

We did not find any evidence of indirect health impacts from this award. Examples of indirect impacts include evidence or estimates of health gains, such as reduced sickness absence from work or productivity benefits, reduced visits to secondary healthcare facilities, or reduced burden on health systems.

Practice and policy impacts

There is some evidence of potential policy impact, although this is a planned impact that has not yet been realised. One interviewee elaborated on this:

> …keeping people on PD has a number of indirect impacts as well in terms of policy; potentially, we might impact the criteria upon which peritonitis is diagnosed in the future. So there's an organisation called the International Society for Peritoneal Dialysis. And they have specified how to diagnose peritonitis, and there's a threshold of 100 cells per microlitre. So, because we have this very accurate way of measuring the cell numbers at the time patients present, that threshold may become modified in the future. So that's something that we would be looking at. (II_1 2025)

Commercial impacts

MicroBioSensor employed approximately 12 full-time equivalents (FTEs) between 2018 and 2023 (II_1 2025), though it downsized to 5–6 FTEs after 2023. Companies House website records (director's report and annual financial statements for the financial year ending 31 December 2023 for MicroBioSensor) list the average monthly number of employees as 13, including 6 current directors (GOV.UK 2025). The Directors' report and financial statements for the financial year ending 31 December 2023 show that MicroBioSensor posted a pre-tax loss of £956,812 and had a net liability position of £1,399,757 (GOV.UK 2025). According to one interviewee, the reason for downsizing after 2023 was that the spin-out was being cautious to secure a large funding round. According to its business plan, they project having 30–40 FTEs by 2030 (II_1 2025).

The i4i award supported the spinout MicroBioSensor and enabled it to grow to approximately 12 FTEs between 2018 and 2023. While we cannot attribute these jobs entirely to the i4i award, given that it finished at the end of June 2017, the i4i funding played a contributing role. These jobs were likely located in Manchester, where the spin-out is based.

The final award report for the NIHR lists that a UK patent application titled 'Microbial sensing devices' was filed (Ref. 1616689.4; NIHR 2017). A similar patent application ('Microbial Sensing Devices') was filed on 28 September 2017 with an international application number PCT/GB2017/052908, which was published on 5 April 2018 (publication number WO/2018/060711; Dobson & Govindji-Bhatt 2018). The abstract for this international patent application is:

> (EN) A device for detecting and/or identifying microorganisms in the environment of a wound, said device comprising: a substrate that has disposed on or in it at least one reporting means, said reporting means comprising a carrier substance in which there is dispersed a metabolic indicator and optionally a selection factor; wherein the selection factor permits growth of specific microorganisms within the reporting means such that the metabolic indicator is only activated by preselected microorganisms. (Dobson & Govindji-Bhatt 2018)

One interviewee noted that it takes time to build a partnership and engagement with big industry stakeholders, something they have achieved eight years after the NIHR i4i award ended. As mentioned above, they have almost secured a funding round from an American company. Moreover, the spin-out's product for PD is currently under review by a large dialysis PD company globally:

> …the product is being evaluated by a large dialysis PD company. So you know, they're interested in distributing the product globally PD… So I mean I think clearly that you know the impacts could be very large ultimately globally because you know this technology detects and confirms peritonitis early, which means patients can get antibiotics quicker and avoid risk of, you know, dying in some cases because it can be fatal this particular infection … (II_1 2025)

Regional impacts

In the UK, the initial impacts centred on Manchester as this was the location of the diabetic foot ulcer clinic where the clinical study took place. The award has potential for wider impact, as around 10% of UK nephrology clinics now use the QuickCheck diagnostic device developed by the team that received this i4i award.

As mentioned earlier, the award contributed to the spinout's headcount of 12 FTEs between 2018 and 2023. These jobs were in Manchester.

Impact on the public

Patients with DFUs were involved in the clinical trial part of this award, as well as, by extension, their family, friends, carers, podiatrists, specialist doctors and nurses on the clinical team, and microbiologists working in hospitals. Feedback from end users (patients) helped shape the design (e.g. the size, shape and layout) and the development of the sensor technology when they were shown different iterations of the laboratory prototypes throughout the duration of the award (NIHR 2017).

There are about 4,000 PD patients in the UK and 450,000 worldwide who could benefit from the novel method for detecting infections developed as a result of this award. The QuickCheck diagnostic device, developed by the team that received the i4i award and which provides an instant leukocyte count in PD effluent, has now been rolled out and used in around 10% of UK nephrology clinics, which are the larger clinics (II_1 2025).

No evidence was found about the award's impacts on wider public attitudes to medical research or any outreach or educational activities conducted.

3.6. Conclusions and lessons learned

The i4i award for a project titled 'Clinical development and evaluation of an advanced prototype for in situ microbial sensing, providing early antibiotic susceptibility data for organisms colonising chronic wounds' (award ID II-LB-0214-20004) had medical and economic impacts.

The award's medical impact lies in speeding up the detection of bacteria in foot ulcer wounds of people with diabetes, as well as in its later impacts on assessing whether PD patients will respond to antibiotics and which antibiotic in particular. The award enabled the pre-existing spin-out company, MicroBioSensor

Ltd, to develop, refine, and test the commercial potential of a QuickCheck diagnostic device across different medical areas.

In terms of economic impacts, the award helped MicroBioSensor, established before the i4i award in 2013, secure around £8m in additional funding to develop its technology, and the company has continued to grow since the award ended in 2017. This additional funding was in the form of venture capital and research grants to develop its technology for disposable, affordable point-of-care safety monitors to detect microbial infections. The award also helped the spin-out hire more staff, thereby contributing to job creation in Manchester.

A key impact of the i4i award is in knowledge generation, as it led to the development of a diagnostic device that speeds up the detection of bacteria in diabetic foot ulcers and in patients on peritoneal dialysis. It also led to product development with the QuickCheck diagnostic device, which has been rolled out to around 10% of UK nephrology clinics. There is some evidence of potential impacts on policy, although this is a planned impact that has not yet been realised. The award enabled MicroBioSensor to develop and refine an accurate method for measuring cell numbers when PD patients present to clinicians, which may, in the future, inform modifications to the cell count threshold (100 cells per microlitre) used by the International Society for Peritoneal Dialysis to diagnose peritonitis.

A key lesson from this case study is that impacts are complex and may manifest in nonlinear ways. For example, this i4i award led to the development of various diagnostic devices for medical applications beyond the expected ones.

Annex to Case Study 2

Table 23: Publications relevant to the i4i award ID II-LB-0214-20004

Year of publication	Article title	Author(s)	DOI	Topic(s)	Journal	Article metadata
2016	Development of a novel collagen wound model to simulate the activity and distribution of antimicrobials in soft tissue during diabetic foot infection	Bianca Price, Andrew Lovering, Frank Bowling, Curtis Dobson	https://doi.org/10.1128/aac.01064-16	Medicine, Pharmacology, Toxicology and Pharmaceutical Science, Biochemistry, Genetics and Molecular Biology, Immunology and Microbiology	Antimicrobial Agents and Chemotherapy	Original language: English Pages (from-to): 6880–6889 Journal Volume: 60 Issue number: 11 Early online date: 12 Sept 2016 Publication status: Published - 12 Sept 2016
2020	Susceptibility of monomicrobial or polymicrobial biofilms derived from infected diabetic foot ulcers to topical or systemic antibiotics in vitro	Bianca Price, Robert Morley, Frank Bowling, Andrew Lovering, Curtis Dobson	https://doi.org/10.1371/journal.pone.0228704	Topical antibiotics' effectiveness in in-vitro biofilms	PLoS ONE	2020-02-18 | Journal article | Author DOI: 10.1371/journal.pone.0228704 SOURCE-WORK-ID: 7246d350-1fc0-4fa4-b469-3c06ea5ffda5 PMID: 32069293 EID: 2-s2.0-85079644383 PMID: 32069293

Year of publication	Article title	Author(s)	DOI	Topic(s)	Journal	Article metadata
2024	Novel Colorimetric and Light Scatter Methods to Identify and Manage Peritoneal Dialysis-Associated Peritonitis at the Point-of-Care	Nishal Govindji-Bhatt, Stephnie Kennedy, Michael Barker, Darren Kell, Duncan Henderson, Nicholas Goddard, Ana Garcia, Adam Milner, Tom Willett, Ryan Griffiths, Peter Foster, William Kilgallon, Rachel Cant, Christopher Knight, David Lewis, Richard Corbett, Habib Akbani, Graham Woodrow, Bhrigu Sood, Osasuyi Iyasere, Simon Davies, Junaid Qazi, Anand Vardhan, Laura Gillis, Martin Wilkie and Curtis Dobson	https://doi.org/10.1016/j.ekir.2023.12.021	New methods, kidney dialysis	Kidney International Reports	2024-03-01 | Journal article | Author

Source: PI search in the publicly available ORCID database (ORCID 2026); manual search using keywords from the 46 published works reported in ORCID.

Table 24: Other funding received by the technical development lead for the i4i award and/or by the spin-out company Microbiosensor Ltd (listed in chronological order, starting with the earliest) (UKRI 2025)

Funder	Recipient of funding	Value of award (GBP)	Funding dates	Project title	Relevance to i4i award from NIHR?
BBSRC	Ai2 Ltd and Curtis Dobson	£219,435	Mar 2006 - Mar 2008	Development of a novel contact lens coating into an antibacterial technology platform for use with medical devices.	Yes, pre-dated i4i
BBSRC	The University of Manchester	£74,410	Sept 2009 - Sep 2013	Assessment of the relative ability of novel peptide biocides to prevent the development of microbial resistance and to disrupt biofilm.	No
BBSRC	The University of Manchester and Curtis Dobson	£178,001	Dec 2012 - Dec 2013	MicroSensor: development of a novel and highly scalable platform technology for rapid in situ screening for infection on medical device surfaces.	Yes, pre-dated i4i
BBSRC	The University of Manchester	£93,520	Sep 2013 - Sept 2017	Dissecting the fundamental biology underlying fluorescein hyperfluorescence in cell cultures	No
Small Business Research Initiative (SBRI) Healthcare	MicroBioSensor	£900,602	September 2015	Reduce admissions through rapid diagnosis of urinary infections in the elderly (SBRI Healthc., 2025)	No (this was to develop and test the diagnostic device in a different medical area from the i4i award)

Funder	Recipient of funding	Value of award (GBP)	Funding dates	Project title	Relevance to i4i award from NIHR?
Innovate UK (Biomedical Catalyst 2016 Early Stage Competition)	MicroBioSensor	Grant: £688,316 (total project cost £983,000) (UKRI 2025)	February 2017 - January 2019	'Evaluation, prototyping and production pathway of a diagnostic for PD infection' (Barker 2017b)	No (PD patients)
UMIP (a division of the University of Manchester's intellectual property commercialisation agent UMI3 Ltd.) (NPIF 2018)	MicroBioSensor	£125,000	2016 or 2017	Unknown	Unknown
Investor Spark Impact (NPIF 2018)	MicroBioSensor	£100,000 investment	2016 or 2017	Unknown	Unknown
Health Innovation Manchester (Energise Innovation Fund)	MicroBioSensor	£50,000	2016 (month unknown)	To pilot their PD Safe device in Manchester (Health Innovation Manchester 2018)	No
Innovate UK	MicroBioSensor	Award: £621,475 (total project cost: £1,242,950)	April 2019 - January 2022	Same-day Test for Antibiotic Resistance (STAR) (UKRI 2025)	No (this was to develop and test the same diagnostic device developed using the i4i award, but in the medical area of Urinary Tract Infections)
Innovate UK	MicroBioSensor	Grant: £822,878 (total project cost £1,686,582)	May 2020 - May 2022	'PeriFAST: a new product to rapidly identify effective antibiotics to treat peritonitis in vulnerable kidney and liver failure patients' (UKRI 2025)	No (applies the diagnostic device to patients with kidney and liver failure)

Funder	Recipient of funding	Value of award (GBP)	Funding dates	Project title	Relevance to i4i award from NIHR?
Kidney Research UK	MicroBioSensor	Value of investment unknown	Early 2025	To help bring a device designed to detect a type of infection known as peritonitis to patients with kidney failure.	No (applies the diagnostic device to patients with kidney failure)

Note: Neither MicroBioSensor nor the PI has received other awards from the NIHR other than the i4i award (II_1 2025).

