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York Health Economics Consortium

The Added Value of NIHR Biomedical Research Centres – Productivity Assessment

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1. Introduction

As part of the update to the 2020 economic analysis of the added value of Biomedical Research Centres (BRCs), the Department of Health and Social Care (DHSC) asked York Health Economics Consortium (YHEC) to explore the productivity impact of the National Institute for Health and Care Research (NIHR) funding to BRCs.

In a scoping report produced in December 2024, YHEC proposed that whilst productivity could be considered in different ways, the focus of research would be on:

- Improving productivity at a national level by improving the health of the workforce.
- Improving outcomes or efficiency in specific care pathways through improved capital levels that improve treatments or processes. The scoping report specifically mentioned human capital, but other types of capital – social, cultural and physical - would also be relevant.

Following the scoping report, YHEC recommended that the case study work should also try to identify projects that have improved the productivity of the NHS by supporting staff to return to work or to maintain the ability to work, or projects that have improved national productivity by supporting people to return to work or maintain the ability to work.

The scoping report suggested a two-fold approach:

- A targeted literature review to identify any studies that have been published linking funding on biomedical research with national level productivity gains from a 'top-down' perspective.
- Case study analysis of selected BRC projects which demonstrated productivity gains (a 'bottom-up' approach).

This report sets out the findings from the literature review and presents the case studies that were identified. It provides a summary of the productivity impact that can be identified from funding to BRCs currently. It also suggests how data collection could be improved in the future, such that the productivity impacts of BRC funding can be more routinely collated and assessed.

2. Literature Review

The search strategy was designed to be pragmatic given the broad scope, project context, timeline constraints and resources available. The strategy was not designed to be exhaustive but aimed to target studies most likely to be relevant to the research question, whilst retrieving a volume of records manageable within the resources of the project. A number of pragmatic search approaches were used to achieve this. These included restricting the number of sources to two databases plus website searching to identify grey literature, restricting the free text searches to the title and keywords of the database record, and using focused subject headings.

The full search strategies are available in Appendix A and the resources searched are in Table 2.1.

Table 2.1: Databases searched

Resource	**Interface / URL**
MEDLINE(R) ALL	OvidSP
EconLit	OvidSP
Google	https://www.google.co.uk/advanced_search

After deduplication, abstracts were uploaded into Covidence with a single reviewer selecting studies for full text review and then final study selection.

2.1 Literature search results

The literature searches were run on 20 March 2025. 2,183 records were retrieved with 2,163 unique studies identified for the search. Following abstract screening, 7 studies were assessed at full text review with 1 study being identified as meeting the inclusion criteria.

2.2 Included study

The one study that met the inclusion criteria was by Jeon and Pohl (2019) who analysed the impact of medical innovations in breast and prostate cancer treatment in the 1990s and 2000s on labour market outcomes in Canada.

Using a conceptual model the authors considered an individual's health capital as a function of time spent on their own health and market health inputs (such as surgeries and medical treatments) with continuous depreciation in health and health shocks. The individual also has a time constraint whereby if they have to spend more time investing in their health capital (such as after a cancer diagnosis) they will have less time to spend in productive work.

The number of new drugs and a quality adjusted patent index were used as a proxy for medical innovation and market health inputs. The quality adjustment to patents was made by using the number of patent subclasses awarded, the number of claims made in the patent and the number of

forward and backward citations made by/for the patent. A five-year lag was used between patent approval and inclusion in the model to reflect the time for the new treatment to be patented and the impact on health outcomes to be visible.

Data from the Canadian Cancer Registry and income tax returns were used to track labour market outcomes for people with breast or prostate cancer which were compared over time with a control cohort without a cancer diagnosis.

Applying the available data to their conceptual model, the authors found that innovations in breast and prostate cancer treatment between 1985 and 2005 (1990 to 2010 with a five year lag) had reduced the employment effects of breast and prostate cancer by between 63% and 70%, reducing the economic costs of breast cancer by CAN$5,800 per year and of prostate cancer by CAN$13,500 per year. However, these benefits were only seen for people with a post-secondary level of education.

2.2.1 Discussion

That only one study could be found looking at productivity related to biomedical research highlights either a lack of research interest in this area or the difficulty of undertaking a top-down analysis. Whilst the overall findings of the identified study from the literature review may not be generalisable to the UK (being based on Canadian data), the study does present an interesting econometric modelling framework that could be, data permitting, adapted to the UK.

