Cambridge Biomedical Campus

# Cambridge Biomedical Campus Healthcare Impact Study

**Final Report**

October 2023

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# Executive Summary

## Overview

In August 2022, the Cambridge Biomedical Campus (CBC) published an assessment of its economic impact on the local and wider economy in a report prepared by the Centre for Economics and Business Research (Cebr). The Cebr report quantified the direct, indirect, and induced Gross Value Added (GVA) impact on the UK and local economy, but it was not designed to fully capture the impact of healthcare provision and clinical innovation on the CBC.

To account for this additional impact, this report aims to estimate the healthcare impact of the CBC across three domains: NHS activity, clinical innovation, and biomedical research funding. The main hypothesis being evaluated in this report is that the CBC drives investment in healthcare, increases research funding, and promotes better clinical outcomes, all of which improve health outcomes and lead to economic gains in GVA terms.

## Domain 1: The value of NHS activity

The CBC plays a critical role in delivering patient care through two trusts located on campus: Royal Papworth Hospital NHS Foundation Trust (RPH), Cambridge University Hospitals NHS Foundation Trust (CUH). The Cambridgeshire and Peterborough NHS Foundation Trust (CPFT) also operates on the CBC, providing inpatient mental health services at Cambridge University Hospital, such as inpatient care for individuals requiring intensive mental health treatment.[1] In addition, proposals for a new purpose-built children's hospital, Cambridge Children's Hospital, are well on their way to the final stages of approval, with the Full Business Case (FBC) being developed throughout 2023.[2]

RPH is a specialist acute trust dedicated to the treatment of heart and lung conditions and offers elective care through specialist clinics, diagnostics, surgery, and rehabilitation. RPH treats patients from across the East of England region and from parts of London within various specialties, hosting one of the largest Respiratory Physiology departments in England. CUH is a large acute teaching hospital offering a wide range of services and is a national referral centre for certain specialties. Once built, Cambridge Children's Hospital will be the world's first hospital to fully integrate mental and physical health services, offering personalised and seamless care, supported by cutting-edge research in child health and genomics.

Using a regression model developed by CF, it is estimated that for every £1 invested in the health system, £4 is returned to the economy in the form of GVA. At a trust-level, using a similar approach it can be shown that for every £1 spent on acute trusts, such as those on the CBC, £1.50 is returned in GVA to the economy. Thus, applying this multiplier ratio to the NHS spend on the CBC, and subtracting the GVA expected from employment activity on the CBC (as calculated by the Cebr report previously), it is estimated that a total of £1.15 billion in economic value is derived from healthcare delivered on the CBC.

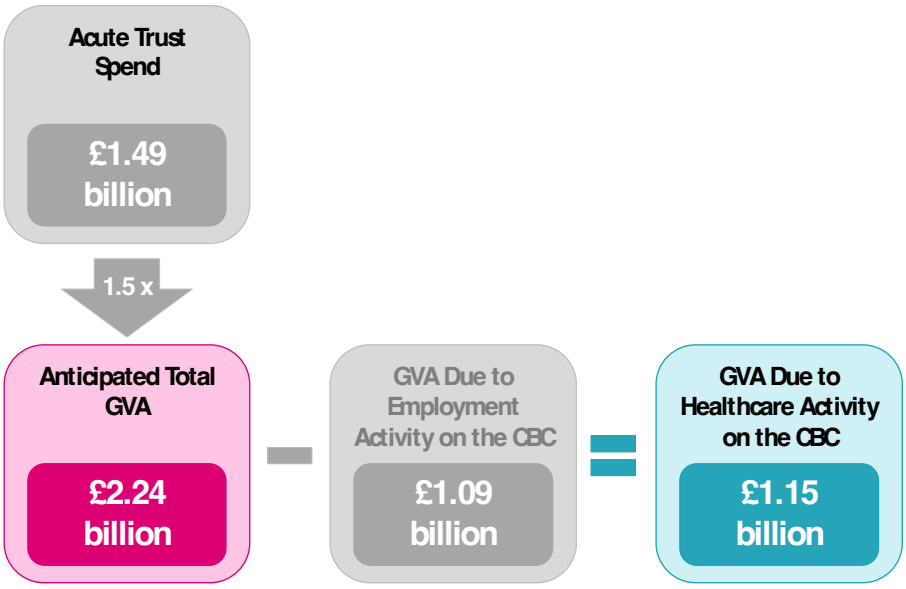
Whilst RPH is already a highly specialised provider of NHS activity, CUH has also driven towards greater specialisation over time, demonstrated by an observed 23% increase in Clinical Oncology hospital spells and 25% increase in Paediatric Cardiology spells since 2019. The increase in complexity necessitates a more skilled workforce across specialties, as well as higher spending on more innovative therapies: thus, the increased complexity and spend on innovative therapies has meant the trusts have seen an overall average 8% increase in NHS

[1] https://www.cpft.nhs.uk/the-s3-ward-environment/

[2] https://www.cuh.nhs.uk/about-us/addenbrookes3/cambridge-childrens-hospital/

spend year on year from 2016/17 to 2019/20, compared to a 4.8% average across all other trusts analysed.

**CF Analysis of Trust spend on the CBC vs anticipated GVA returned to the economy**[3]




## Domain 2: The value of clinical innovations across the local area

Patient outcomes play a significant role in the economic impact of the UK healthcare system on the economy - improving patient outcomes can reduce healthcare costs and increase economic activity.

As part of this report, the impact of patient outcomes from the CBC has been illustrated by analysing mortality rates in cancer, lung, and cardiovascular disease specialties delivered by acute trusts on the CBC. CUH is a major cancer centre with low in-hospital mortality rates, and Cambridge & Peterborough STP have better cancer survival rates for breast, colorectal, and lung cancers than the national average. The analysis has also found that the mortality rate for all cancers in CUH is less than half of the in-hospital mortality rate across England. This lower mortality rate means that an additional 182 lives have been saved at CUH, when compared to what would have happened had the mortality rate matched the national average for 2021/22, of which thirty-four are estimated to be of working age, thereby potentially contributing to the economy more actively.

Analysis shows that CUH and RPH also have lower mortality rates for cardiology specialties than the national average, resulting in an additional eighty-three lives saved. Therefore, it is estimated that lives saved for the working-age population result in a GVA saving of £51.8 million beyond the national average.

## Domain 3: The value of attracting increased biomedical research funding

Research funding, particularly in biomedical research and development (R&D), has a significant economic impact. It contributes to job creation both directly and indirectly, stimulates innovation and commercialisation, generates tax revenues, and attracts additional investment. In the UK, research funding comes from various sources such as public organisations like UK Research and Innovation (UKRI), charitable organisations like the Wellcome Trust, industry funding, university schemes, and international opportunities. These funding sources contribute to the research ecosystem, enabling collaborations and advancements in biomedical research.

[3] CF Analysis: please refer to methodology in the appendix for details of the regression model used to make this estimation. The GVA due to employment activities was calculated previously by the Cebr report.

The Cambridge Biomedical Campus (CBC) which is home to several research organisations, including the University of Cambridge School of Clinical Medicine, provides a concrete example of the economic impact of research funding. The University of Cambridge (UoC) and its School of Clinical Medicine receive substantial research-related income, primarily from public sources and charities. In the 2020-21 academic year, UoC received £734 million in research-related income, resulting in an estimated total productivity of £4.7 billion, in terms of GVA. The School of Medicine within UoC received £220 million, part of which is estimated to contribute an estimated total productivity of £2.03 billion, in terms of GVA. Using models proposed by BEIS, it has also been estimated that an additional GVA of £324 million in productivity is derived from the £46 million public R&D funding received by the MRC LMB on the CBC. These figures demonstrate the economic significance of research funding within the CBC.

The CBC's collaborations with institutions like the National Institute for Health Research, GlaxoSmithKline, the Milner Therapeutics Institute, and AstraZeneca further enhance biomedical research. These partnerships facilitate the exchange of knowledge, resources, and expertise, leading to improved health outcomes and a faster discovery-to-delivery cycle. The presence of the CBC creates an environment conducive to innovation and knowledge creation, as evidenced by Cambridge's high number of patent applications per capita. The CBC serves as a hub for cutting-edge research and development, showcasing the positive economic impact of research funding in driving progress within the biomedical sector.