4. Case Study 3: A randomised placebo-controlled trial of mifepristone and misoprostol versus misoprostol alone in the medical management of missed miscarriage – the MifeMiso trial

4.1. Summary

The MifeMiso trial (reference 15/160/02) represented a shift in the medical management of missed miscarriage, directly informing a change in established NICE guidelines and transforming clinical practice across the UK. This multicentre, double-blind, placebo-controlled randomised trial of 711 women across 28 UK hospitals demonstrated that mifepristone plus misoprostol was significantly more effective than misoprostol alone for managing missed miscarriage. The study found a 7 percentage-point increase in successful miscarriage resolution within 7 days (83% vs 76%) and an 8 percentage-point reduction in the need for surgical intervention (17% vs 25%) (Chu et al. 2020).

The research was conducted by a multidisciplinary team led by Professor Arri Coomarasamy at the University of Birmingham, in collaboration with Tommy's National Centre for Miscarriage Research and the Miscarriage Association. The trial was funded by the NIHR Health Technology Assessment programme (15/160/02). The findings were published in The Lancet in 2020 and led to changes in NICE guidelines in 2023, establishing combination therapy as the new standard of care for the management of missed miscarriage.

This case study draws on a range of evidence sources, including:

- Three semi-structured interviews conducted with key trial researchers via Teams video.
- Research impact documentation (MifeMiso Trial 2016; Researchfish 2025).
- Published trial results to examine the research processes, policy impacts and broader implications for miscarriage care in the UK and internationally.

Key facts about the funding:

NIHR award type: NIHR HTA Programme (reference: 15/160/02)

Study period: October 2017 to July 2019

Principal investigator: Professor Arri Coomarasamy, University of Birmingham

Total NIHR funding: £1,737,115 (2017–2019)

4.2. Introduction

The MifeMiso trial addressed a critical evidence gap in the medical management of missed miscarriage: a specific type of miscarriage where pregnancy tissue remains in the uterus despite foetal death. Prior to the trial, UK clinical practice was guided by the 2012 NICE guidelines, which recommended misoprostol alone for medical management, despite limited evidence supporting this approach over combination therapy with mifepristone and misoprostol.

The NIHR Health Technology Assessment (HTA) programme commissioned this research in response to calls from clinicians and patients for better evidence on optimal medical management strategies. The trial was designed to determine whether pre-treatment with mifepristone before misoprostol administration would improve treatment outcomes compared to misoprostol alone.

Participating Institutions

The MifeMiso trial was conducted across a network of 28 UK healthcare institutions, spanning major cities including London, Birmingham, Newcastle, Liverpool, Edinburgh, Glasgow and Cardiff, as well as smaller centres such as Burnley, Telford and Swansea. This extensive network represented urban and rural settings across England, Scotland and Wales, ensuring the trial's findings would be broadly applicable to diverse NHS contexts and patient populations (Chu et al. 2020).

4.3. Background

Scientific/Health System Context

Miscarriage affects approximately 20% of pregnancies, representing one of the most common adverse pregnancy outcomes (Chu et al. 2020). Miscarriage can lead to physical issues like bleeding and infection (Cantwell et al. 2011), as well as psychological problems such as anxiety, depression and post-traumatic stress disorder (Farren et al. 2020).

In the UK, around 250,000 miscarriages occur annually, creating substantial clinical, psychological and economic burdens on the healthcare system with an estimated annual cost of £81m to the NHS (Researchfish 2026).

There are two main types of miscarriage requiring medical intervention: missed miscarriage and incomplete miscarriage. A missed miscarriage is diagnosed when a non-viable pregnancy is identified on an ultrasound scan during the first 14 weeks of gestation, with all pregnancy tissue retained in the uterus. An incomplete miscarriage occurs when pregnancy tissue has been partly expelled by the uterus already (Chu et al. 2020).

Treatment options available: Women diagnosed with miscarriage have three main management options:

- **Expectant management**: Waiting for the natural expulsion of pregnancy tissue over 7–14 days
- **Medical management**: Using medications to expedite expulsion of retained tissue
- **Surgical management**: Day-case procedure using suction aspiration to remove tissue.

Medical management is the preferred option for many women, chosen by 30–50% of those with missed miscarriage, as it allows them to avoid surgical intervention while maintaining some control over the process (information provided by interviewee MM_1 2025).

Prior to the MifeMiso trial, UK clinical practice was guided by the 2012 NICE guidelines, which recommended misoprostol alone for medical management, despite limited evidence supporting this approach over combination therapy. The 2012 NICE guideline (Clinical Guidance 154) had recommended against the use of mifepristone, stating that clinicians

should not offer mifepristone to women having medical management for incomplete or missed miscarriage (Researchfish 2026). This recommendation was based primarily on a single randomised controlled trial of 115 women that found no benefit of combination therapy over misoprostol alone (Chu et al. 2020). Before 2012, standard practice in the UK had been to offer mifepristone plus misoprostol for medical management of missed miscarriage. The physiological rationale for combination therapy was important for some clinicians: mifepristone, as an anti-progesterone agent, primes the myometrium by blocking progesterone receptors, while misoprostol induces uterine contractions to expel pregnancy tissue.

Researchers noted significant disagreement among clinicians, with some believing combination therapy provided better outcomes while others saw no difference, creating 'clearly two camps' and 'a huge unmet need in terms of the knowledge available and available research evidence' (MM_1 2025; MM_2 2025).

Patient and clinical Perspectives

The research team recognised that missed miscarriage management decisions profoundly impact women's experiences, particularly given the emotional trauma associated with pregnancy loss. For women choosing medical management, treatment failure often results in unwanted surgical intervention, compounding the psychological distress of the miscarriage itself. The researchers understood that women who actively opt for medical management deliberately want to avoid surgery and 'really need to feel empowered in the decision that they've made' (MM_1 2025). When medical management fails, women face forced surgical intervention due to treatment failure. Patient co-design work conducted prior to the trial consistently highlighted this concern as a central issue in trial design. Women who required surgical intervention after failed medical management experienced additional psychological distress because they had to undergo the very intervention they had specifically chosen to avoid. The research team needed to test whether additional mifepristone treatment could resolve miscarriage more quickly than misoprostol alone, directly addressing this patient-identified priority.

4.4. Research input and processes

Funding and resources

The MifeMiso trial was primarily funded through the NIHR HTA programme (15/160/02), which provided the resources for this large-scale multicentre trial. The HTA programme's commissioned call approach was identified as particularly well-suited to this research question by an interviewee, as it addressed an important clinical issue that was unlikely to attract commercial funding due to the involvement of off-patent medications:

> The commissioned call process works really well, because it's a sort of question that is very important and important to patients, but wouldn't necessarily attract separate funding from another institution. (MM_1 2025)

The research team was also supported by additional funding to set up their team and organise their NIHR grant application, with Tommy's Charity playing a crucial role in providing this foundational support.

The trial utilised the NIHR-supported Birmingham Clinical Trials Unit, which provided the mature infrastructure needed to coordinate a complex multicentre study across 28 UK hospitals. The study was supported by NIHR's

CRN and had participation from a wide range of local clinical research networks (LCRNs), thus benefiting from NIHR's strong clinical research delivery infrastructure. The trial was also supported by the University College London BRC. The research team included specialists in miscarriage research, clinicians, patient and public representatives, health economists, statisticians and qualitative researchers, reflecting the multidisciplinary expertise required for comprehensive evaluation of healthcare interventions (Researchfish 2026).

Research activities

The MifeMiso trial was designed as a multicentre, double-blind, placebo-controlled randomised trial – the gold standard for evaluating medical interventions. The choice of study design was crucial for addressing the evidence gap identified by NICE and the clinical community, particularly given the need to overcome the limitations of previous smaller studies.

Study population and inclusion criteria

The trial recruited 711 women aged 16 years and older who were diagnosed with missed miscarriage by pelvic ultrasound scan in the first 14 weeks of pregnancy and chose medical management (Chu et al. 2020). The focus on missed miscarriage specifically was based on physiological reasoning. Researchers explained that with an incomplete miscarriage, patients have already begun bleeding and may have passed some pregnancy tissue, requiring only prostaglandin to empty the remaining tissue. However, with a missed miscarriage, all pregnancy tissue remains in the uterus, making mifepristone beneficial as an anti-progesterone agent when progesterone levels remain high (MM_1 2025; MM_2 2025).

Intervention: Participants were randomly assigned (1:1) to receive either:

- Mifepristone 200mg orally followed by misoprostol 800µg (vaginal, oral or sublingual) 48 hours later
- Matched placebo followed by misoprostol 800µg 48 hours later.

Primary outcome: Failure to spontaneously pass the gestational sac within 7 days after randomisation. This outcome was selected through 'a consensus of a national panel of 152 UK health-care practitioners, informed by patient and public views' (Chu et al. 2020).

Patient and public involvement

The trial incorporated extensive patient and public involvement throughout its design and conduct, reflecting best practice in healthcare research and the particularly sensitive nature of miscarriage research. The team worked closely with both Tommy's Charity and the Miscarriage Association to ensure patient perspectives were central to the research process.

Researchers carefully considered how to assess treatment success while ensuring women could attend follow-up appointments within tight timeframes. The trial needed to be designed to be 'as easy as possible for women to follow up', given participants' emotional vulnerability (MM_3 2025).

The Miscarriage Association served as a formal collaborator on the award. This third-sector charity organisation, which provides support and guidance to women experiencing miscarriage, contributed to the design of patient pathways and the review of all patient-facing documents (MM_1 2025).

Research network and collaboration
The trial leveraged the UK National Miscarriage Research Network, supported by Tommy's Charity. This network represents a collaboration between the University of Birmingham, Imperial College London and the University of Warwick, with Birmingham taking the lead role in delivering trials and clinical research.

The collaborative approach extended beyond academic institutions to include patient advocacy groups. Tommy's Charity provided patient advocates who worked with university-based patient representatives to conduct focus groups on trial design and patient-facing materials (MM_2 2025).

4.5. Research outputs and outcomes

Knowledge production
The MifeMiso trial produced definitive evidence regarding the effectiveness of combination therapy for missed miscarriage management, resolving a longstanding clinical uncertainty with robust, high-quality data.

Primary outcome results: Of 348 women in the mifepristone plus misoprostol group, 59 (17%) failed to pass the gestational sac spontaneously within seven days, versus 82 (24%) of 348 women in the placebo plus misoprostol group (risk ratio 0.73, 95% CI 0.54–0.99; p=0.043(45). This represents a 7 percentage point absolute reduction in treatment failure.

Secondary outcomes: The trial demonstrated a significant reduction in the need for surgical intervention. 62 (17%) of 355 women in the combination group required surgical intervention versus 87 (25%) of 353 women in the misoprostol alone group (risk ratio 0.71, 95% CI 0.53–0.95; p=0.021) (Chu et al. 2020). This 8-percentage-point reduction in surgical intervention represents substantial clinical and patient benefits.

