Investing in breath: reducing the economic cost of lung conditions through increased research and innovation

Key Contacts

Samantha Walker
Asthma + Lung UK
Director of Research and Innovation

swalker@asthmaandlung.org.uk

Alice Billin
Asthma + Lung UK
Research Network and Partnerships Manager

ABillin@asthmaandlung.org.uk

Thalita Marinho
PwC Strategy&
Pharmaceuticals Partner

thalita.marinho@pwc.com

Alisha Kapoor
PwC Strategy&
Impact-led Strategy Lead

kapoor.alisha@pwc.com

Contents

Executive summary

This report has been produced to provide an updated view on the cost of lung conditions on the UK economy and to quantify the potential benefits of greater research and development for these lung conditions, given the cost these have to individuals, the economy and society.

Lung conditions remain a large burden to individuals, health services and the UK economy. They affect one in five people and are the third biggest cause of death in the UK.[1] Lung conditions refers to a set of diseases that affect the respiratory system and can prevent someone from breathing properly. Examples of lung conditions include chronic obstructive pulmonary disease and asthma.

Asthma + Lung UK has commissioned PwC to provide an update to the 2014 British Lung Foundation's analysis of the total cost of lung conditions in the UK.[2] We estimate the total economic cost of lung conditions in the UK was £188 billion for 2019, which is equivalent to 9% of 2022 UK GDP.[3]

"The total economic cost of lung conditions in the UK was £188 billion for 2019, which is equivalent to 9% of 2022 UK GDP"

The economic costs included in this figure are direct (costs which fall directly on the NHS), indirect (costs which fall on society through lost productivity) and intangible (the human cost of excess morbidity and mortality).

Despite this, only 1.8% of all government and charity research funding goes toward lung conditions, a level that is disproportionately low relative to the overall economic cost. Increasing total investment into clinical research on lung conditions could lead to material savings through changes in diagnosis, prevention and care. These breakthroughs could reduce direct costs to the NHS by reducing the number of exacerbations or preventable hospital presentations, hospital admissions and potential deaths associated with lung conditions.

More than ever, there is a need to support the NHS post pandemic to address important challenges such as reducing wait times and optimising limited resources, whilst also improving patient experiences, outcomes and their quality of care. This could present a case for additional public investment into lung conditions to keep the NHS fit for the future, and support UK economic growth.

Looking ahead to the realities of the NHS, there are concerns around funding, staffing and increasing pressures from a growing yet ageing population. However, research and innovation enable the Government to address some aspects of this challenge. Investing more into research could allow for more clinical trials leading to innovations in treatment, diagnostics and approaches to prevention, potentially resulting in impacts that lessen the burden on the health system through reduced impact from lung conditions.

Asthma + Lung UK is looking for a gradual increase in lung conditions public clinical research funding over 2023 to 2030, increasing public funding from the current £47m per year to £141m by 2028. There are multiple options for public funding in lung conditions in terms of scale and funding profiles over 2023-2030. In this report, we focus on one of these options. The funding profile Asthma + Lung UK has outlined is looking to increase public funding by an additional £721m compared to if funding levels per annum stayed at their current level (£47m) over the assessed time period. Investing £721m worth of funding between 2023-2030 could contribute an additional £851m to the economy during that time.

[1] NHS England, Respiratory Disease, 2023
[2] British Lung Foundation, Estimating the economic burden of respiratory illness in the UK, 2014
[3] Statista, Gross domestic product of the United Kingdom from 1948 to 2022, 2023

Increasing research and investment in lung conditions to £141 million a year could contribute £851m to the economy between 2023 and 2030

Addressing structural health challenges through additional research also offers an opportunity to bring more people back to work, who have been forced to reduce their days at work or leave the workforce entirely due to lung conditions. Investing in activities that mean patients do not need as much interaction with the health system in the first place allows for better allocation of resources and bolsters economic opportunities. With a tight labour market as fewer people return to work post-pandemic, including those that suffer from lung conditions, increased workforce participation could help lower inflation by alleviating the supply-side pressures the economy currently faces. Healthier respiratory patients can not only work but work more productively as well as add to the economy through spending from their increased earnings. This, combined with reduced wage pressures from an increased labour pool, could contribute positively to the UK's economic prospects.

The same £721m investment between 2023 and 2030 could also encourage the clustering of intersecting industries and by extension, a 'crowded in' effect through the availability of more investment opportunities and jobs in the UK. **PwC analysis shows that public sector investment of £721m in research and innovation of lung conditions would be expected to lead to wider private sector investments of up to £699m between 2023 and 2030.** Increased collaborations between academia, industry and government all contribute toward the UK's Life Sciences Vision, published during the pandemic, to position the UK at the very forefront of research and innovation – attracting more investment from the best companies across the world.[4]

Public sector investment of £721m in research and development of lung conditions could attract private sector investments of around £700m over the next 7 years

As part of our analysis, we assessed the benefits associated with potential investment areas for lung conditions research and innovation using impact pathway case studies. One example of an innovation that we have identified and profiled impacts for includes a self-management application for lung conditions. Evidence from Wales shows that apps which improve symptom control, medication adherence and enhance patient-healthcare practitioner communication improve the management of diseases and reduce the incidence of exacerbations.[5]

Expanding uptake of a lung conditions self-management application could reduce lung conditions related sick days by 9%[6]

By investing more into UK research and innovation for lung conditions, there is potential to change and save lives, reduce the impact on the health system and help the economy recover.

[4] HM Government, Life Sciences Vision, 2021
[5] NHS Wales, Respiratory Toolkit case study, 2023
[6] This value is inclusive of a conservative take-up rate. Please refer to Appendix 4.2 for more information.

1. Introduction

Context:

Lung conditions remain a significant cost to individuals, the health system and the economy. The most recent report in 2014 by The British Lung Foundation ("Estimating the economic burden of respiratory illness in the UK") found the total costs of respiratory illness was £165 billion (including intangible costs).[7] Focusing only on direct and indirect costs, the British Lung Foundation estimated a cost to the UK of £11.1 billion, representing 0.6% of UK GDP in 2014.

What this report does:

Asthma + Lung UK commissioned PwC to update the cost estimates to 2019 for the total costs to the UK of lung conditions. We chose 2019 as the year of analysis, as it was the last year where datasets were unaffected by COVID-19. This is because the effects and by extension costs of some lung conditions may be inflated due to the presence of COVID-19 while others are reduced.

We also assess the potential impacts of increasing research and innovation into lung conditions and how the UK can reduce the disease burden through greater public investment.

The report explores the direct, indirect and induced benefits from tripling public investment into research and innovation from current levels to £141 million in 2028. We provide case studies that outline the potential benefits from reduced disease burden and a corresponding reduction in costs as a result of activities such as clinical trials that occur from the extra spending.

Lastly, this report reviews how private sector involvement in research and innovation for lung conditions can be positively affected by public expenditure.

Purpose of report:

The purpose of this report is to assess the total cost of lung conditions and demonstrate the impact of increasing public expenditure into lung conditions research and innovation. The impacts identified accrue to a range of stakeholders, including individuals with lung conditions, their employers, the NHS and the wider economy and society.

---

[7] Intangible costs monetise the excess illness and mortality arising from lung conditions.

2. The economic cost of lung conditions

2.1 Approach

Lung conditions are the third largest killer in the UK.[8] They affect different parts of the lungs and airways, making it difficult to breathe. There are many causes of lung conditions and differences in how they are presented and how they are and should be treated. This report includes the same lung conditions listed in the previous report and we have aggregated them by chapters of International Statistical Classification of Diseases and Related Health Problems (version 10; ICD-10). Further detail is provided in the technical appendix. The latest version of ICD has been released, but we have chosen to maintain consistency in the classification of lung conditions. As a result, the lung conditions that have been included in this report are:

- Asthma
- Chronic obstructive pulmonary disease (COPD)[9]
- Lower respiratory infections such as bronchitis and pneumonia
- Other lung conditions
- Trachea, bronchus and lung cancers
- Upper Respiratory Infections such as tonsillitis and laryngitis

A list of 'other lung conditions' is provided in the appendix. Our cost methodology is based on the report by the British Lung Foundation, however adjustments have been made in parts of the approach, so final costs should not be directly compared to the 2014 report to extract trends.

To quantify the overall cost of lung conditions in the UK for 2019, we followed the approach of the British Lung Foundation report on the economic burden of lung conditions in the UK for 2014, breaking down total costs into three categories:

1. **Direct costs**

   Costs to the NHS that arise from primary care GP visits, secondary care costs, which arise from hospitalisations, and non-government expenditure such as out of pocket expenditure and health insurance pay-outs. We estimated total direct costs to be **£9.6 billion in 2019.**

2. **Indirect costs**

   Costs to productivity due to illness causing absence from work and premature death as well as the costs of caregiving from friends or family. We estimated total indirect costs to be **£4.2 billion in 2019.**

3. **Intangible costs**

   We monetised Disability Life Adjusted Years (DALYs) to estimate intangible costs. A DALY represents the loss of the equivalent of one year of full health and is the sum of the years of life lost due to premature mortality (YLLs) and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population.[10] We estimated total intangible costs to be **£174.4 billion in 2019.**

---

[8] Asthma + Lung UK, Lung conditions kill more people in the UK than anywhere in Western Europe, 2022
[9] COPD is the name for a group of lung conditions that cause breathing difficulties including bronchitis and emphysema.
[10] HM Treasury, The Green Book, 2023

Direct, indirect and intangible costs were then summed to calculate the total economic cost of lung conditions which we approximate to be **£188 billion in 2019.**

Whilst our methodology followed that of the BLF report, we updated the assumptions and prices used to calculate costs for 2019 costs. To quantify the costs of lung conditions, we use a population level approach. This means the assumptions we use in our analysis are made at a higher level (e.g UK lung conditions population) and then cascaded down to lower levels (e.g UK asthma population).

In some instances, we leaned on international evidence where there was a lack of UK data. For example, due to lacking data availability on UK specific indirect costs for all lung conditions, we have used direct to indirect cost ratios obtained from the 2010 Economic Burden in Illness Canada (EBIC) report.[11]

2.1.1 Direct costs

This section outlines the direct costs associated with lung conditions in the UK. Direct costs refer to the expenses incurred in providing treatment to patients. Direct costs are broken down into three components:

- Primary care cost of a GP visit
- Secondary care costs arising from hospitalisations at the Clinical Commissioning Group (CCG) level[12]
- Non-government expenditure such as out of pocket costs, Non-Profit Institutions Serving Households (NPISH), enterprise financing and voluntary insurance.

2.1.1.1 Primary Care

The number of general practitioner (GP) visits in England during 2019 was estimated to be 312 million[13] according to NHS Digital and the cost of an appointment by a qualified GP was estimated to be £39.[14] Multiplying these two factors together provides a total cost of primary care of approximately £12.2 billion. This data set only accounts for England. To attain GP costs for the UK, we multiply by the ratio of identifiable health expenditure in England compared to the whole of the UK in 2018-2019.[15]

To estimate the proportion of GP costs associated with lung conditions, we use the same approach in the original study by the British Lung Foundation, using the proportion of prescribing care spending in England to estimate the proportion of GP costs associated with lung conditions. We assume the proportion of lung conditions costs to be in the same proportion as the costs associated with primary care prescribing costs for lung conditions in 2019. The proportion of prescribing care for lung conditions was calculated to be 11% by the NHS.[16]

To estimate the distribution of costs across specific lung conditions, we split costs in proportion to the burden of disease as estimated by the World Health Organisation (WHO). They use disability-adjusted life years (DALYs) to quantify this burden. One DALY represents the loss of the equivalent of one year of full health. For example, the portion of total chronic obstructive pulmonary disease (COPD) DALYs in relation to the total DALYs of lung conditions was 32%. So, 32% of lung conditions primary care costs are assumed to be associated with COPD. The breakdown of these costs is provided in the appendix. **We estimate total lung conditions primary care costs for 2019 to be approximately £1.7 billion.**

---

[11] The Public Health Agency of Canada. The Economic Burden of Illness in Canada: 2010, 2017
[12] CCGs have since been replaced by Integrated Care Boards (ICBs) but for the purposes of this analysis, we have retained the use of CCGs.
[13] NHS, Appointments in General Practice, 2023.
[14] PSSRU, Unit Costs of Health and Social Care 2019, 2020
[15] HM Treasury, Public Expenditure Statistical Analyses 2019, 2019
[16] NHS, Prescription Cost Analysis 2019, 2020

2.1.1.2 Secondary Care

Secondary care costs are incurred during hospitalisation. Direct costs (including secondary costs) in the 2014 report by the British Lung Foundation were derived from Clinical Commission Groups (CCGs) across disease categories. Since the publication of that report, CCGs were replaced by Integrated Care Boards (ICBs). There are no corresponding CCG costs for that year disaggregated by the International Statistical Classification of Diseases and Related Health Problems (version 10; ICD-10).

To obtain secondary care costs, we use the Clinical Commission Group (CCG) 2013-2014 Programme Budgeting Benchmark dataset from the 2014 report, and we inflated these costs to 2019 values using historical inflation rates.[17] Costs for upper (nose, nasal cavity, mouth, throat and voice box) and lower (trachea and lung) respiratory infections were not isolated from the costs of general infections in the CCG data, therefore annual secondary care costs of pneumonia for the year of 2019[18] were obtained and used as a proxy for lower respiratory infection secondary care costs. This underestimates the costs of respiratory infections however in the absence of disaggregated respiratory infection costs it helps capture a portion of the costs of respiratory infections. We adjusted these values using the England to UK multiplier to include all of UK secondary care expenditure on lung conditions. **Overall, we estimate the total cost of secondary care to be approximately £6.3 billion.**

2.1.1.3 Non-Government Expenditure

Primary and secondary care costs relate to NHS expenditure only. However, the costs of lung conditions also extend to patient out-of-pocket costs such as prescription charges and insured expenditure.

To estimate the full cost of lung conditions, we use the amount of total private spending as a proportion of total public spending as a multiplier. We then apply this multiplier to the sum of primary and secondary care costs (relating to NHS expenditure only), distributing it equally across ICD-10 codes.

Using this approach, we calculate private spending to be £35.7 billion, accounting for 21% of total government spending on healthcare in 2019. We used this scaling factor equally across ICD-10 codes and applied it to our estimates of primary and secondary care costs. **The estimated total cost of non-government expenditure was approximately £1.7 billion.**

Summing the three cost components, the total direct costs of lung conditions in the UK is estimated to be £9.6 billion in 2019.

“Direct NHS costs of lung conditions in 2019 were £9.6 billion”

[17] ONS, GDP Deflator: Year on Year growth, 2023
[18] Campling J, Wright HF, Hall GC, Mugwagwa T, Vyse A, Mendes D, Slack MPE, Ellsbury GF. Hospitalization costs of adult community-acquired pneumonia in England, 2022

2.1.2 Indirect costs

Indirect costs account for the cessation or reduction of work productivity due to the morbidity and mortality of a disease. They include sick leave and worker replacement as well as the costs of caregiving. Lung conditions also contribute towards sick leave in children. This has not been estimated as part of this analysis. However, being absent in school in the UK has been shown to have a negative impact on achieving good GCSE grades,[19] which in turn affects lifetime earnings.[20]

To obtain indirect costs for lung conditions in the UK we followed the approach used by the British Lung Foundation who obtained the ratio of direct to indirect costs of lung conditions estimated by the Public Health Agency of Canada (PHAC) in their 2008 report on the economic burden of illness in Canada.[21] They then applied the ratio as a multiple to their estimated direct costs to obtain indirect costs. We followed this methodology, however we used PHAC's updated 2010 report which included a greater number of indirect cost components.