Further, rather than using medical innovation as the market health input, it may be possible that overall medical research funding could be used, with the model expanded to also include other variables that could impact on health capital, such as overall expenditure on the NHS per capita and average population health characteristics (such as smoking rates or BMI). This could be considered as a point for future research, but it is beyond the scope of the currently funded activity to explore the productivity impact of funding to the BRCs.

3. Case Studies

3.1 Methodology

YHEC initially asked the NIHR to search through the titles and summaries of projects funded through the BRCs, looking for the following terms:

- Productivity
- Efficient or Efficiency
- Manufacturing
- Time saved
- Absenteeism
- Time off work
- Presenteeism
- Working age
- Return to work

Using these broad search terms, the NIHR was able to identify 5 potential projects. YHEC then approached the individual BRCs to ask if they were able to provide any examples of projects funded that would have had an impact on productivity. In total, BRCs provided a further 20 projects that may make potential case studies.

By reviewing the 25 studies, YHEC's frame of reference for how productivity could be impacted by BRC funded projects broadened beyond that in the scoping report. Specifically, no consideration had been given in the original definition to productivity gains to the NHS from improving health outcomes.

One measure of productivity for the NHS is total health outcomes achieved per pound spent. Projects that resulted in treatments for patients that produced better patient outcomes for the same or a reduced level of NHS resource (i.e., produced a saving to the NHS) must by default increase NHS productivity by increasing total health outcomes per pound spent.

Projects may also have resulted in interventions that improved health outcomes but required additional NHS resource. If these were approved by the National Institute for Health and Care Excellence (NICE), these could also be seen to have improved NHS productivity. This is based on the assumption that NICE approved interventions displace less cost-effective activities, thus increasing total health outcomes per pound spent.

As such, the potential case studies were reviewed to see if they provided evidence of impact on productivity in the following areas:

- Improving the health of the national workforce, thereby raising employment or reducing absenteeism or presenteeism (including NHS staff).
- Improving outcomes or efficiency in specific care pathways through improved capital levels that improve treatments or processes.
- Improving total health outcomes per pound spent by the NHS through new interventions.
- The 25 potential case studies were reviewed to find up to 10 examples that either:

- Provided quantified evidence of a productivity impact.
- Showed potential for significant impact on productivity.
- Had a clear link to potential future interventions to raise productivity.

The purpose was not to produce detailed case studies, but rather to use the evidence provided by the BRCs and NIHR, and that was available from public sources such as websites or publications, to produce short summaries of projects focussing on the productivity impact of the project.

3.2 Case study summaries

3.2.1 Early cancer detection using AI

Each year in the UK, approximately 35,000 people under 50 will be diagnosed with cancer, with 46.6% diagnosed at stage III or IV. This means that approximately 16,000 people in the UK each year are diagnosed with stage III or IV cancer. Cancer survival by stage varies by type of cancer but worsens as cancer is diagnosed at later stages. For example, five year survival rates for breast cancer are 90% if diagnosed at stage II, 70% if diagnosed at stage III and about 25% if diagnosed at stage IV. Earlier diagnosis of cancer would not only save lives, but earlier detection in a working age population would also increase productivity due to reducing lost working years.

The Government has targeted 75% of cancers to be diagnosed at stage I or II by 2028. The NIHR, together with Cancer Research UK and supported by Health Data Research UK, has provided £10m to develop AI tools that will help accurately predict people who are most likely to get cancer and aid in earlier diagnosis.

Given the mean salary of someone aged 50 in the UK is £39,699, with a retirement age of 67, every life saved for someone aged 50 has the potential to stop a loss in productivity over 17 years of £674,883. This means that if the AI tools developed just improved the absolute diagnosis rates of cancer at Stage I and II by 1%, and 20% more people diagnosed at Stage I and II were alive at five years compared with later diagnosis (which is conservative given the difference in survival by stages for breast cancer), the AI tools would generate £15m in productivity related gains to the UK economy.

