New Zealanders for HEALTH RESEARCH
Ngā Tāngata o Aotearoa mō te Rangahau Hauora

NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Valuing health research in New Zealand

Feasibility study

NZIER report to New Zealanders for Health Research

October 2022

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Authorship

This paper was prepared at NZIER by Sarah Hogan, Olivia Wills, and Bonnie Yue Wang.

It was quality approved by Jason Shoebridge.

The assistance of Sarah Spring is gratefully acknowledged.

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Registered office: Level 13, Public Trust Tower, 22–28 Willeston St | PO Box 3479, Wellington 6140
Auckland office: Ground Floor, 70 Shortland St, Auckland
Tel 0800 220 090 or +64 4 472 1880 | econ@nzier.org.nz | www.nzier.org.nz

Key points

Investment in health research is critical to accessing the benefits of global efforts

New Zealand's investment in health research represents a significant contribution to the international knowledge base from which all nations may gain substantial health benefits, as well as the critical link to ensuring New Zealanders get the greatest possible benefit. Only with investment in domestic research and research capability will the health issues unique to New Zealand, of particular priority to New Zealand, and, critically, of particular concern for Māori and Pacific people, be given adequate attention and resource to deliver the safe, effective and cost-effective technologies, services and programmes that are needed.

The potential value of health research in New Zealand is in the billions annually

One simple way of illustrating the potential value of future health research is to estimate the value of lost production due to premature deaths from what are currently considered to be non-amenable causes of mortality. Based on deaths in 2017 (the most recent complete year for which complete mortality data is available), our estimate of this potential is $3 billion to $4 billion. This figure represents a 'size of the prize', and while the full value may never be fully realised, the age-old adage that 'you have to be in to win' does apply.

Public investment in research has been hampered by concerns about returns

In New Zealand and internationally, however, investment in health research is often negatively impacted by concerns about the value it delivers. With a constrained budget and a health system under pressure, governments naturally want to ensure that investments will provide a good return from a societal perspective. For this reason, many reports have attempted to estimate the societal value of health research, including the value of health gains and productivity gains associated with a healthier population.

We undertook a feasibility study to investigate how health research might be valued in New Zealand

This report was commissioned to investigate the feasibility of a study on the value of health research in New Zealand. To do this, we investigated the range of methods used in the published literature to estimate the value of health research, the data and information sources, and the modelling techniques. We also evaluated the merits of the various methods and assessed their potential application in the New Zealand context.

Methods used internationally can be characterised by their approach to health gain estimation and their approach to economic impact estimation

The methods used to estimate the health gains from health research fit into two broad categories: Top-down and bottom-up approaches. Top-down approaches are relatively easy to apply but involve heavy use of previously published values and assumptions to attribute observed health improvements and resulting productivity gains to research. Bottom-up approaches are based on case studies of particular health conditions or research developments, with the most robust of these supported by extensive use of bibliometric

methods to establish the link from investment to impacts and ensure the full investment is captured, based on an inputs-outputs-outcomes-impacts framework or similar.

The estimation of broader economic benefits is typically based on input-output tables, which NZIER does not recommend due to the implicit assumption that factors of production are in unlimited supply and that increased activity will not affect factor prices. Sometimes reports also include computable general equilibrium modelling, which produces more realistic economic impacts by accounting for the impacts of investment on factor prices.

The body of evidence as a whole is stronger than any single report

Bottom up-approaches are more credible and robust, but they are resource intensive, so reports have typically included a very narrow range of case studies (often only one) before extrapolating to the full range of health research. In a single report, extrapolation from a small range of case studies is not a robust or credible method, even when supplemented by some top-down estimation. However, when these reports are taken as a body of evidence, they cover a wide range of research areas and types, so the range of estimates generally represents a reasonable range for the value of health research.

New Zealand's health research is likely to deliver substantial flows of benefits

Considering the body of evidence from countries with similar health issues, health systems and economies, reflecting a wide range of health research similar to New Zealand's research portfolio, an expected value can be estimated. Our ballpark estimate is that based on approximately $493.444 million of investment in health research annually, the total benefits to New Zealand are likely to be between $1.1 billion and $1.9 billion, or annual flows of between $64 million and $148 million. These estimates require further research to be confirmed.

New Zealand data constraints make valuing health research challenging

The use of top-down methods and/or a small number of case studies for a bottom-up approach would not generally provide credible evidence for the value of health research. Overcoming this problem would require a range of case studies, at least five, possibly 10, to ensure the impact is representative of the range of research undertaken in New Zealand.

However, such an approach would not only be time-consuming and resource intensive, but it would also be particularly so in the New Zealand context due to the lack of any centralised data on research inputs, outputs and outcomes to facilitate tracing investments and application of bibliometric methods to validate attribution of impacts.

Currently, the costs of overcoming challenges may not justify the benefits of this type of research, suggesting that alternative framing of the question may be of more value.

We recommend

In light of our assessment of methods and data, we recommend one of three approaches:

1 A major study using bottom-up and extensive bibliometric methods to establish the value of health research from a broad base of representative case studies.

2 A gradual approach to building the evidence base through individual case studies that contribute to a portfolio of values over time.

3 An alternative framing of the question to "how much do New Zealanders value health research?". This question could be addressed using conjoint analysis and established methods to better understand how much New Zealanders think the Government should invest and what the priority areas for investment should be. A key advantage of this approach is that it offers a future-focused view with direct implications for priority setting.

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Glossary

Commonly used terms in this report are defined in Table 1 below.

Table 1 Commonly used terms and their definitions

Term	Definition
Amenable / non-amenable mortality	Premature deaths that could potentially be avoided (amenable) or are considered unable to be avoided (non-amenable), given effective and timely healthcare.
Benefit-cost ratio (BCR)	An indicator showing the relationship between the relative costs and benefits of a proposed project, expressed in monetary or qualitative terms.
Bibliometric methods/analysis	The application of a scientific, sometimes computer-assisted, review methodology that can identify core research or authors, as well as their relationship, by covering all the publications related to a given topic or field, to measure outputs and establish a connection between inputs, outputs and outcomes of research.
Computable general equilibrium (CGE) model	A class of economic models that use actual economic data to estimate how an economy might react to changes in economic activity or economic inputs, adding the ability to factor the impacts of price and wage dynamics – considerations that are left out of traditional input-output models.
Disability-adjusted life year (DALY)	A generic measure of disease burden, in which the measurement includes both years of life lost due to premature mortality (YLLs) and years of life lost due to time lived in states of less than full health, or years of healthy life lost due to disability (YLDs). One DALY represents the loss of the equivalent of one year of full health.
Discounting	The process of converting a cost or benefit occurring in the future to an equivalent value received immediately, reflecting the opportunity cost of resources and the assumed societal rate of time preference (preference for value now over value in the future)
Gross value added (GVA)	The contribution made to the economy by an investment or activity as measured by the value of goods and services produced as a result of the investment or activity minus the cost of inputs and materials used in the production process.
Input-output model/table	A quantitative economic model that represents the interdependencies between different sectors of a national economy or different regional economies, often presented as

Term	Definition
	tables showing how output from one industrial sector may become an input to another industrial sector.
Internal rate of return (IRR)	The discount rate that would yield a zero net present value for an investment, or the annual growth rate of the investment value.
Premature mortality	Deaths of people aged under 75 years.
Productivity	The efficiency of production of goods or services expressed by some measure, e.g. the total production of a population or economy.
Quality-adjusted life year (QALY)	A generic measure of disease burden, including both the quality and the quantity of life lived, commonly used in health economic analyses to allow interventions with different types of outcomes to be compared. One QALY represents one year lived with full health.
Return on investment (ROI)	The percentage increase or decrease in the value of an investment over a set period (e.g. 10 or 20 years) or the total growth, from start to finish, of the investment. Sometimes called rate of return (ROR).
Spillovers	Economic impacts in one or many sectors as a result of a change in activity (such as that induced by increased investment) in another, seemingly unrelated, sector.

Source: NZIER

1 Background

1.1 Health research and the New Zealand context

Research contributes to the wellbeing of populations through a range of mechanisms. Health research directly links to wellbeing through its impact on longevity and quality of life. More broadly speaking, health research also contributes to achieving economic objectives: A healthier population can reduce the financial burden of ill-health by reducing demand for costly health services and social welfare and is likely to be more productive.

A key argument that is often made is that health research (indeed any research) in New Zealand is of little value as New Zealand is a small player on the global research landscape and should, therefore, focus on translating the results of international research for the New Zealand population and context. However, the New Zealand Health Research Strategy 2017-2027 clearly identifies that the Government's vision is for New Zealand to "*have a world leading health research and innovation system that is founded on excellent research and improves the health and wellbeing of all New Zealanders*". Prioritising health research that addresses the health needs of all New Zealanders, with a focus on Māori and Pacific peoples, means that international research cannot provide an adequate substitute for research that takes place in the domestic context.

In addition to major discoveries and advancements in care as a result of New Zealand research on asthma, cot death, heart failure, and many other common health issues, New Zealand research has contributed to improved outcomes in key areas of concern domestically, such as the impact of household crowding on meningococcal disease, the impact of uninsulated homes on school attendance, sickness and hospitalisation, and the impact of earthquakes on health.

Health sector leaders and decision-makers frequently refer to the critical enablers of the publicly-funded health system as being the workforce, physical infrastructure, and information and communication technology. But it can equally be argued, particularly in the face of an ageing population and the rising prevalence of complex multi-morbidity, that health research is a critical enabler of a sustainable publicly funded health system: Health research provides the necessary information to ensure all other resources across the system are put to best use, allowing the system to continue delivering good outcomes without requiring an ever-increasing share of gross domestic product (GDP) to achieve this.

1.2 Public investment in health research

The primary rationale for government support of health research is that the private sector will typically underinvest in research due to the high uncertainty that research outcomes will lead to commercial gains. For this reason, there is a particularly strong justification for government investment in basic research, but in countries where health systems are primarily publicly funded, commercial gains from all health research are expected to be lower, so rationale for government investment across the spectrum of research is strong.

Health research can be costly and does not always lead to conclusions with any immediate application. The social, health and economic impacts of research are difficult to identify because they span a wide range of impact types that require specific data for every health condition or health event related to the research.

Estimates of returns on investment in health research have varied widely. The resulting uncertainty around the societal value of health research is a critical barrier to optimising public health research investment.

1.3 New Zealanders for Health Research

New Zealanders for Health Research (NZHR) was established in November 2015 to increase investment in health research from government, industry and philanthropy. Based on a belief in the potential for knowledge gained from health research to save and improve people's lives, NZHR is committed to ensuring that health research results are translated into policy, practice and individual decision-making.

1.4 The value of health research – feasibility study

NZHR commissioned NZIER to complete a feasibility study to inform potential investment in a major research project to estimate the value of health research in New Zealand. It was agreed that a feasibility study for this purpose should:

- Estimate the 'size of the prize': the value of lost production due to premature death from non-amenable causes of mortality in the adult population.
- Review the international literature to:
  - Identify a possible range for the value of health research
  - Understand the pathway from research to impact, including impact areas, causal relationships, and time lags
  - Assess the range of modelling techniques used to estimate the value of health research.
- Assess the state of New Zealand data in terms of its suitability, completeness and granularity to:
  - Identify how it could be used to model the diffusion of social and economic benefits in New Zealand using a 'top-down' approach
  - Make recommendations to address data gaps that currently hinder a more detailed and robust estimation of the value of health research.
- Estimate a 'ballpark' value of health research in New Zealand by triangulating published estimates from overseas and New Zealand data and context.
- Assess the quality of information from health research case studies in the New Zealand context for suitability for a 'bottom-up' approach.

2 Our approach

2.1 The size of the prize

We estimated the value of lost productivity due to premature death in New Zealand adults from non-amenable causes based on two scenarios:

- potential productivity value, based on the assumption that people out of paid employment generate similar value to people in paid employment through unpaid work
- actual productivity value, based on the assumption that lost productivity is captured by the value of paid work that would have been expected for individuals who died prematurely according to their age at death and the productivity of same age living individuals.

We include only adults in this ballpark estimation because the productivity value of children's lives requires a cost-benefit approach that considers education costs in the short term against productivity generated over the longer term. Although the application of discounting has a heavy impact on the future productivity of children, and the number of premature deaths of children due to non-amenable causes is not large, the exclusion of children from our analysis means our estimates are likely to be conservative.