Indirect costs as defined by PHAC in 2010 are:

- production costs due to absence from work due to illness,
- lost productivity due to premature death and
- the costs incurred by the unpaid caregivers of lung condition patients such as friends and family.

Figure 2.1 shows the direct and indirect costs as well as the indirect to direct cost ratio of the following ICD-10 chapters in Canada, namely infectious diseases, neoplasms and respiratory system with respective costs ratios being 0.41, 0.15 and 0.47.

Figure 2.1: Cost ratio of indirect to direct costs by ICD chapter in Canada (2010)

ICD chapter	Direct Costs (C$m)	Indirect costs (C$m)	Cost Ratio
I: Infectious diseases	$ 2,254	$ 925	0.41
II: Neoplasms	$ 5,360	$ 790	0.15
X: Respiratory system	$ 6,514	$ 3,094	0.47

The indirect ratio is then applied to the direct costs we previously estimated, with ICD chapter cost ratios being matched to their respective disease categories to obtain total indirect costs of lung conditions in the UK. Lower and upper respiratory infections are grouped into infectious diseases, Trachea, bronchus and lung cancers are grouped within neoplasms and COPD, asthma and other lung conditions are grouped within the respiratory system classification. As shown below in Figure 2.2, **we estimated the total cost of indirect costs of lung conditions in the UK to be approximately £4.2 billion.**

[19] GOV.UK, Just one day off can hamper children's life chances, 2016
[20] Hodge et al. GCSE attainment and lifetime earnings, 2021
[21] Public Health Agency of Canada, Economic burden of illness in Canada, 2005-2008, 2014

Figure 2.2: Indirect cost of lung conditions in the UK (2019)

Health Category	ICD chapter	Direct Costs (£)	Cost Ratio (£)	Indirect Costs (£)
Asthma	X: Respiratory system	£1,477,895,856	0.47	£701,966,500
Chronic obstructive pulmonary disease	X: Respiratory system	£1,724,115,066	0.47	£818,914,954
Lower respiratory infections	I: Infectious diseases	£1,470,464,676	0.41	£603,451,564
Other lung conditions	X: Respiratory system	£4,184,832,479	0.47	£1,987,699,062
Trachea, bronchus and lung cancers	II: Neoplasms	£723,752,046	0.15	£106,672,410
Upper respiratory infections	I: Infectious diseases	£48,413,484	0.41	£19,868,000
Total	**-**	**£9,629,473,606**	**-**	**£4,238,572,490**

2.1.3 Intangible costs

Intangible costs represent the suffering by an individual from a disease. This includes a patient's anxiety or pain and is difficult to monetise. We can estimate these losses in welfare using measures of health such as the quality adjusted life year (QALY) or disability-adjusted life year (DALY), which are globally recognised measures for wellbeing costs.

QALYs are not disaggregated by ICD-10 chapters and therefore cannot be used to calculate total intangible costs of lung conditions, however DALY values by lung conditions in the UK for 2019 have been estimated by the WHO Global Burden Estimates. By applying a monetary value to a DALY, the total cost of lung conditions can then be calculated. The methodology of this is outlined in the section below.

2.1.4 The disability adjusted life year

The DALY is a health measure used to determine the disease burden of an individual where one DALY equals the loss of one year of health. They are the sum of years of life lost due to premature mortality (YLL's) and years of healthy life lost due to disability (YLDs).

The willingness to pay for a healthy quality adjusted life year (QALY) is £70,000 as outlined in HM Treasury Green Book guidance.[22] This assumes a person would be willing to pay £70,000 for a year of good health. We have assumed the counterpoint is true and that a person would be willing to pay to *avoid* a DALY.[23] The total number of DALYs for lung conditions and their associated cost are located below in Figure 2.3.

The total number of DALYs due to lung conditions in the UK for 2019 was estimated by the WHO to be 2.5 million. With the cost of avoiding a DALY being £70,000, **the total intangible cost of lung conditions in the UK is estimated to be approximately £174 billion as shown below in Figure 2.3.**

[22] HM Treasury, The Green Book, 2023

[23] While we have used the cost of a QALY and DALY interchangeably, £70,000 is close to the net present value of a cost per DALY averted as calculated by Daroudi et al, Cost per DALY averted in low, middle- and high-income countries: evidence from the global burden of disease study to estimate the cost-effectiveness thresholds, 2021

Figure 2.3: The volumes of lung conditions DALYs and their DALY Total Cost (2019)

ICD-10 Category	Total number of DALYs (2019)	DALY Total Cost (£)
Asthma	272,300 DALYs	£19,061,000,000
Chronic obstructive pulmonary disease	791,300 DALYs	£55,391,000,000
Lower Respiratory Infections	481,300 DALYs	£33,691,000,000
Other lung conditions	205,100 DALYs	£14,357,000,000
Trachea, bronchus and lung cancers	681,200 DALYs	£47,684,000,000
Upper Respiratory Infections	59,900 DALYs	£4,193,000,000
Total	**2,491,100**	**£174,377,000,000**

2.2 Results

2.2.1 Total costs

"The total economic cost of lung conditions in the UK in 2019 is estimated to be £188 billion, which equates to 9% of 2022 UK GDP"

We estimate the total economic cost of lung conditions in the UK in 2019 to be £188 billion, which equates to 9% of 2022 UK GDP as shown below in Figure 2.4. Most of this cost (88%) is attributable to the intangible costs associated with excess mortality and reduced quality of life. Excluding intangible costs provides an estimated total cost to the UK of nearly £14 billion, which equates to 0.5% of 2022 UK GDP. Direct NHS costs in 2019 were £9.6 billion and UK wide productivity costs due to respiratory illness were £4.2 billion.

"UK wide productivity costs due to respiratory illness were estimated at £4.2 billion in 2019"

Figure 2.4: Total economic costs of lung conditions in the UK in 2019

ICD-10 Category	Direct Costs	Indirect Costs (£)	Intangible Costs (£)	Total costs (£)
Asthma	£1,477,895,856	£701,966,500	£19,061,000,000	£21,240,862,356
Chronic obstructive pulmonary disease	£1,724,115,066	£818,914,954	£55,391,000,000	£57,934,030,021
Lower Respiratory Infections	£1,470,464,676	£603,451,564	£33,691,000,000	£35,764,916,240
Other lung conditions	£4,184,832,479	£1,987,699,062	£14,357,000,000	£20,529,531,543
Trachea, bronchus and lung cancers	£723,752,046	£106,672,410	£47,684,000,000	£48,514,424,456
Upper Respiratory Infections	£48,413,484	£19,868,000	£4,193,000,000	£4,261,281,483
Total	**£9,629,473,606**	**£4,238,572,490**	**£174,377,000,000**	**£188,245,046,098**

The following part of this report chapter breaks down the costs and compares them by lung conditions.

2.2.2 Costs by lung conditions

Segmenting our analysis of costs by ICD-10 code shows that COPD has the highest total economic cost in the UK of £57.9 billion (31%) as shown in Figure 2.5 below. It also has the largest intangible costs and direct costs outside of other lung conditions, and this is reflective of the high disease burden.

"COPD is estimated to have had the highest total economic cost in the UK in 2019 of £57.9 billion"

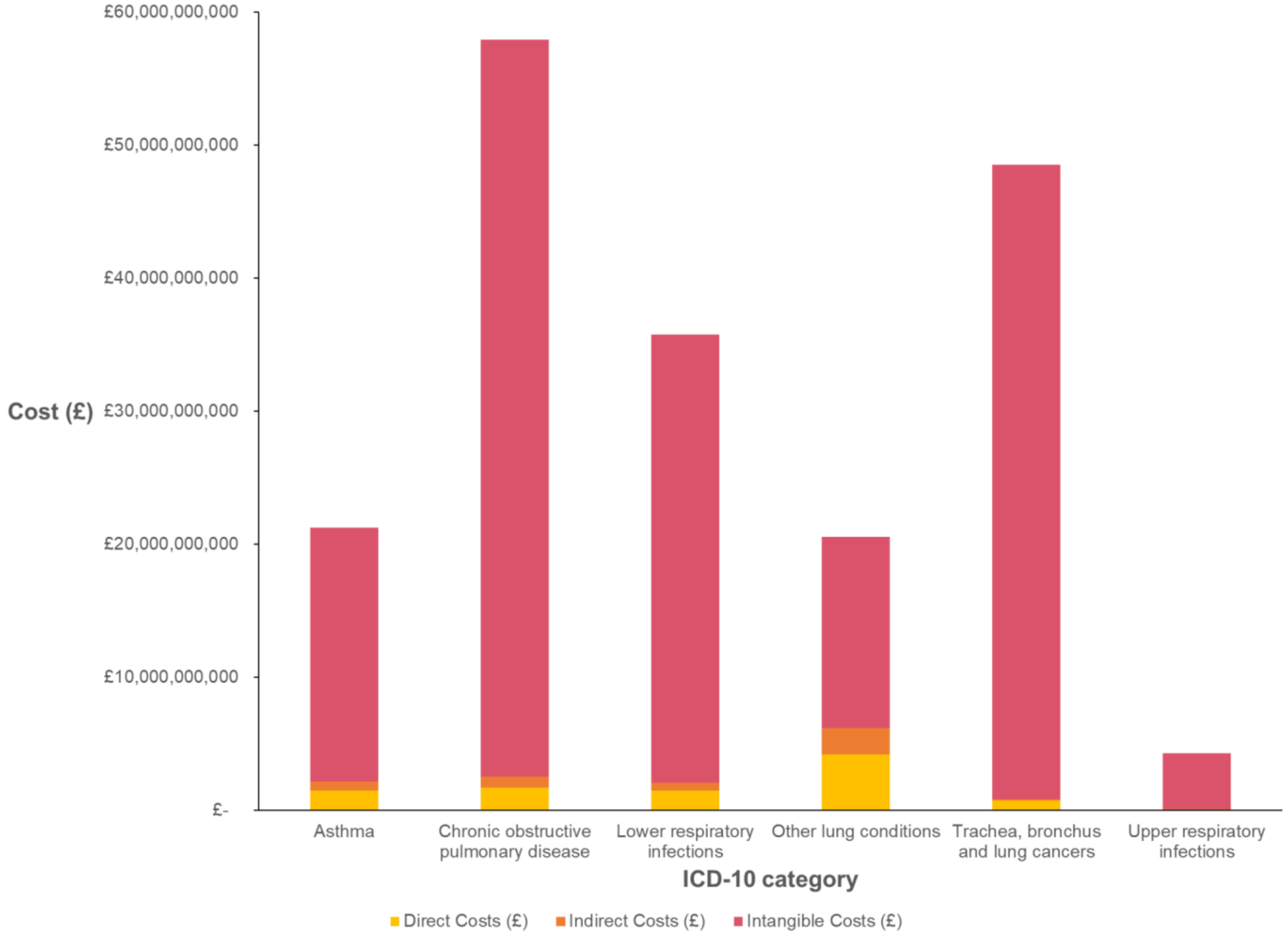
Lower respiratory infections make up 19% of total cost compared to upper respiratory infections which account for 2.3%. This can be explained due to the differences in the average severity of symptoms of upper and lower respiratory infections. 'Other lung conditions' have the highest direct cost to the NHS however they are excluded from Figure 2.5. Other lung conditions include:

- Postprocedural respiratory disorders, not elsewhere classified.
- Respiratory failure not elsewhere classified.
- Other respiratory disorders.
- Respiratory disorders in diseases classified elsewhere.

There are several reasons why 'other lung conditions' incur high direct costs. Firstly, there is a range of rare lung conditions that cannot be aggregated into distinct categories. Cumulatively though, the cost of these other lung conditions adds up. Secondly, they may be rare diseases that treatments do not exist for or are very expensive such as pulmonary hypertension. The other lung conditions category also includes respiratory failures that occur, and this would incur high secondary care costs as well, especially if they are not diagnosed. For these reasons, we have decided to exclude other lung conditions in the comparison graphs.

Of the lung conditions that we analysed, COPD and asthma represent the largest indirect costs to the UK economy as shown below in Figure 2.5. We expect targeted interventions into these two lung conditions would have distinct impacts on overall productivity.

Figure 2.5 Total cost of lung conditions by ICD-10 category in 2019



3. The impact of increased research and innovation

3.1 Context

This section of the report outlines the importance of research and innovation for lung conditions, and how additional investment would benefit the UK economy at a macro level. The next chapter outlines example impact pathways to demonstrate ways in which additional investment may result in better outcomes for specific cohorts living with lung conditions.

3.2 The importance of research and innovation for lung conditions

Investment in research and innovation is needed to save lives and improve the wellbeing of those who currently live with lung conditions. Research and investment often lead to advances, through how lung conditions are understood, prevented, diagnosed and treated. There are many areas of lung conditions that remain unexplored. Increasing research into these areas could lead to improved health outcomes for the lives of more than nine million people in the UK who suffer from a lung condition[24] by reducing the need for some to require health services and for others to improve the diagnosis, treatment and care they receive.

Innovation also remains a key UK government priority. A recent paper found that while the UK is world-leading at R&D and creating start-ups around new ideas, it lags many other countries when it comes to getting great ideas to market.[25] It identified key opportunities to improve research and innovation such as increasing public sector procurement with grants, developing a more joined up supply chain approach, and investing in skills. Research and development in lung conditions will likely benefit from these identified opportunities, whilst also being a potential opportunity to build the UK's capabilities in supporting these identified opportunities.

Additionally, the UK Government has highlighted investment into the Life Sciences as a top priority as part of its wider vision to be a global Science Superpower, leading research and innovation in the medical world. As part of its strategy, the Government set a target for the UK to invest 2.4% of its Gross Domestic Product (GDP) in Research and Development of the Life Sciences by 2027 appreciating the value of increasing investment on both health and economic outcomes.[26] The UK has also seen a recent drop in Life Sciences foreign investment in 2022, falling from second to ninth in a list of the top beneficiary countries,[27] which it will likely want to recover from in order to achieve the desired objective as global Science Superpower.

3.1.1 Research and Innovation in the UK

The UK demonstrated through the COVID-19 pandemic its position as a research and innovation leader with its contributions toward the creation and production of vaccines. In 2021, the UK Government spent more on health R&I as a percentage of GDP than in any other country apart from the US in the world.[28]

---

[24] National Asthma and Chronic Obstructive Pulmonary Disease Audit Programme, Drawing breath, 2023
[25] Department for Science, Innovation & Technology, Making innovation matter 2023, 2023
[26] HM Government, Life Sciences Vision, 2021
[27] ABPI, UK life science inward investment in freefall, 2023
[28] HM Government, Life sciences competitiveness indicators 2023, 2023

3.1.2 Research and Innovation in the UK for lung conditions

The most up to date figure on research and innovation is from 2018,[29] indicating that £47m of government funding goes towards research and innovation for lung conditions, representing only 1.8% of total government and charity research and award expenditure.