Additional secondary outcomes showed consistent benefits of combination therapy, including a reduced need for additional misoprostol doses (14% vs 18%) without prolonging treatment duration. Importantly, the trial found no difference in the incidence of adverse events between study groups, confirming the safety of combination therapy (Chu et al. 2020).

Academic impact and dissemination
The trial results were published in The Lancet, ensuring maximum academic visibility and credibility, and the findings were disseminated through multiple channels, including professional meetings, conferences and collaborator networks (MM_2 2025). In 2020, the NIHR selected the MifeMiso trial findings as a featured research alert, highlighting that missed miscarriage should be treated with mifepristone plus misoprostol rather than misoprostol alone.

The research team updated existing systematic reviews to incorporate their findings. When combined with previous smaller studies in an updated meta-analysis, the evidence demonstrated a clear benefit for combination therapy (risk ratio 1.15, 95% CI 1.01–1.30), strengthening the overall evidence base (Chu et al. 2020).

Economic evidence
The economic evaluation conducted alongside the trial provided compelling evidence for the cost-effectiveness of combination therapy. The combination therapy resulted in a cost saving of £182 (95% CI £26–338) per successfully managed miscarriage, making it a dominant intervention – both more effective and less costly than current practice (Okeke Ogwulu et al. 2021).

The cost savings arose from several sources. While upfront medication costs were higher with combination therapy (£34 for mifepristone plus misoprostol versus £16 for misoprostol

alone), these were more than offset by reductions in surgical intervention costs (£197 vs £281 per woman), additional misoprostol doses, emergency visits and inpatient admissions for failed medical management.

Researchers outlined wider economic benefits, noting that higher treatment resolution rates and reduced need for unplanned surgery would enable more women to return to work in a timely manner, reducing sick leave for working women (MM_2 2025). The economic evaluation found that combination therapy is probably dominant (both health-improving and cost-saving).

Direct clinical and health system impacts

The MifeMiso trial has transformed the medical management of missed miscarriage in the UK, with evidence of rapid adoption following guideline changes. The impact on clinical practice has been both immediate and comprehensive, affecting protocols, training and patient care across the NHS.

Early evidence suggests widespread adoption of the new protocol across NHS trusts. Researchers reported ongoing efforts to track whether early pregnancy units have changed their local practices, noting that early data from a limited number of units suggest 'the vast majority have switched back to giving the dual treatment' (MM_3 2025; MM_1 2025). This uptake represents a significant practice change, moving from sporadic use of combination therapy before the trial to almost complete (86%) uptake after the NICE guidance change in 2023.

Population impact: The research has implications for the approximately 250,000 miscarriages that occur annually in the UK. Based on the trial findings, this could result in 2,800 fewer surgical procedures per year, calculated by applying the 8% reduction in surgical intervention rates observed in the trial to the estimated 35,000 women who choose medical management annually.

Health system benefits: The 8-percentage-point reduction in surgical intervention rates from 25% to 17% translates to reduced theatre time and surgical capacity requirements, decreased anaesthetic risks for patients, lower rates of surgical complications, including bleeding and infection, and reduced need for emergency procedures. The 7-percentage-point improvement in treatment success rates means significantly more women achieve their preferred outcome of successful medical management, resulting in reduced psychological harm, reduced need for repeat medications, shorter symptom duration and improved patient satisfaction.

Healthcare resource optimisation: The combination therapy reduces resource utilisation, including emergency department visits for failed medical management, additional consultant appointments for treatment monitoring, repeat ultrasound scans to assess treatment progress and inpatient admissions for surgical management of failed medical treatment.

Patient experience and quality of care

The trial findings have significant implications for patient experience and quality of care, addressing fundamental concerns about treatment effectiveness and patient autonomy in miscarriage care.

Reduced psychological distress: The trial included qualitative interviews revealing that surgery can be 'quite psychologically damaging to women' and that women needing surgery after failed medical management experienced significant psychological stress from requiring 'an additional treatment that they didn't want' (MM_1 2025). The reduction in surgical intervention rates directly reduces this source of psychological distress.

Improved treatment success and enhanced patient autonomy: The higher success rate of combination therapy means more women experience successful medical management aligned with their treatment preferences. The improved effectiveness provides women with a more reliable non-surgical option. The faster resolution of miscarriage with combination therapy reduces the duration of physical symptoms, bleeding and uncertainty, enabling women to begin psychological recovery sooner.

Policy and practice implementation

The impact of the MifeMiso trial extends beyond immediate clinical practice changes to broader policy frameworks for miscarriage care, demonstrating how evidence from a single trial can catalyse systematic improvements in healthcare delivery.

NIHR research alert: NIHR featured the MifeMiso trial findings as a research alert in November 2020 to inform healthcare providers and policymakers about the new evidence (Researchfish 2026). This alert provided rapid dissemination of key findings to the NHS research and clinical community, facilitating awareness and early adoption of the evidence (NIHR 2020).

NICE guideline development and implementation: The trial findings led to a comprehensive review and revision of NICE guidelines. In 2021, Professor Coomarasamy met with the NICE guideline committee to present findings of the MifeMiso trial. This direct engagement with guideline developers ensured that the evidence was properly considered and understood in the context of existing recommendations.

In August 2023, NICE guideline NG126 'Ectopic pregnancy and miscarriage: diagnosis and initial management' (NICE 2023) was updated to include guidance to prescribe both mifepristone and misoprostol for medical management of miscarriage rather than misoprostol alone. The updated guidelines explicitly cited findings and publications from the MifeMiso trial, thereby reversing the 2012 guidance.

Scottish policy implementation: The trial findings have been incorporated into the new framework to improve miscarriage care introduced by the Scottish government in early 2025 (The Scottish Government Children and Families Directorate 2025), which is backed by £1.5m in government funding. This framework relies on a graded model of care approach and specifically references the evidence on mifepristone in managing missed miscarriage.

Clinical guideline development: Beyond NICE, the trial findings have influenced other clinical guidelines. The Royal College of Obstetricians and Gynaecologists' (RCOG) 'green top' guideline on recurrent miscarriage has been updated to align with recommendations from the Lancet series, which incorporated the MifeMiso trial evidence (Researchfish 2026).

Parliamentary and political engagement

The MifeMiso trial was conducted within a broader context of political attention to miscarriage care. Following the 2021 publication of the Lancet series incorporating MifeMiso evidence, parliamentary debates led to commitments from health ministers to implement recommendations for miscarriage care in England. The research has been integrated into government policy frameworks, with the research team working with the Department of Health and Social Care and NHS England to create commissioning guidelines for miscarriage care and a national patient charter (Researchfish 2026).

A House of Commons roundtable discussion took place in June 2022, featuring Tommy's National Centre for Miscarriage Research, Tommy's Charity and advocates. Professor Coomarasamy delivered a Tommy's Charity petition to Downing Street with over 250,000

signatures, calling for the implementation of recommendations, including support after every miscarriage, mental health support after each loss, an end to the postcode lottery through standardised care and the formal recording of all miscarriages (Researchfish 2026).

Public awareness and healthcare system transformation

The trial has contributed to broader public awareness and education initiatives around miscarriage care, helping to reduce stigma and improve understanding of treatment options. The research team's collaboration with Tommy's Charity has enabled broad public engagement through extensive networks and communication channels.

The rapid translation from research completion to guideline implementation (within three years) provides a model for other areas of healthcare research, while the emphasis on patient involvement throughout the research process represents a broader shift toward patient-centred healthcare delivery.

4.6. Conclusions and lessons learned

The MifeMiso trial is an example of successful health research that has transformed clinical practice for miscarriage care in the UK. The study demonstrated that mifepristone plus misoprostol is significantly more effective than misoprostol alone for the medical management of missed miscarriage, while also being cost saving for the healthcare system.

The trial's findings have led to changes in NICE guidelines, influenced parliamentary debates on miscarriage care, contributed to policy frameworks in Scotland, and contributed to new standards of care that benefit approximately 250,000 women experiencing miscarriage annually in the UK. The research has reduced the number of surgical procedures required by an estimated 2,800 cases per year, improving patient experience and reducing healthcare costs.

The collaborative approach involving academic researchers, patient advocacy groups, and healthcare charities demonstrated how patient-centred research can effectively address clinical needs. The rapid translation from trial completion to policy implementation (within three years) exemplifies best practice in evidence translation and provides a model for other areas of healthcare research.

The trial was conducted within a broader ecosystem of coordinated miscarriage research that included the landmark Lancet series, development of the graded model of care, and creation of patient support tools. This ecosystem approach demonstrates how individual research projects can be part of larger efforts to transform care for specific patient populations.

The MifeMiso trial illustrates the value of the NIHR's HTA programme in addressing important clinical questions that might not attract commercial research funding but have significant implications for patient care and healthcare system efficiency. The study's success demonstrates that well-designed, adequately funded research can challenge established clinical guidelines based on limited evidence and drive meaningful improvements in patient care.

The ongoing monitoring of implementation and the integration of findings into broader miscarriage care frameworks suggest that the impact of this research could continue to grow over time.

The trial's success can be attributed to several key factors. The extensive patient and public involvement throughout the trial design and conduct was crucial for ensuring the research addressed real patient needs and preferences. The partnership between academic

researchers, patient advocacy groups, and healthcare charities was essential to the successful completion and impact of the trial, providing access to research networks, patient populations, and policy influence.

Early and sustained engagement with policy makers and guideline development bodies facilitated rapid translation of evidence into practice. The foundational support provided by Tommy's Charity demonstrates the importance of sustained investment in research infrastructure and capacity building, enabling successful applications for larger grants and providing stability for long-term research programmes.

5. Case Study 4: Improving the management of children with respiratory and urinary tract infection in primary care

5.1. Summary

This case study examines the impact of a NIHR Career Development Fellowship (CDF-2009-02-10) awarded to a professor that supported research into the management of respiratory and urinary tract infections in children. The fellowship enabled the PI to prioritise research activities, develop a multidisciplinary team and establish collaborative networks. It played a key role in generating early findings and supporting the development of diagnostic tools such as DUTY and STARWAVe.

The CDF contributed to research outputs that have informed multiple NICE guidelines (including NG224 and NG91), antimicrobial stewardship strategies and public health campaigns. The fellowship improved research capacity, facilitated partnerships and supported the development of tools that continue to influence antimicrobial stewardship initiatives. It also positioned the PI for subsequent leadership roles in NIHR-funded research on infection management in primary care.

While the CDF is part of a wider body of NIHR-funded work,[16] it served as a platform for long-term impact by enabling foundational studies, collaborative networks and the development of evidence that has informed policy and clinical practice. The fellowship's outputs have contributed to measurable benefits in clinical practice and policy, particularly in diagnostic accuracy and antibiotic use in primary care.

5.2. Introduction

This case study looks at the impact of the Career Development Fellowship (CDF) awarded to the PI. The CDF[17] provided foundational support for the PI's study into managing respiratory and urinary tract infections in children. By enabling the PI to prioritise research and build a multidisciplinary team, the fellowship was instrumental in establishing the PI as a leader in infection management and antibiotic stewardship. While it is part of a wider body of NIHR-funded work, the CDF played a key enabling role in generating early findings, building collaborative networks and supporting the development of tools such as DUTY (Hay et al. 2016). The box below lists the fellowship's key details.[18]

16 NIHR support for the professor has come from diverse funding sources since 2004, including the Health Technology Assessment (HTA), Career Development Fellowship, Public Health Research, Efficacy and Mechanism Evaluation and Programme Grants for Applied Research. See Annex and also: https://fundingawards.nihr.ac.uk/?query=Professor%20Alastair%20Hay

17 The research activity code for this is '1. Underpinning Research which helps underpin investigations into the cause, development, detection, treatment and management of diseases, conditions and ill health'.