Premature deaths due to non-amenable causes were identified from Te Whatu Ora's Mortality Collection. Life years lost prematurely were calculated as the difference between age at death and age 75. Employment earnings were extracted from Stats NZ as an average value for each 5-year age band and applied to the life years lost for everyone who died prematurely and adjusted to reflect the employment rate in each 5-year age band to generate actual rather than potential productivity loss.

Future productivity is discounted to 2022 under two alternative discount rates, five percent and two percent. Discounting of future benefits and costs is recommended by the Treasury, which provides two justifications for this common approach:

- An intuitive justification for discounting is that most people would prefer receiving a dollar today over receiving a dollar in a year's time. This is referred to as time preference or the time value of money.
- A second related justification for discounting, and the one which is used in practice to derive the discount rate (r), is that when a person assesses a proposal, they will require a return at least as high as they can obtain from any other investment of equal risk. (The Treasury 2015)

2.2 Literature review and methods assessment

We conducted a focused literature search to identify published reports on the value of health research to assess what methods are commonly used and their respective information and data requirements.

We restricted our literature search to studies from high-income country contexts, focusing on those with similar health issues, health systems, economies and health research focus areas. This meant a focus on Australia, the UK and Canada.

In total, 17 studies estimating the value of health research were assessed and summarised in this report. Of these, 15 were based on overseas contexts, and two were based on the New Zealand context.

2.3 Assessment of data

In light of the requirements of established methods to estimate the value of health research, we investigated what data is available in New Zealand to support the use of these methods and identified challenges that data gaps pose for estimating the value of health research in the New Zealand context.

3 The size of the prize: Valuing the potential benefits of future health research

Non-amenable premature mortality refers to the number of New Zealanders under the age of 75 who die due to conditions and health-related events for which life-saving treatments, cures or preventative strategies are yet to be researched and discovered. For this reason, non-amenable premature mortality represents a significant opportunity for health research.

To provide an indication of the potential economic value that could be generated through health research that results in a reduction in mortality due to what are today considered to be non-amenable causes, we:

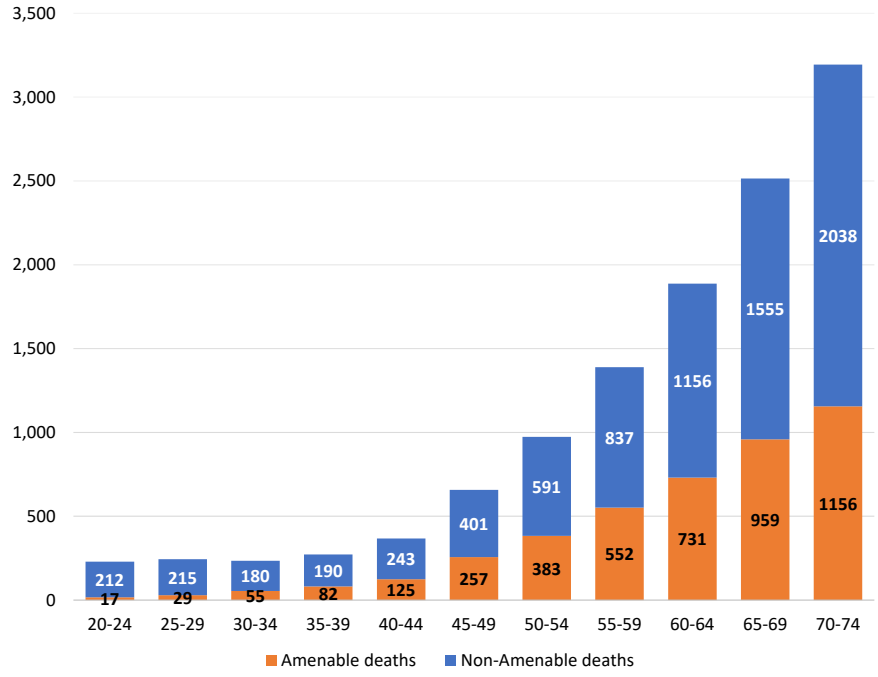
- quantify deaths to non-amenable causes by age
- model the future value of production that would be generated by individuals who died, based on average employment earnings for each 5-year age group, allowing for employment earnings to change with age over the modelled lifetimes
- provide estimates for potential productivity (based on the assumption that all individuals who died may have generated a production value equivalent to valued production even if their time was spent on unvalued activity, such as household production, volunteer work, etc.).

3.1 Premature deaths from non-amenable causes

In 2017, the most recent year for which complete mortality data is available, there were 7,618 premature deaths to non-amenable causes, with the number of these increasing with age and higher than deaths due to amenable causes at any age.

Figure 1 Number of premature deaths due to amenable and non-amenable causes

2017, by age group

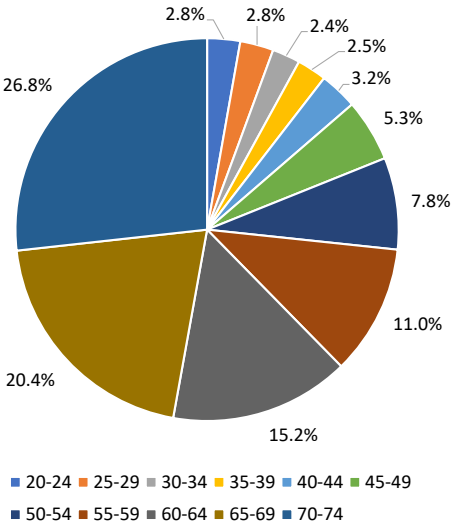


Source: NZIER, Te Whatu Ora mortality data

As shown in the figure below, premature deaths in the 55- to 74-year age group account for nearly three-quarters of all non-amenable premature deaths.

Figure 2 Share of premature deaths due to non-amenable causes

2017, by age group



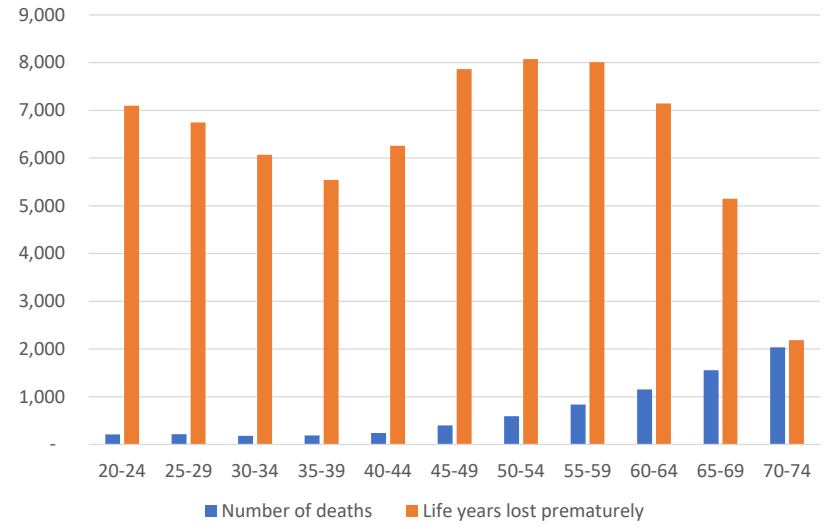
Source: NZIER, Te Whatu Ora mortality data

3.2 Life years lost prematurely due to non-amenable causes

While the distribution of premature deaths is heavily skewed to the older age groups, the number of life years lost prematurely (calculated as the difference between the age at death and 75) is more evenly distributed due to the large number of years lost to individuals who die at younger ages. The balance of the number of premature deaths and the number of life years lost prematurely produces a peak in life years lost prematurely in midlife.

Figure 3 Number of premature deaths and life years lost prematurely due to non-amenable causes by age group

2017



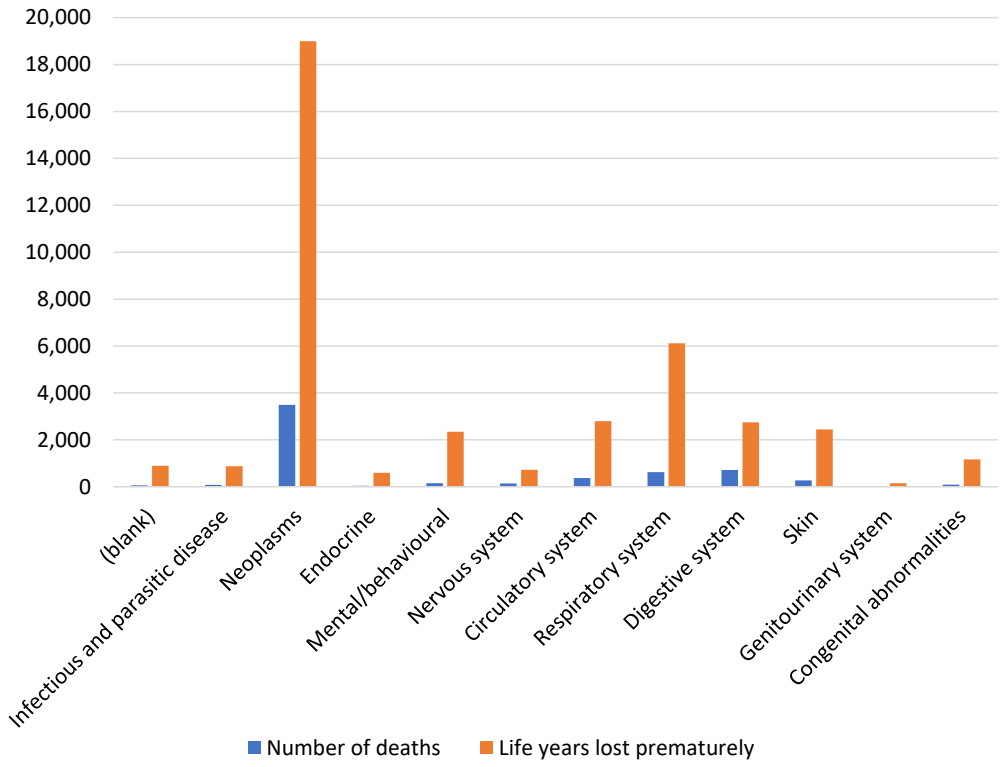
Source: NZIER, Te Whatu Ora mortality data

3.3 Premature deaths and life years lost prematurely to non-amenable causes, by chapter

Causes of mortality are organised by chapter, grouping clinical codes together for a higher-level view of mortality. In 2017, significantly more deaths and life years lost prematurely were due to neoplasms (cancers), indicating significant potential for economic impacts from health research in this area.

Figure 4 Number of premature deaths and life years lost prematurely due to non-amenable causes by ICD-10AM chapter

2017



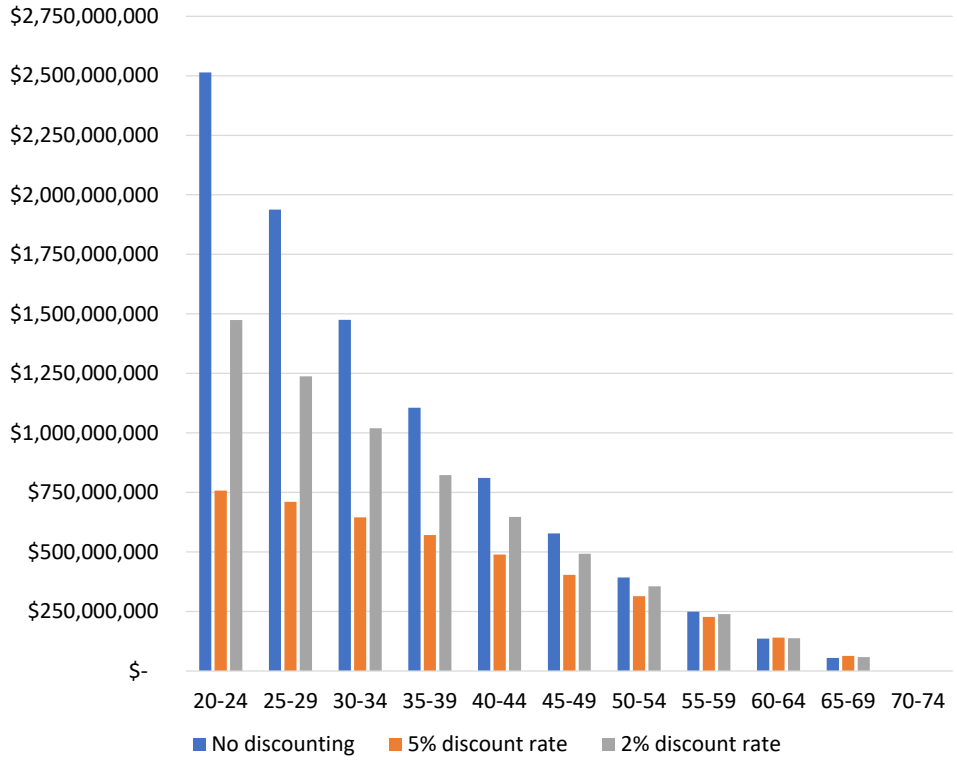
Source: NZIER, Te Whatu Ora mortality data

3.4 Potential productivity value of premature life years lost

Potential productivity, based on valuing all life years lost prematurely using average earnings for the relevant age groups over the remaining life years to 75 for all deaths, reflects the total value of the paid production that is likely to have been lost as well as an estimated value of unpaid production (including household production and volunteer work). Valuing unpaid production is important as activities that are not measured as paid labour productivity are often direct substitutes for paid labour productivity (some people are employed to perform household tasks like cooking and cleaning, childcare, care of older people, and other social and health sector work that is of the same nature and value to society as similar unpaid work) and even where they are not, they nevertheless provide a non-zero value to society.