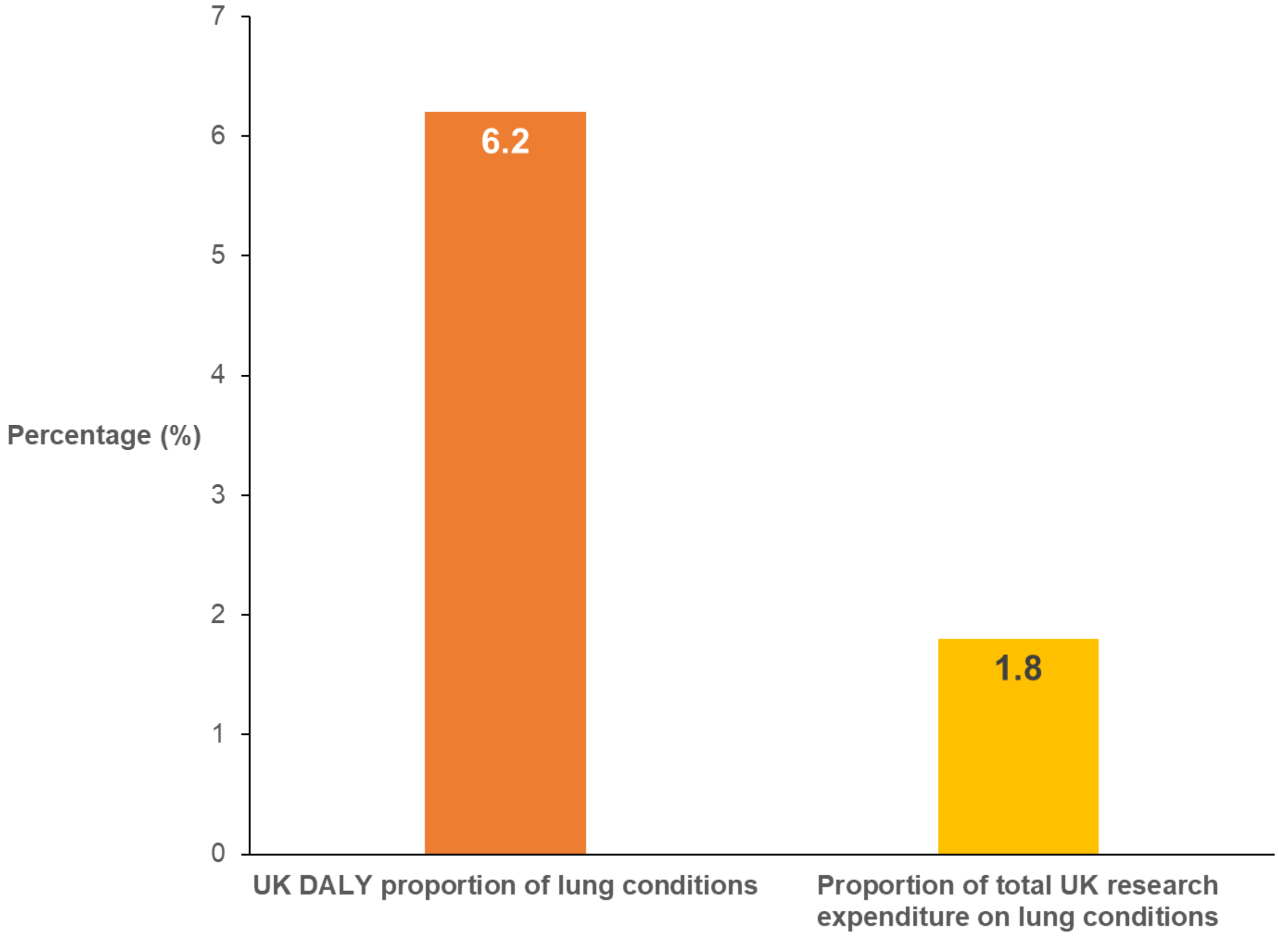
Despite the total economic burden of illness attributed to lung conditions set out in the previous chapter, only 1.8% of all public research spend goes toward lung conditions.[30] Figure 3.1 shows that the proportion of monetised DALYs that lung conditions are responsible for is more than triple the proportion that is spent on research.[31] The proportion of total UK government and charity research expenditure for lung conditions is only 1.8% while the proportion of disease burden that lung conditions represents in the UK is 6.2%.

The proportion of DALYs lung conditions is responsible for (6.2%) is more than triple the proportion that is spent on research on the disease (1.8%)

This means the monetary cost of disease burden is three times more than what is spent publicly on research on lung conditions. **Therefore, current expenditure into lung conditions can be seen as disproportionate to the overall health burden.**

[29] UK Clinical research collaboration, UK Health Research Analysis: 2018, 2020
[30] UK Clinical research collaboration, UK Health Research Analysis: 2018, 2020
[31] UK Clinical research collaboration, UK Health Research Analysis: 2018, 2020

Figure 3.1: UK DALY proportion of lung conditions compared to research expenditure proportion on lung conditions



3.1.3 The future state

Asthma + Lung UK has recommended an increase in funding to £141 million per year to bring public funding in line with the proportionate impact of lung conditions in the UK (ie. triple investment to bring it in line with the burden of lung conditions)[32].

Increased total investment into lung conditions research could lead to breakthroughs in diagnosis, prevention and care. These breakthroughs could reduce direct costs to the NHS by reducing the number of exacerbations[33] or preventable hospital presentations, hospital admissions and deaths.

In doing so, it could also relieve the downward pressure on acute NHS services who have struggled to cope with the backlog and demand following the pandemic. In a time where the importance of resource allocation is paramount, this would help create the breathing room to support the NHS to maximise their operating efficiencies in light of anticipated budgeting constraints. The resulting impact of this change is a healthier population that is more active in the labour market and that is more able to contribute towards the path to economic recovery.

The global lung conditions treatments market was worth $143 billion in 2021 and is predicted to double by 2028.[34] Increasing investment into lung conditions can also support the government's vision to create a thriving life

[32] See Footnote 8.
[33] An exacerbation is the worsening of a disease or an increase in its symptoms. For example, this can occur in asthma patients and lead to hospitalisation and in some cases, death.
[34] The Business Research Company, How Global Respiratory Diseases Drugs Market Players Should Strategize For 2022-2031, 2022

science sector and cement the UK as a prospective global science and technology superpower.[35] There is an opportunity to make the UK the preferred choice in the world to do respiratory research.

The complexity of lung conditions and the widespread number of patients that it affects offers an opportunity to reap the gains from new technologies. AI, genomics technologies, and cell and gene therapy hold promise for unprecedented understanding of these conditions that affect 545 million people globally.

Now the government has prioritised lung conditions in its Life Science Vision, we need to see continued support and increased public investment to achieve this change and progress across the five areas set out in Asthma + Lung UK's concept document.[36]

Sir Mene Pangalos
BioPharmaceuticals R&D, AstraZeneca UK

3.1.4 What would increased investment look like?

The proportion of health research that is spent on lung conditions would need to triple to be in line with its disease burden. Tripling the level of investment from the current £47m per year to £141m per year would need to be profiled over the short-medium term to allow for the relevant infrastructure to be developed to support the increased funding. Asthma + Lung UK have developed an iterative blueprint to allocate funding across five areas until 2030. Below are five pillars on which the additional funding would focus on.

1 Platform	2 Diagnostics	3 Treatments	4 Digital management	5 Prevention
Building a platform for respiratory data	Creating cutting-edge diagnostic tools	Accelerating the development of lifesaving treatments	Driving patient-centred innovation to transform self-management	Understanding early disease progression and targeting underlying causes

Asthma + Lung UK anticipates that this funding could be focused on two areas, the first on the construction of new lung conditions centres and secondly on additional funding expenditure on direct grant contributions.

The first half of the additional funding expenditure concentrates on the construction of new lung conditions centres across the UK. Each centre would have a unique research capability that would help develop new treatments and diagnostics and identify ways to prevent and better self-manage respiratory disease. We have not considered how this funding would be broken down by the initial capital expenditure required to build the centres and the ensuing operational costs afterwards.

The second half of the additional funding expenditure focuses on direct grant contributions for research into lung conditions. Currently, funding for lung conditions research and innovation sits at £47m per year.[37] We have

[35] HM Government, Life Sciences Vision, 2021
[36] HM Government, Life Sciences Vision, 2021

[37] UK Clinical research collaboration, UK Health Research Analysis: 2018, 2020

assumed that this level of funding has stayed level since 2018, given lack of data availability and have not accounted for inflation.

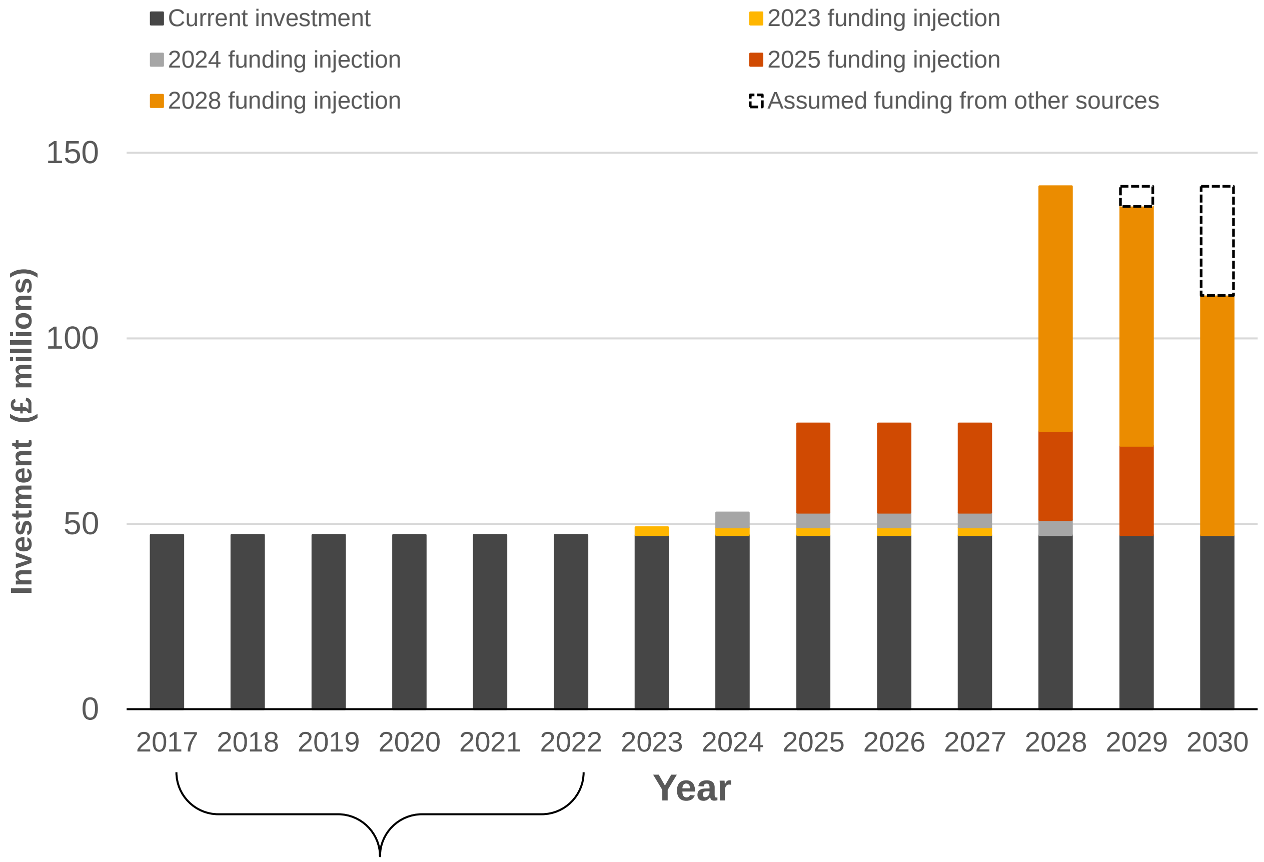
Asthma + Lung UK is looking for a gradual increase in lung conditions public research funding over 2023 to 2030, increasing public funding from the current £47m per year to £141m by 2028. There are multiple options for public funding in lung conditions in terms of scale and funding profiles over 2023-2030. In this report we focus on the potential impacts of one option which Asthma + Lung UK has outlined over the period of 2023-2030. The funding profile Asthma + Lung UK has outlined is looking to increase public funding by an additional £721m compared to if funding levels per annum stayed at their current level (£47m) over the assessed time period.

Asthma + Lung UK anticipates that funding to reach a figure of £141m per year will not occur in the short term. Therefore, we have profiled an approach that incrementally increases the total amount of yearly funding over the overall investment period from 2023-2030.

- As shown in Figure 3.2, in 2023 the additional funding will begin with a £10m commitment that is split over a five-year period ending in 2027.
- In 2024, an additional £20m will be committed over a five-year period. Each year will split the additional funding equally.
- In 2025, an additional £120m will be committed over a five-year period during the 2025 Spending Review. Each year will split the additional funding equally.
- In 2028-2030, the final £195m will be spent with £66m occurring in the first year. This final round of funding is front loaded, with £66m occurring in the first year, then £64.5m in the final two years.

Figure 3.2 shows how as the release of funds overlap, 2028 is expected to be the year of highest spend, £141 million. As funding commitments from earlier years are completed in 2028 and 2029, Asthma + Lung UK wish to see continued annual investment of at least £141 million by securing funding from additional sources. In this report, impacts on investment are modelled based on Asthma + Lung proposed timeline excluding assumed funding from other sources.

Figure 3.2: Asthma + Lung UK's proposed option for annual public investment in research and innovation of lung conditions



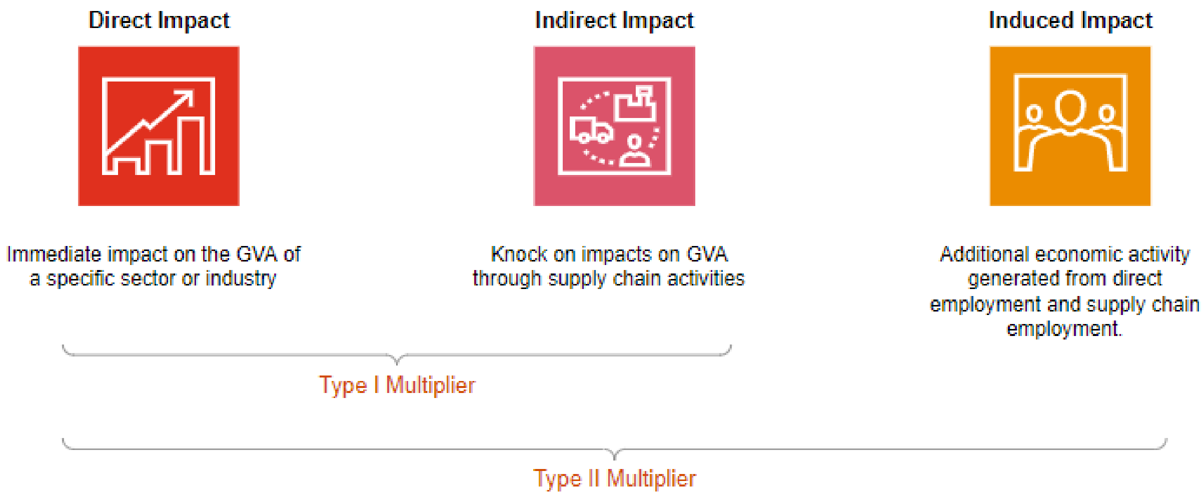
Assume current investment is equal to UKCRC 2018 estimation.

3.3 Impact of increased investment

3.2.1 Direct, induced and indirect benefits

Our analysis considers the estimated economic impacts associated with increasing investment in research and innovation of lung conditions in the UK.

We examine how investment in the healthcare sector contributes to the economy through Gross Value Added (GVA). GVA captures the gross economic contribution that a sector makes to the economy, in terms of the value that its activities add to overall economic output. In addition to the direct economic contribution of the industry, we use type I and II multipliers to estimate the industry's broader economic contribution through its supply chain (indirect impact) and employee spending (induced impact).



Investing in respiratory research and innovation not only benefits the sectors that are directly associated with the outputs, such as the pharmaceutical industries, but we know that additional spending can have a positive spill over effect through their spending within the supply chain.

In our context, this could mean more purchases on the suppliers of the health and construction industries. For example, this could be contracting research organisations, clinical trial providers, and building material suppliers. More demand for these services creates more jobs in the UK, boosting competition and driving economic growth and innovation.