18 Details retrieved from the NIHR website: https://fundingawards.nihr.ac.uk/award/CDF-2009-02-10

Key facts about the funding:

NIHR award type: Career Development Fellowship (CDF-2009-02-10)

Study period: January 2010 to December 2013

Principal investigator: Professor Alastair Hay

Total NIHR funding: £420,688 (2010–2013)

Funding: £1,737,115

This case study draws on a range of evidence sources, including two semi-structured interviews conducted via Teams video with the PI and a business director at Lupin.

This CDF was chosen to illustrate how NIHR-funded career fellowships support academics as they develop into leaders in healthcare and can help address critical healthcare challenges, in this case, infection management and antibiotic use in primary care.

This fellowship has delivered measurable benefits across clinical practice and policy. The fellowship has provided the basis for developing findings that have informed multiple NICE guidelines, including NG224 and NG91, antimicrobial stewardship strategies and public health campaigns.[19]

While it is difficult to isolate the impact of a single award within a researcher's broader career,[20] the CDF served as a platform for long-term impact. It improved research capacity, enabled key partnerships to be built and supported the development of tools that continue to influence antimicrobial stewardship initiatives today. The fellowship also helped position the PI for future leadership roles in NIHR-funded research focused on improving infection management in primary care. Following the CDF award, the PI was awarded a prestigious NIHR Research Professorship, providing five-year funding to investigate ways to reduce the impact on NHS resources of treating children's respiratory tract infections.

5.3. Background

Scientific/health system context

Antibiotics are used to treat or prevent certain bacterial infections. However, their overuse has contributed to the rise of antibiotic resistance. While antibiotic resistance can occur naturally, inappropriate or excessive use can accelerate it – part of a broader issue known as antimicrobial resistance (AMR), which includes resistance to antibiotics, antivirals, antifungals and antiparasitics. When bacteria become resistant, they are less likely to respond to standard treatments, which can lead to serious health issues such as bloodstream infections, sepsis and hospitalisation.

Primary care plays an important role in antibiotic use and antimicrobial stewardship. In the UK, General practitioners (GPs) are responsible for prescribing most antibiotics. However, studies show that up to 20% of antibiotic prescriptions in English primary care may be inappropriate (Nuffield Trust 2025; Public Health England 2018). Despite a growing push to improve antimicrobial stewardship, there has been a lack of more practice-oriented evidence to guide antibiotic prescribing in

19 UK Health Security Agency. 2017. 'Keep Antibiotics Working campaign TV Advertisement.' 23 Oct. As of 12 August 2026: https://www.youtube.com/watch?v=ef4QHUS5760

20 Detailed NIHR funding awarded to the researcher are listed in the Annex to this case study.

children (Costelloe et al. 2010). Diagnostic uncertainty in children is especially challenging. Symptoms often overlap between viral and bacterial illnesses, and young children are often unable to describe their symptoms clearly. This either leads to clinicians under-treating a serious infection or to unnecessary antibiotic use (Hay, Redmond et al. 2016).

Against this backdrop, the NIHR-funded Career Development Fellowship (2010–2013) aimed to address these gaps by supporting the PI's investigation into the management of children with respiratory and urinary tract infection in primary care, with a particular focus on improving diagnostic accuracy in children. The fellowship was built on an established programme of work and was structured around three interlinked studies: TARGET (Treatment of Acute Respiratory Tract Infections in Children), the VAPAR (Vaccines and Antibiotics as Predictors of Antimicrobial Resistance) study, which added to TARGET, and DUTY (Diagnosis of Urinary Tract Infection in Young Children).

Together, these studies have provided important insights into the risks of routine antibiotic use, the value of urinalysis in young children and the accuracy of clinical algorithms for infection prediction. While studies like DUTY have received their own funding, the CDF played a crucial role in laying the foundation for collaborations and leading work that has had a real-world impact on prescribing practices and policy. Findings from these grants have informed both policy and clinical guidance, contributing to national AMR reduction goals and supporting better prescribing decisions.

Key individuals/organisations

The NIHR fellowship was awarded to a clinical academic whose research focused on managing acute infections and antibiotic use in primary care. Based at the University of Bristol, the PI has worked closely with leading universities in London, Oxford and Southampton, as well as with over 200 general practices across England and Wales. These collaborations enabled large-scale cohort studies and supported the development of clinical tools such as the STARWAVe and DUTY algorithms (Hay et al. 2016; Hay, Redmond et al. 2016) designed to improve diagnostic accuracy and guide more targeted antibiotic prescribing.

The PI's team included GPs, nurse practitioners and researchers with expertise in prognostic modelling, diagnostic accuracy and health economics. The partner organisations were instrumental in recruiting participants, collecting data and validating the clinical algorithms, playing a key role in the fellowship's production of research with real-world impact.

5.4. Research input and processes

Funding and resources

The fellowship (CDF-2009-02-10) has generated over 40 research outputs (that cited the award ID) across diverse topics, including respiratory tract infections (RTIs), urinary tract infections (UTIs), antibiotic prescribing and primary care methodology.[21] Key papers include systematic reviews, randomised controlled trials, cohort studies, feasibility studies and intervention development protocols. Much of this work was also supported by additional NIHR funding through programme and project-specific awards. This broader support played a significant role in building on what the fellowship had started and further developing this research. Notable contributions focus on improving diagnostic accuracy, reducing unnecessary antibiotic use and addressing AMR.

21 Information gathered from: https://pubmed.ncbi.nlm.nih.gov/?term=CDF-2009-02-10&page=4

The fellowship's recipient used key infrastructure and facilities to generate many of the research outputs:

1. Many studies involved data collection and analysis within UK GP settings, using primary care networks as the foundational infrastructure for recruiting participants and conducting trials (e.g. diagnostic algorithms for UTIs).
2. Multidisciplinary collaborations were evident across studies, involving experts in microbiology, paediatrics, epidemiology and health economics.
3. Many studies utilised electronic health records to gather large-scale data, showcasing the integration of digital infrastructure into research.
4. Randomised controlled trials, such as the ARCHIE trial (Wang et al. 2018)[22] relied on specialised clinical trial units for study design, patient recruitment and intervention delivery.

Research Activities

Two large-scale studies, TARGET and DUTY, were developed as part of the CDF and received support from the RDN (formerly the CRN). While the fellowship provided protected time and leadership capacity for the PI to develop and coordinate these studies, the PI also received dedicated funding through other NIHR research awards.[23] This combination of support through the CDF and project-specific investment enabled the successful delivery of many studies aimed at improving infection diagnosis and antibiotic use in children.

TARGET was conducted between July 2011 and June 2013 and recruited 8,394 children aged 3 months to 16 years from 247 general practices across England. The study aimed to improve clinical risk stratification for hospital admission in children presenting with RTIs and acute coughs. Primary care clinicians recorded detailed symptom reports, clinical signs, and 30-day outcomes, including hospitalisation. To support data quality and consistency, participating clinicians received training coordinated through four academic hubs: Bristol, London, Oxford, and Southampton. This approach was critical to enabling the development of the STARWAVe clinical rule, a seven-point tool designed to help general practitioners identify children at low, normal or high risk of hospitalisation and support more informed, targeted decisions about antibiotic prescribing (Hay, Redmond et al. 2016).

The DUTY study looked at 7,163 children under the age of five who were acutely unwell and at risk of UTIs, a group where diagnosing UTIs is particularly challenging. The children were recruited from 225 GP practices, four children's hospital emergency departments, and four walk-in centres across England and Wales. The study collected data on clinical features, including medical history, symptoms, physical signs, and dipstick test results. It then compared urine test results from NHS laboratories with those from a central research lab. The research laboratory results proved to be more accurate, especially when clean-catch urine samples were used. This result highlighted inconsistencies in routine NHS laboratory testing and pointed to a need for more standardised practices.

The DUTY study also developed diagnostic algorithms, particularly for clean-catch samples, that performed better than clinical judgement alone in deciding which children should have a urine sample taken. These algorithms showed higher sensitivity and

22 These studies also have additional NIHR funding. RP-PG-1210-12012 is the award ID for the ARCHIE trial.

23 Award Number 08/66/01 for the DUTY Study and NIHR-RP-02-12-012 for the TARGET Study.

specificity. While dipstick testing did add some value, particularly with clean-catch samples, its benefits were limited by cost, and it was less reliable with nappy pad samples, which had higher contamination rates and lower accuracy (Hay, Birnie et al. 2016). An economic evaluation of the DUTY study further demonstrated that clinical algorithms based on symptoms and signs are not only more accurate but also more cost-effective than GP clinical judgment in selecting children for urine sampling (Hollingworth et al. 2017). The analysis also found that routine dipstick testing adds little value and is not cost-effective.

5.5. Research outputs and outcomes

Benefits to future research

The fellowship played a key role in building long-term research capacity, not just for the PI, but also for the wider academic and clinical teams involved. It allowed the space and support to develop a strong foundation in the design and delivery of large-scale studies in primary care.

Through the TARGET and DUTY studies, the PI and his research team developed experience in setting up and running cohort and diagnostic studies in often complex, real-world clinical settings. They gained expertise in statistical modelling, using tools like AUROC analysis and bootstrap validation to develop reliable prediction rules. These methods have helped develop practical tools such as the STARWAVe and DUTY algorithms, which continue to influence clinical research and policy. Findings from the DUTY study informed key updates to NICE guidance. The study addressed a research recommendation from the 2007 guideline by systematically evaluating which symptoms and signs were most predictive of UTI in young children. As a result, the updated NICE guideline (NICE 2022) now recommends that clinicians consider additional indicators such as a previous UTI (increased risk), nappy rash (decreased risk) and abnormal ear examination (decreased risk). A further change, introduced in 2017, was the recommendation to routinely perform urinalysis in children under three years old, reflecting DUTY's demonstrated diagnostic utility in primary care.

This work has also strengthened health economic expertise, particularly in evaluating the cost-effectiveness of clinical decision tools, for example, the Hollingworth et al. (2017) study. Understanding how these models could reduce unnecessary antibiotic use while also being efficient and sustainable for the NHS has become a central part of this research.

Importantly, this CDF led directly to further opportunities and NIHR awards. The PI has since secured multiple NIHR-funded projects,[24] including a Research Professorship[25] and a range of programme- and project-specific awards. In total, the work supported by the CDF has helped attract at least 11 other NIHR awards.

Health and care impacts

As shown by a 2023 NIHR impact case study (NIHR 2023b), the work initiated through the PI's NIHR CDF laid a foundation for several clinical tools and policy-relevant findings that have directly improved care in primary settings. The DUTY study had notable policy influence, with its evidence supporting the NG224 NICE recommendation for urine dipstick testing in children aged three months to three years with

24 See Annex.

25 NIHR Funding Awards. n.d. 'Reducing the burden of paediatric respiratory tract infections to the NHS.' NIHR. As of 12 August 2026: https://fundingawards.nihr.ac.uk/award/NIHR-RP-02-12-012

suspected UTIs. Its contribution to improving diagnostic accuracy in primary care was also recognised by the Royal College of General Practitioners, which awarded it Research Paper of the Year.

The TARGET study led to the development of the STARWAVe clinical rule, which helps GPs assess hospitalisation risk in children presenting RTIs. By stratifying children into low, normal, or high-risk categories, STARWAVe provides clinicians and parents with clear decision rules that may lead to better symptom management and reduced reliance on urgent care services (Hay, Redmond et al. 2016).

Results from broader research funded by NIHR and involving the PI have directly informed Public Health England (now UKHSA) antimicrobial stewardship policy and led to changes in recommendations in five NICE clinical guidelines.[26] Together, these have contributed to real-world benefits: notably a 12% reduction in primary care prescriptions (four million fewer prescriptions/year) between 2018 and 2022 (NIHR 2023b).