# About this Report

## Cambridge Biomedical Campus (CBC)

Cambridge Biomedical Campus (CBC) is a world-class research and innovation hub that brings together leading biomedical institutions, including the University of Cambridge, two major hospital trusts in Cambridge University Hospital NHS Foundation Trust (CUH) and Royal Papworth Hospital NHS Foundation Trust (RPH), and several research institutes.

Cambridge is considered one of the leading research and development clusters in Europe, and the CBC is among other leading global innovation clusters which include: Kendall Square in Boston, San Francisco, Oslo, and the Max Planck in Germany.

Several key factors contribute to the CBC's importance and success:

- **Collaboration :** CBC enables collaboration between institutions, researchers, and industry partners, accelerating breakthroughs and innovation
- **Talent pool**: CBC attracts top talent from around the world, fostering a culture of excellence and innovative research projects and funding opportunities.
- **Infrastructure**: CBC offers state-of-the-art facilities and infrastructure, enabling researchers to conduct innovative research and translate discoveries into clinical applications
- **Clinical relevance:** CBC's proximity to major hospitals provides direct access to patients, biosamples, healthcare data, and expertise, accelerating the development of new medical interventions and therapies.

## Cambridge University Health Partners (CUHP)

Cambridge University Health Partners (CUHP) plays a significant role in the development and operation of the CBC.[4] CUHP is one of six Academic Health Science Centres in England whose aim is to improve patient healthcare by bringing together various organisations, including hospitals, clinics, general practitioners, community health services, mental health services, and social care providers. The CUHP partners are Cambridgeshire and Peterborough NHS Foundation Trust, Cambridge University Hospitals NHS Foundation Trust, Royal Papworth Hospital NHS Foundation Trust, and the University of Cambridge. Within the context of the Cambridge Biomedical Campus, CUHP is consistently recognised by NHS and industry leaders in several ways:

- **Collaboration and Partnership:** CUHP acts as a collaborative platform, facilitating partnerships between the University of Cambridge, the NHS Trusts, and other organisations involved in healthcare delivery and research. This collaboration enhances the sharing of expertise, resources, and knowledge.
- **Research and Innovation:** CUHP fosters research and innovation on the campus by promoting interdisciplinary collaboration among researchers, clinicians, and industry partners. This collaboration leads to the development of new treatments, medical technologies, and approaches to healthcare delivery.
- **Education and Training:** CUHP supports education and training programs, ensuring that healthcare professionals and researchers receive high-quality training and remain at the forefront of scientific and medical advancements. This includes medical education, professional development, and training in research methodologies.
- **Clinical Services:** As an Academic Health Science Centre, CUHP supports the delivery of clinical services through its partner NHS Trusts. This involvement helps integrate research findings and innovative practices into patient care, improving outcomes and

[4] https://www.cuhp.org.uk/assets/documents/CUHP-Impact-Review-2018-19.pdf

enhancing the quality of healthcare services provided on the Cambridge Biomedical Campus.

- **Strategic Planning:** CUHP actively participates in the strategic planning and development of the Cambridge Biomedical Campus, working closely with the University, NHS Trusts, and other stakeholders. This involvement ensures that the campus evolves in a way that aligns with the partners' shared vision, goals, and priorities.

Overall, CUHP plays a crucial role to facilitate collaboration, drive research and innovation, support education and training, and enhance clinical services within the Cambridge Biomedical Campus, contributing to the advancement of healthcare and the translation of scientific discoveries into tangible patient benefits.

## Purpose of this report

- The Cambridge Biomedical Campus recently assessed the economic impact of the Campus organisations on the local and wider economy as part of the Centre for Economics and Business Research (Cebr) report.[5]
- The report estimated the direct, indirect, and induced Gross Value Added (GVA) impact on the UK economy and local economy, and briefly touched on the value derived from improvements in health outcomes.
- To build on the Cebr report and articulate the significant impact from healthcare provision, healthcare innovation and increased investment in the NHS – things that the CEBR report was not designed to capture, this report has been produced by CF.
- CF has produced this report by conducting primary analyses and through stakeholder engagement to estimate the impact of the campus across the following domains:
    - **NHS Activity:** the report will test the hypothesis that the CBC drives investment in healthcare in the local area and this in turn translates into economic gain in GVA terms
    - **Clinical innovation**: the report will test the hypothesis that co-location of industry, research and healthcare provision drives higher quality care provision across the catchment area and therefore promotes better overall clinical outcomes and therapy area specific outcomes
    - **Biomedical research funding:** the report will test the hypothesis that the CBC attracts research funding and this in turn increases the absolute economic output of research in the CBC

[5] https://cambridge-biomedical.com/wp-content/uploads/Cebr_CBC-report_03082022.pdf

# Domain 1: The value of NHS activity

## Economic significance of NHS activity

### How the NHS impacts the economy

The National Health Service (NHS) is one of the largest healthcare systems and one of the largest employers in the world with 1.3 million staff. As such, it is a key player in the UK economy, serving as the primary healthcare provider for millions of people across the country. As a publicly funded organisation, the NHS has a significant role in the economic landscape, impacting the economy in several ways. Its significance extends beyond just providing healthcare services to the population, as the NHS also generates employment opportunities, supports, and shapes the way medical research and innovation is conducted, and contributes to overall economic productivity and growth. Understanding the NHS' role in the economy is crucial in evaluating the contribution that healthcare on the CBC has on the wider economy and the benefits it brings to the UK.

One way in which the NHS impacts the economy is through creating employment opportunity – as the biggest employer in Europe, and the world's largest employer of highly skilled professions.[6] The employment opportunities generated by the NHS help to reduce unemployment rates, stimulate consumer spending, and contribute to overall economic stability. Additionally, the NHS creates a multiplier effect in the economy, as the income generated by its employees can be spent in local communities which stimulates economic growth and generates economic activity at regional and national levels.[7]

In addition to employment growth, the NHS also plays a crucial role in research and innovation, as a hub for innovative medical research and development. This contributes to advancements in medical knowledge, technology, and treatments, leading to better healthcare practice and improved patient outcomes. In fact, the unique delivery model in which the NHS delivers its services to its patients, has a significant bearing on the type of research activity the UK can conduct.

Moreover, a healthy population can contribute significantly to the workforce, leading to increased economic productivity and growth. By preventing and managing illnesses, the NHS helps to reduce morbidity and mortality rates, promoting overall population health. When considering the value of wellness, the observed impacts become even more significant. For example, according to the International Public Policy Observatory (IPPO), addressing the issue of poor mental health and wellbeing among NHS staff could potentially save the NHS up to £1 billion annually, as the estimated cost of poor staff mental health and wellbeing currently stands at £12.1 billion per year.[8] Consequently, a healthy workforce is more productive and able to participate actively in the labour market, resulting in increased economic output and growth.

### NHS activity and NHS spend

NHS activity and NHS spend are closely related and have a significant but complex bearing on the economic impact of healthcare. NHS activity refers to the provision of healthcare services such as number of patients treated, and procedures performed. It includes both planned and emergency care, from routine check-ups to specialised treatments. The factors that influence NHS activity can broadly be organised in three categories:

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[6] https://www.longtermplan.nhs.uk/online-version/.../caring%2520for%2520others

[7] https://cambridge-biomedical.com/wp-content/uploads/Cebr_CBC-report_03082022.pdf

[8] https://theippo.co.uk/rapid-evidence-review-economic-analysis-nhs-staff-wellbeing-and-poor-mental-health/

1. **Population context**: Population growth, ageing population and comorbidities, seasonal factors, and public health emergencies impact the type and volume of activity.
2. **Effectiveness of prevention**: Primary, secondary, and tertiary prevention impact the volume of activity.
3. **Services offered:** changes in clinical guidelines and policies and level of specialisation can impact the type of activity.

NHS spend refers to the amount of money that is allocated to the NHS each year for the provision of healthcare services to the population. Broadly, this covers primary care including GP services, secondary care including hospital services and specialist clinics, community care, and mental health.

### Gross Value Added (GVA) as a measure of economic impact

To quantify the economic impact of the organisations on the CBC, GVA will be used as a reference measure. This is a widely used economic indicator that measures the value of goods and services produced by each individual industry or sector. It provides a comprehensive measure of the economic contribution made by different entities and is a valuable tool for analysing the impact of NHS spending on the economy. In context of this study, GVA is expected to provide insights into how healthcare expenditure contributes to economic growth and overall productivity on a broader scale.