To estimate the direct impact of increasing funding for lung conditions research and innovation, we have taken the total amount of investment per year and multiplied it by a GVA per output ratio. A GVA per output ratio converts the amount of injected spending into an expected GVA value.

We use Type I multipliers to measure the indirect impact. Type I Multipliers estimate the impact on the supply chain because of the change in output. It calculates the total change in output resulting from changes in investment without considering subsequent effects. To calculate the indirect impact, we take the total impact using our Type I multiplier and isolate it from the direct impact.

Type II Multipliers capture the direct, indirect and induced effects resulting from a change in output. In other words, we estimate the downstream changes of spending through additional income in the industries. Additional rounds of spending have impacts on income and production within the economy. For example, if the government spends an additional £1 for households, they will be able to spend this increased income on goods and services within the economy. The recipients of this additional household spending in turn are able to spend this additional income too. Type II multipliers account for this additional demand and downstream spending increase.

We used Asthma + Lung UK's iterative spending profile option as a starting point to allocate funding across five areas until 2030. From here, we allocated a weighting of Type I and Type II Multipliers[38][39] based on what the spending was to be on. If half of the additional funding expenditure concentrates on the construction of new lung conditions centres across the UK and the second half of the additional funding expenditure focuses on direct grant contributions for research into lung conditions, the industry specific multipliers would reflect this also. Hence, we used Type I and calculated Type II multipliers for the healthcare and construction sectors. These multipliers are applied to the direct impacts to calculate the indirect and induced economic impacts of increasing investment. Adding all the values for direct, indirect and induced impact from the additional spending pathway that includes

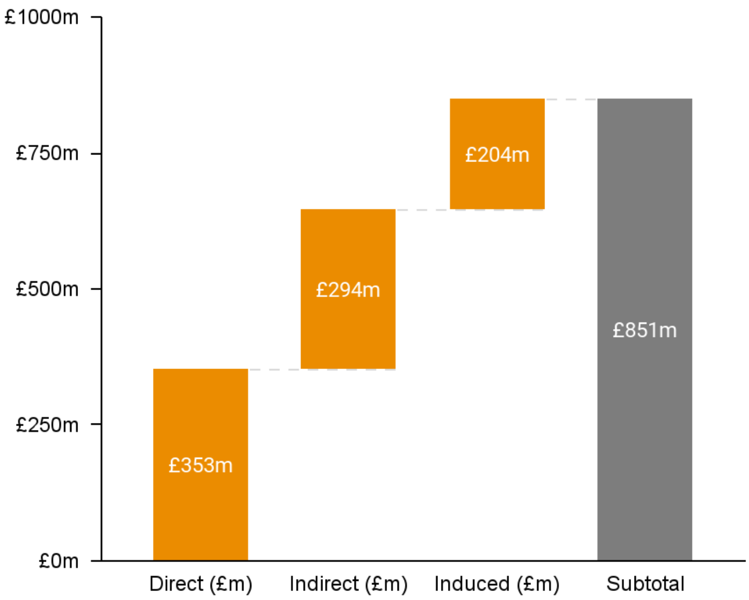
[38] Sussex, J., Feng, Y., Mestre-Ferrandiz, J. et al. Quantifying the economic impact of government and charity funding of medical research on private research and development funding in the United Kingdom, 2015

[39] ONS, UK input-output analytical tables, industry by industry, 2023

£141 million of investment in 2028, brings us to a total of £851m in UK GVA from 2023-2030. As shown in Figure 3.3, £353 million of the total GVA is direct, while £294 million and £204 million is indirect and induced respectively.

If the level of R&I were to increase to £141m in 2028 under Asthma + Lung UK's proposed option: lung conditions research and investment could contribute approximately £851m to UK Gross Value Add (GVA) from 2023-2030.

Figure 3.3: Breakdown of the total economic benefit of additional investment into respiratory R&I from 2023-2030



This analysis relies on several assumptions. The first assumption we have made is that there is not a reduction in public research expenditure elsewhere (ie. it is additional expenditure rather than re-allocated expenditure), and the second assumption is that the remainder of government expenditure elsewhere remains constant. This means that we have not analysed whether additional funding for respiratory research could be better spent elsewhere, or on other diseases. We note that the investment profile that we have defined for this report could have been allocated differently.

3.2.2 Crowding-in multiplier

There is research which suggests that private investment into biomedical research of disease is influenced by public sector investment. Current pharmaceutical spending on R&D in Europe is approximately £39.7 billion and, in the UK, it is £5.6 billion with 49.2% dedicated to clinical trials.[40] Public sector funding can foster further investment by removing costly barriers to research and development, particularly through building infrastructure, longer term studies or by increasing collaboration. This phenomenon, often referred to as the crowding in effect,

[40] European Federation of Pharmaceutical Industries and Associations, The Pharmaceutical Industry in Figures, 2023

is highly present in the healthcare sector in the UK as pharmaceutical companies follow investment patterns and decisions from the public sector.[41]

As the private sector can expect a greater return on investment once there is increased public investment, they will be more inclined to pool their resources into that specific area and expand their investment efforts. In the past, public and private sector collaboration has yielded medication advancements and improved patient outcomes.

Research indicates that there is an increase in private investment as a result of increased public sector investment in the biomedical sector. A paper written by Sussex, Feng et al. in 2016 found the crowding-in multiplier to be 0.97 for biomedical research in the health care sector in the United Kingdom. We assume this same behaviour is likely to be prevalent for research into lung conditions too.

Our analysis finds that public sector investment of £721m in research and innovation of lung conditions could lead to wider private sector investments of up to £699m between 2023 and 2030. We estimated this by summing together our proposed investment schedule between 2023 and 2030, and then adjusting that using the crowding-in multiplier.

Our analysis finds that public sector investment of £721m[42] in research and innovation of lung conditions could lead to wider private sector investments of up to £699m between 2023 and 2030

[41] Sussex et al., Quantifying the economic impact of government and charity funding of medical research on private research and development funding in the United Kingdom, 2016
[42] Funding between 2023 and 2030.

4. Assessing potential use cases of further R&D

4.3 Context

To further illustrate the benefits of research and innovation into lung conditions in the UK, we chose to model the positive impacts of targeted investment into specific areas of development. To quantify these, select impacts, we use impact pathways. Impact pathways are conceptual frameworks that link the causal impacts between an activity and their intended outcomes beyond what is being delivered. They are commonly used to quantify the downstream impacts of programs and interventions in public policy. We use impact pathways to structure how we think certain interventions could lead to a change.

To effectively model the impacts of investment the stakeholders benefit from it has to be considered, as these accrue across a wide range of people. We have identified specific stakeholders who this benefit will apply to. These could include, but are not limited to:

- **Patients,** who suffer from a respiratory condition who can continue work and be more productive.
- **NHS**, who incur fewer costs because patients are healthier.
- **Employers,** who experience less sick leave because their employees are healthier.

There are numerous areas of development that could be targeted for investment, therefore we narrowed down our selection of investment areas based on several criteria:

- How much of a need there is for investment in the area.
- The materiality of the impacts.
- Data availability.
- How it aligns with Asthma + Lung UK's strategic vision to make the UK the global leader in lung conditions research.

As a result, we developed three examples where investment could be targeted:

- An application that focuses on improving self-management for lung conditions patients. This would reduce the number of GP and A&E visits, the number of patient sick days whilst also leading to a health increase in patients.
- Increasing the number of respiratory clinical trials through clinical research investment, which would lead to increased treatment development and innovation.
- Expanding the usage of synthetic AI to clinical trials. This would lead to reduced clinical trial costs through a reduction of clinical trial dropouts and replacements. In doing so, reducing the costs encourages the completion of more clinical trials for lung conditions.

We have modelled the gross impacts of investment into these areas only and do not consider the costs of implementation. However, the case studies modelled serve to further highlight potential benefits of investment into lung conditions research and innovation.

4.4 App development case study

Evidence from Wales[43] shows that apps which improve symptom control, medication adherence and enhance patient-healthcare practitioner communications improve the management of diseases and reduce the incidence of exacerbations. Recent implementation of the AsthmaHub app in Wales demonstrated the material impact that an app could have on healthcare costs. The app allowed patients to better manage their symptoms by providing them with resources and materials to increase their knowledge and awareness of asthma.

After two years, app users made 36% fewer visits to their GP and 19% fewer visits to A&E. Additional research found that apps allowed improved communication and coordination between patients and healthcare providers.[44] This demonstrated a relationship between improved self-management with reducing visits to the emergency department and hospitalisations as well as improving symptom control and medication adherence.

As investment into research and innovation of lung conditions increases the benefits associated with developing a management app are large. Evidence suggests that investing in management apps can lead to improvements in the health outcomes of patients as they are better equipped to manage their diagnosis, for example through improved medication adherence, deeper knowledge of their illness and increased communication with clinicians. **One study found that the use of an app leads to an increase in 0.1 QALYs per person.[45]**

As patients experience reduced symptoms and exacerbations of their diagnoses, it leads to reduced sick leave from work. Research finds that the use of an app and particularly the **impact of educational resources being readily available to patients is significant in reducing the number of sick days employees with lung conditions take**.[46] This leads to cost savings to employers who experience a reduced economic burden from their employees taking fewer sick days. The methodology used for this estimation is provided in Appendix 4.1.

While we have not modelled it here, there is evidence that certain lung conditions patients are unable to participate in the labour force at a greater level compared to the median population.[47] An app like this one could help to address this issue and in doing so also tackle lost income to employers, foregone taxation, and additional direct costs from welfare.

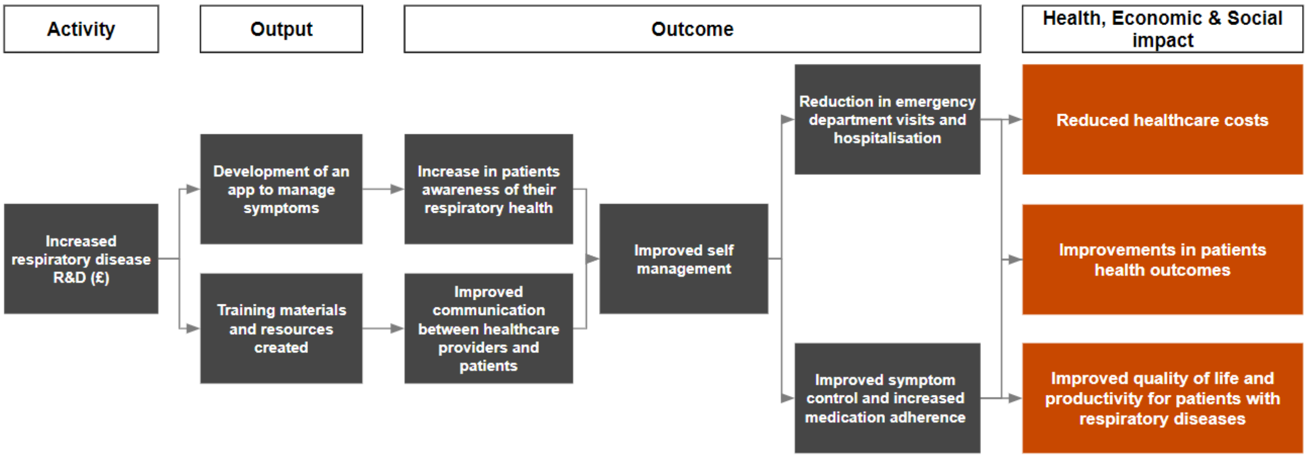
As the impact pathway demonstrates in Figure 4.1 below, the lung conditions self-management app and the training resources that are developed with it brings with it two outcomes. Healthcare professionals can communicate better with patients who also have more awareness of their own respiratory health. Additionally, we expect this to lead to better patient self-management of their respiratory health. Improved self-management of respiratory health leads to fewer interactions with the NHS, thus reducing their costs. It also leads to an improved quality of life for the lung condition patients who have the app through a reduction in sick days because they are healthier. This reduces the impact of reduced productivity from lung conditions patients to the wider economy.

To model the counterfactual, we looked at how many GP and A&E visits were due to patients with lung conditions and forecasted them over a period from 2023-2030 using growth rates of lung conditions incidence. We also examined the costs of a sick day with the current number of days lost at work due to respiratory illness.

---

[43] NHS Wales, Respiratory Toolkit case study, 2023
[44] NHS Wales, Respiratory Toolkit case study, 2023
[45] Dritsaki et al, An economic evaluation of a self-management programme of activity, coping and education for patients with chronic obstructive pulmonary disease, 2016
[46] Gallefoss and Bakke, Impact of patient education and self-management on morbidity in asthmatics and patients with chronic obstructive pulmonary disease, 2000
[47] Potential Limited, The economic cost of uncontrolled asthma, 2021

Figure 4.1: Impact pathway showing the outcomes and impacts associated with the development and rollout of a lung conditions self-management app



If those with lung conditions used this self-management application for 6 months, we would expect to see the benefits illustrated in Figure 4.1 above.

We also apply a take up rate in order to conservatively estimate the benefits. The take up rate is an expected percentage of the total benefit to adjust for how many people will use the app.

It is unlikely that everyone suffering from a lung condition would download this app, and then continue to use it over a longer-term period. Evidence suggests that the usage of mobile health applications are used the most close to the date of adoption, and this usage gradually reduces over time.[48] Benchmarking reports indicate annual retention rates of mobile health applications is 16%.

We evaluated three different scenarios, reflecting the volatility in mobile application retention. To reflect the available evidence, we have assumed three different long term retention rates over the ten-year analysis period, with 16% of the UK total lung condition population assumed to use the application for at least six months in this medium scenario modelling, with the findings demonstrated in Figure 4.2. We assume the retention rate of the mobile app remains static between 2023 and 2030.

To model the impacts, we found the difference in the number of GP and A&E presentations following the introduction of the app. We also assumed that the impacts would accrue to lung conditions patients in the UK. We monetised this by using the costs of GPs and A&E presentations. Figure 4.2 shows the total NHS cost savings of reduced GP and A&E visits averaged out over the ten-year analysis period to be around £128m each year.

To model the health impacts, we took the expected increase in QALYs from the self-management app and applied them to the lung conditions patient population between 2023 and 2030. Figure 4.2 shows that we might see an average increase of 240,000 QALYs per year during this period for the lung conditions population.

To model productivity impacts, we first had to forecast the number of sick days lost to lung conditions in the UK between 2023 and 2030. We then applied the expected reduction in sick days to this population. **We found an average avoidance of 410,000 sick days per year.**

Through multiplying the total cost of a sick day by the number of sick days saved, we were able to estimate an annual average productivity gain of £117m over the seven-year period between 2023 and 2030 as shown in Figure 4.2 and in Figure 4.3. We assume that the sick days that are taken will only be applied to lung conditions patients who are employed.

[48] Lee et al. Effect of self-monitoring on long-term patient engagement with mobile health applications 2018

Figure 4.2: Total impacts of investing in the development of a lung conditions management app (2023-2030) based on the medium scenario

Investing in the development of a respiratory disease management app, assuming a 16% take up rate, could lead to:

Estimated cost savings to the **NHS** of **£128 million** per year	Average increase of **240,000 QALYs** per year
Annual **productivity gains** of **£117 million**	**Annual reduction of 410,000 sick days**

Outside of the benchmarked medium scenario, we assume different ranges for the low and high scenario. The high retention scenario, we assumed to be 1.5 times the retention of the medium scenario. This means that the retention rate for the high retention scenario is 24%. For the low retention scenario, we halved the retention rate of the medium scenario. This means that the retention rate for the low retention scenario is 8%.