This more than covers the cost of the tool and only relates to people identified by the tool in one year. Within 15 years, even with these conservative assumptions, the introduction of AI tools would mean that there were 320 more people in the UK workforce, generating £12.6m a year in productivity gains. That is £2m more than the investment in the research.[1]

[1] Calculation details: 16,000 people aged under 50 diagnosed at stage III or IV. 1% of these were instead being diagnosed at stage I or II this would be 160 people. If 20% more people were still alive at five years than if they had a later diagnosis, 32 people were alive at five years because of the AI tool. These 32 people would be 55 at the end of five years (on the assumption they were 50 at diagnosis) and so would have 12 more years of earnings at £39,699 per year. Productivity saving = 16,000*0.01*0.2*£39,699*12

3.2.2 Curing resistant high blood pressure with a one-off outpatient treatment

Monitoring people with hypertension accounts for 12% of all GP visits in the UK, equating to 46 million GP appointments. At an estimated cost to the NHS of £45 per appointment, hypertension costs the NHS approximately £2bn per year in monitoring costs, before treatment costs and dealing with health outcomes from elevated blood pressure are considered.

Whilst there are different causes of hypertension, unilateral aldosterone-producing adrenal adenomas (APAs) is a potentially curable cause for 5% of people with hypertension. Cambridge, Barts and UCLH BRC investigators have developed a PET radioscope ligand that can pinpoint the APAs which can then be ablated with ultrasound. A trial showed that the technique provided a clinical cure of the APA in 43% of patients and the investigators are now in advanced discussions to fund commercialisation of the technique.

If adopted across the NHS, 1 million GP appointments per year (£45 million) could be saved even before consideration of savings from drug treatments and reduction in poor health outcomes.[2]

3.2.3 Use of AI to speed up radiotherapy planning

In 2024, 120,000 cancer patients were treated with radiotherapy, although it has been estimated that 180,000 patients should have received radiotherapy but didn't due to supply shortages. Radiation oncologists spend many hours studying CT scans to accurately map radiation fields and calculate doses of treatments for patients with cancer. Reducing the time taken to do this would increase productivity and the capacity to treat more people.

In a collaboration with Microsoft Research, an investigator at Cambridge BRC has developed and implemented a cloud-based AI-based algorithm (OSAIRIS) that reduces the time taken to review scans considerably. The BRC has estimated that OSAIRIS has freed up consultant oncologist time worth £200,000 in each of the three Trusts where the tool is used. If rolled out to all 62 radiotherapy centres in the UK, the productivity savings in consultant time would equal £12.4 million a year.

Productivity savings to the wider economy are likely to be even greater from more rapid access to radiotherapy improving survival and therefore the ability to return to work. For example, for head and neck cancer tumour volume doubles every 19 days, meaning survival for each days delay in treatment can reduce by 2% per day [1].

3.2.4 AI-empowered monitoring of cystic fibrosis

Cystic fibrosis (CF) affects around 12,000 people in the UK and is the commonest life-limiting inherited condition in Europe. Thick secretions in the lungs result in inflammation and recurrent

[2] Calculation details: 46 million GP appointments for monitoring hypertension, of which 5% (2.3 million) are due to APA. The technique would reduce these by 43% (1 million).

bacterial infection which can lead to exacerbations of the condition and hospitalisation. People with CF account for 9,500 hospital admissions a year.

Cambridge BRC in collaboration with the Royal Papworth Hospital developed a home monitoring platform that was shown to slow decline in lung function for people with CF, as well as reducing the days of IV antibiotics needed, routine clinical attendances and emergency admissions. On the back of this research, the BRC is currently undertaking a trial to explore whether an AI algorithm can be developed to predict the future onset of pulmonary exacerbation.

With each hospital admission for an exacerbation costing in the region of £6,500, if AI tools managed to reduce admissions by just 10%, the productivity savings from requiring less NHS resource to treat people with CF would be approximately £6.2 million per year.

3.2.5 The impact of accessing NHS Talking Therapies on benefit receipt

In 2024, DWP figures showed that 20,000 new incapacity to work benefit claims due to poor mental health are approved every month in the UK, representing two thirds of all such claims. An estimated 633,000 people claim a disability element of universal credit due to mental ill health [2],[3]. Alongside the personal costs to each individual unable to work, the total costs to society in the lost output and productivity is substantial with the benefits costs alone being at least £2.4 billion a year. The costs in lost output from economic inactivity are estimated at £9.2 billion [4].

Maudsley BRC has funded a project to understand how NHS Talking Therapies and Employment Advisor Support can impact benefit receipt in people with mental health problems, and how individual sociodemographic characteristics can affect outcomes. To do this, the project is aiming to link data between Talking Therapies services and the DWP to understand work trajectories for people who access Talking Therapies and Employment Advisor Support. It will also consider whether these trajectories differ depending on the characteristics of those accessing the services. In undertaking this analysis, the project will provide information that could inform future service design to ensure both Talking Therapies and Employment Advisor Support maximise work related outcomes where this is appropriate.