## NHS activity on the Cambridge Biomedical Campus (CBC)

Hospitals in the UK can be broadly characterised into three types of hospitals: local district hospitals, acute hospitals, and specialist acute hospitals. These categorisations are helpful to provide a general overview, but actual characteristics of hospitals are complex, and can be influenced by a combination of their scale and the types of services they provide, e.g., those focusing on chronic illnesses, multi-specialty at regional level hospitals, research, and teaching hospitals.

### Where NHS activity is happening

The CBC is home to several world-leading healthcare, research, and academic institutions, and plays a crucial role in delivering patient care, not only across the Cambridge and Peterborough Integrated Care System but also to the wider region and beyond. This report has focused on quantifying the impact of Cambridge University Hospitals NHS Foundation Trust (CUH) and Royal Papworth Hospitals NHS Foundation Trust (RPH) which includes Addenbrooke's Hospital and Rosie (Maternity hospital):

Cambridge University Hospitals NHS Foundation Trust (CUH) is an acute hospital, providing its services through acute inpatient and outpatient channels including emergency admissions, and offers more innovative services and specialised care compared to local district hospitals. It is also a teaching hospital providing a range of services including neuroscience, cancer care and transplantation. It offers both elective and non-elective (emergency) care to patients and serves as a national referral centre for certain specialist services including neurosurgery and genetic testing.

Royal Papworth Hospitals NHS Foundation Trust (RPH) is a leading specialist hospital dedicated to the treatment of heart and lung conditions including transplantation. The hospital is known for its pioneering research and innovative treatments and serves patients across England and beyond. RPH offers elective care through specialist clinics, diagnostics, surgery, and rehabilitation services.

In 2019 RPH relocated to the CBC, closer to the university and commercial partners (including pharmaceutical organisations), to draw on each of their strengths and drive added value from synergies. This has led on several high-profile initiatives: for example, The Heart and Lung

Research Institute opened to bring the university and the NHS closer together and the clinical and research facility opened to run pharmaceutical and non-pharmaceutical trials and to emphasise its national and regional services.[9]

RPH focuses on a narrower set of services but with much greater specialism within them; including pulmonary endarterectomy, balloon pulmonology, angiography and angioplasty, transplant, and Extra Corporeal Membrane Oxygenation (ECMO), and regionally provides services for cystic fibrosis, sleep laboratory, and weaning services for people on ventilation.[10]

### CUH has become more specialised

Overall, NHS activity delivered by CUH and RPH has not grown significantly since pre-covid years. However, analysis as part of this report has demonstrated there has been a growth in activity observed within certain specialties at CUH, indicating a drive towards greater specialisation. The increased specialisation is highly consistent with the strategic aims of the of the hospitals and of the CBC.

This increase in specialisation also indicates that these trusts provide more efficient and effective care, as staff and resources are concentrated on specific areas of expertise. This can lead to better outcomes for patients, improved patient satisfaction, and lower costs.

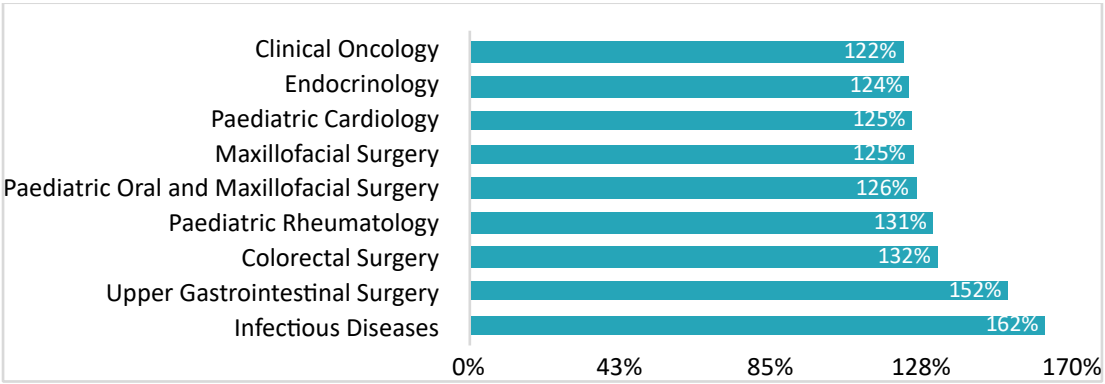
The greater level of specialisation at CUH is demonstrated by the significant growth observed in activity levels across several specialties, despite only minimal growth in total inpatient activity. This observation is based on analysis of the activity data in the NHS Hospital Episode Statistics (HES) Admitted Patient Care (APC) data, which is a national statistical database for England, containing details of all admissions, outpatient appointments, and A&E attendances at NHS hospitals. The APC dataset within HES contains detailed information on each episode of admitted patient care, including patient demographics, diagnoses, procedures, and outcomes.

Analysis of overall activity and specialty-level activity shows that within CUH there has been a 23% increase in the number of Clinical Oncology hospital spells, alongside a 25% increase in Paediatric Cardiology spells since 2019. There is also a significant increase in infectious diseases though this is likely due to COVID-19-related activity. (**Figure 1**).

**Figure 1. Percentage of activity in 2022 compared to 2019 for top ten specialties with greatest growth for CUH:**

[9] Insight from Stakeholders interviewed as part of this study

[10] Insight from Stakeholders interviewed as part of this study




Although CUH has recently demonstrated its increased specialisation, RPH is already established as a highly specialised hospital, delivering specialised care within the fields of heart and lung conditions. RPH treats patients from across the East of England region and parts of London, and hosts one of the largest Respiratory Physiology departments in England.

### Greater specialisation is driving both trusts to treat more complex cases

As specialisation increases, case complexity also tends to increase, due to a higher demand for specialised resources and expertise within the NHS to deliver the care. The connection between specialisation and case complexity within the NHS is intricate and has several factors contributing to it, however, there is an obvious trend towards greater specialisation in both CUH and RPH which can be correlated with their respective spend.

At CUH, there has been a 16% increase in case complexity for non-elective hospital spells since 2019. This means that the cases being treated at CUH have become more complicated over time, resulting in an increased demand for specialised medical expertise and resources. Similarly, RPH has experienced an 11% increase in case complexity for elective spells over the same time-period. This suggests that patients being treated at RPH are presenting with more complex health conditions that require specialised care and resources.

### How case complexity is estimated

Healthcare Resource Groups (HRGs) are used to classify and cost hospital stays and procedures based on their level of complexity: clinically similar treatments, diagnoses, and procedures that require comparable levels of healthcare resources are grouped together, and their unit costs are analysed. The complexity of a procedure is determined by several factors, including the level of expertise and training required, the amount of time needed, and the level of technology and equipment necessary.

To assess the complexity of patient activity, this study calculated the difference in unit cost between groups from 2019 to 2022. Typically, more complex procedures and hospital stays require greater resources and have higher costs, therefore this approach can be used as a proxy to evaluate complexity.

### Increased complexity has contributed to higher overall spend

The increase in complexity necessitates a more skilled workforce across specialties, as well as higher spending on more innovative therapies. Across both trusts, spending on workforce has increased by approximately 10% year on year from 2016/17 to 2020/21, compared to a national increase of 6% year on year. Additionally, drugs spend across the trusts has increased on average by 15% year on year over the same time-period.

As a result, the trusts in the CBC have experienced a greater increase in total spend over time compared to other trusts across England, as evidenced by analysis on trust spend relative to

catchment size. Collectively, the trusts have seen an average 8% increase in spend year on year from 2016/17 to 2019/20, compared to 4.8% average across all other trusts within the dataset.

## Modelling the economic benefit expected from NHS spend at the CBC

### NHS spend can be translated into GVA

As previously discussed, the rising levels of specialisation at CUH and RPH, combined with an increase in the complexity of cases, have resulted in a corresponding rise in NHS spend. To ascertain the true economic impact of NHS Activity on the CBC, it is crucial to translate this spend into expected GVA; by making this translation we are not only able to understand the economic impact of healthcare spend, but also compare this against other industries.