Figure 4.3: Scenario testing of the total impacts of investing in the development of a lung conditions management app (2023 – 2030)

Retention rate	Low (8%)	Medium (16%)	High (24%)
NHS saving annual average (£)	£63,935,258	£127,870,517	£191,805,775
Productivity saving annual average (£)	£58,679,072	£117,358,144	£176,037,216
Avoided sick days	2,273,822	4,547,645	6,821,467
Increases in QALY	1,320,430	2,640,861	3,961,291

4.5 Clinical trials case study

Clinical trials are needed for new therapies, devices, treatments and medicines and the UK is regarded as a global leader in clinical research. The number of patients taking part in clinical research reached over a million in 2021 to 2022.[49] However, there is more opportunity to expand this due to the UK's impressive life sciences infrastructure and health care network. Clinical trials increase survival rates of patients as well as improving the care they receive. NIHR CRN supports commercial and non-commercial research, providing over 47,000 jobs and generating £2.7 billion gross value added in 2018 to 2019.[50] I**n 2018 to 2019, the NHS received an estimated income of £355 million from life sciences companies.[51] In the same period, per participant in a trial, the NHS received on average £9000 from life sciences companies and saved nearly £6000 from treatment costs being covered by commercial sponsors**[52]. As indicated in a recent review, making clinical trials a strategic focus of the UK government is core to delivering on its ambition to become a life science superpower.[53]

However, clinical research into lung conditions is staggeringly low. Despite COPD being the third largest killer worldwide, there are only 780 active clinical trials being conducted on it globally.[54] By comparison, there are currently over 41,000 active trials into cancer treatment.[55]

Lung conditions are a global issue. 15% of deaths in the EU are attributed to lung conditions, and the UK has the highest rate of death of lung conditions in western Europe.[56] The US spent over $170 billion on lung conditions in 2016. Tackling lung conditions through more clinical trials is needed for the UK to position itself as a global leader in life sciences.

In order to increase the number of clinical trials being conducted in the UK the Government must take a multifaceted approach to support clinical research:

- Build upon digital platforms to deliver clinical research.
- Expedite costing, contracting and approvals.
- Improve visibility of research to patients and the public to drive clinical trial participation.
- Support commercial sponsors in accessing patient groups to develop studies.
- Offer more research grants to non-commercial bodies to encourage clinical research.

We imagine what the future number of respiratory clinical trials could look like following government investment into reducing the barriers to clinical research for commercial and non-commercial bodies as well as strengthening and developing clinical research infrastructure in the UK.

4.5.1 Clinical trial impact pathway

To model the benefits of increased lung conditions clinical trials, we assumed a tripling of the current number of annual clinical trials for lung conditions over the course of seven years with a take up rate assumed to be equivalent to the cumulative percentage increase of investment outlined in Asthma + Lung UK's proposal.

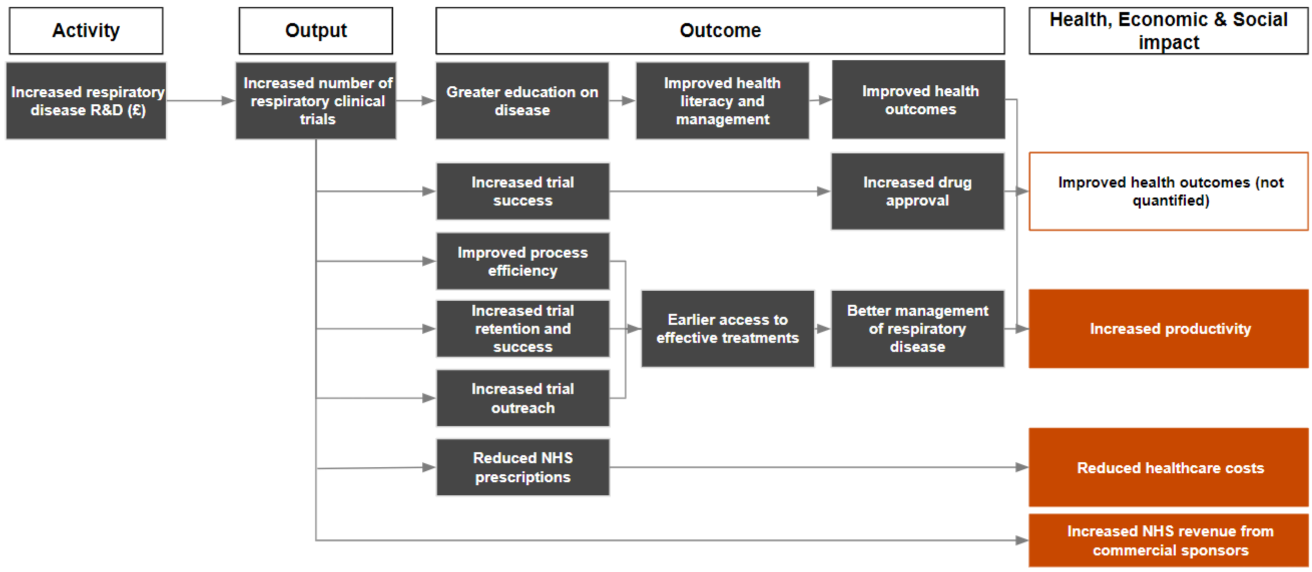
---

49 NIHR, Annual statistics, 2023
50 HM Government, Commercial clinical trials in the UK: the Lord O'Shaughnessy review - final report, 2023
51 The Business Research Company, How Global Respiratory Diseases Drugs Market Players Should Strategize For 2022-2031, 2022
52 HM Government, Commercial clinical trials in the UK: the Lord O'Shaughnessy review - final report, 2023
53 HM Government, Commercial clinical trials in the UK: the Lord O'Shaughnessy review - final report, 2023
54 Stolz et al, Towards the elimination of chronic obstructive pulmonary disease: a Lancet Commission, 2022
55 PwC analysis
56 Asthma + Lung UK, Strategy to 2027: Fighting for Breath, 2023

Within this case study, we do not expect the clinical trials to be purely sponsored by commercial sponsors or pharmaceutical companies, but likely to come from a collaborative approach with universities, academics, and the industry.

With the impact time frame established, we developed the impact pathway to map out the causal linkage between increased investment (the input), increased lung condition clinical trials (the output) and the outcomes that lead to quantifiable impacts. The impact pathway developed can be found below in Figure 4.4.

Figure 4.4: Impact pathway showing the outcomes and impacts associated with increasing the number of clinical trials



As shown in Figure 4.4, an increase in the number of respiratory clinical trials leads to several outcomes:

1. An increase in clinical trials leads to more clinical trial participation. This in turn leads to a greater amount of education and involvement on a patient's own treatment which leads to improved health literacy and self-management. As a result, we would expect improvements in health outcomes for lung conditions clinical trial participants. Furthermore, it gives individuals earlier access to treatments which results in the impact of improved productivity gains for individuals due to reduced absence and presentism due to illness.

2. An uptake in lung conditions clinical trials has the outcome of an increased likelihood in trial success leading to innovative and effective treatment being developed and made available to the public. We cannot model the impact of hypothetical treatments. However, we can qualitatively evaluate the benefits from the outcome of increased treatments being developed.

3. For every individual who participates in a commercially sponsored clinical trial the NHS receives revenue from commercial sponsors and saves money on the treatments patients no longer have to receive due to being part of clinical trials. As a result, an impact of increased trials is reduced costs to the NHS and increased revenue. We show the results in Figure 4.5 below.

Figure 4.5: Total impacts of investing in additional clinical trials for lung conditions

Tripling of investment into clinical research could result in:
Increased annual revenues to the NHS of £154 million by 2030
Increased annual savings to the NHS of £97 million by 2030
Increased annual productivity gains of £137 million by 2030

To model the impacts of increased lung conditions clinical trials we first had to establish the counterfactual. In this case, that would be the current level of annual respiratory clinical participants. This was estimated to be approximately 25,000 lung conditions clinical participants a year. To obtain the net impacts we assume a tripling of participation from 2023-2030 in line with the proposed investment timeline of Asthma + Lung. The difference was then used to obtain the net impacts.

To model productivity gains, we found that participating in a clinical trial led to increased productivity gains of approximately £8400 a year in 2023[57]. The percentage of the UK working population is approximately 63%.[58] Of that 63% we estimated the proportion of individuals with lung conditions who were employed to be 60%.[59] Productivity benefits are then applied to that proportion of lung conditions participants.

Applying inflation and a discount factor to obtain net present values, we found that tripling of lung conditions clinical trials would lead to annual productivity gains of approximately £137 million by 2030. The driving factor for these savings is the earlier access to treatments which effectively manage lung conditions. Examples include the novel treatment AIRFLOW-1 which has shown promising outcomes for patients with COPD.[60] Revefenacin, a drug to dilate the lungs also has been found to improve lung function in COPD patients.[61]

Quantifying the impacts of new treatments of lung conditions as a result of increasing clinical trials is beyond the scope of this report. However, the benefits of existing treatments outline the potential positive outcomes of greater and faster treatment development for lung conditions.

Existing treatments have been successful in alleviating symptoms, reducing mortality and improving overall quality of life. For example, Roflumilast has been found to reduce average annual exacerbation rates from COPD by 17%,[62] thus reducing healthcare costs and improving a patient's quality of life. However, the rate at which new treatments have been developed has been slow. An increase in the number of clinical trials focusing on lung conditions would increase the development of new treatments and reduce the economic cost of lung conditions in the UK.

To model the quantifiable impacts of increased lung conditions clinical trials on the NHS, we found that per clinical trial participant, when adjusted to 2023 prices, the NHS received approximately £10,600 from commercial sponsors in revenue and cost savings due to foregone treatment costs of £6700. As these benefits only apply to commercially sponsored trials, we assume benefits are only applied to 34% of clinical participants, as this the annual proportion of commercially sponsored clinical trials[63], which aligns with the collaborative approach we

---

[57] PwC analysis
[58] GOV.UK, Working Age Population, 2023
[59] Eisner MD, Yelin EH, Trupin L, Blanc PD, The influence of chronic respiratory conditions on health status and work disability, 2002
[60] Royal Brompton and Harefield NHS, NHS Foundation Trust, 2016
[61] COPD Foundation, Improvements in Lung Function with Nebulized Revefenacin in the Treatment of Patients with Moderate to Very Severe COPD: Results from Two Replicate Phase III Clinical Trials, 2019

[62] Calverley et al., Roflumilast in symptomatic chronic obstructive pulmonary disease: two randomised clinical trials, 2006

[63] NIHR, Annual Statistics, 2023

assume in this example. Applying these values to the net increase in clinical trial participants would lead to an impact of £154 million in revenue generated for the NHS and cost savings of £97 million by 2030.

Although not modelled as an impact it is important to consider the outcome of improved health from better self-management due to clinical trial participation. Clinical trial participation allows for patients to take a more active role in their own health[64] as they are taught more about their illness and how to better manage it. Educational interventions during clinical trials into asthma and COPD have been found to have several benefits for patients; a reduction in hospitalizations,[65] incidence of anxiety and depression falls, improved inhaler technique and increased smoking cessation.[66] Furthermore, the overall quality of life of patients improves and mortality rates are reduced.[67] We have not modelled these specific impacts. However, our modelling of productivity gains reflects these benefits. Nonetheless, it is important to highlight the benefits that come from clinical trial attendance alone.

In conclusion, there are several positive impacts and outcomes associated with an increase in lung conditions clinical trials from increased investment into clinical research. Firstly, it generates revenue and costs saving for the NHS. Furthermore, it will encourage innovation in effective lung conditions treatments which is necessary considering the current slow rate of development. Finally, it provides several health benefits to individuals improving their quality of life as well reducing productivity losses.

[64] National Institute on Aging, Clinical Research: Benefits, Risks, and Safety, 2023
[65] Guevera et al, Effects of educational interventions for self management of asthma in children and adolescents: systematic review and meta-analysis, 2003
[66] Folch et al, Educational programs for patients with Chronic Obstructive Pulmonary Disease, 2017
[67] Lutter et al. Impact of Education on COPD Severity and All-Cause Mortality in Lifetime Never-Smokers and Longtime Ex-Smokers, 2020

4.6 Synthetic AI data repository case study

With limited research funding for lung conditions, it is important to best utilise the resources that are available to progress treatment development. Clinical trials are expensive. A portion of clinical trial costs can be exacerbated through the cost of participants who drop out.[68] The limited resource pool could pose a barrier to potential lung conditions treatments being developed due to this risk.

To develop new treatments and improve care for lung conditions, access to robust data is required. This could come from a group of lung patients who can help us understand specific lung conditions better, or through data platforms that aggregate clinical trial data. Having a shared infrastructure for lung conditions data will help research and innovation become more competitive, collaborative, and attract more funding for research.

AI has already been earmarked to change the way clinical trials are conducted.[69] Applications of AI in clinical trials include the design of clinical trials, participant recruitment and monitoring of adherence to treatment. It can also assist trial site selection and analysis of trial data.

Synthetic data is information generated on a computer to augment or replace real data to improve AI models, protect sensitive data, and mitigate bias.[70] Synthetic AI data sets are based on real data, but it is impossible to identify real patients because they do not exist. Synthetic data allows researchers to have more access to information. This information is complete and can be reviewed without affecting the privacy of patients. It can be used to accelerate early-stage clinical trials or to provide a base for secondary analysis.[71] It also speeds up the completion of clinical trials, and treatment approvals.[72] Accelerated approval was granted for leukaemia treatment by the FDA using a comparator arm of historical data from 694 patients.

Asthma + Lung UK notes that barriers to participation in clinical trials in lung conditions patients include difficulty of attending trials through breathlessness, and a lack of motivation due to the belief that nothing can be done to help them.[73]

In the future, synthetic AI may be able partially address this participation issue for patient controls in a clinical trial in certain therapeutic areas. This is because the AI would be able to predict how a patient's disease would progress based on their personal characteristics and because in this case, the AI would not need to consider how a patient might respond to any treatment intervention. It could reduce the dropout rate for clinical trials, and by extension remove the associated cost of replacing participants.

This in turn, lowers the overall cost of respiratory drug clinical trials. Lowering barriers to market entry through the costs of drug research and development also encourages greater competition. It allows more players to conduct clinical trials. If there are more successful clinical trials for lung conditions, this could result in more novel treatments that the government could purchase at a lower cost than they otherwise would have.

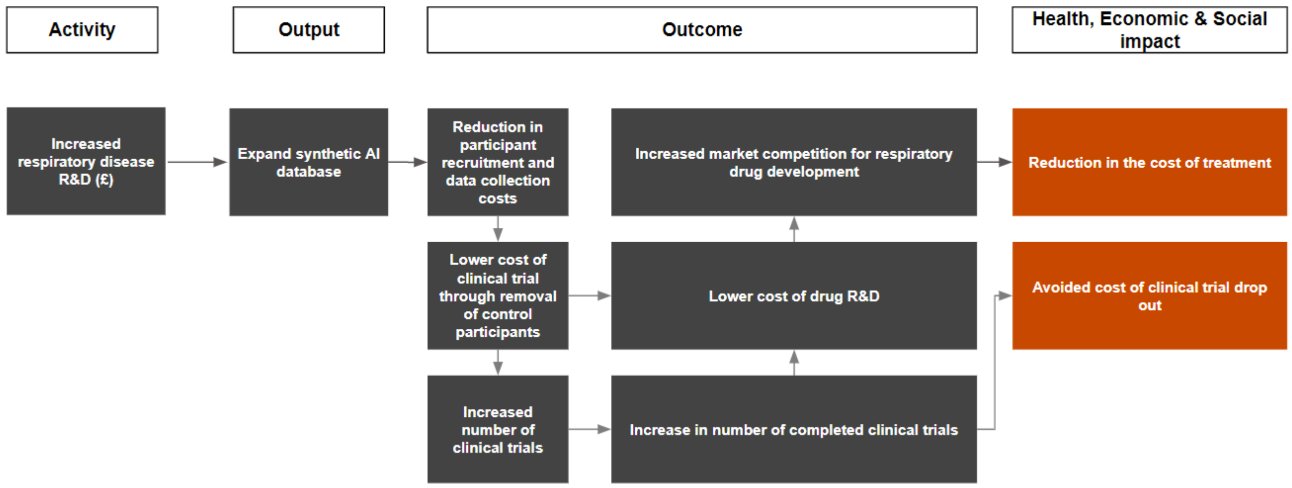
As the impact pathway demonstrates in Figure 4.6 below, **synthetic AI leads to a reduction in participant recruitment and data collection costs for pharmaceutical companies and the NHS by removing the need to recruit control cohorts in the first place.** This in turn lowers the existing costs of clinical trials. This new lower cost of drug R&D could lower the barriers to entry for drug development and in turn, increase the number of completed clinical trials. Furthermore, clinical trials terminate due to low participant accrual, resulting in lost NHS savings and revenue as explained in the increase of clinical trials pathway above.