The potential productivity gains from this project are substantial. If the evidence gathered by the project resulted in just 1 in 1,000 people being able to return to or to enter the workforce this would save £2.4 million in benefits payments, with a productivity gain in the region of £9m per year.

3.2.6 PROFILE - Reducing the need for urgent surgery in Crohn's disease

In the UK, there are 200,000 people who live with Crohn's disease, with 10,000 new diagnoses each year [5]. A 'step up' approach to care had been the clinical paradigm, with more effective medications only used after a disease flare or complication. Cambridge BRC in combination with The Wellcome Trust, funded a trial (PROFILE) of a 'top down' approach, to use effective targeted biologic medications (such as infliximab and adalimumab) from the time of first diagnosis.

The PROFILE trial showed that a top down approach resulted in far superior patient outcomes over 12 months. There was an absolute difference in flares of 55% in the top down group compared to the step up group and a 10 fold reduction in urgent bowel surgery in the top down group [6].

An economic analysis using the trial results showed that as well as improving patient quality of life, the top down approach would save the NHS the equivalent in resource (primarily through reduced hospitalisations and surgeries) of between £1,600 and £10,000 per patient over five years even after drug costs have been taken into account [7].

The findings have now been incorporated into UK guidelines. When multiplied by the 10,000 new diagnoses of Crohn's disease each year this suggests productivity savings to the NHS of between £16m and £100m over five years. These savings will increase each year as they are likely to extend beyond five years and new patients are diagnosed each year.

3.2.7 RETurn to work After stroKE (RETAKE)

Stroke is estimated to cost the UK economy £1.6 billion in lost productivity every year [8]. In 2017, Nottingham BRC supported a trial of an early intervention for stroke survivors who were in work at the time of the stroke. The goal of the intervention was to return people to work if possible. The intervention was delivered by specially trained occupational therapists who assessed the impact of the stroke on the participant and their job; and then coordinated support from the NHS, employer and other stakeholders. The therapist negotiated workplace adjustments, monitored return to work and explored alternatives where current work was not feasible or could not be sustained.

Over 500 people were recruited into the trial in 20 hospitals and it was completed in 2023. Whilst the intervention did improve quality of life compared to people who only received usual care, it did not impact on work outcomes. Whilst this means the intervention is unlikely to be rolled out in the NHS, the research highlights the importance of BRCs in being able to stop ineffective interventions being rolled out that would lower overall productivity in the NHS. With the intervention costing in the region of £1,200 per person and 25,000 people under the age of 60 having a stroke in the UK each year, the trial findings could have averted £30 million of unproductive spending per year by public services, if the intervention had been rolled out nationwide without a trial.

3.2.8 Understanding the impact of musculoskeletal disease on productivity

BRCs have not just contributed to research that could directly impact productivity. They have also undertaken research that provides a knowledge base so that interventions to raise productivity can be designed and trialled.

In 2024, 543,000 people were unable to work or were limited in their ability to work due to musculoskeletal diseases (MSK) [9]. Since 2020, Manchester BRC has undertaken a range of research to understand the impact, nature and predictors of a range of MSKs on employment and productivity.

This includes a prospective cohort study of patients with rheumatoid arthritis starting treatment with methotrexate or biologic therapy who were in full time employment. The study provided evidence that higher disability and psychological distress at start of treatment predicted a patients ability to stay in work with higher fatigue and disability when starting treatment predictors of presenteeism. The authors concluded that the study showed importance in controlling disease and improving function on enabling work participation

An analysis of 10 years of the UK Household Survey Employees showed that people who reported having arthritis were more likely to have a sickness absence, be absent long-term or to take early retirement than people without arthritis.

Another study was a systematic review of work-related outcomes for people with osteoarthritis, rheumatoid arthritis (RA), systemic lupus erythematosus, axial spondyloarthritis (axSpA), psoriatic arthritis, systemic sclerosis (SSc) and gout. The review concluded that work participation is likely to be beneficial for people with these conditions.