Expression of NHS spend on the CBC in terms of expected GVA is a complex and a multi-variable problem. CF have previously demonstrated the impact of healthcare spend as a whole on economic growth through work completed with NHS Confederation.[11]

To understand how health system spend translates into GVA, the CF methodology used specific economic models and a variety of healthcare and economic data. The approach used a macroeconomic model to estimate the impact of the NHS on the wider economy, considering factors such as workforce productivity and levels of deprivation. Additionally, the model analysed NHS financial data, such as healthcare spending, workforce, and capital investment, to estimate the economic value generated by the NHS. These factors and data points are highly relevant to this impact study of the CBC.

The work ascertained that investing in healthcare systems has a multiplier effect on the wider economy, with every £1 spent by the NHS generating an additional £4 in economic value. The main argument to support the hypotheses that investing in health leads to economic growth is that increasing spending on the NHS results in a healthier population with higher levels of workforce participation. This creates employment opportunities, drives innovation, and improves the health and well-being of the population, which in turn leads to increased productivity and economic growth.

The findings of this model align with other approaches documented in the literature. For instance, a report titled 'Prioritizing health: A prescription for prosperity' highlights the significant economic benefits of investing in health.[12] The authors in the report estimate an incremental economic return of $2 to $4 for each $1 invested, a ratio that closely aligns to the CF methodology. Like the CF model, the report considers various factors, including the reduction of premature deaths, improvements in health conditions, and the removal of barriers to labor force participation. Furthermore, the authors indicate to the value of wellness; highlighting that by promoting physical and cognitive health among workers, these investments can contribute more effectively to expanded employment, increase productivity, and foster economic growth.

### Refactoring the model to estimate GVA for NHS spend on the CBC

The model produced on behalf of NHS Confederation considers a whole-system approach, i.e., including spending across all the settings, primary, community, social care as well as secondary care, and so it cannot be directly applied to acute trust spend in isolation. Therefore, as described in the methodology (**see appendix**), the regression model has been refactored to focus only on acute trust NHS spend.

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[11] https://www.nhsconfed.org/system/files/2022-10/Health-investing-and-economic-growth-analysis.pdf

[12] https://www.mckinsey.com/industries/healthcare/our-insights/prioritizing-health-a-prescription-for-prosperity

### The increased Trust NHS spend within the CBC will return £2.24 billion in GVA

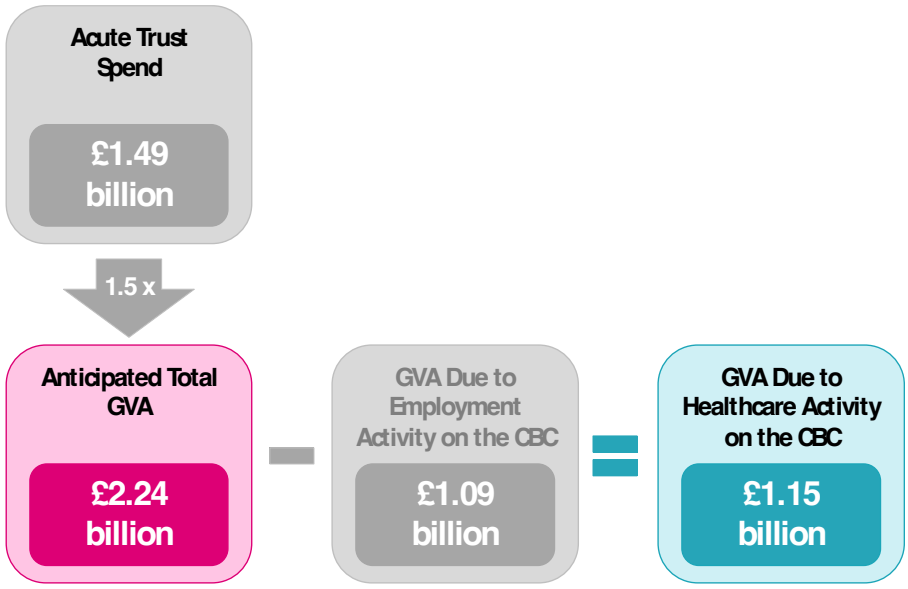
In modelling Trust spend to estimate GVA at a national level, the refactored model estimates that for every £1 spent on acute trusts, £1.50 is returned in GVA to the economy. When applied to the CBC, this equates to a total of £2.24 billion in economic value from healthcare delivered on the CBC, made up of £1.85 billion from CUH, and £0.40 billion from RPH (**Figure 2**).

This finding of £1.50 generated in GVA from trust spend compared to £4 generated from a system-wide spend of £1 is consistent with the notion that a considerable proportion of GVA would, in theory, be attributed to population health management, and preventative care in primary and community care settings – i.e., outside of acute care.

### Refinement of the GVA to include only health-related benefit

The GVA calculation of £2.24 billion derived using the CF methodology includes benefits from employment. To meet the aims of this study, i.e., to include only benefits derived from health-related activity, the employment-related GVA calculated by the Cebre report can be deducted from the £2.24 billion figure. Thus, it is estimated that the additional NHS spend at the Trusts on the CBC corresponds to £1.15 billion (£2.24 billion – £1.09 billion = £1.15 billion); this is illustrated in **Figure 2**

**Figure 2. CF analysis of trust spend to determine an estimate of GVA due to healthcare activity on the CBC. GVA due to employment activity was previously calculated as part of the Cebr report[13]**




[13] https://cambridge-biomedical.com/wp-content/uploads/Cebr_CBC-report_03082022.pdf

# Domain 2: The value of clinical innovations across the local area

## Economic significance of patient outcomes

The translation of NHS Spend to GVA that was estimated in the previous section already provides a reliable indication of the economic impact of the acute trusts on the CBC, but it is important to consider the role that patient outcomes play in some further detail. Patient outcomes are a critical component of the healthcare system, and they have significant economic implications for the UK. Improving patient outcomes can have a positive impact on the economy in two main ways:

1. **Reduced healthcare costs:** When patients have better health outcomes, they are less likely to require costly treatment or hospitalisation. This can lead to significant savings for both patients, and the healthcare system. In addition, improved patient outcomes can lead to shortened hospital stays and reduced readmission rates, which can further reduce healthcare costs.
2. **Increased economic activity:** When patients have better health outcomes, they are more likely to participate in the workforce sector and contribute effectively towards the economy.

### Focusing on mortality rates

Although measuring the impact of improved patient outcomes in terms of DALYs (disability-adjusted life years) and QALYs (quality-adjusted life years) is feasible using different metrics, it remains highly intricate and challenging to arrive at a dependable singular value that is applicable across diverse medical specialties. Therefore, such an approach is beyond the scope of this study. Instead, we advocate for a more appropriate method that highlights the positive economic benefits of patient outcomes and elucidates their impact on the local economy by focusing on mortality rates. To achieve this, we will employ a previously validated methodology that CF has developed, which links the mortality rates of working-age populations to GVA (gross value added).

To illustrate this impact, we will focus on mortality rates seen across three main specialties delivered by the acute trusts on the CBC:

- Cancer
- Respiratory disease
- Cardiovascular disease

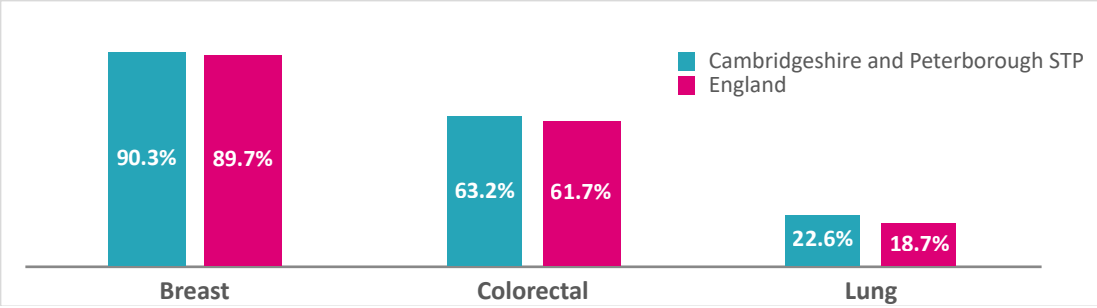
## Modelling the number of additional lives saved

### Economic impact of better cancer survival rates

RPH is a major cancer centre and plays a critical role in the management of cancer patients within the region for several types of cancers. In-hospital mortality rates for cancer patients are low; this is, in the most part, because many treatments can be provided outside of hospital settings such as at outpatient clinics, cancer centres and even at home. This means that it is possible that most patient deaths may occur outside of the hospital setting. Data from the National Disease Registration Service (NDRS) shows Cambridge & Peterborough STP have better cancer survival rates than the national average for 5-year survival rates for breast, colorectal and lung cancers (**Figure 3**). Data is for patients diagnosed from 2004 to 2019.[14]

[14] https://digital.nhs.uk/data-and-information/publications/.../2004-to-2019

**Figure 3. Five-year cancer survival rates for Cambridge & Peterborough STP (includes both CUH and RPH) and England, for patients diagnosed from 2004 to 2019**




To understand the mortality rate for patients during hospitalisation and up to 30 days following discharge, Summary Hospital-level Mortality Indicator (SHMI) data was analysed. It was found that the mortality rate for all cancers in CUH is less than half of the mortality rate seen across England (3.8% vs 8.4%), and is lower for cancers of the colon, lung, and pancreas.