[68] MD Group, The True Cost of Patient Dropouts in Clinical Trials, 2020
[69] Hackernoon, Why Using Artificial Intelligence in Clinical Trials is Becoming the New Normal, 2022
[70] IBM, What is synthetic data?, 2023
[71] Anju, What is the Role of Synthetic Data in Early-Phase Clinical Trials?, 2021
[72] Accenture, Faster and cheaper clinical trials, 2021
[73] Asthma + Lung UK, Clinical trial recruitment: Asthma + Lung UK's proposed solution, 2023

An additional by-product of cheaper drug development costs is also increased market competition for lung conditions treatment and with that, potentially cheaper treatments for patients when products enter the market.

Removing control cohorts in respiratory clinical trials could save £74 million a year

Figure 4.6: Impact pathway showing the outcomes and impacts associated Synthetic AI data in clinical trials



To model the impacts of the avoided cost of clinical trial dropouts, we took the number of lung conditions participants and estimated how many could be replaced by synthetic AI if there was no longer a need to have control participants. The cost savings during the analysis period of 2023-2030 are calculated by multiplying the number of avoided lung conditions clinical trial control dropouts by the combined costs of dropping out and replacement. This resulted in savings of £74 million annually by 2030 and removing the need to replace 3800 clinical participants annually.

Figure 4.7: Total impacts of associated Synthetic AI data use in clinical trials

Synthetic AI could result in:
Annual savings of £74 million by 2030
Avoidance of replacing 3800 respiratory clinical participants annually by 2030

5. Conclusion

The overall economic cost of lung conditions is £188 billion in 2019. The burden from chronic lung conditions have not improved since the last report. The total cost equates to approximately 9% of the UK GDP in 2022. In contrast, the proportion that the government and charities spend on lung conditions research is only 1.8%

More investment into research and innovation is needed to combat this economic and health burden, and to save lives. Additional research funding would make this ratio more proportionate. There has been historic underinvestment into lung health by the government but there is an opportunity to meet this challenge. £721m worth of funding between 2023-2030 (£141m of it in 2028) into research around prevention, diagnosis and care provides the chance to change and save lives. In doing so, new treatments, forms of care and cures become a more possible reality.

This would address the two present challenges, the current caseload of the NHS, and the tight labour force. Additional investment in lung conditions is necessary to tackle the UK's healthcare challenges and to support economic growth.

Investing in research and innovation allows for more clinical trials, leading to more advancements in treatment, diagnostics, and prevention. Addressing structural health challenges through research also helps bring more people back to work, reducing the strain on the health system and boosting economic opportunities. Healthier respiratory patients contribute to the workforce and alleviate wage pressures, positively impacting the UK's economy. Additional investment into lung conditions research and innovation could generate £851m in economic benefits, whilst stimulating private investment simultaneously.

We provide three case study examples on how specific activities funded by the additional investment could further reduce costs for the NHS, and costs associated with clinical trial activities that are necessary to progress against lung conditions.

The case studies are examples of how increased investment could benefit a range of stakeholders. Firstly, our examples demonstrate the impact to lung conditions patients, through reduced use of A&E and gains in QALYs by using a respiratory self-management app. By using the app and managing their health better, they are also more productive and less absent employees. Our case studies also accrue impacts to the NHS through increased clinical trials by the government providing foundations to encourage greater number of clinical trials. More clinical trials mean more revenue for the NHS, and fewer medication costs. Lastly, we have also modelled benefits to pharmaceutical companies through lower clinical trial costs and by reducing clinical trial dropouts in control cohorts and replacements. That could lead to reductions in the cost of treatment for patients.

Overall, there are multiple benefits to those with lung conditions, the UK economy and multiple other stakeholders (including the NHS) from increased research and development in lung conditions.

Appendix 1: Abbreviations

In this section, we provide a list of abbreviations used throughout this report.

Abbreviation	Term
CCG	Clinical Commission Groups
COPD	Chronic Obstructive Pulmonary Disease
DALY	Disability Adjusted Life Years
GDP	Gross Domestic Product
GVA	Gross Value Add
GP	General practitioner
ICB	Integrated Care Boards
ICD	International Statistical Classification of Diseases
NPV	Net Present Value
PHAC	Public Health Agency of Canada
QALY	Quality Adjusted Life Year
UK	United Kingdom
YLD	Years of life lost due to premature mortality
YLD	Years of healthy life lost due to disability

Appendix 2: Economic cost methodology

The economic cost methodology draws upon the methodology used in the BLF 2014 report.[74] The total costs are broken down into:

- Direct costs
- Indirect costs
- Intangible costs

Appendix 2.1: General economic cost of lung conditions assumptions

Figure A2.1: Table of general economic cost of lung conditions assumptions

Item	Value	Source
GP cost (2019)	**£39**	Curtis, L. & Burns, A. (2019) Unit Costs of Health and Social Care 2019, Personal Social Services Research Unit, University of Kent, Canterbury.
GP visits (2019)	**312 million**	Bostok, L (2020), General practice delivered 1.22m appointments for every weekday in 2019.
Lung conditions prescription costs proportion (2019)	**11%**	NHS Digital, (2020), Prescription Cost Analysis-England 2019.
Proportion of non-government healthcare expenditure (2019)	**21%**	ONS, (2021), Healthcare expenditure, UK Health Accounts: 2019.
England to UK multiplier (2019)	**1.22 (2dp)**	HM Treasury, (2019), Public Expenditure Statistical Analyses 2019.
Secondary care cost of pneumonia (2019)	**£731,000,000**	Campling J, Wright HF, Hall GC, Mugwagwa T, Vyse A, Mendes D, Slack MPE, Ellsbury GF. Hospitalization costs of adult community-acquired pneumonia in England, 2022

[74] British Lung Foundation, Estimating the economic burden of respiratory illness in the UK, 2017

Item	Value	Source
GP cost (2019)	**£39**	Curtis, L. & Burns, A. (2019) Unit Costs of Health and Social Care 2019, Personal Social Services Research Unit, University of Kent, Canterbury.
DALY cost (2022)	**£70,000**	Gov.UK, (2022), The Green Book.

Appendix 2.2: Estimating primary care costs

1. Estimating total GP costs

The number of GP visits[75] in England in 2019 and the cost of a GP appointment[76] in 2019 were used to estimate the total costs of primary care.

$$Annual\ GP\ visits\ \times\ cost\ of\ a\ GP\ appointment\ =\ £12.17\ billion$$

2. Estimating lung conditions GP costs

The proportion of lung conditions costs were assumed to be in the same proportion as the costs associated with primary care prescribing costs in 2019.[77] For example, if the diseases of the nervous system category were associated with 15.2% of primary prescribing care costs, then we assumed 15.2% of primary care costs would be associated with diseases of the nervous system.

$$Total\ GP\ costs\ \times\ Proportion\ of\ respiratory\ disease\ prescription\ costs\ =\ £1.36\ billion$$

3. Breaking down GP costs by specific lung conditions

To estimate the distribution of costs amongst specific lung conditions, we split costs in proportion to the burden of Disability Adjusted Life Years (DALYs) as estimated by the WHO. For example, the portion of total COPD DALYs in relation to other lung conditions was 32%. So, we assumed 32% of lung conditions primary care costs to be associated with COPD. The breakdown of costs is shown in Figure A2.2 below.

Figure A2.2: DALY proportion and primary care costs by lung conditions

Health Category	Number of DALYs in 2019 ('000s)	Proportion of lung conditions DALYs	Primary care costs (£)
Upper Respiratory Infections	59.9	0.02	£32,724,532

[75] Refer to Figure A2.1
[76] Refer to Figure A2.1
[77] Refer to Figure A2.1

Health Category	Number of DALYs in 2019 ('000s)	Proportion of lung conditions DALYs	Primary care costs (£)
Lower Respiratory Infections	481.3	0.19	£262,943,529
Trachea, bronchus and lung cancers	681.2	0.27	£372,152,778
Chronic obstructive pulmonary disease	791.3	0.32	£432,302,544
Asthma	272.3	0.11	£148,762,774
Other lung conditions	205.1	0.08	£112,050,110
Total	**2,491.10**	**1.00**	**£1,360,936,266**

Appendix 2.3: Estimating secondary care costs

1. Breaking down secondary care costs by lung conditions

In order to obtain secondary care costs, we used the Clinical Commission Group (CCG) 2013-2014 Program Budgeting Benchmark dataset from the 2014 BLF report.[78] We matched CCG health categories to ICD-10 codes, and these costs were inflated to 2019 values. Costs for upper and lower respiratory infections were not isolated within the CCG data. As a substitute, annual secondary care costs of pneumonia were used as a proxy for lower respiratory infections costs however upper respiratory infection secondary care costs were not included so the total secondary care costs of respiratory infections are likely underestimated. Secondary care costs by lung conditions are shown below in Figure A2.3.

Figure A2.3: Secondary care costs by lung conditions

Health Category	Secondary care costs in 2014 (£)	Secondary care costs in 2019 (£)
Lower Respiratory Infections	£ -	£ 731,000,000
Upper Respiratory Infections	£ -	£-
Trachea, bronchus and lung cancers	£107,921,195	£117,059,017

[78] British Lung Foundation, Estimating the economic burden of respiratory illness in the UK, 2017

Chronic obstructive pulmonary disease	£675,866,558	£733,093,022
Asthma	£783,835,451	£850,203,775
Other lung conditions	£2,504,573,471	£2,716,638,829
Total	**£4,072,196,675**	**£5,147,994,643**

Appendix 2.4: Estimating non-government expenditure costs

1. **Estimating non-government expenditure costs by lung conditions**

In Figure A2.4, we scaled NHS direct costs by a private healthcare expenditure[79] multiplier to account for total healthcare expenditure. We assumed that costs were distributed equally amongst the lung conditions ICD-10 codes, as shown in Figure A2.5.

$$(Total\ primary\ care\ costs\ +\ Total\ secondary\ care\ costs)\ \times\ 0.21\ =\ Non\ government\ expenditure$$

Figure A2.4: Total primary and secondary care costs by lung conditions

Health Category	Primary care costs (£)	Secondary care costs (£)	Primary + secondary care total cost (£)
Lower Respiratory Infections	£262,943,529	£731,000,000	£993,943,529
Upper Respiratory Infections	£32,724,532	-	£32,724,532
Trachea, bronchus and lung cancers	£372,152,778	£117,059,017	£489,211,794
Chronic obstructive pulmonary disease	£432,302,544	£733,093,022	£1,165,395,566
Asthma	£148,762,774	£850,203,775	£998,966,549
Other lung conditions	£112,050,110	£2,716,638,829	£2,828,688,938
Total	**£1,360,936,266**	**£5,147,994,643**	**£6,508,930,908**

Figure A2.5: Non-government expenditure costs by lung conditions

Health Category	Primary + secondary care total cost (£)	Non-Government Expenditure (£)
Lower Respiratory Infections	£ 993,943,529	£208,728,141

[79] Refer to Figure A2.1.

Upper Respiratory Infections	£ 32,724,532	£6,872,152
Trachea, bronchus and lung cancers	£489,211,794	£102,734,477
Chronic obstructive pulmonary disease	£1,165,395,566	£244,733,069
Asthma	£998,966,549	£209,782,975
Other lung conditions	£2,828,688,938	£594,024,677
Total	**£6,508,930,908**	**£1,366,875,491**

Appendix 2.5: Estimating total direct costs in England and the UK

1. **Estimating total direct costs by lung conditions**

To estimate the total direct costs of lung conditions, the costs of primary care costs, secondary care costs and non-government expenditure costs summed together. We present the results in Figure A2.6.

Figure A2.6: Total direct costs by lung conditions

Health Category	Direct Costs (£)
Lower Respiratory Infections	£1,202,671,670
Upper Respiratory Infections	£39,596,684
Trachea, bronchus and lung cancers	£591,946,271
Chronic obstructive pulmonary disease	£1,410,128,635
Asthma	£1,208,749,524
Other lung conditions	£3,422,713,615

Total	**£7,875,806,399**

2. **Adjusting direct costs to include the UK**

The data set underpinning our analysis only provides estimates for England. To adjust these costs for the UK, they were multiplied by the ratio of identifiable health expenditure in England compared to the whole of the UK in 2018-2019[80], as shown in Figure A2.7.

Figure A2.7: UK adjusted direct costs by lung conditions

Health Category	England direct Costs (£)	UK wide direct costs (£)
Lower Respiratory Infections	£1,202,671,670	£1,470,464,676
Upper Respiratory Infections	£39,596,684	£48,413,484
Trachea, bronchus and lung cancers	£591,946,271	£723,752,046
Chronic obstructive pulmonary disease	£1,410,128,635	£1,724,115,066
Asthma	£1,208,749,524	£1,477,895,856
Other lung conditions	£3,422,713,615	£4,184,832,479
Total	**£7,875,806,399**	**£9,629,473,606**

Appendix 2.6: Estimating indirect costs

1. **Estimating indirect costs using direct costs for England and the UK**

We follow the approach used in the BLF 2014 report by using the ratio of direct to indirect costs in Canada. The cost ratios per ICD-10 chapter can be found below in Figure A2.8 as well as the estimates of indirect costs in England and the UK in Figure A2.9 and Figure A2.10 respectively.

Figure A2.8: Direct to indirect cost ratio as reported by the Public Health agency of Canada

ICD-10 chapter	Direct costs (CAD$)	Indirect costs (CAD$)	Cost ratio

[80] Refer to Figure A2.1

I: Infectious diseases	$2,254	$925	0.41
II: Neoplasms	$5,360	$790	0.15
X: Respiratory system	$6,514	$3,094	0.47

Figure A2.9: Indirect costs by lung conditions for England

Health Category	ICD chapter	Direct Costs (£)	Cost ratio	Indirect Costs (£)
Lower Respiratory Infections	I: Infectious diseases	£1,202,671,670	0.41	£493,554,257
Upper Respiratory Infections	I: Infectious diseases	£39,596,684	0.41	£16,249,748
Trachea, bronchus and lung cancers	II: Neoplasms	£591,946,271	0.15	£87,245,812
Chronic obstructive pulmonary disease	X: Respiratory system	£1,410,128,635	0.47	£669,778,630
Asthma	X: Respiratory system	£1,208,749,524	0.47	£574,128,190
Other lung conditions	X: Respiratory system	£3,422,713,615	0.47	£1,625,710,151
Total		**£7,875,806,399**		**£3,466,666,788**

Figure A2.10: UK adjusted indirect costs by lung condition

Health Category	England indirect costs (£)	UK Wide indirect Costs (£)
Lower Respiratory Infections	£493,554,257	£603,451,564
Upper Respiratory Infections	£16,249,748	£19,868,000
Trachea, bronchus and lung cancers	£87,245,812	£106,672,410
Chronic obstructive pulmonary disease	£669,778,630	£818,914,954
Asthma	£574,128,190	£701,966,500
Other lung conditions	£1,625,710,151	£1,987,699,062
Total	**£3,466,666,788**	**£4,238,572,490**

A2.7: Estimating intangible costs by lung condition

1. Estimating intangible costs by lung conditions

In order to estimate intangible costs, we used the total number of DALYs by lung conditions as estimated by the WHO in 2019. We multiplied by the cost of a DALY (£70,000) to generate intangible costs which are shown in Figure A2.11 below to estimate the willingness to pay to avoid the disease burden.