Figure 5 Potential productivity value of premature life years lost by age group, under different discounting

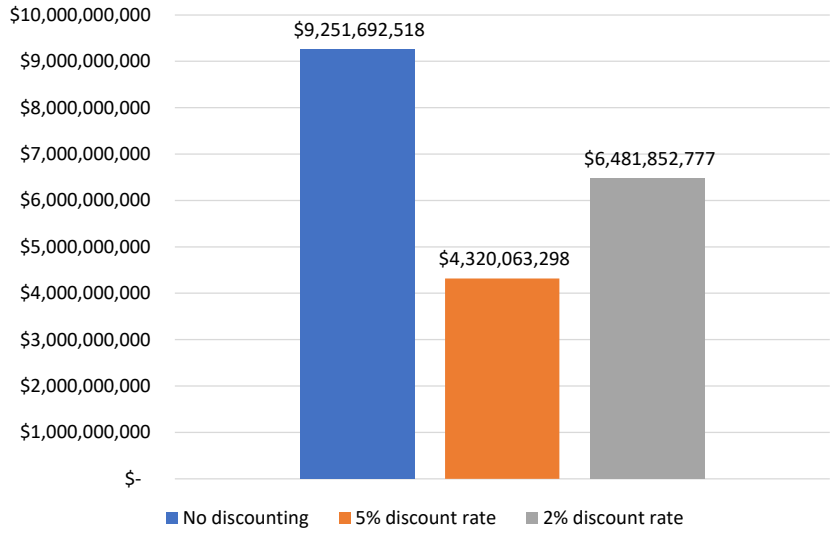
2017 deaths, 2022 dollars



Source: NZIER

Figure 6 Total potential productivity value of premature life years lost under different discounting

2017 deaths, 2022 dollars



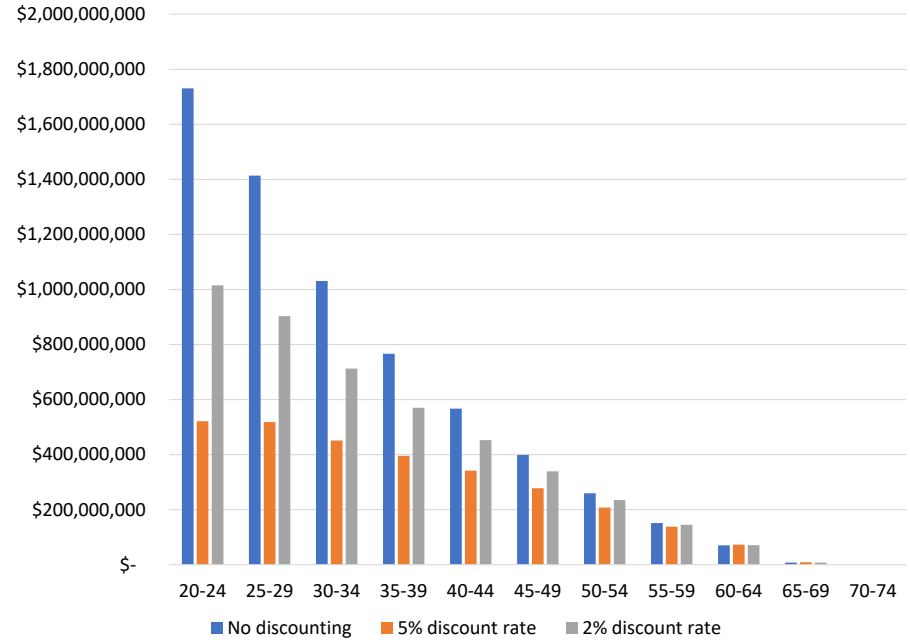
Source: NZIER

3.5 Lost labour productivity

Of the total potential productivity loss, lost labour productivity was calculated by adjusting the average earnings by age group for the employment rate observed in that age group.

Figure 7 Labour productivity value of premature life years lost by age group, under different discounting

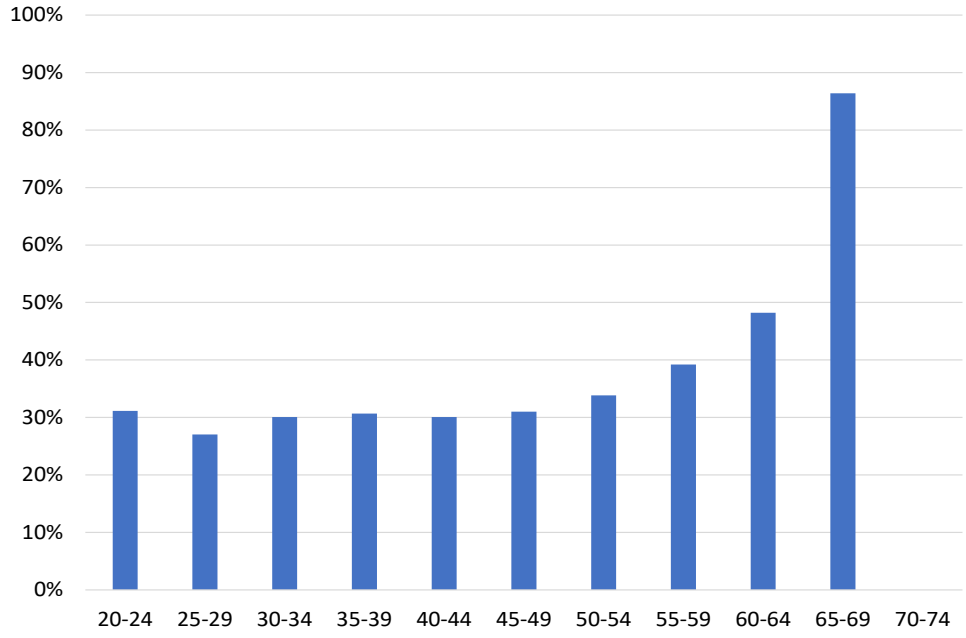
2017 deaths, 2022 dollars



Source: NZIER

Figure 8 Percentage of potential productivity value lost to employment adjustment under different discounting

2017 deaths, 2022 dollars

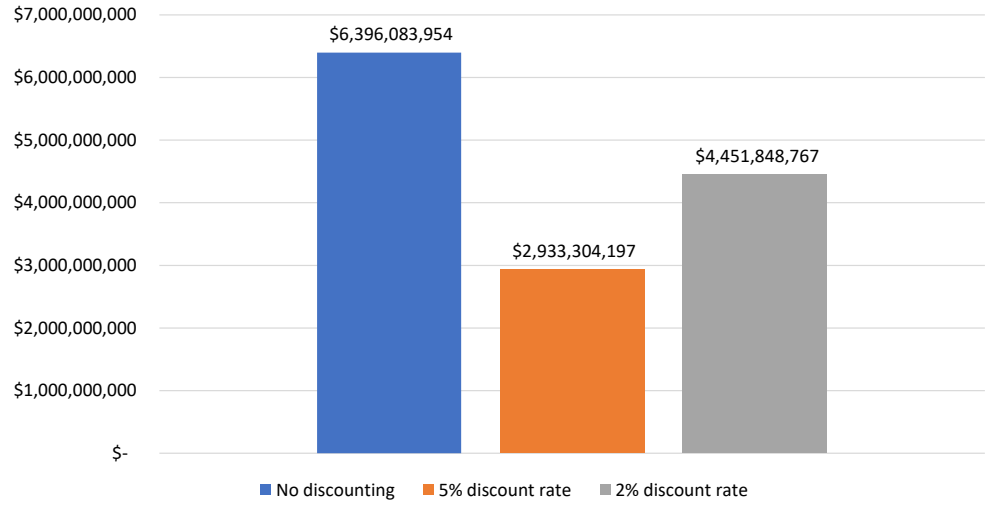


Note: Discounting has no impact on the percentage of potential productivity value lost to employment adjustment.

Source: NZIER

Figure 9 Total labour productivity value of premature life years lost under different discounting

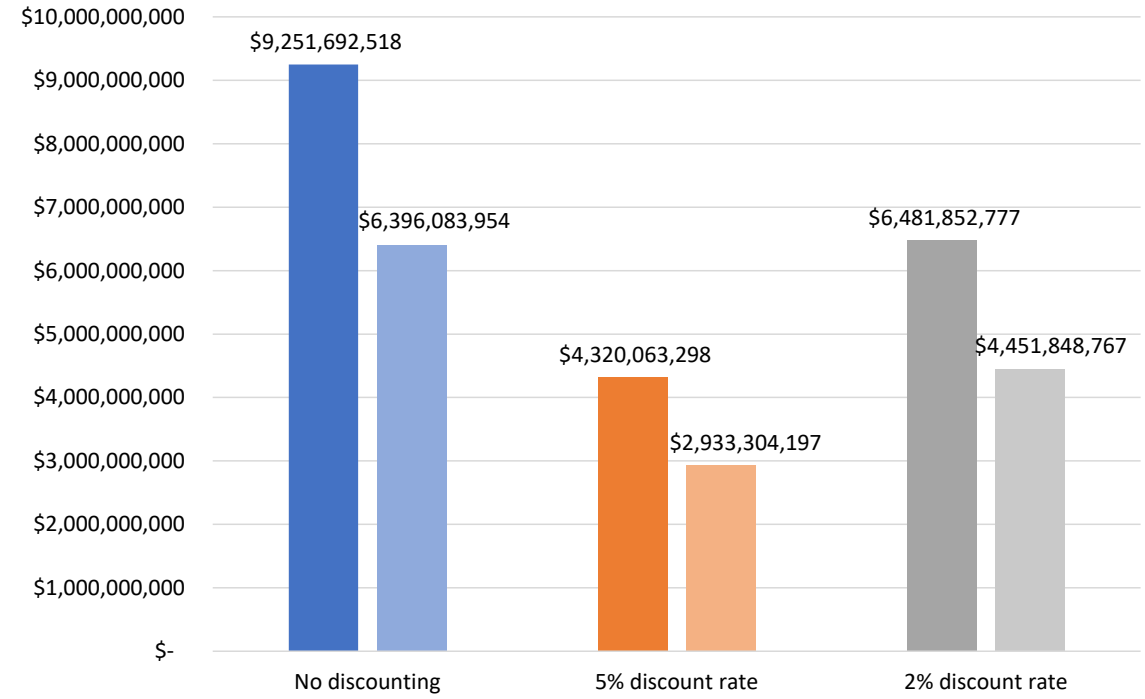
2017 deaths, 2022 dollars



Source: NZIER

Figure 10 Value of lost productivity with and without employment adjustment

Under discounting scenarios



Note: Lighter shade shows the effect of employment adjustment.

Source: NZIER, Te Whatu Ora mortality data and Stats NZ earnings, filled jobs and estimated resident population data

This analysis indicates that with a conservative approach in which only labour productivity is valued, and all future income is discounted at five percent, the deceased individuals' lifetime of lost productivity associated with premature deaths to non-amenable causes in 2017 is worth nearly $3 billion in 2022 dollars.

Allowing for the value to society of non-labour productivity (valued at the same rate as labour productivity), this figure could exceed $4 billion.

4 Approaches to valuing health research

Studies estimating the value of health research typically address the key concerns of the question, although not always explicitly. These include:

- the definition of health research that affects the scope of the study
- the perspective taken for the study
- a framework for identifying health research impacts at a conceptual level which also guides the selection of quantifiable and monetisable benefits
- the attribution of impacts to research investment
- the relevant time lags from investment to impact
- the extent of crowding out or crowding in.