To quantify the impact of these survival rates on patients of a working age population, it is important to also know the age of the patients in the SHMI data. However, this information is not available from the SHMI dataset, so, as an alternative, the Hospital Episode Statistics data (HES) can be used. The HES data set itself has a limitation that it includes only mortality during hospitalisation – i.e., does not account for mortality outside of the hospital.

Using the HES dataset, analysis shows that across all cancers, CUH mortality rate is 0.4% compared to 1.1% nationally for 2022/23 year to date. This means that CUH has seen an additional 182 lives saved than would have been saved if the national mortality rate were applied; of these, 34 are of working age and most applicable to this analysis.

## Respiratory disease

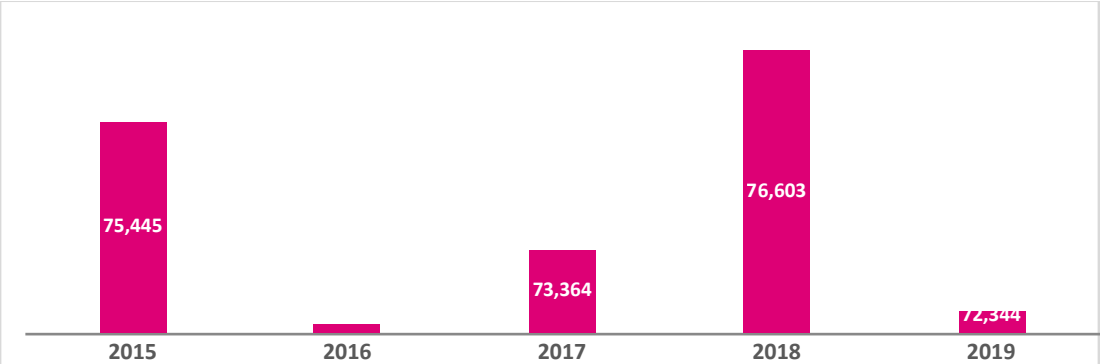
Respiratory disease is a major public health concern in the UK, with high rates of hospital admissions, emergency department visits, and GP consultations, it has a significant impact on population health, and the UK economy. According to surveys of the general population, reported by the British Lung Foundation, approximately 12.7 million people in the UK (approximately 1 in 5) have a history of asthma, COPD, or another longstanding respiratory illness. The annual cost of respiratory disease to the NHS is estimated to be £11 billion. The most common respiratory conditions are asthma and chronic obstructive pulmonary disease (COPD), which together account for a considerable proportion of respiratory-related deaths.

Respiratory disease is a major public health concern in the UK, with high rates of hospital admissions, emergency department visits, and GP consultations; it has a significant impact on population health, and the UK economy. According to surveys of the general population, reported by the British Lung Foundation, approximately 12.7 million people in the UK (approximately 1 in 5) have a history of asthma, COPD, or another longstanding respiratory illness,[15] and annual mortality in England and Wales involving respiratory diseases averaged 74K between 2015 and 2019, (**Figure 4**).

**Figure 4. Yearly deaths in England and Wales involving respiratory diseases, in thousands.**[16]

[15] https://statistics.blf.org.uk/lung-disease-uk-big-picture - :.....for males and females.

[16] https://www.ons.gov.uk/aboutus/transparencyandgovernance/freedomofinformationfoi/.../




The annual cost of respiratory disease to the NHS is estimated to be £11 billion.[17] The most common respiratory conditions are asthma and chronic obstructive pulmonary disease (COPD), together accounting for a considerable proportion of deaths.

Improving access to care, promoting early diagnosis and prevention, and supporting patients to self-manage their conditions are key strategies for managing respiratory disease. The NHS Long Term Plan has set out several ambitious targets for improving respiratory health outcomes, including reducing hospital admissions and deaths from respiratory disease.

As a leading specialist hospital focusing on the diagnosis and treatment of heart and lung conditions, RPH plays a significant role in the management of lung conditions, including lung cancer, chronic obstructive pulmonary disease (COPD), interstitial lung diseases, and cystic fibrosis, among others. To accurately evaluate the hospital's impact, it is essential to acknowledge that lung cancer patients may face an elevated risk of respiratory infections and other respiratory conditions. Therefore, assessing the overall mortality rate related to respiratory conditions, rather than outcomes for lung cancer alone, can offer a more comprehensive view of patient outcomes and provide valuable insights into the effectiveness of the hospital's care.

Mortality rates for major respiratory diseases at both a national level, and for RPH and CUH were identified to work out how many more people are alive in the past year than would be if treated elsewhere.[18] This analysis has found that the mortality rate seen across respiratory conditions for RPH is substantially lower than the national mortality rate at 0.5% compared to 4.4% for 2022/23 year to date. This results in 144 additional lives saved compared to the expected national mortality. Analysis of the mortality rate seen within CUH over the same period shows that an additional fifty-nine lives are saved, equating to 203 total additional lives saved for the CBC due to improved patient outcomes compared to national. Looking specifically at the working age population, this equates to thirty additional lives saved across RPH and CUH – which can be translated into an estimated GVA.

### Cardiovascular disease (CVD)

Cardiovascular disease (CVD) is an umbrella term for diseases of heart and circulation, including inherited conditions and conditions that develop in life such as coronary heart disease (CHD), atrial fibrillation (AF), heart failure and stroke.[19] The NHS Long Term Plan (LTP) has outlined detailed strategies and targets to support the prevention of 150,000 heart attacks, strokes, and dementia cases, making CVD the largest area where the NHS can save patient lives over the next 10 years. Despite recent medical advances, CVD remains one of the largest

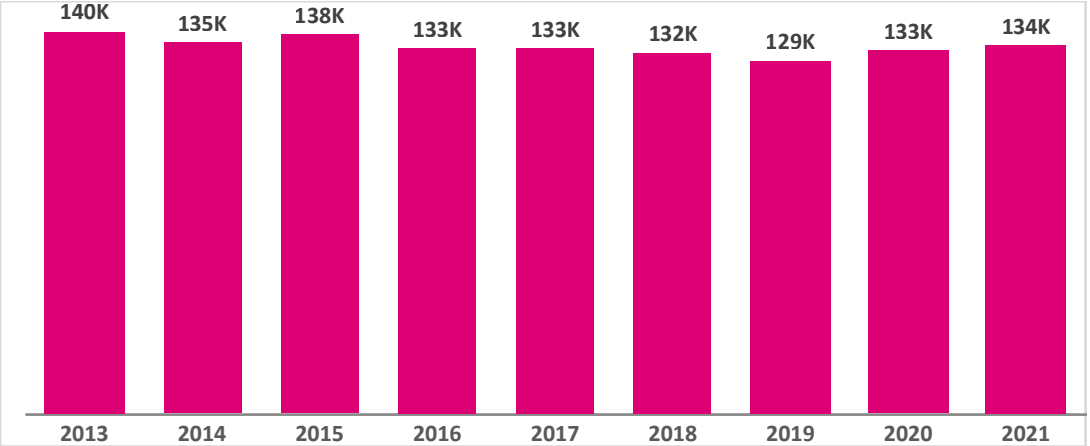
[17] https://www.england.nhs.uk/ourwork/clinical-policy/respiratory-disease/

[18] https://digital.nhs.uk/.../statistical/cancer-survival-in-england/index-for-clinical-commissioning-groups-2004-to-2019

[19] https://www.bhf.org.uk/what-we-do/our-research/heart-statistics

causes of death and disability in England (**Figure 5**);[20] the number of premature deaths linked to CVD is on the rise for the first time in 50 years.[21] CVD is also the largest driver of inequalities in life expectancy in England[22] and individuals in England's most deprived areas are 4 times more likely to die prematurely from CVD over those in the least deprived areas.[23] Tackling CVD prevention represents a promising solution to further reduce health inequalities and work towards meeting the NHS Long Term Plan (LTP) targets.[24]

**Figure 5. Yearly deaths in England and Wales involving diseases of the circulatory system, in thousands.**[25]




CUH provides a comprehensive range of cardiology services while RPH specialises in heart and lung transplantation, as well as advanced cardiology care including surgery, heart failure management, cardiac rehabilitation, and interventional cardiology procedures. RPH has elevated levels of activity within cardiology specialties, approximately 200% more than the level delivered within CUH.