3.2.9 Mental health app for NHS staff

In June 2025, over 626,800 full time equivalent days were lost to the NHS through absence due to mental health related illness, accounting for 29.1% of all sickness absences. Taking just the cost per hour of a band 4 nurse (£37), the cost of lost productivity through lost working time to the NHS from mental ill health in June 2025 alone exceeded £174 million. Projected to the whole of 2025 these losses would exceed £2 billion. As not all days lost will have been for the least experienced nurses and expensive locums or agency nurses will have been used to cover some of the absences, this is likely to be an underestimate of the true productivity cost of mental ill health absences to the NHS.

Maudsley BRC provided seed funding for a trial of an app ('Foundations') between 22 March and 3 June 2021 in 16 NHS Trusts across England, including over 1,000 healthcare workers. The Foundation App focuses on promoting mental well-being, manage stress and improving sleep through behaviour change and development of positive well-being habits. Healthcare workers randomised to use the app were statistically more likely to have a reduction in psychiatric morbidity symptoms or report having insomnia by the end of the trial than healthcare workers in the control group.

3.2.10 Birth defects prevented by fortifying flour with folic acid

Lack of folate in the diet can cause a range of health issues, most notably neural tube defects such as spina bifida. Spina bifida not only incurs substantial productivity losses to the individual affected but also to their caregiver. Working hours for caregivers are estimated to be reduced by between 7 and 11 hours per week [10].

There are also substantial resource implications of treating neural tube defects to the NHS with lifetime treatment costs estimated to be in excess of £500,000 per person affected [11].

Cambridge BRC supported research using data from the National Diet and Nutrition Survey to show that population serum folate levels had fallen markedly between 2009 and 2019. The proportion of females of reproductive age with folate levels below the cut off level for risk of neural tube defects had increased from 69% to 89% over the same period. The research directly influenced the introduction of compulsory fortification of flour with folic acid as part of the Bread and Flour (Amendment) (England) Regulations 2024.

Using the research supported by Cambridge BRC, the Government estimated that fortification of flour will prevent 200 children a year being born with a neural tube defect, saving the NHS £20 million in treatment costs over 10 years but also £93 million in productivity savings due to greater labour market participation of people who would otherwise been carers [12].

3.2.11 Discussion

Of the ten case studies included in this research, four are of projects that have resulted in fully changing clinical practice or national policy, have started to be fully adopted in the NHS or have stopped potentially cost ineffective interventions being used in the NHS. These interventions were using AI to aid in radiotherapy planning, a top-down approach for Crohn's disease, fortifying flour to stop birth defects, and work focussed rehabilitation for stroke. Just these four projects alone could have generated between £600 million and £1 billion in productivity savings over 10 years. These four projects alone, could, over 10 years, return the equivalent of between 24% and 40% of the £2.5bn in Government funding BRCs and BRUs have received since their inception in 2007.

Looking at the remaining projects that have not yet changed practice, the potential returns are even higher. The approach to curing high blood pressure with a one-off treatment for patients with APAs could, in ten years, generate productivity savings just in freeing up GP appointments equivalent to £450m or 18% of all funding that has been provided thus far to BRCs and BRUs.

Whilst absence from work was not included as an outcome in the trial of the NHS mental health app, given the impact on psychiatric symptoms and insomnia the trial highlighted that relatively low cost interventions can make clinically meaningful impacts around the causes of mental health absences. If such interventions could reduce absences due to mental health in NHS staff by just 13.5%, the increase in productivity would generate productivity savings over 10 years to the NHS which would cover the entirety of funding provided to BRCs and BRUs since 2007.

4. Conclusions

This report has provided a high-level description of where funding for BRCs and BRUs can be expected to impact on productivity by:

- Improving the health of the national workforce thereby raising employment or reducing absenteeism or presenteeism (including NHS staff).
- Improving outcomes or efficiency in specific care pathways through improved capital levels that improve treatments or processes.
- Improving total health outcomes per pound spent by the NHS through new interventions.

A literature review only identified one study that had attempted to take a top-down approach to assess the impact of biomedical research on productivity (i.e. it examined total funding on an area of biomedical research and its impact on national level productivity). Whilst this study highlighted a potential approach that could be used in the UK, the lack of studies linking biomedical research on productivity using a top-down approach is likely to indicate how difficult this is to do robustly. Whilst the identified study shows a top-down approach is possible with the right data, the evidence from the case studies suggests a bottom-up approach will be simpler to undertake and explain to policy makers.