4.1 Definition

Valuing health research requires a definition of health research that is likely to be different from definitions used for other purposes. A widely used definition of health research is based on what has become known as the 'four pillars of health research' (Bernstein et al. 2006):

- basic biomedical research (investigating mechanisms of health or disease)
- applied clinical research (on, or for, patients)
- health services and policy research (investigating health services themselves)
- population and public health research (investigating populations and broader health determinants).

All of these types of research should be in scope for any study that attempts to estimate the return on investment in health research. Regardless of the specific kind of research which may be of particular interest, earlier investment will have generated critical knowledge, or later investment will have enabled the translation of results into practice. Ignoring investment along the research spectrum is underestimating the investment required to deliver returns. Consequently, the appropriate definition of health research from the perspective of a value of health research study should be deliberately broad.

4.2 Perspective

Perspective is important to a study estimating the value of health research because it determines which benefits need to be identified and monetised. There are three broad categories for perspective:

- public sector perspective, in which the broader health and economic benefits are viewed as the return on public investment
- private sector perspective, in which key commercial benefits are valued and compared with the initial private sector investment
- societal perspective, in which broader health, economic and commercial benefits are viewed as a return on the combined public and private investment.

4.3 Framework

The Health Research Council defines research impact as "*The direct and indirect influence of excellent research on individuals, communities or society as a whole, including improvements to health and equity, and other social, economic, cultural or environmental benefits for New Zealand*" (Health Research Council of New Zealand 2020). A range of conceptual frameworks exist in the literature to provide a deeper understanding of the potential benefits of health research and the causal mechanisms by which those benefits are achieved.

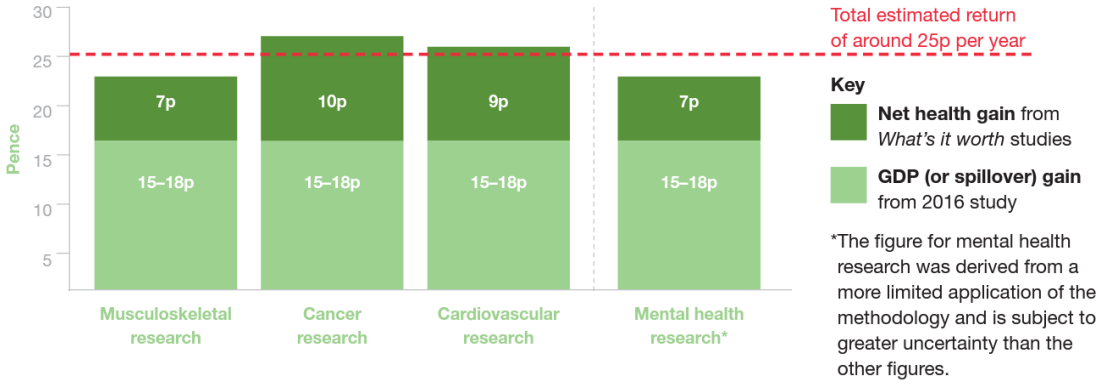
The most common explicitly mentioned framework underpinning published studies that provide a return on investment or benefit-cost ratio for health research is the payback framework originally developed by Martin Buxton, Stephen Hanney and Teri Jones at the Health Economics Research Group at Brunel University, UK (Buxton, Hanney, and Jones 2004).

The payback framework consists of a series of categories to classify the individual paybacks from research, including five distinct categories, each of which has implications for the quantification and monetisation of impacts:

- Knowledge production – impact estimates are scaled to reflect the volume of publications that resulted from the research as a measure of the impact that has already occurred
- Research targeting, capacity building, and absorption – impact estimates are scaled to reflect an expert assessment of the potential future impact
- Informing policy and product development – impact causality is evidenced by the extent to which the research is reflected in policies and guidelines as identified using bibliometric methods
- Health and health sector benefits – health impacts and health sector net savings are estimated from impacts on health outcomes and associated service utilisation
- Broader economic benefits – increased productivity across other sectors associated with improved health outcomes in workers (spillovers) and commercialisation of products and innovations.

Spillovers are important to capture in estimating the value of research from a public or societal perspective, as previous studies have identified these as being significantly greater than the value of health gains achieved (See, for example, Figure 11 below).

Figure 11 Estimated equivalent yearly return from £1 of public or charity investment



Source: Grant and Buxton (2018)

4.4 Attribution of impacts

Health gains and changes in economic conditions occur due to a wide range of constantly changing factors, not all of which are well-understood or quantifiable. As a result, there is rarely certainty around attributing benefits to a single causal factor. Health research is no exception. Researchers attempting to estimate the value of health research need to address the proportion of attribution that is reasonable in context. Factors for consideration include:

- efficacy of the intervention
- pre-existing trends and volatility in impact variables
- introduction of other new interventions within a similar timeframe (where the focus is on a particular research area and associated intervention)
- contribution of international research to the knowledge base.

In general, when the intervention resulting from research produces an immediate effect, attribution is less uncertain. Where there are significant time lags, the attribution issue becomes more challenging.

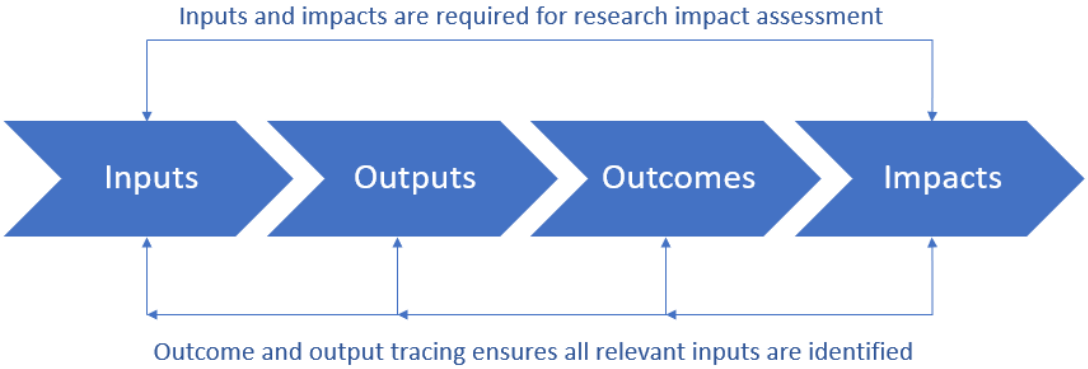
Some approaches make use of an input-outputs-outcomes-impacts framework to establish clear links between research investment and monetisable impacts:

- Research inputs are defined as the funds invested in supporting research activity and may include both public and private funds, depending on the perspective of the assessment.
- Research outputs are usually defined as citations or publications, which require careful tracking and recording in bibliometric databases kept for impact assessment or bibliometric methods to trace all relevant investments from outcomes to early outputs.
- Research outcomes include the products, research tools, medicines, patents, clinical practice guidelines, policy, services and programmes developed and implemented from the new knowledge disseminated through research outputs.

- Research impacts include the health (morbidity and mortality), direct and indirect economic, and societal impacts of changes in clinical practice or implementation of programmes and services resulting from research outcomes.

While only input and impact values affect the assessment of research value, the tracing of links from impacts back through outcomes and outputs to inputs also ensures all relevant inputs are captured, and an unrealistic estimation of research value does not occur, helping to address a key issue for the valuation of health research when the focus is on specific research areas or specific conditions/diseases.

Figure 12 Inputs-outputs-outcomes-impacts framework



Source: NZIER

The challenge in this exercise is that research is not a linear process. Bernstein et al. (2006) identified the establishment of links between health research outputs and outcomes, especially where knowledge develops incrementally over time, as one of the main challenges in identifying health research impacts. Further challenges are related to the cross-fertilisation effects of basic and early research, making the attribution of inputs unclear.

In practice, the development of scientific knowledge in health research is not just non-linear; it is iterative, often with many apparently 'dead ends' that do not lead to subsequent research stages either alone or within a timeframe that makes linking straightforward. These concerns are often particularly true of basic science research that underpins research that translates insights to the human health context, and this explains why many studies that attempt to value health research exclude basic research, starting instead from investment in phase 1 clinical trials.

4.5 Time lags

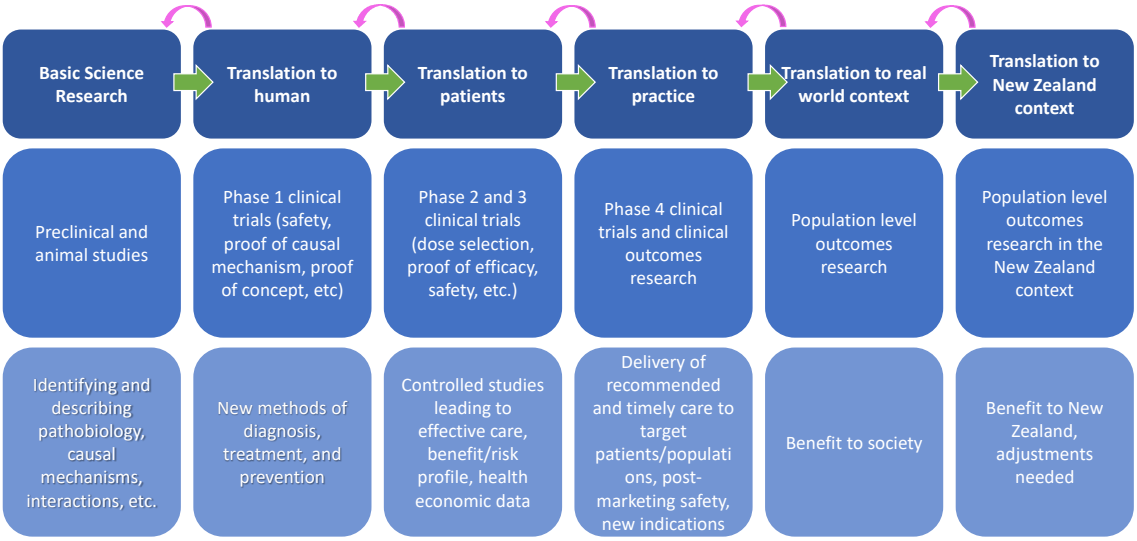
Time lags matter in the estimation of investment value for two main reasons: Firstly, impacts that occur in the future are subject to discounting. The further into the future these impacts occur, the greater the discounting and the lower the present value of the investment. Secondly, attribution of health gains (and therefore resulting economic impacts) is more challenging for research and interventions that produce impacts that may not be apparent for long periods of time (e.g. an intervention to address obesity in young adults may reduce the rate of type 2 diabetes 20 years later).

The time lag between investment in health research and the generation of health gains is often many years, with some studies tracing back 40 years or more to identify early investment.

While a conceptual model of the translation of research into practice is usually presented as a linear process, in reality, the process may involve several loops associated with the frequent iterative process of research. Furthermore, the linear conceptual model does not reflect the obstacles and bottlenecks that frequently cause delays and prevent the smooth flow of knowledge across different stages of the innovative process, particularly with the virtually inevitable involvement of different organisations and institutions (Balconi, Brusoni, and Orsenigo 2010).

Conceptual models of time lags often include 'translational gaps', describing the stages from early or basic research to developing clinical guidelines. Each stage introduces its own delay, but research has not accurately identified what and where the translational gaps are or how long they are, resulting in the overall time lag estimates obscuring complexities that are likely to be relevant to policy (Morris, Wooding, and Grant 2011). Most models of time lag estimation ignore the gap between the publication of guidelines and change in practice (Morris, Wooding, and Grant 2011). Even a change in practice can precede health gains by many years, depending on the intervention and problem it is designed to address.

Figure 13 Translation of basic research to a real-world context



Source: NZIER based on EUPATI (2022)

Throughout the literature, there is a convergence of assumptions and findings around an average 17-year time lag for research evidence to reach clinical practice (see, for example, (Westfall, Mold, and Fagnan 2007; Trochim 2010; Green et al. 2009; Balas and Boren 2000; Grant, Green, and Mason 2003; Wratschko 2009). However, a wide range of estimates exists.

In the published studies that estimate the value of health research, there are two broad approaches to identifying time lags:

- Bibliometric analysis, in which the timing of changes in clinical guidelines that reflect research insights, provides an indication of the time lag from research investment to the beginning of a flow of health gains.
- Econometric analysis, in which the relationship between an impact measure such as health gains and the investment in research is specified mathematically and the time lag estimated from panel data.

5 Published evidence

Our literature search was restricted to studies from high-income country contexts, focusing on those with similar health issues, health systems, economies and health research focus areas. This meant a focus on Australia, the UK and Canada. Despite the literature search focussing on Australia, the UK and Canada, one US study was picked by the search and was included. This section describes the published evidence in terms of methods and results.