Figure A2.11: Intangible costs by lung conditions

ICD-10 Category	DALY Rate (DALYs)	DALY Total Cost (£)
Lower Respiratory Infections	481,300 DALYs	£ 33,691,000,000
Upper Respiratory Infections	59,900 DALYs	£ 4,193,000,000
Trachea, bronchus and lung cancers	681,200 DALYs	£ 47,684,000,000
Chronic obstructive pulmonary disease	791,300 DALYs	£ 55,391,000,000
Asthma	272,300 DALYs	£ 19,061,000,000
Other lung conditions	205,100 DALYs	£ 14,357,000,000
Total	**2,491,100 DALYs**	**£ 174,377,000,000**

Appendix 3: Economic benefits methodology

This appendix outlines the steps, assumptions and sources that we used to calculate the values in the main report.

Appendix 3.1: Estimating the impact of increasing lung conditions R&I expenditure

The impact assessment methodology draws upon relevant literature to understand the potential benefits the UK could achieve from 2023-2030 if public and charity research funding for lung conditions was increased.

Asthma + Lung UK proposes an option where this additional investment would begin in 2023 and increase incrementally until it will reach a target of £141 million in 2028. Asthma + Lung UK anticipates that this funding will be distributed equally across two initiatives.

The first half of the additional funding expenditure concentrates on the construction of new lung conditions centres across the UK. Each centre would have a unique research capability that would help develop new treatments and diagnostics and identify ways to prevent and better self-manage respiratory disease.

We have not considered how this funding would be broken down by the initial capital expenditure required to build the centres and the ensuing operational costs afterwards. The second half of the additional funding expenditure focuses on direct grant contributions for research into lung conditions. Figure A3.1 details the general assumptions for estimating the impact of increasing lung conditions R&I expenditure.

Figure A3.1: General assumptions for estimating the impact of increasing lung conditions R&I expenditure

Item	Value	Source
Current value of public and charity investment into lung conditions in the UK	**£47 million**	UK Clinical research collaboration, (2020) UK Health Research Analysis: 2018,
GVA per unit of output ratio (health)	**0.61 (2 d.p)**	ONS, (2023), UK input-output analytical tables, industry by industry 2019 and PwC analysis
GVA per unit of output ratio (construction)	**0.37 (2 d.p)**	ONS, (2023), UK input-output analytical tables, industry by industry 2019 and PwC analysis
GVA Type 1 Multiplier (health)	**1.40 (2 d.p)**	ONS, (2023) UK input-output analytical tables, industry by industry 2019 and PwC analysis
GVA Type 1 Multiplier (construction)	**2.27 (2 d.p)**	ONS, (2023) UK input-output analytical tables, industry by industry 2019 and PwC analysis

GVA Type 2 Multiplier (health)	**1.94 (2 d.p)**	ONS, (2023), UK input-output analytical tables, industry by industry 2019 and PwC analysis
GVA Type 2 Multiplier (construction)	**2.88 (2 d.p)**	ONS, (2023), UK input-output analytical tables, industry by industry 2019 and PwC analysis
Private investment Multiplier	**0.97 (2 d.p)**	Sussex et al., (2016) Quantifying the economic impact of government and charity funding of medical research on private research and development funding in the United Kingdom

1. Current investment value of lung conditions research and target state

The current value of investment of lung conditions funding in the UK is £47 million pounds a year. Asthma + Lung UK's projected target is three times the current value of investment.

$$3 \times \sim current\ value\ of\ investment\ of\ lung\ conditions\ funding\ in\ the\ UK\ =\ £141\ million$$

Appendix 3.2: Establishing a timeline of additional funding for lung conditions research and innovation

1. Establishing a timeline of additional funding for lung conditions research and innovation

Asthma + Lung UK anticipates that funding to reach a figure of £141m per year will not occur in the short term. Therefore, we have profiled an option that incrementally increases the total amount of yearly funding over the overall investment period from 2023-2030.

- As shown in Figure A3.2 and Figure A3.3, in 2023, the additional funding will begin with a £10m commitment that is split over a five-year period ending in 2027.
- In 2024, an additional £20m will be committed over a five-year period. Each year will split the additional funding equally.
- In 2025, an additional £120m will be committed over a five-year period during the 2025 Spending Review. Each year will split the additional funding equally.
- In 2028-2030, the final £195m will be spent with £66m occurring in the first year. This final round of funding is front loaded, with £66m occurring in the first year, then £64.5m in the final two years.

Figure A3.2 shows how as the release of funds overlap, 2028 is expected to be the year of highest spend, £141 million, and then year on year funding would slightly decrease as earlier funding commitments finish by 2029 and 2030. Although Asthma + Lung UK wish to see continued annual investment of £141 million from other sources by 2029, the impacts modelled are derived from the original investment timeline proposed by Asthma + Lung UK and excludes assumed funding from other sources.

Figure A3.2: A timeline of additional funding for lung conditions research and innovation

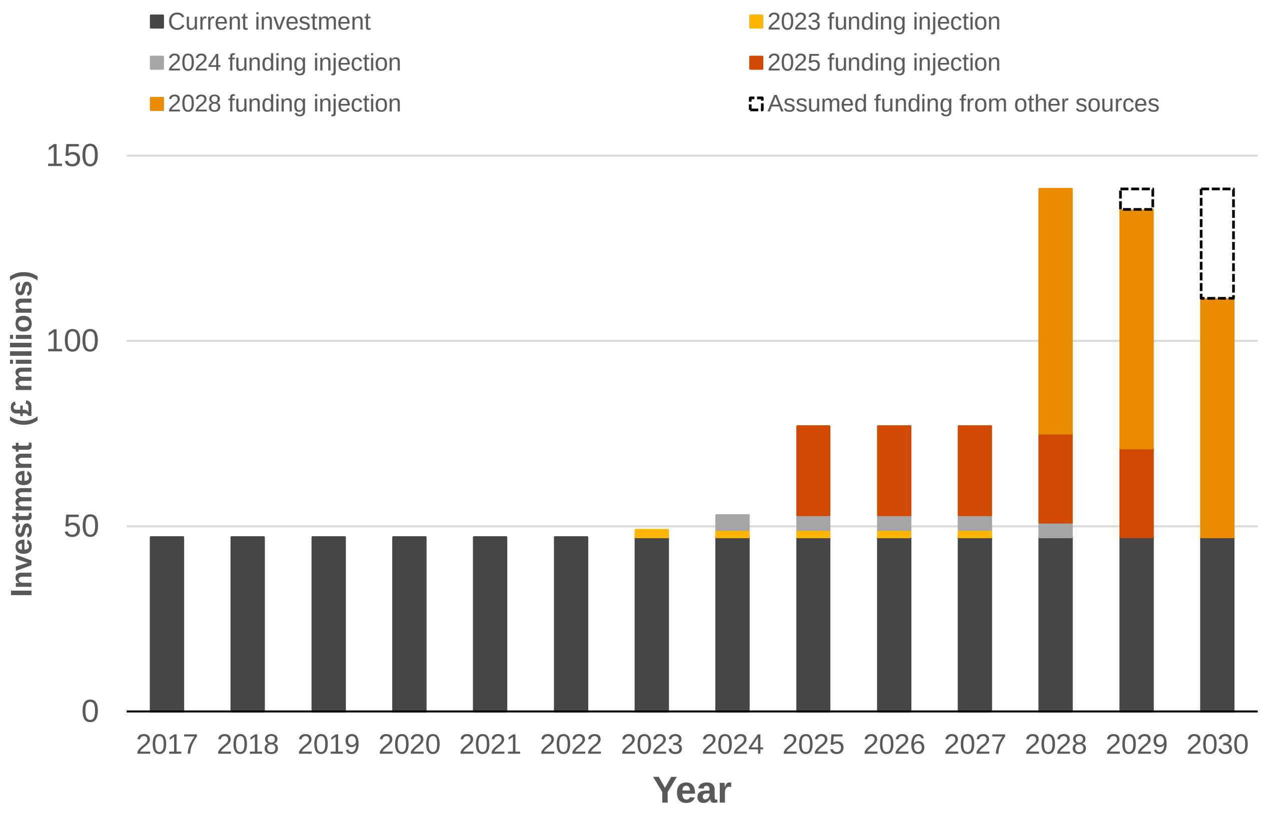


Figure A3.3: A timeline of additional funding for lung conditions research and innovation

	Current investment	2023 funding injection	2024 funding injection	2025 funding injection	2028 funding injection	Investment Total (£m)
2017	47					47
2018	47					47
2019	47					47
2020	47					47
2021	47					47
2022	47					47
2023	47	2				49
2024	47	2	4			53
2025	47	2	4	24		77
2026	47	2	4	24		77
2027	47	2	4	24		77
2028	47		4	24	66	141
2029	47			24	64.5	135.5
2030	47				64.5	111.5

Appendix 3.3: Estimating GVA Multipliers

The first half of the additional funding expenditure concentrates on the construction of new lung conditions centres across the UK. We have not considered how this funding would be broken down by the initial capital expenditure required to build the centres and the ensuing operational costs afterwards.

The second half of the additional funding expenditure focuses on direct grant contributions for research into lung conditions. Given the funding will be spent equally on the centres and on research, we have taken the average of the two multipliers associated with these activities. The first multiplier is Health, to reflect the research that will be conducted. The second multiplier is Construction, to reflect the spend on research infrastructure.

We calculated the multipliers using an internal tool that converted 2019 ONS Input Output values into a multiplier and a GVA per unit of output ratio, as shown in Figure A3.4.

- GVA per output ratios are used to convert injections of spending into GVA.
- Type I Multipliers estimate the impact on the supply chain as a result of the change in output. In other words, Type I multipliers sum together the direct and indirect effects.
- Type 2 Multipliers capture the direct, indirect and induced effects resulting from a change in output.

Figure A3.4: Average calculated GVA multipliers

	Multiplier average	Health	Construction
GVA per unit of output ratio	0.49	0.61	0.37
GVA Type 1 Multiplier	1.83	1.40	2.27
GVA Type 2 Multiplier	2.41	1.94	2.88

Appendix 3.4: Estimating economic impacts of increased lung conditions investment

1. Estimating direct impacts

In order to estimate direct impacts, we multiply the GVA per unit of output ratio against the total investment value of the given year. In this calculation, we assume that the output is the direct investment from the government into public expenditure into lung conditions research, as shown in Figure A3.5. We provide an example calculation below for the investment year of 2017.

$$0.49 \times £47m = £23\ million$$

Figure A3.5: Estimating direct impacts from investment totals

	Investment Total (£m)	Direct Impacts (£m)
2017	47	23
2018	47	23
2019	47	23
2020	47	23
2021	47	23
2022	47	23
2023	49	24
2024	53	26
2025	77	38
2026	77	38
2027	77	38
2028	141	69
2029	135.5	66
2030	111.5	55
Total (£m)	**£1,003**	**£491**
Total (£m) (2023-2030)	**£721**	**£353**

We then take the sum of the analysis period from 2023-2030 to arrive at a direct impact of £353m.

2. Estimating indirect Impacts

We use Type I multipliers to measure the indirect impact. Type I Multipliers estimate the impact on the supply chain as a result of the change in output. It calculates the total change in output resulting from changes in investment without considering subsequent effects. In order to estimate indirect impacts, we multiply direct impact by the GVA Type 1 multiplier, then subtract the direct impact from it to isolate the indirect impacts as shown in Figure A3.6. We provide an example calculation below for the investment year of 2017.

$$(1.83 \times £23m) - £23m = £19\ million$$

Figure A3.6: Estimating indirect impacts from direct impacts

	Direct Impacts (£m)	Indirect Impacts (£m)
2017	23	19
2018	23	19
2019	23	19
2020	23	19
2021	23	19
2022	23	19
2023	24	20
2024	26	22
2025	38	31
2026	38	31
2027	38	31
2028	69	58
2029	66	55
2030	55	46
Total (millions)	**£491**	**£409**
Total (millions)	**£353**	**£294**

We then take the sum of the analysis period from 2023-2030 to arrive at an indirect impact of £294m.

3. Induced Impacts

In order to estimate induced impacts, we multiply direct impact by the GVA Type 2 multiplier, then subtract the direct impact and indirect impact from it, as shown in Figure A3.7 to isolate the induced impacts from the total impacts. We provide an example calculation below for the investment year of 2017.

$$(2.41 \times £23m) - £23m - £19m = £13\,million$$

Figure A3.7: Estimating induced impacts from direct and indirect impacts

	Direct Impacts (£m)	Indirect Impacts (£m)	Induced Impacts (£m)
2017	23	19	13
2018	23	19	13
2019	23	19	13
2020	23	19	13
2021	23	19	13
2022	23	19	13
2023	24	20	14
2024	26	22	15
2025	38	31	22
2026	38	31	22
2027	38	31	22
2028	69	58	40
2029	66	55	38
2030	55	46	31
Total (millions)	**£491**	**£409**	**£283**
Total (millions)	**£353**	**£294**	**£204**

We then take the sum of the analysis period from 2023-2030 to arrive at an induced impact of £204m.

4. **Estimating the total economic impact**

We take the sum of the direct, indirect and induced impact for the analysis period of 2023-2030. The total economic impact during this period is £851m as shown in Figure A3.8.

Figure A3.8: Summing together the total economic impact

Direct (£m)	Indirect (£m)	Induced (£m)	Total (£m)
£353	£294	£204	**£851**

Appendix 3.5: Government investment into lung conditions research increasing private investment

We have used the average of the low sensitivity value and high sensitivity value within the academic paper to calculate the wider estimate multiplier. We have then multiplied this value by the initial investment year on year.

This wider investment is added onto the additional government investment to calculate total investment overall. We take the sum of the benefit impact for the analysis period of 2023-2030, as shown in Figure A3.8. The total additional investment by the private sector is estimated to be £699m.

Figure A3.9: Estimating induced impacts from direct and indirect impacts

	Public investment Total (£m)	Wider Investment Multiplier	Wider Investment (£m)	Total Investment (£m)
2017	47	0.97	46	93
2018	47		46	93
2019	47		46	93
2020	47		46	93
2021	47		46	93
2022	47		46	93
2023	49		48	97
2024	53		51	104
2025	77		75	152
2026	77		75	152
2027	77		75	152
2028	141		137	278
2029	135.5		131	267
2030	111.5		108	220
Total (millions)	**£1,003**		**£973**	**£1,976**
Total (£m) (2023-2030)	**£721**		**£699**	**£1,420**

Appendix 4: Impact assessment methodology

This appendix explains our approach to estimating the economic impacts of potential case studies that would be funded by the additional government investment. We have examined two case studies:

- An application that focuses on improving self-management for lung conditions patients
- Increasing the number of clinical trials

The case studies examine different impacts depending on the activity the additional investment could fund. We have only calculated the benefits that occur, not the costs that would be required to implement. In general, these case studies were developed following stakeholder consultations with Asthma + Lung UK and a review of their investment blueprint.