These examples demonstrate how policy change through research is often built gradually, with studies designed to address clearly defined clinical uncertainties. The PI's journey shows how each piece of research has contributed to a broader agenda: strengthening diagnostic confidence, informing national messaging, and thereby supporting antimicrobial stewardship at scale.

The work initiated through the CDF also helped build the evidence base around how routine antibiotic use in primary care contributes to resistance, and how more targeted prescribing can help mitigate that risk. These findings informed large-scale public health initiatives, including the 2017 'Keep Antibiotics Working' campaign, which aimed to change patient expectations around antibiotics. Importantly, this campaign was rooted in evidence from the PI's work demonstrating how even a single course of antibiotics can double an individual's risk of carrying resistant bacteria.

Commercial impacts

Although the NIHR CDF awarded to the PI did not directly result in the development of the commercial product called 'Otigo',[27] the product's impact is relevant when evaluating the broader effects of the NIHR funding. Otigo's development and commercialisation are associated with the work of Hay et al. (2019), particularly the CEDAR trial,[28] as well as the wider research environment supported by the CDF. The product's relevance to AMR is indirect: by providing pain relief, Otigo enables clinicians to withhold antibiotics unless clinically required, which may reduce unnecessary antibiotic prescriptions (Otigo Ear Drops 2026).

The PI's research has informed clinical guidelines, including those issued by NICE (2022),[29] which influence the marketing and prescribing of Otigo. However, the PI was not directly involved in the product's development. Ongoing research, such as the CPRD study,

26 NG143, NG224, NG120, NG109 and NG91

27 Otigo is an ear drop solution that contains two active substances: phenazone, an analgesic (pain reliever), and lidocaine hydrochloride, a local anaesthetic. These ingredients work together to provide local symptomatic treatment and pain relief in conditions of the middle ear without tympanic perforation, such as acute inflammation, post-influenza inflammation and barotraumatic otitis. As a combined anaesthetic-analgesic ear drop, Otigo is considered an alternative to paracetamol or ibuprofen. The product's relevance to antimicrobial resistance is therefore indirect: by providing effective pain relief, Otigo enables clinicians to withhold antibiotics unless clinically indicated, which may contribute to a reduction in unnecessary antibiotic prescriptions.

28 NIHR Funding Awards. n.d. 'Children's drops for ear pain in acute otitis media: the CEDAR randomised controlled trial.' NIHR. As of 12 August 2026: https://fundingawards.nihr.ac.uk/award/13/88/13

29 NICE guideline NG91.

is assessing whether products like Otigo have reduced antibiotic prescriptions for ear infections, but definitive data are not yet available (interviewee CDF_2 2025). Current evidence suggests a possible impact on prescribing rates, though this has not been conclusively demonstrated.

The CEDAR trial, funded separately by NIHR for the PI, has been described as influential in the development of Otigo. According to one interviewee (CDF_1 2025), representatives from Renascience Pharmaceuticals (founders of Otigo) indicated that the trial played a significant role in the product's development. While the CDF did not fund either the CEDAR trial or Otigo directly, it was an early fellowship that supported the PI's research career and his capacity to lead subsequent NIHR-funded projects, including CEDAR.

Otigo's market uptake has been described as 'very discrete' and measurable (CDF_1 2025). Recently, Lupin Healthcare acquired Renascience on 2 April 2025 for £12.3m, and they report that Otigo is now prescribed across the UK, with average monthly sales of approximately 15,000 packs, peaking during winter (CDF_1 2025). They attribute the product's adoption to its inclusion in NICE guidelines, which has facilitated its use across NHS regions (CDF_1 2025).

5.6. Conclusions and lessons learned

The CDF awarded to the PI stands as a strong example of how targeted research funding can drive meaningful change in healthcare. By supporting foundational studies and building collaborative networks, the fellowship has enabled the development of practical tools and evidence that have improved the management of childhood infections in primary care. The impact of this work has reached far beyond the original study sites, influencing clinical practice, policy and public understanding across the UK. The resulting improvements in diagnostic accuracy and antibiotic stewardship have empowered both healthcare professionals and patients, contributing to better health outcomes and more sustainable use of antibiotics.

Overall, the fellowship demonstrates the long-term value of investing in research leadership and capacity. The benefits, including in clinical, policy and public health domains, highlight the valuable role of early-career support in tackling major health challenges like AMR.

Annex to Case Study 4

Table 25: Summary of awards held by the fellow by award type and completion status

Title	Type of Award	Award ID	Completed
Air Filtration to reduce Respiratory Infections (including COVID-19) in care homes	Research Award	NIHR129783	Yes
Improving the management of children with respiratory and urinary tract infection in primary care	Career Development Award	CDF-2009-02-10	Yes

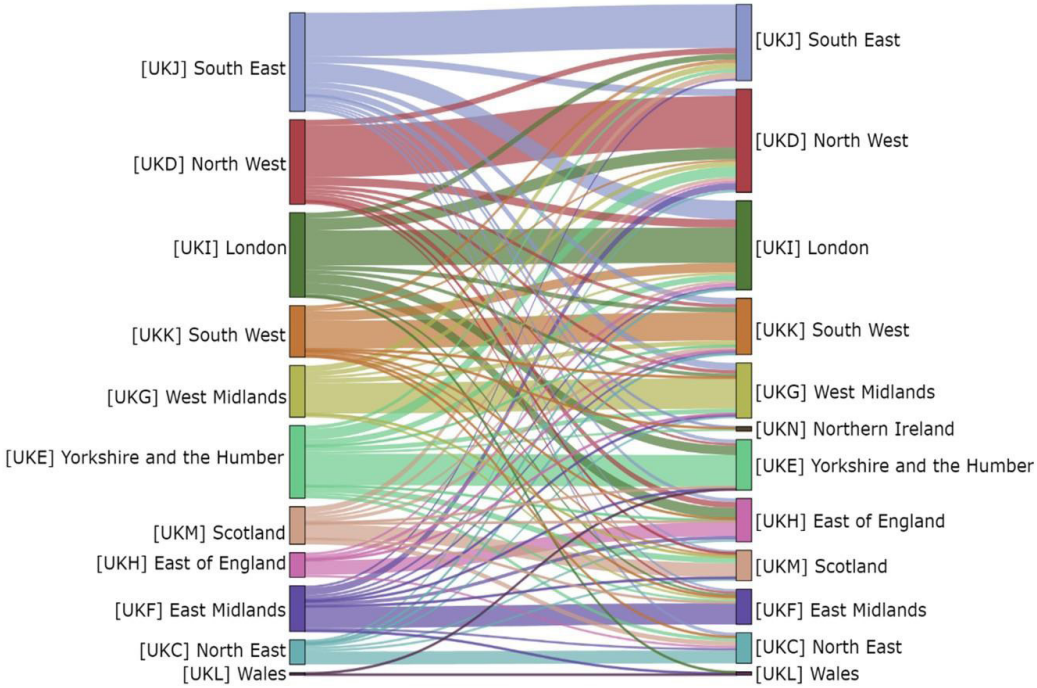
Title	Type of Award	Award ID	Completed
Reducing the burden of paediatric respiratory tract infections on the NHS	Career Development Award	NIHR-RP-02-12-012	Yes
NIHR Senior Investigator Award	Career Development Award	NIHR200151	Yes
Ibuprofen and paracetamol in combination and separately for fever in pre-school children	Research Award	03/09/2001	Yes
The Diagnosis of Urinary Tract Infection in Young Children (DUTY) study	Research Award	08/66/01	Yes
Children's drops for ear pain in acute otitis media: the CEDAR trial	Research Award	13/88/13	Yes
Immediate oral, immediate topical or delayed oral antibiotics for acute otitis media (REST)	Research Award	16/85/01	Yes
Rapid respiratory microbiological point-of-care testing in primary care	Research Award	NIHR131758	Yes
Improving the use of antibiotics for children with acute respiratory infections in primary care	Research Award	RP-PG-0608-10018	Yes
Improving primary care antibiotic prescribing to reduce antibiotic-resistant urine infections: IPAP-UTI	Research Award	NIHR204400	No

6. Research Excellence Framework (REF) case study data analysis

In an additional piece of work related to the case studies, we identified NIHR-funded case studies that featured in the REF 2021 case study database. We analysed the REF database to understand how the regional distribution of funding translates to impact across UK regions. In this analysis, any impact is captured (e.g. on health, economy and society more widely), rather than only the economic impacts, that are otherwise the focus of the project.

Figure 21 below shows how projects in different NUTS1 regions lead to impacts across the same and other regions of the UK. The NUTS1 region on the left of the figure indicates the location of the university where the research took place. The NUTS1 region on the right of the figure indicates the location where the impact occurred, based on the mention of a location in the 'details of the impact' section of the case study, showing that investments in one region can result in impacts in other regions of the UK. For instance, we see that while 44% of total project impacts in the South East occurred in the same region as the case study's origin, 56% occurred in a different region (primarily in the North West, London and the South West). Scotland had the highest percentage of impacts from NIHR-funded REF case studies in different NUTS 1 regions (62.5%).

Figure 21: Sankey diagram showing impact flows in the NIHR-funded REF case studies



Source: RAND Europe analysis.

Appendix G. **CGE modelling technical details**

Marco Hafner (RAND Europe), Erez Yerushalmi (Birmingham City University)

1. The CGE model to assess the economic impact of funding through the NIHR

A robust modelling framework is required to evaluate NIHR's economic impact at both national and regional levels. Past studies have employed various methodologies to quantify returns on research investment, each with strengths and limitations. One common approach for short-run economic effects is input-output modelling, which uses fixed economic multipliers derived from inter-industry transaction tables to estimate how an initial expenditure (e.g. a research grant) ripples through the economy.

Based on Leontief's framework, input-output models are attractive for their transparency and ease of calculating direct, indirect and induced effects on output and employment (Smith et al. 2019). However, input-output models have important limitations. For example, they assume a linear relationship between inputs and outputs and no capacity constraints in the economy. This means they implicitly assume that resources such as labour and capital are infinitely elastic in supply, i.e. that if a research project needs workers or materials, these can be drawn from an unlimited pool without affecting other sectors. However, economies have finite resources, and large public or private investment expenditures can bid up wages or prices, crowd out alternative uses of resources, or otherwise shift the economic equilibrium.

Input-output models also hold technology and relative prices constant as they do not allow for substitution between inputs. They typically consider a fixed snapshot of the economy without behavioural responses of different economic agents to price changes. As a result, input-output-based impact estimates may overstate effects by ignoring the opportunity costs and adjustments that occur in a real economy (Koks et al. 2016). Input-output analysis captures demand-side spending effects mechanically but lacks a representation of supply-side constraints or feedback mechanisms (e.g. how an influx of funding might draw labour from other industries, or how increased demand might raise prices).

To overcome these limitations and capture a more realistic, system-wide impact, our study employs a CGE model of the UK economy. CGE models are a standard tool in economic analysis for assessing policy impacts or exogenous shocks, widely used in fields such as trade policy, taxation and environmental economics and increasingly in regional economic analysis (Giesecke & Madden 2013). A CGE model represents the economy as a whole system of interdependent markets (e.g. for goods, services, labour and capital), grounded in microeconomic theory. Rather than using fixed multipliers, a CGE model computes a new equilibrium after a shock by allowing prices, wages and quantities to adjust so that supply and demand balance in all markets.