5.1 Study context and scope

The table below describes the studies that met the inclusion criteria.

Table 2 Context and scope of included studies

Authors/year	Country	Definitions	Scope
(KPMG 2018)	Australia	Medical research sector defined as: Medical researchers from relevant University Departments; medical research institutes (MRIs); hospitals and other medical research organisations undertaking and supporting medical research in Australia, including the medical technology and pharmaceutical sector.	Health system savings: Including burden of disease improvements and direct and indirect savings in the health system. Job creation: the number of people directly employed in research and reliant industries. Broad economic benefits: Overall impact on GDP, productivity gains and wider flow-on impacts to other industries, over 20 years.
(Fraser of Allander Institute 2022)[1]	Scotland	Medical research funded by charities only. Includes funding that flows to private and public sector medical research, and universities.	Impact of spending on supply chains and wages. Direct impacts (goods and services purchased from suppliers), indirect impacts (national supply chain) and induced impact (employment and wages), modelled as annual impacts.
(Fraser of Allander Institute 2022)	UK	[as above]	[as above]
(Fraser of Allander Institute 2022)	Northern Ireland	[as above]	[as above]
(Fraser of Allander Institute 2022)	Wales	[as above]	[as above]
(Access Economics 2008)	Australia	Impact of all health R&D spending	Impact on heath gains (measured in DALYs (Disability-adjusted life years) over 30 years.
(Smith et al. 2019)	UK	impact of investment in early phase biomedical research to the Oxford Biomedical Research Centre	Impact on income, job creation, and indirect effects (changes in demand across all sectors) over 10 years.
(Deloitte Access Economics 2011)	Australia	Impact of NHMRC-funded research into cardiovascular disease, cancer, SIDS, asthma, muscular dystrophy	Impact on projected gains in health system expenditures, productivity gains and commercial returns over 50 years.

[1] Fraser of Allander Institute (2022) refers to (Black and Cooper 2022a; 2022b; 2022c; Spowage 2022).

Authors/year	Country	Definitions	Scope
(Johnston et al. 2006)	USA	Impact of phase III randomised trials funded by the National Institute of Neurological Disorders and Stroke	Cost and health benefits associated with each use of an intervention (derived from published cost-utility and other economic models) multiplied by the additional uses prompted by trial results over 10 years.
(Sussex et al. 2016)	UK	Impact of government and charity funding of medical research on private research and development funding	Impact on private pharmaceutical R&D expenditure only over 35 years.
(Glover et al. 2018)	UK	Impact of public and charitable funded musculoskeletal disease research only	Impact on health outcomes (measured in QALYs (quality-adjusted life-years)) only over 20 years.
(Glover et al. 2014)	UK	Impact of public and charitable funded cancer research only	Impact on health outcomes (measured in QALYs) only over 20 years.
(HERG 2008)[2]	UK	Impact of cardiovascular disease research and mental health research only	Health gains, and GDP gains that result directly and indirectly from research and further activity it stimulates over 20 years.
(Craig et al. 2020)	UK	Impact of biomedical research centres and units funded by the National Institute of Health Research	Impact on health gains, net of the health care costs of delivering them, and gains to the local and national economy, in particular the income directly and indirectly from the research and further activity stimulated by it, over 36 years.
(de Oliveira et al. 2013)	Canada	Impact of cardiovascular disease research only	Impact on health gains, and spillovers from public or charitable sector investment to other sectors of the economy, over 10 years.

Source: NZIER

5.1.1 Definitions

KPMG (2018), Access Economics (2008) and Sussex et al. (2016) take broad definitions of health research, encompassing spending both from a range of sources and on a range of research types.

Several studies restrict the medical research definition to a specific funding source or research type. The series by the Fraser of Allander Institute (Black and Cooper 2022a; 2022b; 2022c; Spowage 2022), which separately estimates Scotland, the UK, Northern Ireland and Wales, all include medical research spending by charities only. Craig et al. (2020) only include biomedical research centres funded by the National Institute of Health Research (UK).

Other studies restrict the medical research definition to one or a range of diseases. HERG (2008) include spending on cardiovascular disease and mental health, de Oliveira et al.

[2] HERG (2008) is Health Economics Research Group, Office of Health Economics, and RAND Europe (2008).

(2013) include just cardiovascular disease, Glover et al. (2014) include cancer research and Glover et al. (2018) include musculoskeletal research only.

Three studies restrict both sources of funding and spending type. Smith et al.(2019) include only Oxford Biomedical Research Centre spending on early phase research, Deloitte Access Economics (2011) include one spending source for research into five disease groups, and Johnston et al. (2006) only include phase III trials from one funding source.

5.1.2 Scope

The research we identified takes a range of perspectives on 'value' of health research. The value measured can range from the relatively narrow (e.g. the Fraser of Allander series measuring the impact on supply chains and wages) to broad economic benefits (e.g. KPMG measuring GDP impact). De Oliveira et al. (2013) and Sussex et al. (2016) identify spillovers from public or charity spending on private investment.

Several measure the impact on health gains from the research investment, measured in QALY or DALYs, and convert these into monetary measures using national thresholds. While Glover (2014) and Glover (2018) only look at the health gains from research investment, these studies are later combined with Sussex et al. (2016) to report more economy-wide impacts.

5.2 Study data and methods

The table below outlines the data and methods used within each of the studies.

Table 3 Data and methods of included studies

Authors/year	Data	Methods
(KPMG2018)	Australian Bureau of Statistics (ABS), Australian Institute of Health and Welfare (AIHW) and the National Health and Medical Research Council (NHMRC), Input-Output database, National Survey of Research Commercialisation (NSRC)	Estimated ROI for HIV, mental health and HPV Reduction in burden of disease to quantify health gains Computable general equilibrium model estimated broad economic benefits across sectors, including the overall impact on GDP, productivity gains and flow-on impacts to other industries
(Fraser of Allander Institute 2022)	Input-Output tables for the UK, including the ONS UK Input-Output table, the Scottish Government's Input-Output table and NISRA's Input-Output table. ONS Workforce Jobs dataset and the ONS Business Register and Employment Survey.	Input-output modelling
(Fraser of Allander Institute 2022)	UK Health Research Analysis, Association of Medical Research Charities	Input-output modelling
(Fraser of Allander Institute 2022)	UK Health Research Analysis, Association of Medical Research Charities	Input-output modelling
(Fraser of Allander Institute 2022)	UK Health Research Analysis, Association of Medical Research Charities	Input-output modelling
(Access Economics 2008)	Australian Institute of Health and Welfare	Top-down approach: attributed 50% of health gains in the observation years to

Authors/year	Data	Methods
		health research and assumed a lag of 40 years
(Smith et al. 2019)	Input-output tables, Oxford Biomedical Research Centre data	Input-output modelling
(Deloitte Access Economics 2011)	Australian Bureau of Statistics R&D data, NMHRC expenditure	Top-down approach: assumed health gains attributable to NHMRC-funded research, and lag time
(Johnston et al. 2006)	NINDS data on trials and systematic review to estimate the effect of interventions on heath and costs	Compare health benefit (QALYs) from interventions to cost of trial
(Sussex et al. 2016)	Medical Research Council, Wellcome Trust, Arthritis Research UK, MSD research activity index.	Vector error correction model using time series for ten disease areas for government, charity and private sector.
(Glover et al. 2018)	National Cancer Research Institute Cancer Research Database, cancer incidence data, NHS economic evaluation database, MEDLINE	The researchers estimated the public and charitable expenditure on MSD-related research, the benefit in QALYs minus the cost, the proportion of net monetary benefit attributable to the research; and the elapsed time between research funding and health gain.
(Glover et al. 2014)	Collection of expenditure directly from organisations and existing literature.	As above, but with cancer-related research.
((HERG 2008)	Annual expenditure on research from Medical Research Council, Higher Education Funding Councils, Department of Health, British Heart Foundation, Wellcome Trust. Published guidelines and health gains data.	Identified QALY gains for specific interventions, monetised using QALY value. Also included spillovers.
(Craig et al. 2020)	Medical Research Council, Department of Health, Higher Education Funding Council for England, ONS data on private investment by the pharmaceutical industry, EvaluatePharma, UK Health Research Analysis	Update to approach used in Glover/HERG/Sussex series. Re-calculates using an alternative valuation of $60,000 per QALY.
(De Oliveira et al. 2013)	Literature review for researching spending and impact, data from Medical Research Council on spending, and patent data	Bottom-up approach: measures expenditure on cardiovascular disease research and health gains accrued, assigns the proportion of health gains attributable to the research, and spillovers. Calculated each intervention separately.

Source: NZIER

5.2.1 Data

The studies reveal the six high-level data requirements to estimate the impact of health research:

- Amount of investment in health research
- Amount of health gains

- Estimate of time between investment and health gain
- Estimate of the amount of health gain attributable to research
- Estimate of productivity gain resulting from health gain
- Estimate of economic spillovers resulting from productivity gain.

Input-output tables are an important data source for studies identifying the general impact on production. These are nationally reported tables which broadly show the relationships between industries, the goods and services they produce, and who uses them. Sources for expenditure data range from national accounts of health R&D spending by year to research institute-specific accounts of spending on a particular programme. Results from this exercise can become inputs to a computable general equilibrium model to introduce a dynamic impact and gain more granular insights into the economic impacts of increased productivity.

A key issue emerging from the literature is that research funding data can suffer from changing definitions over time and may not be available at a granular level for an appropriate time period.

5.2.2 Methods

A range of key methods emerges from the literature on estimating the value of health research. These include:

- input-output modelling
- computable general equilibrium modelling
- top-down approaches
- bottom-up approaches.

Input-output modelling

Existing international research can be grouped together in clusters. Four papers from the Fraser of Allander Institute (2022) estimated separately the contribution of medical research funding by charities in Scotland, Wales, Northern Ireland and the UK. These identified the impact of spending on supply chains and wages, capturing direct impacts (goods and services purchased from suppliers), indirect impacts (national supply chain) and induced impact (employment and wages). This analysis was possible using input-output tables, to produce a static impact estimation.

Computable general equilibrium modelling

A computable general equilibrium (CGE) model is a data-driven, widely applied tool in economic impact analysis, aiming to capture the effects of a new policy or technology affecting economic activity. The model captures the economy-wide effects of changes that directly affect a particular industry, as well as indirectly affecting supplying industries, competing industries, and factor markets (e.g. labour and capital). CGE modelling provides a more comprehensive and detailed view of broad economic impacts, taking into account the relationships between sectors and each sector's response to market changes.

Top-down

Top-down approaches involve capturing the gains in life expectancy or QALYs over a period of time and assigning a proportion of these to be due to health research. These methods can rely heavily on underlying assumptions around the amount of health gains due to research and the lag between investment and health gain. Figure 14 shows the different calculation methods for top-down and bottom-up estimations.

Bottom-up

Given the heavy reliance on assumptions necessary for top-down approaches, more recent literature focuses on bottom-up methodologies. Instead of starting with overall health gains, these approaches build the benefits up from known health interventions with well-defined health outcomes. This approach is used to estimate:

- the value of investment in research into specific diseases/conditions
- the value of investment in health research generally, based on a case study approach, with more robust results obtained when the number of case studies is high, and the health gains are broader and more significant.

Over four papers, a group of researchers attempted to estimate the economic returns from medical research in the UK. Glover et al. (2018), HERG (2008), and Glover et al. (2014) estimated the value of research into musculoskeletal disease, cardiovascular disease, and cancer respectively. All three use the same method: they estimated the amount of public money spent in each area; the time between investment and return; the amount of health gain attributable to the research based on specific interventions that were informed by the research; and the health benefit, valued in QALYs, from the health gains.

These three studies reported the internal rate of return (IRR), effectively the discount rate that would yield a zero net present value, or the annual growth rate of the investment value. These studies found an IRR of 7 percent, 9 percent and 10 percent for musculoskeletal, cardiovascular and cancer research, respectively. The fourth paper investigated the general returns to the economy from health research by capturing spillovers. This was restricted to the impact of public research spending on private sector R&D investment. Sussex et al. (2016) estimated an IRR in terms of impact on GDP of public medical research as 15–18 percent. Adding together these two components, the researchers suggested that the total return to medical research was about 25 percent (about 10 percent for health gain plus 15 percent for GDP gain) annually - $0.25 returned annually per dollar invested.

The KPMG (2018) study used only three case studies (HPV, HIV, and depression) to explore the possible health gains associated with health research, but only one of these (depression) was used to inform the broader economic impacts of health research, making the broad economic impact analysis essentially a single case study.