Analysis of activity data across cardiology specialties shows that mortality rates for both RPH and CUH are lower than national, at 0.9% across both trusts, compared to 1.6% nationally. This results in an additional eighty-three lives saved across the trusts than if the national mortality rate was applied, of which eleven lives saved are of working age.

## Quantifying economic impact of reduced mortality

By using the lives saved from working age population as a measure, we are assuming this population is mostly healthy and contributes to the economic output. We apply assumptions on the proportion of the working age population who is in full time employment from ONS which is 75.7%.[26] GVA from predominantly Urban areas (excluding London) was £51,700 per workforce job.[27] As summarised in **Table 1**, the lives saved result in a GVA saving of £51.8

[20] https://www.bhf.org.uk/for-professionals/healthcare-professionals/.../the-cvd-challenge/the-cvd-challenge-in-england

[21] https://www.heartuk.org.uk`/downloads/health-professionals/heart-uk-cvd-prevention-policy-paper---july-2019.pdf

[22] https://analytics.phe.gov.uk/apps/segment-tool/

[23] https://www.gov.uk/government/publications/.../health-matters-preventing-cardiovascular-disease

[24] https://www.bhf.org.uk/-/media/files/for-professionals/research/heart-statistics/bhf-cvd-statistics-uk-factsheet.pdf

[25] https://www.nomisweb.co.uk, Mortality statistics - underlying cause, sex and age, ICD-10 codes included: I00-I99 IX Diseases of the circulatory system.

[26] https://www.ons.gov.uk/employmentandlabourmarket/.../employmentintheuk/march2023

[27] https://www.gov.uk/government/statistics/rural-productivity/...2020

million – this value represents the additional saving above and beyond the national average. It is important to note that this represents the total number of additional lives saved, beyond the national average.

**Table 1. Summary of lives saved across three specialties and the corresponding economic impact**

| Specialty | Total number of additional lives saved | Working-age lives saved above national | No. in employment | Average age | GVA 1 year (000's) | GVA total for working years remaining (000s) |
|---|---|---|---|---|---|---|
| Cancer | 182 | 34 | 26 | 51 | £ 1,331 | £ 21,251 |
| Respiratory | 203 | 30 | 23 | 48 | £ 1,174 | £ 23,834 |
| Cardiology | 83 | 12 | 9 | 54 | £ 470 | £ 6,692 |
| **Total** | | | | | | **£ 51,777** |

# Domain 3: The value of attracting increased biomedical research funding

## Economic significance of research funding

### How investment in biomedical R&D contributes to the economy

Investments in biomedical research and development have a significant impact on GVA and the wider economy, as they lead to additional economic activity and generate money that flows back into the economy. This is achieved through various channels:

1. **Job creation:** R&D creates jobs directly in the research sector, for example, primary investigators, post-doctoral fellows, and other specialist roles, as well as indirectly in related functions and industries. This job creation can boost employment levels, increase wages and salaries, and reduce unemployment rates, but also increase spending in the local economy.
2. **Innovation and commercialisation:** R&D is a key driver of innovation, which can lead to the development of new products and services with commercial value. This commercialisation can result in the creation of new businesses, the expansion of existing ones, and the generation of revenues and profits that contribute to the economy.
3. **Tax revenues:** As the biomedical research and development presence grows, it can generate additional tax revenues for the UK economy. These revenues can be used to fund public services and infrastructure, which in turn can contribute to the overall economic growth.
4. **Attraction of further research funding:** Successful biomedical research and development can attract further funding from public and private sources, which can create a cycle of innovation, investment, and economic growth.

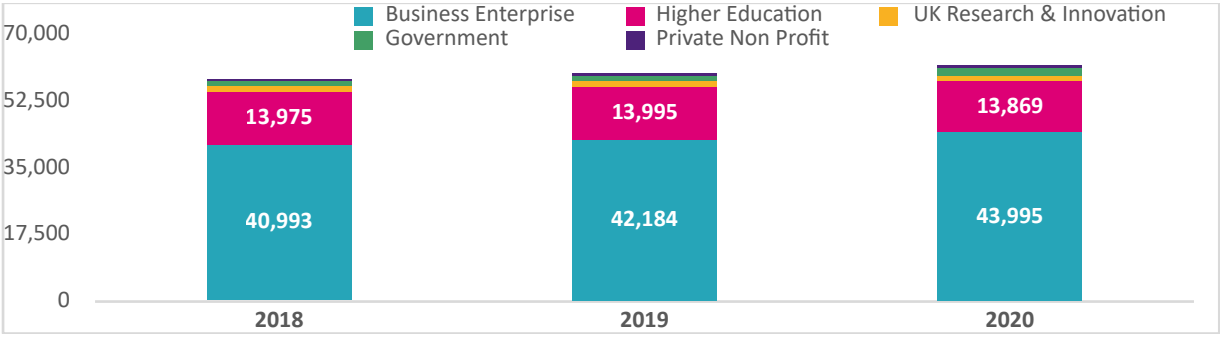
### UK Research funding landscape

The research funding landscape in the UK is dynamic and highly competitive, with a diverse range of funding sources available to support research projects and initiatives. Two main sources of research funding were assessed for this study:

1. **Public funding mainly from UK Research and Innovation (UKRI), including UK research councils and Research England:** UKRI is a government-funded agency that oversees and coordinates research and innovation activities across the UK; it encompasses several funding councils including the Medical Research Council (MRC) and Biotechnology and Biological Sciences Research Council (BBSRC), as well as the National Institute for Health Research (NIHR).
2. **Non-public funding bodies:** this encompasses a range of other funding bodies, and for the purposes of this study these organisations will be considered as private-sector funding bodies:
    a) **Charitable funding:** examples of such organisations include the Wellcome Trust, Cancer Research UK (CRUK), and the British Heart Foundation (BHF). These charities often have specific research priorities and provide funding through grants and fellowships to support innovative research in various areas of biomedical sciences.
    b) **Industry funding:** Pharmaceutical and biotech companies may also provide funding for research projects through collaborations, partnerships, and other arrangements. These industry-funded projects often focus on applied research and development of new therapies, diagnostics, or medical technologies.
    c) **University funding**: The University of Cambridge, as a major academic institution on the CBC, also provides funding for biomedical research through its internal funding schemes, including research grants, fellowships, and awards.

d) **European and international funding**: Researchers can also access funding from European and international sources, such as the European Research Council (ERC). These funding opportunities often support collaborative research projects involving multiple institutions and countries.
e) **Philanthropic funding:** Private philanthropic foundations and donors may also provide funding for biomedical research, and these sources can vary widely in terms of focus areas and funding mechanisms.

**Figure 6. Research and development expenditure within the UK by organisation, in £m**[28]




## The Impact of Research Funding on the CBC

The diversity of the organisations on the CBC mean that gathering a single consolidated financial picture of all the incoming research funding into the CBC is not readily possible. Therefore, this report will instead seek to use the funding data available for the University of Cambridge, and where possible for the School of Clinical Medicine, to provide an indicative estimation of the GVA impact of R&D funding on the CBC. It is important to note that this represents an underestimation of the actual funding overall, and thus the true GVA impact will be larger when all organisations on the CBC are accounted for.