In our context, this means the model can simulate how NIHR research funding affects not just the directly funded sectors but also related sectors, factor markets and household incomes across all regions. Crucially, the CGE approach incorporates the supply side of the economy, recognising that labour and capital

are not unlimited and that increased demand for these inputs can drive up costs or reallocate them from other uses. In essence, several key advantages of the CGE approach make it well-suited for this study's objectives.

First, CGE models consider how all markets interact. They capture feedback effects, such as changes in household income that lead to changes in consumption, which in turn affect demand for goods in other sectors. In the case of research funding, this allows us to capture not just the immediate spending but also second-round effects (e.g. higher incomes might increase demand in unrelated sectors). By capturing the entire circular flow of the economy, we ensure that estimates of economic impacts account for both positive and negative feedback loops, yielding a net effect that is economically coherent.

Second, unlike input-output, CGE modelling imposes budget constraints and full employment on factors, preventing unlimited expansion. The model will show rising wages or in-migration when a region's research sector expands, rather than assuming that extra labour appears from nowhere. This feature prevents overestimation of impacts by accounting for opportunity costs. If some resources are diverted from other productive uses to accommodate the activity funded through the NIHR, the model will net out the output lost elsewhere from the output gained in the target sector.

Third, in a CGE framework, relative prices (e.g. wages and the prices of goods and services) adjust until the economy reaches a new equilibrium. This means we can evaluate not just output changes but also welfare changes, such as real income gains to households, and incorporate policy responses (e.g. how government budget constraints are affected).

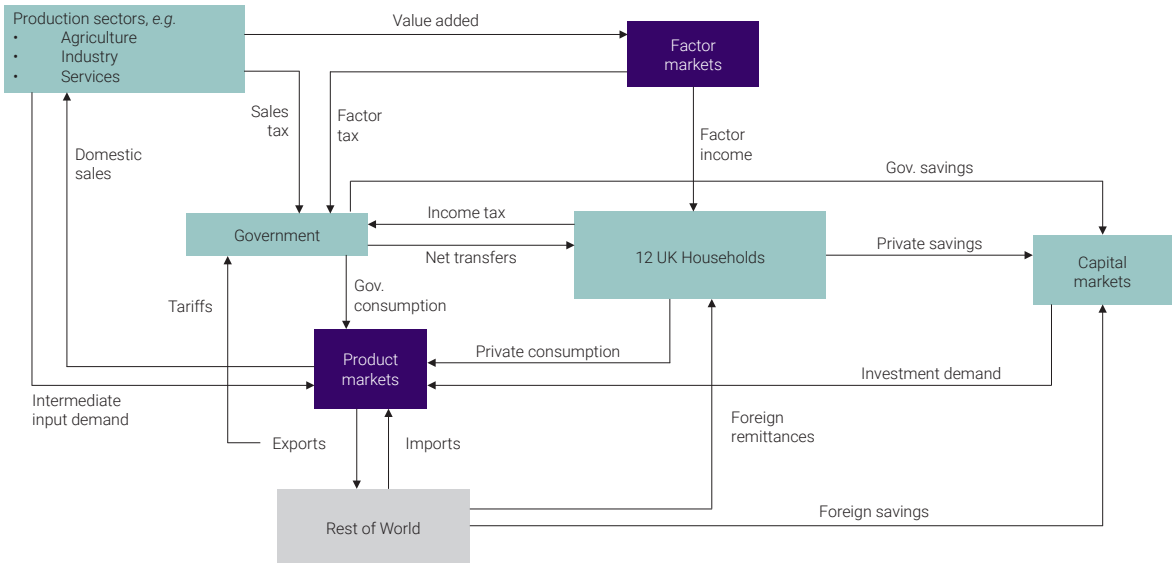
Fourth, our CGE model is multi-regional, disaggregating the UK into 12 regions: nine regions in England plus Northern Ireland, Scotland and Wales. This feature allows us to track how national expenditure through the NIHR impacts regions differently, accounting for each region's economic interactions with other regions.

The following sections describe the technical details of the economic model, as well as the assumptions and data inputs used to calibrate the model for the analysis.

2. Model description and assumptions

We have developed a CGE model based on a static framework that compares one steady state to another, without modelling the dynamic transition between them. In the CGE model, three weak inequality conditions – profit, market clearance, and income balance – hold simultaneously. Figure 22 provides a schematic representation of the economy within the model, illustrating monetary flows through directional arrows.

Figure 22: A depiction of the model



Note: The figure shows the linkages between various agents (households, government, rest of world), various markets for goods and inputs and the flow of money.

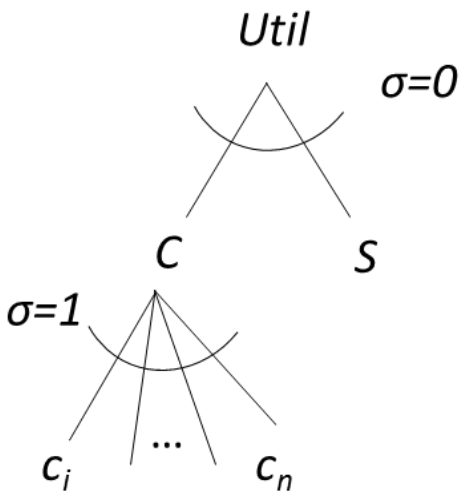
The model incorporates 12 UK regional households (r=1,12), each endowed with capital and labour, which they supply to factor markets in exchange for income. In addition to earnings from factor markets, households receive transfers from other agents, including other households, the government, and the rest of the world. Households' total income is allocated between consumption, by purchasing goods in commodity markets, and savings. The model also includes 12 regional R&D sectors, which demand labour and capital.

2.1. Households

Households are modelled as rational agents with a two-level utility function. At the first level, utility is derived from a fixed-share allocation between consumption and private savings, following a Solow-type assumption. At the second level, households maximise a Cobb-Douglas utility function over various goods. Figure 23 provides a graphical representation of the household utility function.

The government's budget is primarily financed through commodity taxes (e.g. VAT and production taxes), income taxes from households, and other revenue sources. On the expenditure side, the government purchases goods from the product market to provide public services, disburses transfers to households, and subsidises firms.

Figure 23: Two-level household utility function



Note: The household has a multi-level utility function. At the top level, the household consumes a bundle of goods and saves in a fixed proportion. In the lower level, the household consumes various commodities using a Cobb-Douglas function. σ *represents the substitution elasticity.*

The model represents a small open economy, implying that the UK does not influence world prices. The economy engages in trade with the rest of the world, exporting and importing goods at exogenously determined prices quoted in foreign currency.

All agents contribute to savings, which take the form of private, government and foreign savings. These savings constitute the capital supply used to finance investment in commodities. Consistent with a Solow-type framework, savings are assumed to be maintained in a fixed proportion relative to consumption.

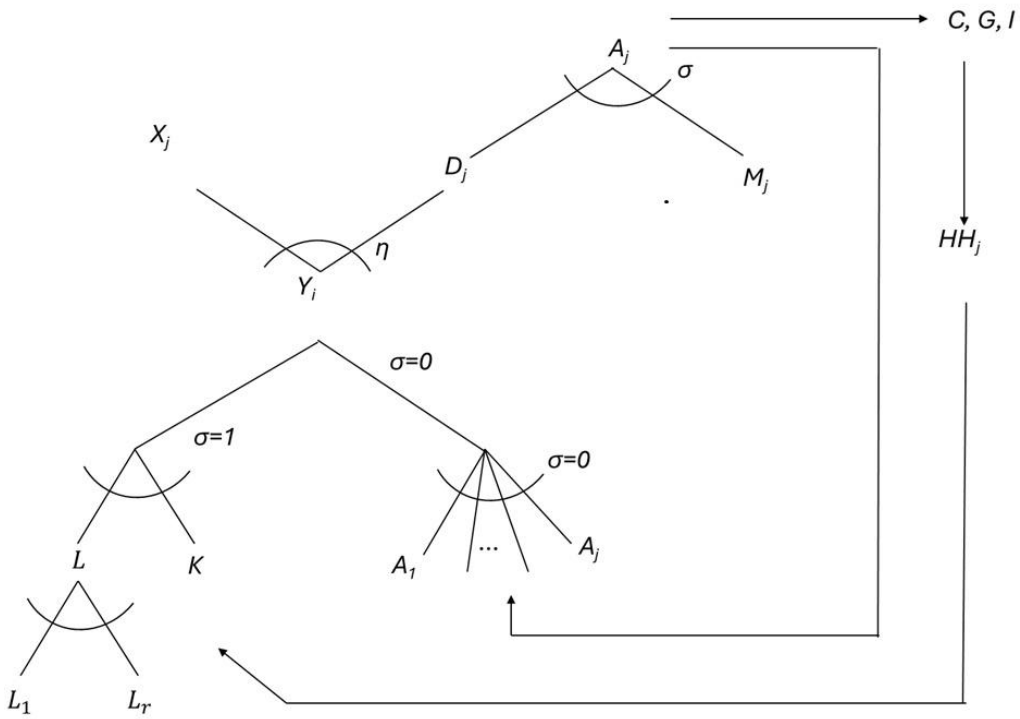
2.2. Firms

The model includes five main activities and five Armington composite commodities, from which we disaggregate the activity 'Science R&D' into 12 regional subfirms (to be explained in more detail below). Excluding the Science R&D activities, all others are assumed to be undertaken by perfectly competitive firms. Thus, overall, the model represents 16 activities (a=1,16) and five commodities (c=1,5). The 12 Science R&D regional activities (regional firms) and the 'Human Health Services' activities are supported in part by NIHR funding. The remaining three sectors represent 'Pharmaceuticals', 'Residential Care' and a composite sector covering all other goods and services.

Firms produce goods using a multi-level, differentiable, constant returns to scale (CRS) production function that combines input factors (labour and capital) with intermediate goods. Figure 24 provides a general illustration of the main model structure, which omits, for simplicity, the multi-level functions that calibrate the model to regions. The figure shows labour *L* and capital *K*; the Armington final commodity A_j of commodity *j*; activity production Y_i ; exports X_j; imports M_j; and domestic use of the commodity D_j .

There are 12 regional households HH_r that have individual demands for final goods and endowments; each regional household has a fixed supply of labour, employed by the 16 different activities. The model allows for substitution between regional workers (e.g. one R&D regional activity could attract more workers from another region); however, it also allows for migration of workers from one region to another.

Figure 24: Production structure



The model adopts the Armington (1969) framework, which treats goods as differentiated by origin, to capture the potential for cross-hauling, that is, simultaneous imports and exports of similar commodities. Under this approach, the output from domestic producers is converted into commodities that are aggregated with imported varieties to form the total domestic supply. This composite supply can then be allocated either to export markets or to domestic uses, including household and government consumption, investment, and intermediate demand by domestic industries (Armington 1969).

2.3. External economies

For regional Science R&D firms, we specifically add an external economies feature to capture potential agglomeration dynamics (Markusen & Melvin 1981; Melvin 1969). For instance, the provision of initial funding and seed capital in the R&D sector can give rise to a localised cluster or innovation hub, which, in turn, attracts additional firms, human capital and complementary services. This cumulative process reinforces regional specialisation and productivity, reflecting a departure from CRS and embodying increasing returns to scale.

Thus, for Science R&D activities (a3-a14), we assume that individual firm $i \in a = (3, 14)$, in region r behave as $Y_{ir} = {Y_r}^{\beta} F_i(v)$; with Y_{ir} the individual firm i in region r; Y_r the regional industry-wide R&D output; $F(v)$ the CRS production function with v representing inputs, such as capital, labour and intermediate products. Finally, $0 < \beta < 1$ is the external returns scale parameter that reflects the industry-level scale economies (agglomeration). When $\beta = 0$, we return to the basic perfectly competitive CRS sector. Since F is CRS and is identical to all individual firms within a sector, total regional R&D industry output can be written as $Y = Y^{\beta} F\left(v\right)$ and

after rearranging obtain $Y = F(v)^{\frac{1}{(1-\beta)}}$. In other words, Science R&D activities (a3-a14) are homogeneous of degree $1/(1-\beta) > 1$ in primary inputs, rather than homogeneous of degree 1 as in CRS.