Figure 14 Top-down and bottom-up approaches

Source: NZIER

5.2.3 Use of assumptions

A common theme across all studies is the recognition that measuring the true impact of health research is data intensive and rarely comprehensively recorded, leading to the researchers needing to make significant assumptions. Many studies use literature searches and existing estimates of the impact of interventions on health gains to reach their results, assuming that previous estimates that are often derived in a different context will apply in the context of interest. Sometimes expert opinion is sought as a substitute or to complement such 'benefit transfer' approaches.

5.2.4 Process

All studies, even those with extensive assumptions and simplifications, describe a time-consuming and costly process. The question of whether such investment is worthwhile arises given the high degree of uncertainty around results. While bottom-up approaches offer a slightly more robust attribution model, for example, capturing the health gains can be a manual process of collating annual streams of health gains for each intervention for different patient groups. Grant and Buxton (2018b) estimated that compiling the necessary data for a UK study of this type would take 18–24 months.

5.3 Study results

Table 4 below summarises the results estimated by the research studies reviewed for this report.

Table 4 Results of published studies on the value of health research

Authors/year	Results
(KPMG 2018)	Medical research has BCR of 3.9 (1990 – 2004). Of $78 billion in gains, $52 billion from health gains and $26 billion from wider economic gains (productivity and commercialisation). $2.6 billion higher GDP due to historical medical research.
(Fraser of Allander Institute 2022)	Every £1 million spent supported £1.98 million of output, £1.33 million of gross value added (GVA), and 31 jobs.
(Fraser of Allander Institute 2022)	Every £1 million spent supported £3.15 million of output, £1.83 million of gross value added (GVA), and 27 jobs.
(Fraser of Allander Institute 2022)	Every £1 million spent supported £2.44 million of output, £1.63 million of gross value added (GVA), and 31 jobs.
(Fraser of Allander Institute 2022)	Every £1 million spent supported £2.30 million of output, £1.47 million of gross value added (GVA), and 26 jobs.
(Access Economics 2008)	Return on investment is 117%.
(Smith et al. 2019)	Rate of return on investment is 46% (each #1 generates 0.46 through income and job creation)
(Deloitte Access Economics 2011)	ROI is approximately 509% for CVD, 170% for cancer, 12% for SIDS, 22% for asthma and -30% for MD
(Johnston et al. 200)6	Projected net benefit over ten years of $15.2 billion
(Sussex et al. 2016)	Every additional £1 of public research expenditure is associated with an additional £0.83–£1.07 of private sector R&D spend in the UK. The spillover effect implies a real annual rate of return (in terms of economic impact) to public biomedical and health research of 15–18 %.
(Glover et al. 2018)	IRR from MSD-related research was 7%.
(Glover et al. 2014)	IRR from cancer-related research was 10%.
(HERG 2008)	IRR from cardiovascular research was 9%. IRR from mental health research was 7%
(Craig et al. 2020)	IRR from MSD: 13% Cancer: 17.5% Mental health: 15% Cardiovascular: 18%
(De Oliveira et al. 2013)	IRR from cardiovascular research was 20.6%.

Note: IRR is the discount rate that would yield a zero net present value. E.g. an IRR of 7% can be interpreted as each $1 invested returning $0.07 each year in perpetuity.

Source: NZIER

Given that studies cover a range of definitions, scopes, and methods, it is unsurprising that the results also cover a wide range. Results are commonly reported as a Benefit-Cost Ratio (BCR) or IRR. IRR is the discount rate that would yield a zero net present value. E.g. an IRR of 7 percent can be interpreted as each $1 invested returning $0.07 each year in perpetuity.

One crucial difference in comparable results is that HERG (2008) find an IRR from cardiovascular research of 9 percent and mental health of 7 percent, while Craig et al. (2020) report an IRR of 18 percent and 15 percent, respectively. This difference in result is

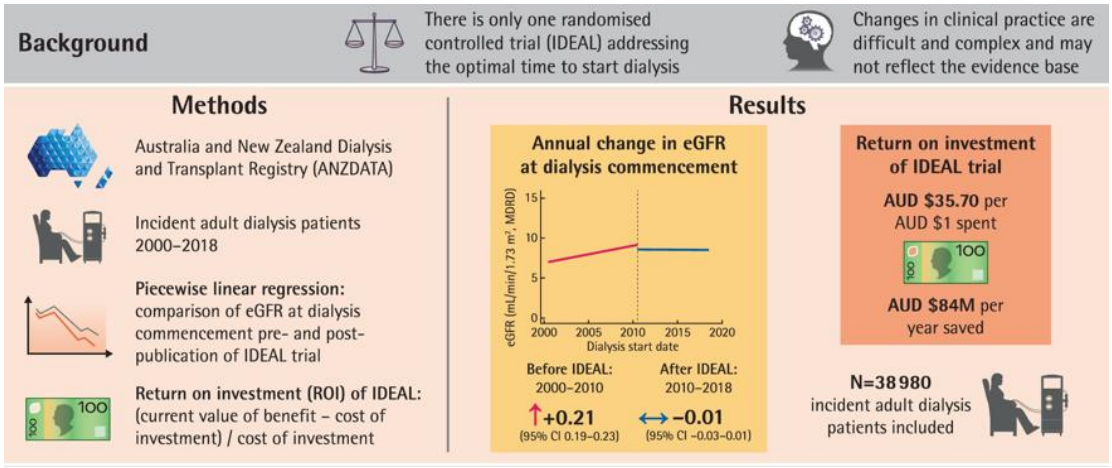
mostly driven by an alternative valuation of a QALY, demonstrating the powerful effect of a single assumption on the final result.

6 New Zealand context

6.1 Previously published evidence in the New Zealand context

Two studies investigated the value of health research in New Zealand. Dansie et al. (2021) estimated the impact of the publication of a randomised controlled trial on subsequent clinical timing decisions and the cost savings these changes accrued. In the original randomised controlled trial, carried out in Australia and New Zealand, researchers found that earlier initiation of dialysis for patients with chronic kidney disease was not associated with improved clinical outcomes but added a longer duration of dialysis treatment at a significant cost per patient. Dansie et al. demonstrated that this research was influential in dialysis treatment timing decisions, and the research had a return on investment of AU$35.70 for every $1 spent.

Figure 15 Summary of a key New Zealand study on the value of a randomised controlled trial



Source: Dansie et al. (2021)

Another New Zealand study, NZIER (2020), estimated the value of clinical research with modern medicines to be worth at least $150 million per year for the New Zealand economy. This focused on one component of health research, Phase I-III trials of medicines, and calculated the total value as direct (gross operating surplus plus labour income) plus indirect (demand for goods and services from other sectors to support operations).

6.2 New Zealand data relevant to health research valuation

New Zealand's data for valuing the health and economic impacts of health research is adequate but not ideal:

Health research inputs

There does not currently exist a single dataset of research funding and activity in New Zealand that would satisfy the requirements of either a bottom-up or top-down approach. Worse, what data is held on health research funding and activity is not defined, collected or presented consistently.

That being said, the following data are available to inform the inputs components of a study on the value of health research:

- Health research investment data is unavailable from a single source with sufficient granularity to support a bottom-up approach or as a time series which would be ideal for a top-down approach. This data is potentially available but may require significant resources to collect and collate from a range of sources.
- Funding agencies' application, contract and reporting data is held by funding agencies (MBIE, HRC, RSNZ, TEC, MPI, Callaghan Innovation) and includes information on applications, awarded contracts and subsequent reporting by recipients. The data describes research, researchers involved, contracts and funding, outputs and outcomes. The different agencies collect different data and use different classifications and data standards. This makes aggregation difficult, but the data is likely to support a bottom-up approach, provided the data is reasonably complete.
- Stats NZ's biennial R&D Survey conducted since 1996 measures the level of R&D activity, employment, and expenditure in the business, government, and higher education (university) sectors; however, this data is not granular enough to support a bottom-up approach to valuing health research investment. The data does, however, align with the Input-output table category of scientific research and would support input-output and CGE modelling.
- The Innovation Module of Stats NZ's Business Operations Survey (BOS) provides information on the characteristics of innovation in New Zealand firms, including the source of ideas or information for innovation, expenditure on R&D, and innovation outcomes for firms since 2003. The same granularity concern as above applies, but this data may also help establish the pathway from inputs to outputs and outcomes for a bottom-up approach.
- Inputs in the tertiary education context are also challenging to capture. Sources and allocations of research finance in the sector are available from Education Counts from approximately 2004 onwards, including: Vote TEC funding for research by fund type, PBRF allocations, university external research income by source, university PBRF external research income, university research contract income, expenditure on R&D by universities, University research expenditure by research type, and university research expenditure by purpose (2009-2013). TEC also produces an electronic report which describes: Quality rating of staff at an aggregate level, FTE information at an aggregate level, nominated and other research outputs by type, and demographic information such as age and gender. TEC also produces a report describing funding to tertiary organisations and external research income.

Some studies include the direct employment benefits of health research in value estimation. This is a questionable choice as labour employed in health research is unlikely to be unproductive in the absence of health research investment. However, data on employment in health research can be a key element of an inputs-outputs-outcomes-impacts approach to bottom-up methodologies. This data represents a major gap. Currently, the closest available data is from Stats NZ:

- The Census describes:
  - Occupation (sub-major group) collected as part of the Census, which includes the categories "design, engineering, science and transport professionals", "education

professionals", "health professionals", and "engineering, ICT and science technicians", all of which may include people whose occupation involves health research, but also many others with no involvement in health research.

  - Industry subdivision collected as part of the Census, which includes the categories "professional, scientific and technical services", "tertiary education", "hospitals", and "medical and other health services", all of which may include people whose occupation involves health research, but also many others with no involvement in health research.

- Business demography statistics describe:

  - Enterprises by industry, which include "professional, scientific and technical services", "education and training", and "health care and social assistance", all of which may include people whose occupation involves health research, but also many others with no involvement in health research.

Using this data to estimate the labour inputs in health research would either significantly overestimate inputs or require an assumption regarding the proportion in these categories employed in health research. It is unclear what information would support such an assumption to be considered reasonable. That being said, the inclusion of labour inputs is of relatively minor significance in a study on the value of health research as it is unlikely that labour inputs are significantly more productive when employed in health research than when employed in other fields that are conceivable substitutes for the health research workforce.

Overall, health research inputs represent an area where significant resources are likely to be needed to collect and collate the necessary data for a study on the value of health research.

Health research outputs and outcomes

The following data are essential to inform the outputs components of a study on the value of health research:

- Bibliometric data to support a more confident attribution of impacts for a bottom-up approach is also not collected centrally or regularly. Again, this data is potentially available but may require significant resources to collect and collate.
- One possible source of bibliometric data is the datasets held by the funding agencies, which contain some information on outputs and outcomes.
- Return On Science (a national research commercialisation programme to deliver new research to market from universities, research institutions and firms) collates a dataset that describes project name, project stage, principal investigator, client, project type (physical sciences, biotech and life sciences, ICT, agritech and agbio). This data may be helpful in supporting the bottom-up estimation of commercial returns.

Health research impacts

The following data are available to support the modelling of impacts:

- Population by age group and gender is a critical dataset for modelling health gains as well as economic impacts. This is available from Stats NZ.

- Direct health gain estimation is possible for a wide range of disease/conditions using the data from the Global Burden of Disease study, which provides DALYs. Where necessary, additional values may be obtained from clinical trials and evaluation studies.
- Labour force participation rates by age group and gender are essential for a realistic estimation of economic impacts. Good data is available from both Stats NZ and OECD.
- New Zealand's Input-output table is available from Stats NZ with the same level of granularity that would have informed estimation of the value of health research for Australia (e.g. the KPMG report). The limitation of ANZSIC codes that dictate the granularity of New Zealand and Australian Input-output tables is the lack of a specific category for health research. Instead, using these tables will mean an implicit assumption that the economic impacts of health research will be similar to the economic impacts of the broader scientific research and development category.
- NZIER's CGE model contains a database of 206 industries and 206 commodities over which economic impacts can be estimated.

6.3 Investment in health research in New Zealand

Health research in New Zealand receives funding from a range of sources, including government funding (from health research funds and broader research funding streams), tertiary funding, commercial funding and philanthropic funding.

New Zealanders for Health Research compiled these funding sources for 2018/19 (see Table 5 below).