General outline of our approach

1. Review Asthma + Lung UK investment blueprint, desktop review and creating impact pathway criteria

Our starting point was to review Asthma + Lung UK documents to see if there were any future planned activities that we could leverage and model the impacts for. The main source that we reviewed was *Making the UK the best place to do respiratory research and innovation: areas for investment*. We also performed a desktop review to see what potential activities could be funded by the initial government investment.

There are numerous areas of development that could be targeted for investment. We narrowed down our selection of investment areas based on several criteria:

- How much of a need there is for investment in the area.
- How beneficial the impact would be.
- The materiality of the impacts in terms of data availability and the causality of investment leading to positive impacts.
- How it aligns with Asthma + Lung UK's strategic vision to make the UK the global leader in lung conditions research.

2. Define the case study activities and creating the impact pathways

We developed three examples of where investment could be targeted:

- An application that focuses on improving self-management for lung conditions patients. This would reduce the number of GP and A&E visits, the number of patient sick days whilst also leading to a health increase in patients.
- Increasing the number of clinical trials through clinical research investment, which would lead to increased treatment development and innovation and clinical participation.
- Expanding the usage of synthetic AI to clinical trials. This would lead to reduced clinical trial costs through a reduction of clinical trial dropouts and replacements for control groups. In doing so, reducing the costs encourages the completion of more clinical trials for lung conditions.

The impact pathways outline the causal relationship between an activity and the final outcome.

3. Collect data for modelling

To estimate the impacts of the case studies, we needed to extract data points on the current state or counterfactual, as well as values of how the case study would affect this counterfactual. We used a range of publicly available sources from government data sets, and we prioritised using primary data where this was available. Where this was not available, we leveraged secondary data from literature or estimates from our previous work.

4. Estimate the impacts of the case studies

The final step in our approach was to estimate the impacts of the case studies using calculations.

Appendix 4.1: An application for improving self-management for lung conditions patients

Figure A4.1: General assumptions used

Item	Value	Source
Number of GP visits (2019)	**312,000,000**	GP Online, (2020), General practice delivered 1.22m appointments for every weekday in 2019. Link
Number of A&E visit minor (2019)	**8,639,357**	NHS, (2022) Hospital Accident & Emergency Activity 2021-22 Link
Number of A&E visits major (2019)	**16,377,759**	NHS, (2022) Hospital Accident & Emergency Activity 2021-22 Link
% of visits related to lung conditions	**11%**	NHSBSA, (2021) Prescription Cost Analysis - England 2019 (Link)
Incidence of lung conditions (2011)	**9,515,480**	British Lung Foundation, Lung disease in the UK – big picture statistics Link
Incidence of lung conditions (2012)	**9,874,953**	British Lung Foundation, Lung disease in the UK – big picture statistics Link
Mortality rate of lung conditions	**- 0.30%**	British Lung Foundation, Lung disease in the UK – big picture statistics Link
Number of sick days lost to lung conditions 2019	**5.6m**	ONS, (2023) Sickness absence in the UK labour market Link
Reduction in GP visits due to app	**36%**	NHS Wales, NHS Wales Respiratory Toolkit Link
Reduction in A&E visits due to app	**19%**	NHS Wales, NHS Wales Respiratory Toolkit Link
Unit cost of GP (2022)	**£42**	The King's Fund, (2023) Key facts and figures about the NHS, Link
Unit cost of A&E minor	**£86**	The King's Fund, (2023) Key facts and figures about the NHS, Link
Unit cost of A&E major	**£418**	The King's Fund, (2023) Key facts and figures about the NHS, Link
Mobile health applications retention rate	**16%**	Lee et al. (2018) Effect of self-monitoring on long-term patient engagement with mobile health applications. Link

Estimating direct NHS savings

1. **Estimating the current number of GP visits, minor and major A&E visits and forecasting them**

We extracted the current number of GP visits, minor and major A&E visits and forecasted them over the analysis period of 20232023. The savings in question apply to the NHS.

2. **Estimating the current number of GP visits, minor and major A&E visits related to lung conditions and forecasting them**

We took the proportion of visits that occur due to lung conditions and applied them to our projections.

3. **Estimating the incidence of lung conditions**

We extracted two datasets that estimated the incidence of lung conditions in the years 2011 and 2012 to calculate a growth rate in incidence. This growth rate in incidence was applied to the analysis period. This was adjusted by subtracting the number of mortalities that occurred during that period. The percentage of mortality rate was calculated through analysis of the number of deaths between 2008 and 2012.

4. **Calculating the quantum of benefit intervention and applying a take up rate**

We then applied the two values which reduced the rate of GP and A&E visits due to the intervention of the self-management mobile application for patients with lung conditions. We applied a take up rate in order to conservatively estimate the benefits. The take up rate is an expected percentage of the total benefit to adjust for how many people will use the app.

We evaluated three different scenarios, reflecting the volatility in mobile application retention based on available benchmark data. To reflect the available evidence, we have assumed three different long term retention rates over the ten-year analysis period, with 16% being the medium retention scenario.

We assume the retention rate of the mobile app remains static between 2023 and 2030 as the lung conditions population increases over this same period. Outside of the benchmarked medium scenario, we assume different ranges for the low and high scenario.

The high retention scenario, we assumed to be 1.5x the retention of the medium scenario. This means that the retention rate for the high retention scenario is 24%. For the low retention scenario, we halved the retention rate of the medium scenario. This means that the retention rate for the low retention scenario is 8%.

5. **Monetising the benefit intervention**

We then multiplied the reduction in presentations by their unit costs to arrive at the total NHS savings. We then applied inflation to these cost savings.

Estimating health savings of the lung conditions app

Figure A4.2: General assumptions used

Item	Value	Source
Increase in QALY from self-management app	**0.1**	Ditsaki et al., (2015). An economic evaluation of a self-management programme of activity, coping and education for patients with chronic obstructive pulmonary disease Link

1. **Identifying the number of lung conditions patients**

We extracted the number of lung conditions patients from the previous section. These impacts apply to people living with lung conditions from 2023-2030.

2. **Applying the take up rate of benefit increase and increase in QALYs due to the application**

We use the same retention take up rate from the health savings calculation and apply it to our estimated QALY benefits.

In lieu of primary data that explains the relationship of a self-management app and an increase in QALYs, we have used a secondary source that details the increase through a self-management programme.

3. **Calculating total health improvements**

We calculate the total health improvement by applying the increase in QALYs by the total lung conditions population.

4. **Discounting the findings**

We discount the findings to arrive at the total health impact. For more on QALYs, please see the explanation below.

Figure A4.3: Assumptions used

Item	Value	Source
Reduction in sick leave due to app	**53%** (This value is an average between the two sources listed)	Gallefoss et al, (2000). Impact of patient education and self-management on morbidity in asthmatics and patients with chronic obstructive pulmonary disease Link Nathell, (2005). Effects on sick leave of an inpatient rehabilitation programme for asthmatics in a randomised trial Link
Direct cost of a sick day	**£96**	Greater Manchester Combined Authority, Cost Benefit Analysis Link
Indirect cost of a sick day	**£137**	Greater Manchester Combined Authority, Cost Benefit Analysis Link

Estimating productivity savings

1. **Estimating the days lost of work from respiratory illness**

We extracted the number of sick days lost to lung conditions between 2009 and 2019 to extract a growth rate. We then applied this growth rate to the future analysis period of 2023-2030. The impacts in question apply to employers within the UK economy.

2. **Estimating the impact of the app on sick days**

We took an average of two literature sources detailing the effects of improved patient education on the amount of sick days taken.

3. **Estimating the reduced number of sick days**

The percentage reduction in sick days was applied to generate a new total number of sick days, incorporating the retention rate to conservatively estimate the number.

4. **Estimating the costs of sick days**

We found the direct and indirect unit cost of a sick day in 2017 and applied historical and future inflation over the analysis period. We then applied the discount rate of this cost.

5. **Estimating the potential savings to lung conditions caused sick days**

We then multiplied the reduced number of sick days by the unit costs to estimate the total savings to productivity.

Appendix 4.2: The impact of the number of clinical trials

Figure A4.4: Assumptions used

Item	Value	Source
Number of clinical trial participants	**1,390,482**	NIHR, (2023). Annual Statistics Link
Proportion of clinical trials that are for lung conditions (%)	**1.8%**	UKCRC, (2020). UK Health Research Analysis 2019 Link
NHS life science funding (£) (2023)	**£ 10,554**	PwC analysis
NHS saving (£) (2023)	**£ 6677**	PwC analysis
Increase in wages per participant (£) (2023)	**£ 8447**	PwC analysis
Commercial sponsorship proportion	**34%**	NIHR, (2023). Annual Statistics Link
Population of working age	**62.9%**	GOV.UK (2023). Working age population 2023 Link
Lung conditions population who are employed	**60.1%**	Eisner MD, Yelin EH, Trupin L, Blanc PD, (2002). The influence of chronic respiratory conditions on health status and work disability Link

1. **Estimating the number of clinical trials participants for lung conditions**

   The number of lung conditions clinical trial participants in the UK was calculated by applying the proportion of research and investment of lung conditions as a percentage of total research and investment to the annual number of clinical trial participants in 2022. We did not consider growth rates for this calculation. The analysis period for this impact pathway is 2023-2030.

2. **Estimating the target number of clinical trials**

   This number was multiplied by three to reflect the approximate future changes in funding. We assume that tripling the current investment of lung conditions research and innovation also means that the number of clinical trials for lung conditions will also be tripled.

3. **Estimating the number of working participants**

   The number of working participants was considered. In order to model productivity gains, individuals not of working age had to be excluded.

4. **Identifying the impacts of clinical trial participation**

Three impacts were identified from clinical trial participation. They are:

- NHS savings from reduced prescription costs per participant[81]
- NHS revenue from commercial sponsorship per participant[82]
- Annual productivity gains due to clinical trial participation[83].

Calculating the NHS savings and revenue impacts

The levels of NHS savings and revenue values were applied to the net increase in clinical participants for commercially sponsored clinical trials. These values have been extracted from a previous analysis PwC has completed and updated to 2023 values. Productivity gains were applied to the net increase in working clinical participants with lung conditions. The total was calculated by multiplying the number of increased participants by the increase in wages per participant as shown in Figure A4.5.

Figure A4.5: Total benefits of increased lung conditions clinical trials

Increased Clinical Trials	Value
NHS Savings (£)	**£97,138,555**
Revenue (£)	**£ 153,553,446**
Productivity (£)	**£ 137,497,502**

[81] Refer to Figure A4.4
[82] Refer to Figure A4.4
[83] Refer to Figure A4.4

Appendix 4.3: Applying the usage of synthetic AI

Figure A4.6: General assumptions used

Item	Value	Source
Number of clinical trial participants	**1,390,482**	NIHR, Annual Statistics 2022/2023 Link
Proportion of clinical trials that are for lung conditions	**1.8%**	UK Clinical Research Collaboration, (2020) UK Health Research Analytics 2018 Link
Dropout rate	**30%**	MD Group, (2020) The True Cost Of Patient Drop-outs In Clinical Trials Link
Cost of a drop out	**£5708**	MD Group, (2020) The True Cost Of Patient Drop-outs In Clinical Trials Link
Cost of a replacement	**£17,068**	MD Group, (2020) The True Cost Of Patient Drop-outs In Clinical Trials Link

1. **Calculating the number of lung conditions clinical trial participants**

   We multiplied the number of clinical trial participants by the proportion of clinical trials that are for lung conditions in order to calculate the number of lung conditions clinical trial patients. This is done from 2023-2030.

2. **Calculating dropout rates for control only**

   We assumed that half the clinical trial population does not receive the treatment, so we halve the dropout rate to find the drop out for our control analysis.

3. **Calculating the total number of dropouts of lung conditions clinical trials**

   We apply the proportion of lung conditions clinical trial dropouts in control and apply that to the number of lung conditions clinical trial participants to determine the number of dropouts.

4. **Calculating the cost of lung conditions clinical trial dropouts**

   We then take the sum of the cost of a dropout and the cost to replace a dropout and multiply this by the number of control lung conditions dropouts calculated in Step 3 to estimate the total cost and potential impact of lung conditions clinical trial dropouts. We assume that Synthetic AI will remove the need for control participants during respiratory trials.

5. **Take up rate of the intervention**

   However, we assume that Synthetic AI will not be used at 100% in the first year. We have applied a gradual take up rate to account for this over the period. From 2023, the take up rate will follow the cumulative proportion of investment as outlined by Asthma + Lung UK. The total impacts are shown in Figure 4.7.

Figure A4.7: Synthetic AI impacts

Cost savings due to synthetic AI (£)	Reduction in clinical participants replacement
£ 73,555,044	**3754**

<u>Other considerations in the modelling</u>

Geographic scope of the impacts

The approach considers the benefits associated with increased investment into lung conditions specifically for the United Kingdom (UK). The benefits analysed apply more broadly to lung conditions at a macro level. Limited data availability makes more granular regional analysis difficult. For this reason, the report focuses on the benefits that accrue to the UK rather than breaking down the benefits by the four home nations.

Inflation and discounting

All monetary values have been adjusted to take account of inflation and for Social Time Preference Rate. This accounts for society’s time preference, and whether they would have preferred to spend their money towards something else instead of what is being considered. The values are discounted to 2023, which is consistent with guidance in HM Treasury’s Green Book. Calculating this adjusts the final figures to a net present value (‘NPV’) to ensure that they are comparable costs and benefits for a given year. For all of the values, this has been discounted by 3.5% which is the standard discount rate.

All figures are given in current prices (2023) to ensure that they can be compared across different points in time. Adjustments have been made to account for future inflation, so the values are in real terms.

Appendix 5: ICD-10 aggregations used in the analysis

The lung conditions mapping in this analysis to calculate the economic cost in the UK is based on the previous BLF report. The costs were not calculated by aggregating the costs of individual diseases together by ICD-10 categories.

ICD-10 aggregates other diseases of the respiratory system together. As shown in Figure A5.1: other lung conditions include[84]:

- Postprocedural respiratory disorders, not elsewhere classified.
- Respiratory failure not elsewhere classified.
- Other respiratory disorders.
- Respiratory disorders in diseases classified elsewhere.

A detailed breakdown can be found in the provided source.

Figure A5.1: List of lung conditions in our report by ICD-10 chapter

Lung conditions in the report	ICD Chapter Number	ICD-10 Chapter
Upper Respiratory Infections	1	Certain infectious and parasitic diseases
Lower Respiratory Infections	1	Certain infectious and parasitic diseases
Trachea, bronchus and lung cancers	2	Neoplasms
Chronic obstructive pulmonary disease	10	Diseases of the respiratory system
Asthma	10	Diseases of the respiratory system
Other lung conditions	10	Diseases of the respiratory system

[84] ICD, Diseases of the respiratory system, 2019.

We prepared this report solely for Asthma + Lung UK's use and benefit in accordance with and for the purpose set out in our engagement letter with Asthma + Lung UK dated 24/04/2023.

This report has been prepared by PricewaterhouseCoopers LLP exclusively for the sole benefit and use of our addressee Asthma + Lung UK at their direction and in accordance with their instructions. To the extent permitted by law, PricewaterhouseCoopers LLP, its members, employees and agents do not accept or assume any liability, responsibility or duty of care for any consequences of non addressees acting, or refraining to act, in reliance on the information contained in this publication or for any decision based on it nor to Asthma + Lung UK for the consequences of using or relying on it for a purpose other than that referred to in our engagement contract.

© 2023 PricewaterhouseCoopers LLP. All rights reserved. 'PwC' refers to the UK member firm and may sometimes refer to the PwC network. Each member firm is a separate legal entity. Please see www.pwc.com/structure for further details.