Thus, the key features for these Science R&D industries are:

- The external economies are captured by the dependence on aggregate output Y^{β}, implying that each firm's productivity improves as the industry grows.
- Firms take Y as given; they do not internalise their contribution to external economies.
- The production function remains concave in private inputs (capital, labour and intermediate inputs), ensuring diminishing returns privately, while still allowing increasing returns at the industry level if $\beta > 0$.

While β is rarely directly reported in this exact functional form, several empirical studies estimate returns to scale or external productivity spillovers, which can help bound plausible values of β, as outlined in Table 26. In this study, we assume a very conservative value of β=5%, which appears to be significantly lower than the accepted value of around 10%-40% reported in Table 26.

Table 26: Empirical estimates of β in R&D/science sectors

Source / Study	Sector	Estimate / Interpretation of β
Romer (1994)	Endogenous growth with knowledge spillovers	β≈0.1–0.3 (implied from spillovers)
Griliches (1992)	R&D productivity	External R&D spillovers ≈ 20–30% of total R&D impact
Jaffe (1986)	R&D spillovers across firms	Significant geographic and technological spillovers, suggesting β in the range 0.1–0.3
Jones & Williams (1998)	Optimal R&D investment	Social returns to R&D ~30–50%, vs private ~10–20% → suggests β of 0.2–0.4
Coelli et al. (2005)	Frontier production function estimates	Returns to scale in services and R&D-intensive sectors often >1

2.4. Model closure rules

Following standard applications in CGE models, the government receives income from taxes and tariffs and net funds from domestic households and the rest of the world. The government saves a fixed amount of its income and provides public services by purchasing commodities in fixed proportions.

In the counterfactual simulations, the closure rule maintains public service provision at baseline levels by endogenously adjusting net transfers between the government and households. This ensures that any fiscal surplus or deficit is offset by corresponding transfers, allowing the government to deliver the same quantity of public services as in the baseline scenario. This assumption is important for accurately interpreting changes in regional household welfare, which reflects both private and public consumption. By holding public provision constant, we isolate the effects of policy shocks on private welfare components without confounding them with variations in publicly provided goods and services.

With respect to international trade, the model assumes a small open economy that takes world prices as given and does not influence them. In this static framework, the closure rule fixes the balance of payments by treating export and import prices, quoted in foreign currency, as exogenous. This approach avoids distortions in welfare interpretation that could arise from allowing, for instance, an increase in the current account deficit to appear as an unearned benefit or 'free gift'. Over the long run, it is assumed that the current account will, on average, be in balance.

3. Calibrating the CGE model to UK data

The model is calibrated using a new 2022 UK regional Social Accounting Matrix (SAM) that we have constructed, primarily based on the ONS Use and Supply tables (ONS 2025b). This SAM is unique in that it is constructed using the most recent available information and provides a disaggregation of households and R&D firms across 12 UK regions. Moreover, our approach simulates how the UK economy in 2022 could have evolved if an equivalent total amount of NIHR funding had been allocated, following the same regional proportions observed between 2013 and 2018.

To derive regional household accounts, we further expand using the gross disposable household income data, institutional sector accounts of households and non-profit institutions serving households (ONS 2025), and regional household final consumption expenditure (ONS 2025). The data has been cross-checked against Public Sector Finances to ensure consistency (ONS 2025).

This newly developed SAM captures the production of 16 industries (four main industries plus a fifth, R&D, disaggregated into 12 regions), and the demand for five main commodities by each of the 12 regional households. While we could have further disaggregated these activities, we chose to simplify our analysis to focus on the core issue. However, the model could be adapted later to test a more detailed sectoral breakdown.

We explain in detail below how the SAM was developed.

3.1. Assembling the Social Accounting Matrix

A SAM is a square, double-entry accounting framework in which total incomes (recorded in rows) must equal total expenditures (recorded in columns) within the economy. To construct the UK SAM, we primarily used data from the ONS Use and Supply tables (ONS 2025b). Use tables describe the consumption of inputs (intermediate and final) by industries and final demand sectors. Supply tables describe the output of goods and services by industries.[30]

Table 27 provides the main accounts of a typical SAM. Each cell in the table represents a matrix of many accounts. The SAM is generally structured to summarise the following key accounts:

- **Activities of production:** Including intermediate inputs, value-added and output.
- **Commodity products:** Including total supply (domestic production plus imports) and demand (intermediate use, final demand and exports).
- **Factors of production:** Including payments to labour and capital and their allocation to households and other sectors.
- **Institutions:** Showing transfers within and between households, government and other institutions.
- **Rest of the world:** Including imports, exports and international transfers.

For example, focusing on the 'Households' column, the 'Household consumption' cell is itself a matrix representing the consumption of various commodities (products) by the 12 different UK regions.

30 Read more on ONS National Accounts: https://www.ons.gov.uk/economy/nationalaccounts

Table 27: Main accounts within a SAM

	Activity (production)	Commodity (Products)	Trade margins	Factors	Households	Government	Taxes	Savings-investment	Rest of the world	Sum
Activity (industry)		Domestic Sales								**Total Row**
Commodity (product)	Intermediate consumption				Household consumption	Government consumption		Fixed Capital Formation and change in stocks	Exports	**Total Row**
Trade margins										**Total Row**
Factors (capital + labour)	Gross value added payments to factors								Net factor income from ROW	**Total Row**
Households				Labour and Mixed income	Inter-household transfers	Government transfer to households			Net current transfers from ROW	**Total Row**
Government									Net current transfers from ROW	**Total Row**
Taxes	Taxes on factors or activities	NET taxes on products or imports			Direct Taxes					**Total Row**
Savings-investment					Household Savings	Government Savings		Capital transfers	Neet capital transfer from ROW	**Total Row**
Rest of the world		Imports						Current external balance		**Total Row**
Sum	**Total column**	**Total column**	**Total column**	**Total column**	**Total column**	**Total column**	**Total column**	**Total column**	**Total column**	

To simplify our model and focus on the sectors most relevant in modelling the impact of NIHR funding, we combine all non-health sectors into 'others' and keep five main production sectors:

1. All other
2. Basic pharmaceutical products and pharmaceutical preparations
3. Scientific research and development services
4. Human health services
5. Residential care and social work activities.

We fill in all appropriate cells with data from the ONS Use and Supply tables and verify the consistency of the SAM's aggregate data. We calculate the SAM's Gross Domestic Product (GDP) at market prices in 2022 and compare it with the official national accounts data, finding that it aligns precisely with the reported GDP of £2,526,428m (ONS 2025). We also test three GDP approaches (production, expenditure, and income) to ensure consistency with the national accounts' framework.

By relying on the ONS Use and Supply Tables, the initial SAM structure yields four institutional sectors: 1) an aggregate household account, 2) a non-profit institutions account, 3) local government and 4) central government. However, as our analysis focuses on the general government sector, we aggregate the local and central government accounts into a single general government category after incorporating the supplementary data.

Table 28 summarises the share of final expenditure by agent and industry. Given our focus on healthcare and medical-related products, we bundle all other non-medical goods together. Focusing on medical-related industries, households' private expenditure on pharmaceutical products, human health services, and residential care and social work, taken together, is around 3.3% of households' total consumption. In comparison, the government's expenditure on the products of those four industries is around 48.3% of its total consumption.

Table 28: Share of final consumption (by agent and industry)

		UK Households	Non-Profit Institutions	General Government
c1	All other	96.7%	75%	52%
c2	Basic pharmaceutical products and pharmaceutical preparations	0.8%	0.0%	2.0%
c3	Scientific research and development services and other	0.1%	1.2%	0.0%
c4	Human health services	1.2%	4.7%	37.7%
c5	Residential care and social work activities	1.3%	18.8%	8.6%
	Total expenditure	**100%**	**100%**	**100%**

Note: The table shows the share of final consumption of total expenditure (minor discrepancies in totals are due to rounding).

Source: ONS Use-Supply tables and authors' rearrangements.

3.2. Regional households

Once the aggregate SAM is balanced, we turn towards disaggregating the households into the 12 regions. We disaggregate the aggregate SAM into the UK's main regions by incorporating three additional ONS publications: (1) Gross Disposable Household Income (GDHI) provided in Aggregate and Regional form (ONS 2025), which we cross-check with (2) UK Economic Accounts: institutional sector – households and non-profit institutions serving households (ONS 2025). These disaggregate labour and capital, transfers and receipts. Finally, we use (3) the Regional Household Final Consumption Expenditure as a proxy for disaggregating household consumption expenditure.

First, we use the Aggregate and Regional GDHI, which measures the total income available to households for consumption or savings after accounting for direct and indirect taxes, as well as any direct benefits received.[31] GDHI thus serves as an indicator for the material welfare of the household sector. The household sector includes residents of traditional households and those living in communal establishments. GDHI also includes the business income of self-employed people.

From the GDHI tables, we utilise the Components of Total GDHI at Current Basic Prices (in £m),[32] which provides both the aggregate components of GDHI for the UK and its constituent regions. We derive the regional capital share as the sum of Operating Surplus and Property Income (received) as a proportion of total GDHI capital. Similarly, the regional labour share (i.e. the wage bill) is calculated as the sum of Mixed Income and Compensation of Employees, expressed as a share of total UK GDHI labour. Table 29 summarises these calculations.

Table 29: Share of capital and labour from the UK total

Household	Region	Labour	Capital
HH1	North East	3%	3%
HH2	North West	9%	9%
HH3	Yorkshire and the Humber	7%	6%
HH4	East Midlands	6%	6%
HH5	West Midlands	7%	7%
HH6	East	10%	10%
HH7	London	21%	21%
HH8	South East	16%	17%
HH9	South West	8%	9%
HH10	Wales	4%	3%
HH11	Scotland	7%	7%
HH12	Northern Ireland	2%	2%
UK	**Total**	**100%**	**100%**

31 For further information and explanation, see: https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/datasets/regionalgrossdisposablehouseholdincomegdhi

32 We used Table 7 within the GDHI: https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/datasets/regionalgrossdisposablehouseholdincomegdhi

Similarly, using GDHI, we disaggregate and fill out three additional accounts: 1) the household contribution to social contributions and other transfers to the government (paid); 2) imputed regional household social contributions/ benefits (received) and other transfers (received) from general government; and 3) current taxes on income, wealth and others (paid). As an additional validation step, we ensure that net external borrowing for general government (i.e. central and local government) is calibrated as closely as possible by cross-checking it against the Government Sector Finances (ONS 2025).

Next, we use ONS UK Economic Accounts for Institutional Sectors: households and non-profit institutions serving households to cross-check with GDHI and specifically to fill in cells related to the non-profit institutions serving households.[33] Note that we would have preferred to aggregate non-profit institutions with households, but we kept them separate because of the way the ONS structured its data.

Finally, to disaggregate regional household final consumption expenditure, we incorporate data from the Regional Household Final Consumption Expenditure (RHFCE) for NUTS1 countries and regions (ONS 2025). This dataset, available for the period 2009–2018, provides a detailed breakdown of domestic household final consumption by COICOP (Classification of Individual Consumption by Purpose) commodities, an international classification system developed by the United Nations.