Table 5 Investment in health research in New Zealand by funding source

2018/19, $000s

Funding source	2018/19 $000s
Government (health research funds)	122,726
Government (other research funds)	90,218
(Total government)	(212,944)
Tertiary	43,500
Commercial	172,000
Philanthropic	65,000
Total	**493,444**

Source: New Zealanders for Health Research

These figures were compiled from a range of sources – a necessary activity for quantifying the level of investment as no single data source on health research funding exists. However, at $493.444 million, these amount to a figure not significantly different from the figure indicated by Stats NZ's – $528 million research and development expenditure in 2018 with health identified as the purpose of the expenditure (see Table 6 below).

Table 6 Research and development expenditure in New Zealand, by purpose

2018

	Private sector	Government	Higher education	Total
Plant production/plant primary products	117	166	35	318
Animal production/animal primary products	195	96	32	323
Mineral resources	18	C	C	39
Energy	50	26	31	107
Manufacturing	503	93	75	670
Construction	68	1	21	90
Transport	126	C	C	135
Information and communication services	353	18	60	431
Commercial services and tourism	220	2	30	252
Health	**253**	**44**	**232**	**528**
Education and training	22	19	80	122
Law, politics, and community services	6	10	48	64
Cultural understanding	35	5	96	136
Economic framework	14	14	39	67
Environment	31	260	71	362
Other (includes defence and other)	139	16	9	164
Knowledge	0	..	85	85
Total	**2149**	**784**	**960**	**3894**

C: Confidential

Source: Stats NZ

A key issue related to this data is that health research investment estimated at $528 million in 2018 by Stats NZ represents only 13.5 percent of overall research and development investment. This raises important questions about the appropriateness of the use of input-output tables and CGE modelling that, due to the input-output tables' lack of granularity, will effectively assume that economic impacts of health research are well represented by the average impacts across the range of fields for research and development investment as described in the table above. Currently, no evidence exists to indicate how reasonable such as assumption might be.

6.4 The estimated value of health research in New Zealand

Because of the range of studies and the presentation of results, we provide a high-level estimate of the value of health research for New Zealand based on:

- published benefit-cost ratios
- published return on investment.

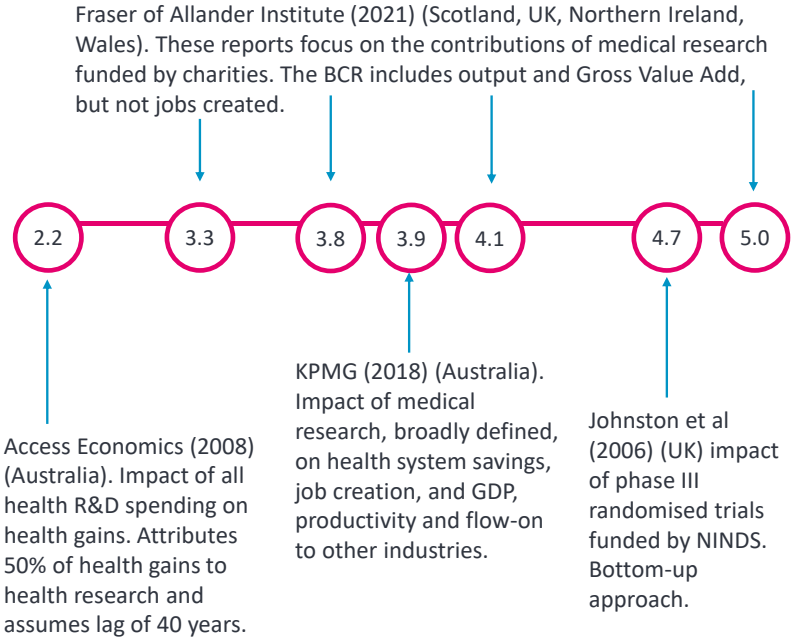
These estimates are hypothetical and require further investigation.

6.4.1 Estimate based on a published range of benefit-cost ratios

Most top-down literature reports benefit-cost ratios (or their equivalent, return on investment). A benefit-cost ratio reports the benefit for every unit of cost. A benefit-cost ratio of greater than one shows an investment delivers value. One example is Deloitte Access Economics (2011) who report benefit-cost ratios for five diseases separately: CVD: 6.1, Cancer: 2.7, SIDS: 1.1, Asthma: 1.2, Muscular Dystrophy: 0.7 (a benefit cost ratio below 1 indicates that the value of benefits is lower than the value of costs and is associated with a negative return on investment).

Johnston et al. (2006) is the only bottom-up study to report a benefit-cost ratio. This research investigated the impact of phase III randomised trials specifically funded by the National Institute of Neurological Disorders and Stroke. This gives a higher ratio of 4.7, likely due to the advanced nature of the research, which could translate directly into clinical outcomes.

Figure 16 Benefit-cost ratios in published literature



Source: NZIER

The Fraser of Allander Institute (2022) study attempted to focus only on research funded by charities which presents a significant attribution problem. The Johnston et al. (2006) study effectively attributes research impacts to a single phase along the research spectrum, underestimating the likely investment.

All studies reviewed were limited to particular disease areas or a narrow research phase. However, based on the range of disease areas and research phase focus areas for the research, the evidence taken as a whole provides a reasonable range for New Zealand's health research investment portfolio. As explained in section 2.2, the context of the studies was also specifically chosen to be restricted to countries with a similar baseline prevalence of health conditions, health systems, and economies.

To obtain the most realistic high-level estimate, we take the additional step of basing our calculation on the studies which produced estimates based on a wide range of investment sources across multiple research phases (Access Economics (2008) and KPMG (2018)). This excludes the top of the range of estimates, potentially producing a conservative estimate.

Based on the estimates from those studies (benefit-cost ratios of 2.2 over a 20-year time period and 3.9 over a 30-year time period) and the $493.444 million investment in health research, the benefits delivered are estimated to be between $1.1 billion and $1.9 billion, over a period of 20 to 30 years, respectively.

6.4.2 Estimate based on a published range of return on investment

Rates of return, or returns on investment, show the amount of return annually without time constraints.

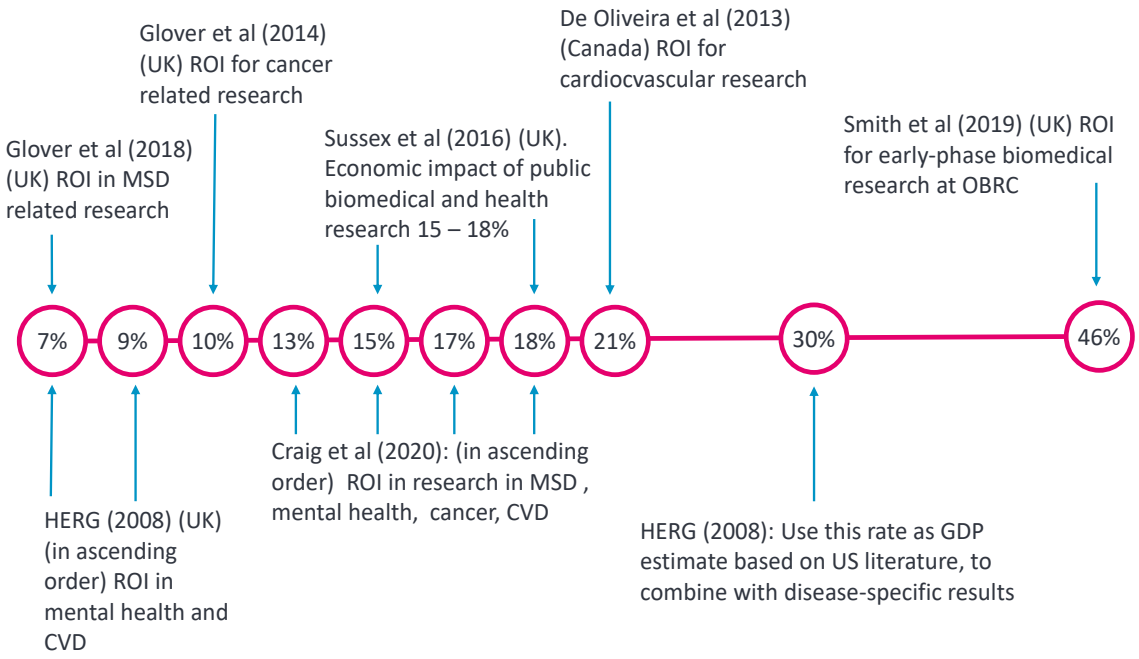
Smith et al. (2019) is the only top-down study in our review to report a rate of return, estimating the impact of investment in early phase biomedical research to the Oxford Biomedical Research Centre in terms of income, job creation and changes in demand across all sectors. They report the highest rate of return, at 46 percent, likely due to the specific, targeted investment in one research centre.

HERG (2008) use a bottom-up approach overall but consider the GDP impacts based on US literature:

> *"We estimated that the GDP gains that result from increased public/charitable medical research deliver an additional rate of return in the range 20–67 (with a best estimate of 30 percent). These figures are obtained from a small empirical literature, much of it US-centred and only a proportion of it specific to medical research. Hence the application to the UK and to medical research is at best tentative."* HERG (2008)

Bottom-up research commonly reports a rate of return. The estimated return is based on bottom-up approaches and ranges from 7 percent (musculoskeletal, UK) to 21 percent (cardiovascular, Canada).

Figure 17 Return on investment in international literature



Source: NZIER

As in the studies that reported benefit-cost ratios, all of these studies were also limited to particular disease areas or a narrow research phase. However, based on the range of disease areas and research phase focus areas for the research, the evidence taken as a whole provides a reasonable range for New Zealand's health research investment portfolio. As explained in section 2.2, the context of the studies was also specifically chosen to be restricted to countries with similar baseline prevalence of health conditions, health systems, and economies.

To obtain the most realistic high-level estimate, we take the additional step of basing our calculation on the studies with a larger number of case studies supporting the estimation (Craig et al. 2020 and HERG 2008) and the Sussex et al. (2016) study, which was based on a broad range of research investment. This excludes both the top of the range of estimates and the bottom of the range, which would be expected as a broader base should produce a value closer to a weighted average.

Based on this approach, the rate of return on investment in health research would be expected to be between 13 percent and 30 percent per annum, sustained for 20 to 36 years as evidenced by the reports from which these figures are derived. With total investment in health research at $493.444 million, the return on investment is estimated to be between $64 million and $148 million per annum. That is, for a one-year investment of $493.444, annual benefit flows of between $64 million and $148 million are expected to be sustained for at least 20 to 36 years.

7 Options for valuing health research in New Zealand

7.1 Top-down approach

A top-down approach to estimating the value of health research in New Zealand is relatively straightforward because where the data is lacking or too onerous to collect or analyse, this approach makes extensive use of assumptions. It is the 'quick and dirty' approach. As described in section 5.2, top-down methods involve capturing the gains in life expectancy or QALYs or DALYs over a period of time and assigning a proportion of these to be due to health research – generally by assumption bolstered by literature review and/or expert opinion. Further assumptions about time lag between investment and health gain are also required, and these are often informed by previously published literature and/or expert opinion. Further assumptions, informed as far as possible by existing evidence, are required to make the connection to productivity.

Once productivity gains are established, this approach can estimate broad economic impacts by either input-output analysis or CGE modelling.

7.2 Bottom-up approach

A bottom-up approach to estimating the value of health research in New Zealand would be less reliant on assumptions. This approach would ideally be based on case studies of health research, particularly where the impact is high, attribution is highly certain, and traceability of research outputs and outcomes as well as inputs is straightforward. The more case studies, across a wide range of health conditions and populations and across a wide range of research types, the stronger the basis for extrapolating to health research in general. Bibliometric methods would establish time lags, and published research complemented by sound estimation techniques would determine the productivity impacts.

Once productivity gains are established, this approach can estimate broad economic impacts using input-output analysis or CGE modelling.

The key concern of this approach is that its strength depends on the number of case studies. However, a large number of case studies would mean highly resource-intensive research. This is the big budget option, so it is not surprising that published studies have tended to keep the number of case studies low.

7.3 Case study

Some published bottom-up studies are essentially just extrapolations based on one or two case studies. A case study can provide robust and compelling results for research value in a particular disease/condition and can be based on a single intervention or multiple interventions. Health gains can be estimated based on evidence from published studies, and bibliometric methods can be used to identify time lags and support the attribution of health gains. Productivity impacts may also be drawn from published studies.

If the case study impacts are significant, it may also be possible to derive interesting results from input-output analysis or CGE modelling. However, extrapolating from a single case study does not provide confidence in estimates of the overall value of health research.

7.4 Input-output analysis

While some studies have limited their analysis of broader economic impacts to input-output analysis, we see this type of analysis as incomplete as it only captures the demand side of the market – essentially assuming no supply constraints.