The bottom-up approach identified a number of 'unicorn' projects that have directly increased productivity within the NHS and at a national level, that by themselves will generate productivity savings that would cover a substantial percentage of all funding that has been provided to BRCs and BRUs. There are also projects that have the potential to generate productivity savings that may well exceed all funding provided to BRCs and BRUs. As the projects that were identified and selected for inclusion as case studies were those that had potential or actual productivity gains, it is not possible to extrapolate the productivity savings estimated in the case studies to all BRC and BRU funding. But given the large number of projects that BRCs and BRUs have funded or supported since 2007, a number of projects that have had significant productivity impacts were identified and included.

It is recommended that to ensure a more complete picture can be built on the productivity impacts of BRC funding in the future, potential projects are asked to identify whether and how they expect to impact on each of the three areas of productivity outlined above and what evidence they will be collecting to support that impact.

5. Appendix A: search strategies for the identification of studies

A.1: Source: MEDLINE ALL

Interface / URL: OvidSP

Database coverage dates: 1946 to March 19, 2025

Search date: 20/03/2025

Retrieved records: 1701

1 exp *biomedical research/ (152830)

2 *research support as topic/ (10693)

3 exp *clinical studies as topic/ (64967)

4 ((biomedic* or bio-medic* or bioengineer* or bio-engineer* or bioscience* or bioscienti* or clinical* or epidemiolog* or experiment* or genom* or gene* or investigat* or medical* or science* or scienti* or stem cell* or translation*) and research*).ti,kf. (151179)

5 ((biomedic* or bio-medic* or bioengineer* or bio-engineer* or bioscience* or bioscienti* or clinical* or epidemiolog* or experiment* or genom* or gene* or investigat* or medical* or science* or scienti* or stem cell* or translation*) and innovat*).ti,kf. (10113)

6 (BRC or BMRC).ti,kf. (163)

7 (translation* and (medicine* or science*)).ti,kf. (5622)

8 (regenerat* and (medicine* or research*)).ti,kf. (11360)

9 (precision medicine* and research*).ti,kf. (780)

10 ("bench* to bed" or "bench* to beds" or "bench* to bedside*" or "bench* to clinic*" or "laborator* to bed" or "laborator* to beds" or "laborat* to bedside*" or "laborator* to clinic*" or "research to practice" or "research into practice").ti,kf. (8107)

11 or/1-10 (362337)

12 exp *efficiency/ (14791)

13 ((nation* or civic or civil* or domestic* or federal* or government* or internal* or public* or state*) and (efficien* or productiv*)).ti,kf. (5595)

14 *gross domestic product/ (305)

15 exp *economic development/ (4392)

16 (gdp or gdps or gross domestic product* or gnp or gnps or gross national product*).ti,kf. (3257)

17 ((econom* or financ* or fiscal* or money or monies or monetary or socioeconom* or wealth) and (augment* or efficien* or expand* or expansion or grow* or increas* or productiv* or proliferat*)).ti,kf. (11833)

18 ((business* or econom* or industr* or socioeconom*) and (develop* or output* or out put* or perform* or progress* or throughput* or through put*)).ti,kf. (34156)

19 ((business* or operation* or organization* or organisation*) and (efficien* or productiv* or profit*)).ti,kf. (2385)

20 ((value or money or monies or wealth) adj creat*).ti,kf. (160)

21 *employment/ (27786)

22 *unemployment/ (4012)

23 (employ* or unemploy*).ti,kf. (54963)
24 ((job* or work*) adj3 (creat* or efficienc* or grow* or perform* or productiv*)).ti,kf. (7047)
25 *absenteeism/ (4600)
26 *presenteeism/ (454)
27 (absenteeism or presenteeism).ti,kf. (3270)
28 ((sector* or service* or market* or industr* or product or products or system*) and (efficien* or productiv*)).ti,kf. (17167)
29 ((health* adj2 (sector* or service* or market* or industr* or product or products or system*)) and (expand* or expansion or grow* or increas* or output* or out put* or proliferat* or throughput* or through put*)).ti,kf. (2297)
30 or/12-29 (164241)
31 11 and 30 (3461)
32 (news or editorial or case reports).pt. or case report.ti. (3471311)
33 exp animals/ not humans/ (5319398)
34 31 not (32 or 33) (3223)
35 limit 34 to (english language and yr="2000 -Current") (1701)