### Research Funding and GVA at the UoC

According to a London Economics report commissioned by the University of Cambridge looking into the economic impact of the university, UoC received funding from several sources **(Table 2).** In aggregate, UoC received £734 million in research-related income during the 2020-21 academic year, ranking it as the second highest-receiving university in the UK for research funding. Notably, a total of £346 million came from public sources; £146 million coming from Research England and £200 million from the UK Research Councils.[29]

**Table 2. Research income received by the University of Cambridge in 2020-21, £m by source**

| Source | Amount (£m) | Proportion (%) | Multiplier |
|---|---|---|---|
| Research England | **146** | **20** | **0.2** |
| UK Research Councils | **200** | **27** | **12.7** |
| UK Charities | **161** | **22** | **12.7** |
| Other UK Research Grants and contracts | **76** | **10** | **0.2** |
| EU Research Grants and contracts | **65** | **9** | **0.2** |
| Non-EU Research Grants and contracts | **87** | **12** | **0.2** |

[28] https://www.ons.gov.uk/.../ukgrossdomesticexpenditureonresearchanddevelopment2020designatedasnationalstatistics

[29] https://www.cam.ac.uk/system/files/le_-_economic_and_social_impact_of_university_of_cambridge_-_final_report.pdf

The authors applied multipliers from the existing literature to the different types of research-related income received by the University of Cambridge in 2020-21. They assigned the multiplier of 12.7 to funding received from UK Research Councils and UK charities (amounting to £361 million) and assigned a multiplier of 0.2 to all other research funding received (amounting to £373 million). Therefore, estimating that the research conducted by the UoC in 2020-21 resulted in total productivity of £4.7 billion.

### Refinement to determine GVA at the Clinical School only

In aggregate, the school of medicine is understood to have received £220 million in research-related income during the 2020-21 academic year. For the purposes of this report, only the funding sources described in **Table 3** for the clinical school were used to refine the UoC model to estimate a corresponding GVA amount resulting from this funding to the School of Medicine. This is because multiplier effects are not readily available for the other funding sources to enable calculations with sufficient confidence. This means that the GVA estimated will be an underestimate, and the true GVA is expected to be even higher.

**Table 3. Subset of research income received by the University of Cambridge School of Medicine in 2020-21, £m by source**

| Source | Amount (£m) | Proportion (%) | Multiplier |
|---|---|---|---|
| UK Research Councils | **62** | **28** | **12.7** |
| UK Charities | **98** | **45** | **12.7** |

Applying the multipliers used for UoC to the different types of research-related income received by the University of Cambridge School of Medicine in 2020-21, indicates that the research conducted by the School of Medicine in 2020-21 resulted in total productivity of £2.03 billion.

### GVA Estimate for the MRC Laboratory of Molecular Biology (LMB) on the CBC

It is also possible to use Department for Business, Energy & Industrial Strategy (BEIS) models to estimate the GVA productivity of the MRC LMB on the CBC. **BEIS has estimated that every £1 in R&D spend may ultimately result in up to £7 in GVA.** Greater levels of public funding help to increase the level of private R&D funding.[30] Within a given year, £1 of public R&D investment in the UK stimulates between £0.41 and £0.71 of private R&D funding. Additionally, public investment continues to influence private spending in subsequent years, where the long-run leverage rate means that every £1 of public spend stimulates between £1.96 and £2.34 of private spend, resulting in a total economic impact of £7.[31] Using data provided by the MRC LMB, it is estimated that public R&D funding of £46.4 million (£46.02 million + £0.40 million) from the UKRI translates into £324 million of added productivity on the Biomedical Campus (**Table 4**).

**Table 4. Summary of R&D funding received by the MRC LMB in 2020/21[32]**

| Source | Amount (£m) | Proportion (%) | Multiplier |
|---|---|---|---|
| Core funding (MRC as part of UKRI) | **46.02** | **80%** | **7.00** |
| Charities | **4.64** | **8%** | **7.00** |

[30] https://commonslibrary.parliament.uk/research-briefings/sn04223/

[31] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897470/relationship-between-public-private-r-and-d-funding.pdf

[32] Source: Office of Finance and Research Contracts, MRC Laboratory of Molecular Biology

| | | | |
|---|---|---|---|
| Other UKRI | **0.40** | **1%** | **7.00** |
| EU | **3.73** | **6%** | **7.00** |
| Universities | **0.18** | **0%** | **7.00** |
| Industry | **1.64** | **3%** | **7.00** |
| Other including supplementary council awards | **1.00** | **2%** | **7.00** |

### Other notable Funding and Partnerships Advancing Biomedical Research

In partnership with the University of Cambridge, CUH hosts a NIHR Biomedical Research Centre (BRC), a NIHR Clinical Research Facility (CRF), a NIHR Experimental Cancer Medicine Centre, and a NIHR Brain Injury MedTech Co-operative. The UK Clinical Research Collaboration (UKCRC) registered Cambridge Clinical Trials Unit (CCTU) and Cambridge Epidemiology and Trials Unit (CETU) deliver research in priority areas of health and social care and public health across all phases of clinical trials, involving NHS organisations, academia, and industry. Leading on innovative trial design, CCTU has membership on UKCRC national working groups and provides leadership of the CCTU Early Phase Statistics Group.

The NIHR Cambridge CRF is a founding member of UK CRF Network, unifying, streamlining, and sharing good practice in operational management to ensure efficient and effective study delivery, and drive forward initiatives that improve the quality of patient experience. Outputs have included guidelines and tools to support operational excellence and workforce development.

CUH also hosts the NIHR BioResource, a national recallable resource involving over 120 NHS organisations, over 250,000 volunteers from the general population, and patients with rare and common diseases. It is one of four key infrastructures supporting population level genomic projects in the independent 'Life Science: Industrial Strategy', from the Office for Life Sciences.[33] The NIHR BioResource Rare Diseases led the Genomics England 100,000 Genomes pilot, providing evidence for the utility of whole genome sequencing in the NHS and changing healthcare policy.

As a member of the Health Data Research (HDR) UK Research Alliance CUH is establishing best practice for using health research data at scale. CUH led the HDR UK Sprint Exemplar project in rare diseases and hosts the HDR UK Gut Reaction Health Data Research Hub in inflammatory bowel disease.

CUH also hosts the East Genomics Medicine Service Alliance and East Genomic Laboratory Hub supporting the rapid adoption of scientific advances in genomics.

As a member of the East of England Clinical Research Network, CUH has the highest rate of recruitment to interventional and observational studies across all secondary care organisations within the Local Clinical Research Networks (LCRN), recruiting 37.5% (16,642) of participants across all Trusts in 2021/2022.

The wider Cambridge Biomedical Campus facilitates research collaborations and translation with those co-located on the CBC including:

- **GlaxoSmithKline's (GSK) Clinical Unit Cambridge** specialising in Phase I/II trials with multiple collaborative projects across themes

[33] https://www.gov.uk/government/publications/life-sciences-industrial-strategy

- **The Milner Therapeutics Institute** with >£6million funding from Astex/AstraZeneca/ Ferring/EliLilly/BristolMyersSquibb/GlaxoSmithKline/Janssen/Shionogi/Pfizer and Eisai to develop pre-competitive research Consortia
- **AstraZeneca**'s new global headquarters and R&D centre

In addition, the CBC is integral to the broader Cambridge University Health Partners life science strategy to accelerate the cycle of discovery to delivery. This strategy will be delivered throughout the region's biomedical ecosystem, which includes 330 life science businesses. The CBC enhances the functioning of the network, taking innovations in early diagnostics and personalised medicine through to adoption and spread, facilitated by the NIHR Applied Research Collaboration and Eastern AHSN.

As noted in the Cebr report, 80% of organisations on the CBC believe that their organisation would have developed slower or significantly slower without location on the CBC.[34] A similar proportion also indicated that they would have been less effective in improving health outcomes had they not been located on the CBC. In fact, stakeholder interviews as part of this report highlighted programs such as the Blue Sky collaboration between the MRC Laboratory of Molecular Biology (LMB) and AstraZeneca (AZ) as notable initiatives.[35]
Established in 2014, the Blue Sky collaboration is a research fund that supports pre-clinical research projects focused on advancing knowledge of fundamental biology and disease. With contributions of approximately £12 million from AstraZeneca and approximately £6 million from LMB, the fund is overseen by a joint Steering Committee comprising members from both organisations; the funding has enabled existing research and development activities of the respective organisations, leading to numerous publications in peer-reviewed journals.[36]

Increased research funding can result in enhanced research capacity, expanded research programmes, attraction of high-quality researchers, and promotion of collaboration, all of which contribute to the generation of patents, publications, citations, and other economically significant outputs.