We specifically use *domestic* household expenditure, which measures total spending within a given region, regardless of whether the expenditure is made by residents or foreign visitors. The data aligns with the UK National Accounts (The Blue Book 2019) and the regional GDHI estimates published in June 2020. All figures are reported at current market prices, meaning they do not account for inflation.

Since RHFCE consumption and the SAM industry classification of goods differ, we use the share of RHFCE in total expenditure as a proxy for disaggregating the SAM final consumption. We map sectoral expenditures as follows:

- Sector 1: Represents all other goods except for Health.
- Sector 2: Corresponds to Basic Pharmaceutical Products and Pharmaceutical Preparations in the SAM and is proxied by the RHFCE category Medical Products, Appliances, and Equipment.
- Sector 3: Covers Scientific Research and Development Services in the SAM, which are not consumed by households or the government. Instead, they are exclusively consumed by non-profit institutions or exported and, therefore, do not require any special attention.
- Sector 4: Includes Other Professional, Scientific, and Technical Services, for which there is no direct proxy in the RHFCE data. Therefore, we approximate its regional allocation using the regional GDHI share, consistent with our approach for factor inputs and other components.

This methodology ensures consistency between household expenditure shares and the broader regional economic structure. Table 30 reports the 12 UK regions' share of total UK household expenditure for each commodity.

33 In the EAIS data, we used Tables 6.3.3 and 6.3.4.

Table 30: Share of UK regional final consumption by industry and region

		All Other	Basic pharmaceutical products and pharmaceutical preparations	Scientific research and development services, and other	Human health services	Residential Care & Social Work Activities
		Sector 1	Sector 2	Sector 3	Sector 4	Sector 5
HH1	North East	3%	3%	3%	3%	5%
HH2	North West	10%	11%	10%	9%	11%
HH3	Yorkshire and the Humber	6%	7%	7%	7%	8%
HH4	East Midlands	5%	7%	6%	7%	6%
HH5	West Midlands	7%	8%	8%	11%	8%
HH6	East	9%	12%	10%	11%	10%
HH7	London	22%	13%	19%	16%	16%
HH8	South East	15%	15%	16%	16%	14%
HH9	South West	8%	9%	8%	9%	9%
HH10	Wales	4%	4%	4%	4%	4%
HH11	Scotland	7%	7%	7%	6%	9%
HH12	Northern Ireland	2%	3%	2%	2%	2%
UK	**Total UK**	**100%**	**100%**	**100%**	**100%**	**100%**

Note: The table shows the share of regional consumption of a commodity relative to total UK consumption.

3.3. Disaggregating regional Science R&D firms

Next, we expand Science R&D activities into 12 regional firms. We assume a fixed share of capital, labour, and intermediate inputs for each sub-R&D regional activity.

In the absence of regionally disaggregated data on the gross value added (GVA) of R&D activities, we use regional total R&D expenditure as a proxy to allocate aggregate UK sectoral R&D GVA across the 12 regions. We therefore use ONS data for the 'Country and regional breakdown of expenditure on R&D in the UK: by sector of performance, 2019' (ONS 2025). Table 31 reports the applied shares of regional Science R&D GVA.

Table 31: Regional shares of UK Science R&D GVA

Region	% of UK GVA
North East	1.93%
North West	7.73%

Region	% of UK GVA
Yorkshire and The Humber	4.56%
East Midlands	6.15%
West Midlands	7.57%
East of England	17.90%
London	16.49%
South East	19.55%
South West	6.74%
Wales	2.06%
Scotland	7.24%
Northern Ireland	2.09%
United Kingdom	**100%**

Note: The table shows the share of regional GVA for the Science R&D sectors relative to the UK total. Total UK R&D expenditure, including government, higher education, business and charity funding, has been used as a proxy for regional GVA.

Furthermore, to incorporate regional disaggregation of NIHR funding, the Scientific R&D sector is disaggregated into 12 regional subsectors using regional GVA data from the ONS (ONS, 2018). Next, we disaggregate labour (wage bill) into regional labour. We proxy the share of labour commuters from their home residence to the regional job location to disaggregate the UK-level wage bill into more refined components (ONS 2023). It is important to note that the commuter data does not distinguish the industry in which a commuter works. We therefore had to assume that workers' commuting patterns in the regional R&D sector mirror those of the general working population across all industries. Finally, we adjusted the matrix of regional labourers and regional industries based on informed discretion and constraints imposed within the SAM to balance it.

4. NIHR funding flows in the CGE model

Based on a secondary data analysis of NIHR funding and discussions with the NIHR, we understand that research funding is mainly directed towards the following ONS sectors in the CGE model: 1) Scientific R&D Services and 2) Human Health Services.

Table 32 summarises the overall NIHR spending between 2013/14 and 2017/18 (values translated to 2023/24 price terms using the GDP deflator at market prices). In total, £6.652bn was spent by NIHR in that five-year period, of which around 1.6% was in Human Health Services and 98.4% in Scientific Research and Development Services. The table also provides the actual NIHR spending across these categories by UK region, showing that London received nearly one-third of the overall UK funding.

Table 32: Aggregate spending through the NIHR for 2013/14–2017/18 (£ in 2023/24 price terms)

Region	Health Services	Scientific Research and Development Services	Total
North East	1,235,383	314,375,944	**315,611,327**
North West	5,444,941	555,639,415	**561,084,356**
Yorkshire and Humber	958,064	622,486,805	**623,444,869**
East Midlands	24,988	350,348,438	**350,373,426**
West Midlands	7,186,743	484,872,622	**492,059,365**
East of England	30,282,524	572,973,763	**603,256,287**
London	53,385,181	2,089,779,745	**2,143,164,926**
South East	4,598,694	934,722,766	**939,321,460**
South West	2,053,583	451,467,549	**453,521,132**
Wales	0	34,664,396	**34,664,396**
Scotland	0	118,293,055	**118,293,055**
Northern Ireland	0	17,032,508	**17,032,508**
All	**105,170,099**	**6,546,657,008**	**6,651,827,107**
Share	*1.58%*	*98.42%*	

Our model channels expenditure through the NIHR as a production subsidy, effectively lowering the per-unit price of the subsidised good or service. In the CGE framework, the market price paid by buyers falls, stimulating both final consumption (by households, non-profit institutions and government) and intermediate consumption (i.e. demand from other sectors that use the subsidised good as an input). This drives firms to supply more at a lower price, encouraging greater uptake by consumers and producers alike. As demand rises, the sector expands its use of labour, capital, and intermediate inputs, generating spillover effects throughout the economy. Downstream sectors, such as medical technology, healthcare services and education, may also benefit from enhanced research capacity and trained personnel, amplifying the wider economic impact of expenditure through the NIHR through higher productivity, employment and regional development. The CGE model captures these interlinkages through price and quantity adjustments across all markets, ensuring a consistent general equilibrium response to the subsidy intervention.

For analytical simplicity, we assume that expenditure through the NIHR originates from outside the economy rather than being financed first through domestic taxation and then distributed as R&D funding by the NIHR. This assumption avoids the need to specify multiple tax policy configurations and ensures that household income remains unaffected by potential tax burdens associated with funding the subsidy.

4.1. Crowding in additional industry R&D

In addition to the potential economic effects of public expenditure through the NIHR, Sussex

et. al. (2016) show that public healthcare research spending generates additional private R&D. They found that:

1. Public investment in healthcare research stimulates, or 'crowds in', additional private sector R&D expenditure. Specifically, for every £1 of public funding, there is an associated increase of approximately £0.83–1.07 in private sector R&D investment.
2. Of the total additional private investment, approximately 44% materialises within the first year, with the remainder accruing progressively over subsequent years.

Based on these estimates, we have provisionally calculated the private sector R&D response to the £6.7bn investment through the NIHR. Using the conservative lower-bound estimate of the public-to-private spillover effect (£0.83 per £1 of public funding) and applying the 44% one-year realisation rate, we estimate that approximately £2.4bn of additional private-sector R&D investment has been catalysed. This is likely an underestimation of the actual spillover effect from NIHR funding to private R&D spending, as we only consider the 44% from the lower-bound estimate of £0.83. As Sussex et al. (2016) demonstrated, the full £0.83 spillover effect materialises over about ten years; however, to be conservative, we focus only on the short-term effects of the investments through the NIHR. Like the expenditure through the NIHR, the additional funding generated by the private R&D sector has been modelled as an output subsidy to the sector.

The estimates by Sussex et al. (2016) are for the national level only. To disaggregate the potential private R&D spillovers by region, we use data (see Table 33) published by the Association of the British Pharmaceutical Industry (ABPI) on: 1) the number of research sites, and 2) clinical trial enrolment by UK region (ABPI 2025).

Table 33: Regional weights for private R&D spillovers

Reg code	Reg	Population (million, 2022)	% of the UK population	Clinical Trial Enrolment by Site Location (2022/23)	% Clinical Trial Enrolment by Site Location	Research Sites (2022 /23)	% Research Sites	Weighted Clinical Trials/ Research Sites
H1	**North East**	2.68	3.97%	2,100	4.99%	43	3.57%	4.28%
H2	**North West**	7.52	11.12%	5,800	13.79%	107	8.89%	11.34%
H3	**Yorkshire and The Humber**	5.54	8.19%	2,400	5.71%	43	3.57%	4.64%
H4	**East Midlands**	4.93	7.30%	1,700	4.04%	51	4.24%	4.14%
H5	**West Midlands**	6.02	8.90%	2,500	5.94%	30	2.49%	4.22%

Reg code	Reg	Population (million, 2022)	% of the UK population	Clinical Trial Enrolment by Site Location (2022/23)	% Clinical Trial Enrolment by Site Location	Research Sites (2022 /23)	% Research Sites	Weighted Clinical Trials/ Research Sites
H6	**East of England**	6.4	9.47%	3,700	8.80%	278	23.09%	15.94%
H7	**London**	8.87	13.12%	7,100	16.88%	226	18.77%	17.83%
H8	**South East**	9.39	13.89%	3,100	7.37%	218	18.11%	12.74%
H9	**South West**	5.77	8.53%	3,900	9.27%	31	2.57%	5.92%
H10	**Wales**	3.13	4.63%	775	1.84%	40	3.32%	2.58%
H11	**Scotland**	5.45	8.06%	8,900	21.16%	120	9.97%	15.56%
H12	**Northern Ireland**	1.91	2.83%	80	0.19%	17	1.41%	0.80%

Note: TI private R&D spillovers applied in the analysis based on ABPI data on regional pharmaceutical industry research sites and persons enrolled in clinical trials. The weighted average is calculated using the percentages of clinical trial enrolment and research sites by region, and assigns equal weight (50/50) to each.

Research sites in the pharmaceutical industry vary from large-scale R&D facilities employing thousands of people to small-scale university spin-out facilities. According to the ABPI, they also include specialist contract research organisations which undertake R&D activities on behalf of pharmaceutical companies. It is important to note that the available indicator only includes the total number of research sites by UK region, not their scale.

The ABPI data for regional clinical trials report the number of people enrolled in industry clinical trials by the location of the site that recruited them. (This is an approximation, since where a clinical trial participant lives is not always in the same area as where their trial site is based – trial participants will often travel to access specialist treatment and diagnostics, for example). To approximate where the additional private R&D expenditure will most likely be created, we calculate the regional shares for both indicators, research sites and people enrolled in clinical trials, and then use the average of the indicators for each region. So, for example, we assume in our analysis that London will create 17.83% of the £2.4bn of additional private R&D crowded in by the initial public expenditure through the NIHR. Scotland is assumed to create about 15.56% of the £2.4bn. Note that the relatively large share for Scotland is driven by the higher number of clinical trials conducted in Scotland, according to ABPI data.

The additional industry R&D is modelled in the CGE as an increase in the regional R&D sector's production.

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