A.2: Source: EconLit

Interface / URL: OvidSP
Database coverage dates: 1886 to March 13, 2025
Search date: 20/03/2025
Retrieved records: 482

1 ((biomedic* or bio-medic* or bioengineer* or bio-engineer* or bioscience* or bioscienti* or clinical* or epidemiolog* or experiment* or genom* or gene* or investigat* or medical* or science* or scienti* or stem cell* or translation*) and research*).ti,kw. (2605)
2 ((biomedic* or bio-medic* or bioengineer* or bio-engineer* or bioscience* or bioscienti* or clinical* or epidemiolog* or experiment* or genom* or gene* or investigat* or medical* or science* or scienti* or stem cell* or translation*) and innovat*).ti,kw. (3402)
3 (BRC or BMRC).ti,kw. (3)
4 (translation* and (medicine* or science*)).ti,kw. (12)
5 (regenerat* and (medicine* or research*)).ti,kw. (17)
6 (precision medicine* and research*).ti,kw. (0)
7 ("bench* to bed" or "bench* to beds" or "bench* to bedside*" or "bench* to clinic*" or "laborator* to bed" or "laborator* to beds" or "laborat* to bedside*" or "laborator* to clinic*" or "research to practice" or "research into practice").ti,kw. (183)
8 or/1-7 (5772)
9 ((nation* or civic or civil* or domestic* or federal* or government* or internal* or public* or state*) and (efficien* or productiv*)).ti,kw. (5699)
10 (gdp or gdps or gross domestic product* or gnp or gnps or gross national product*).ti,kw. (13429)
11 ((econom* or financ* or fiscal* or money or monies or monetary or socioeconom* or wealth) and (augment* or efficien* or expand* or expansion or grow* or increas* or productiv* or

proliferat*)).ti,kw. (52824)
12 ((business* or econom* or industr* or socioeconom*) and (develop* or output* or out put* or perform* or progress* or throughput* or through put*)).ti,kw. (54317)
13 ((business* or operation* or organization* or organisation*) and (efficien* or productiv* or profit*)).ti,kw. (2865)
14 ((value or money or monies or wealth) adj creat*).ti,kw. (824)
15 (employ* or unemploy*).ti,kw. (58886)
16 ((job* or work*) adj3 (creat* or efficienc* or grow* or perform* or productiv*)).ti,kw. (3002)
17 (absenteeism or presenteeism).ti,kw. (422)
18 ((sector* or service* or market* or industr* or product or products or system*) and (efficien* or productiv*)).ti,kw. (16103)
19 ((health* adj2 (sector* or service* or market* or industr* or product or products or system*)) and (expand* or expansion or grow* or increas* or output* or out put* or proliferat* or throughput* or through put*)).ti,kw. (110)
20 or/9-19 (182222)
21 8 and 20 (526)
22 limit 21 to yr="2000 -Current" (482)

A.3: Source: Google

Interface / URL: https://www.google.com/advanced_search
Database coverage dates: n/a
Search date: 25/08/2025
Retrieved records: 12

Six searches were undertaken, as detailed below. The results were assessed for relevance on screen by an information specialist. Potentially relevant records were downloaded for further assessment by the research team.
Search 1:

Any of the words: productivity OR efficiency OR employment OR unemployment
Exact phrase: "biomedical research"
filetype:pdf
220 retrieved, 6 downloaded

Search 2:

Any of the words: economy or economic or financial or fiscal
Exact phrase: "biomedical research"
filetype:pdf
226 retrieved, 3 downloaded

Search 3:

All of these words: “gross national product”
Exact phrase: "biomedical research"
filetype:pdf
198 retrieved, 0 downloaded

Search 4:

All of these words: “gross domestic product”
Exact phrase: "biomedical research"
filetype:pdf
204 retrieved, 3 downloaded

Search 5:

allintitle: All of these words: research
Any of these words: bioengineering OR bioscience OR biosciences OR clinical OR epidemiology OR epidemiologic OR genomic OR gene OR science OR scientific OR medical OR cell OR translational
This exact phrase: "economy"
filetype:pdf
74 retrieved, 0 downloaded

Search 6:

allintitle: All of these words: research
Any of these words: bioengineering OR bioscience OR biosciences OR clinical OR epidemiology OR epidemiologic OR genomic OR gene OR science OR scientific OR medical OR cell OR translational
This exact phrase: "productivity"
filetype:pdf
163 retrieved, 0 downloaded

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