In fact, Cambridge has been reported to have the highest number of patent applications per 100,000 residents in the UK,[37] thus highlighting the tangible outcomes of increased research funding on the CBC's innovation and knowledge creation **(Table 4)**.[38]

**Table 4. Top 10 cities with highest Patent applications 2020 (per 100,000 of population):**

| Rank | City | Patent applications 2020 (per 100,000 of population) |
|---|---|---|
| 1 | **Cambridge** | **259** |
| 2 | **Derby** | **131** |
| 3 | **Oxford** | **79** |
| 4 | **Coventry** | **76** |
| 5 | **Aberdeen** | **48** |

[34] https://cambridge-biomedical.com/wp-content/uploads/Cebr_CBC-report_03082022.pdf

[35] https://www2.mrc-lmb.cam.ac.uk/research/blue-sky-collaboration/

[36] https://www2.mrc-lmb.cam.ac.uk/research/blue-sky-collaboration/

[37] https://www.centreforcities.org/wp-content/uploads/2017/01/Cities-Outlook-2017-Web.pdf, PATSTAT, January-December; Intellectual Property Office, Patents granted registered by postcode, January-December; ONS, Population estimates. Note: Previous version of this tool and of the Cities Factbook used only UK patents.

[38] https://cambridge-biomedical.com/wp-content/uploads/Cebr_CBC-report_03082022.pdf

| | | |
|---|---|---|
| 6 | Bristol | 40 |
| 7 | Edinburgh | 33 |
| 8 | Cardiff | 29 |
| 9 | Aldershot | 29 |
| 10 | Gloucester | 29 |

# Appendix

## Methodology

### Fixed regression model to translate trust spend into GVA

A fixed regression model was developed to find the coefficient between trust spend and GVA. The modelling looked at spend from 138 acute trusts across England and their respective catchments from 2016/17 to 2019/20. GVA per head data available at ITL3 level, which is counties, unitary authorities, or districts in England, is used to account for regional variation. For this reason, trust spend, and catchment were aggregated to ITL3 level to enable comparison.

To perform fixed effects regression analysis between trust spend per head and GVA per head, the following equation was used:

$$Y_{it} = \beta X_{it} + \alpha_i + u_{it}$$

- $Y_{it}$ is the outcome variable, GVA per head, for a given ITL3 (i) and year (t).
- $\beta$ is the coefficient for the regression variables ($X_{it}$), in this case spend per head relative to need and time in years.
- $\alpha_{\text{I}}$ is the fixed effects associated with factors such as IMD and $u_{it}$ is the error term.

The dependent variable in the model is GVA per head and the independent variable is trust spend per head and time in years. A fixed effects regression is used to allow for differences between ITL3s.

### Significance of results

**Spend p-value 0.013:** The p-value of the model is a measure that helps determine the statistical significance of a coefficient estimate in a regression model. A p-value below 0.05 is considered to indicate statistical significance. In this case, the p-value for spend variable is 0.013, suggesting that there is a statistically significant relationship between the independent variable 'spend' and the dependent variable 'GVA' in the regression model.

**R-squared 0.639**: The r-squared value, also known as the coefficient of determination, is a measure of the proportion of the total variance in the dependent variable that is explained by the independent variables in the regression model. The R-squared value of 0.639 in this model indicates that approximately 63.9% of the variance in the 'GVA' variable can be explained by 'spend' and 'time' variables in the regression model.

## Data used within the regression model

| Data | Source | Granularity | Adjustments |
|---|---|---|---|
| **Trust spend** | NHS England TAC data in providers | Operating expenditure (TAC Op Ex)<br>Years 2016/17 to 2019/20 | Catchment size needed to be projected to ITL3 alongside spend data to ensure accurate spend per head calculations at ITL3 level. This was done using the following approach:<br>• MSOAs were mapped to ITL-3s, and total catchment size was summed per ITL-3<br>• The proportion of catchment between each ITL-3 for a single trust was used to split the trust spend by ITL-3<br>• Trust spend and catchment was then summed across a given ITL-3, and spend per head was calculated as total spend divided by total catchment |
| **Trust catchment** | Office for Improvement & Disparities (OHID), NHS Acute (Hospital) Trust Catchment Populations | All admissions Catchment per MSOA | |
| **Gross value added (balanced) per head of population at current basic prices** | Office for National Statistics | ITL<br>ITL Code<br>Year<br>GVA per head<br>Years 2016/17 to 2019/20 | N/A |
| **Indices of Deprivation (2019)** | GOV.UK | LSOA (2011 geography)<br>Index of Multiple Deprivation (IMD) score | • 2019 values were assumed constant across all years<br>• IMD scores were projected from local authority to ITL3 using population weighted average |

## Regression model assumptions and considerations

In deriving an estimate for the GVA, several assumptions were necessary. These assumptions should be considered while evaluating the results.

- The model assumes that the relationship between spend and GVA for the latest year is based on the same factors as previous years, such as factors affecting GVA, including utilisation, which have remained stable or have not significantly changed over time.
- Although the model does not account for additional factors such as economic fluctuations, it does exclude data for COVID year 2020/21 due to the significant increase in hospital spend during this period. Including this data could potentially distort the model and provide an inaccurate view of the relationship between trust spend and GVA.
- Deprivation was accounted for using the Index of Multiple Deprivation (IMD) score, however after careful analysis this was excluded due to reducing model accuracy. The rationale for this being that IMD has a greater impact on value-add of healthcare outside of the acute setting.
- Linear regression can describe a correlation between two variables, but it does not establish causation. To further understand the impact of Trust Spend, additional analysis would need to be conducted, accounting for a wider range of variables that may influence GVA.
- It is important to note that the latest available trust spend data is for the years 2021/22, and 2022/23 year is expected to be published within Q1 of 2023. The calculated GVA figure can be recalculated using the latest figures of overall trust spend, once available.

### Assumptions supporting healthcare outcome analyses

- It should be noted that the values calculated in Domain 2 represents mortality only in three specialties. These specialties make up only 18% of total activity across CUH and RPH.
- First domain value of £2.24 billion already accounts for morbidity more broadly, and this analysis does not, as it covers only mortality.
- It is expected that the true economic impact is bigger, if QALY and DALY savings were also considered, and additional activity is accounted for.
- Morbidity and mortality would have significant impact across all age groups (this model only focused on mortality in working age group) – would impact use of community and social care services which may represent costs to the NHS.

### NHS activity

- Activity levels analysed using NHS Hospital Episode Statistics (HES) Admitted Patient Care (APC)
- All spells were grouped by treatment specialty.
- Data was analysed for January 2022 to December 2022, and compared to the same months in 2019, pre-COVID.

### Case complexity

- Case complexity is calculated by comparing the difference in unit cost per groups of patient activity using Healthcare Resource Group (HRG) code.
- Both APC and Emergency Care Dataset (ECDS) from HES were analysed for years 2019 and 2022.
- 2019 HRG base tariff prices are used as a proxy for complexity.
- Activity cost is calculated based on volume of spells for a given HRG and the associated price.
- All HRG activity cost is summed over a month and divided by the total number of spells to give an average spell cost per month.
- The average spell cost for a month is divided by the average spell cost for the same month in 2019 to produce a complexity index.

### Workforce and drugs spend

- NHSE Trust Accounts Consolidated (TAC) data was analysed for latest data for years 2016/17 to 2019/20.
- Trust catchment data, which is provided at the Middle Layer Super Output Area (MSOA) was obtained from Office for Health Improvements & Disparities (OHID).[39]
- Workforce and drug spend data from TAC data was adjusted based on the overall catchment size per trust, and year-on-year growth was calculated.
- In total, data was available for one hundred acute trusts.

[39] https://app.powerbi.com/view?r=...//1hZDQ3LTVmM2NmOWRlODY2NiIsImMiOjh9