However, input-output analysis provides insight into the flows of benefits across sectors resulting from investment in one sector.

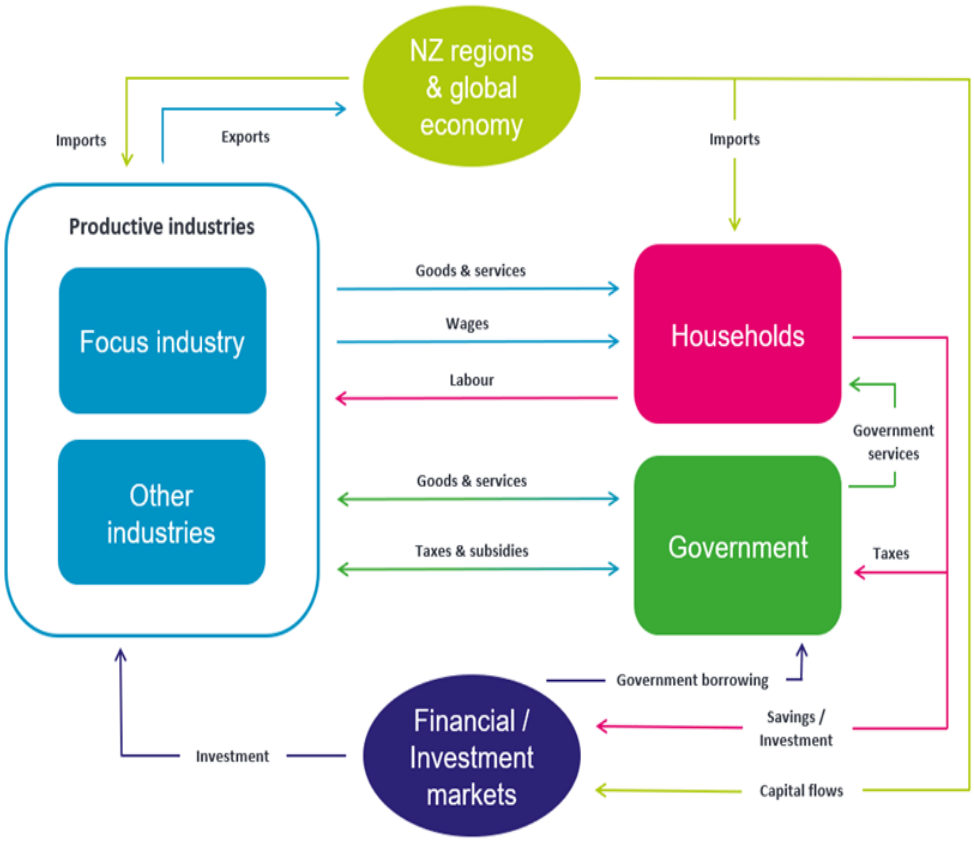
7.5 CGE modelling

CGE modelling is the preferred approach to assessing the broader economic impacts of any major activity or expenditure with implications for productivity in a world where supply constraints and economic effects impact factor prices (wages, input prices, etc.). A CGE model can capture the economy-wide effects of changes directly on the affected industry and indirectly on supplying industries, competing industries, and factor markets (e.g. labour and capital).

NZIER's CGE model (TERM) is a bottom-up regional model that draws on New Zealand's input-output table. The input-output table provides comprehensive economic data that shows the relationship between industries, goods and services they produce, and users of goods and services. Essentially, the data describes the structure of New Zealand's economy, reflecting the production and expenditure measure of GDP. Based on this data, the TERM model identifies impacts across 88 districts, 206 industries and 206 commodities. This means that regional impacts and national impacts can be assessed. Because the TERM model can assess each region as a separate economy, it can account for region-specific inter-linkages between industries, and their links to households (via labour supply), local and central government, capital markets, the rest of New Zealand (via inter-regional trade), and global markets through international trade.

Figure 18 below depicts the structure of NZIER's TERM CGE model.

Figure 18 NZIER's CGE model (TERM)



Source: NZIER

7.6 Summary of possible methods for estimation of a New Zealand value of health research

The information presented above is summarised in the table below.

Table 7 Summary of possible methods for estimation of a New Zealand value of health research

	Top-down	Bottom-up	Case study
Health impacts	High-level data on health outcomes over time	Identified from a range of case studies across a range of diseases or conditions	Single intervention for a single disease or condition
Time lags	Assumed (e.g. expert opinion, published studies)	Established through bibliometric methods	Established through bibliometric methods or direct information
Productivity impact	Assumed (e.g. expert opinion, review of literature)	Identified through published studies where available for any interventions or conditions within the range of case studies	Identified through published studies on the specific health condition and intervention

	Top-down	Bottom-up	Case study
Broad economic impacts (spillovers)	Input-output analysis or CGE modelling	Input-output analysis or CGE modelling	Input-output analysis or CGE modelling, although depending on the case study, impacts may be too small for a national model. An alternative is estimating specific economic impacts based on health gains and target population demographics.
Advantage	Computationally easier	Strongest approach to total economic impact estimation if a large number of case studies is used	Specific and reasonably robust for a particular intervention/disease
Disadvantage	Heavily assumption-based, not credible Broad economic impacts estimated as impacts of equivalent investment in scientific R&D Based on past impacts – cannot inform value of present or future investment	Computationally demanding and resource intensive Broad economic impacts estimated as impacts of equivalent investment in scientific R&D Based on past impacts – cannot inform value of present or future investment	Insufficient to inform the overall value of health research If Input-output or CGE modelling is used, broad economic impacts estimated as impacts of equivalent investment in scientific R&D Based on past impacts – cannot inform value of present or future investment

Source: NZIER

7.7 An alternative approach: Conjoint analysis

An alternative approach, asking a slightly different but no less policy-relevant question, is to use conjoint analysis to identify how much value New Zealanders place on health research. Conjoint analysis is a survey method of data collection and analysis developed in mathematical psychology with a strong theoretical basis. Conjoint analysis has been successfully used in:

- market research
- transport economics
- environmental economics
- healthcare.

The technique was recommended to the UK Treasury for valuing quality in the provision of public services and has been well received by policymakers.

Conjoint analysis has gained widespread use in health care decision-making internationally with applications that including

- eliciting patients' and community preferences in the delivery of health services
- establishing clinician preferences in priority setting

- developing outcome measures
- determining optimal treatments for patients
- evaluating alternatives within randomised controlled trials
- establishing patients' preferences in the doctor-patient relationship.

  (Ryan and Farrar 2000)

Although conjoint analysis is survey-based, it elicits preferences using a more robust system than a traditional survey: Participants express their preferences by repeatedly choosing their preferred alternative from 'choice sets' consisting of two or more alternatives. The alternatives in the choice set are typically defined so that there is a trade-off that participants are forced to confront.

Conjoint analysis is based on the idea that any good or service, decision or investment, can be described by its attributes (characteristics) and that the extent to which people value it depends on the levels of attributes. Based on the choices that participants make, conjoint analysis identifies people's preferences and assigns utilities to the attributes – numerical values that represent the relative importance of the attributes. The technique can be used to:

- identify willingness to trade between characteristics
- produce overall benefit scores for alternatives, allowing alternatives to be ranked for priority setting
- identify which attributes are important
- estimate the relative importance of different attributes to identify the impact of each attribute on the overall value
- estimate willingness-to-accept (WTA) and willingness-to-pay (WTP).

While an initial survey panel with a balanced representation of the general population is generally sought for conjoint analysis, some software packages that perform conjoint analysis also enable participants to share the survey to their own social media contacts, increasing survey size through 'snowball sampling', making the survey aspect of the research relatively cost-effective.

7.7.1 Key benefits of conjoint analysis

Using conjoint analysis to estimate the value of health research would be less resource intensive than bottom-up and top-down methods to identify the value of impacts and would deliver some important benefits, including:

- an original way of exploring a question that has never been able to be satisfactorily answered using traditional methods
- arguably more robust results than can be obtained through bottom-up and top-down valuation methods
- insights into why health research is important to New Zealanders
- insights into what kinds of health research are important to New Zealanders
- insights into how different demographic groups feel about the value of health research

- insights relevant to investment priority-setting for research investment agencies
- policy-relevant insights into how much New Zealanders value health research today rather than a backwards-looking analysis that identifies the value of impacts generated in the past.

8 Case studies for a bottom-up approach

In this section, we briefly assess potential case studies for a bottom-up approach to valuing health research.

Estimating the value of health research internationally has relied heavily on using case studies to establish a more credible attribution of research impact to investment. We assessed the potential for case studies to inform a New Zealand-specific research project on the value of health research.

Broadly speaking, the criteria for the selection of case studies should include:

- Impact across a broad population or high level of impact on a small population. This requires the health condition to have high prevalence or high incidence and/or a more moderate prevalence/incidence but with a significant impact on affected individuals.
- Clearly identifiable intervention and high level of confidence in attribution of impacts to intervention. Impact attribution depends heavily on the uniqueness of the intervention or the uniqueness of the research. Attribution becomes challenging when multiple research streams are underway internationally, with multiple interventions introduced.
- Granular impact data that allows for monetisation of impact, which could include:
  - mortality associated with the condition, the economic value of which can be estimated based on commonly used methodologies for lost productive capacity due to premature mortality
  - DALYs associated with the condition, the economic value of which can be estimated based on the willingness-to-pay for a DALY derived from the Ministry of Transport's value of a statistical life (VoSL)
- Information on the research that led to the intervention, including:
  - the start date of research by stage
  - the date of outputs by stage, particularly clinical guidelines or implementation of intervention
  - the amount of health research investment from all sources
  - direct employment generated by the research.

  Given New Zealand's lack of detailed central data sources on inputs, outputs and outcomes, the traceability of research and the identification of total investment are particularly challenging for research areas that have been ongoing over long periods of time or have included many different groups of researchers.

Table 8 below summarises the assessment of a sample of potential case studies. Green/yellow/red areas indicate where the case study has been assessed as offering good/moderate/poor performance against the criteria described above.

Table 8 Case study assessment summary

Disease/condition	Impact size	Impact attribution	Impact data	Research traceability	Research investment
SIDS					
Asthma					
Neonatal hypoglycaemia "sugar babies"					
Hepatitis C					
Heart failure test					
CoolCap device for premature babies					
Real-time bedside clinical data to reduce ICU deaths					
He Kainga Oranga Programme – meningococcal disease					
Christchurch Health and Development – passive smoking, lead in petrol, conduct problems					
Wireless heart pump					
Clinical tests based on novel peptides in heart failure					
Fast track cardiac diagnostic tool					
LiLACS NZ study – interventions for health and wellbeing in advanced age					
Zoledronate					
Warm Up New Zealand					

Source: NZIER

9 Recommendations

Estimating the value of health research is a challenging and resource-intensive undertaking. Bottom-up approaches to the estimation that rely on case studies are more robust if a sufficiently broad set of case studies is used to inform the modelling.

For any estimation of the value of health research investment, researchers will need:

- comprehensive data on research inputs to quantify the total investment
- ideally, outputs and outcomes to establish a credible basis for attribution
- robust published evidence of productivity impacts (associated with the absenteeism and presenteeism effects of morbidity) or a strong basis on which to estimate the productivity impacts (e.g. premature deaths)
- health data that describes the prevalence of the disease or condition before the intervention as well as after the interventions
- various economic and population data sets to inform the economic modelling
- expert advice to support important decisions about scope and attribution
- ideally, a CGE model capable of estimating spillover effects across a range of sectors.

Currently, not all of these are readily available. In particular, data on research inputs, outputs and outcomes are most lacking. This means bibliometric methods to support a bottom-up approach will be highly labour intensive and face a significant probability of yielding unsatisfactory results.

We recommend that:

- the Ministry of Health, as the steward of the health and disability system, undertake detailed data collection on investment in health research and this data is updated annually and made publicly available
- the Ministry of Health work with Stats NZ to identify the best approach to defining and collecting data on employment in health research
- New Zealanders for Health Research initiates discussions with health research organisations to establish a common methodology for tracking publications and citations associated with health research to support future research reliant on bibliometric methods and enable a greater understanding of the total investment required and time lags inherent in the pathway from basic research to research impact
- Stats NZ investigates the feasibility of more granular data associated with the input-output tables (e.g. health or medical research sub-category of scientific research).

In addition, we recommend that a research project designed to estimate the value of health research in New Zealand, taking into account the current gaps in data, should be based on one of three approaches:

1 A major study using bottom-up and extensive bibliometric methods to establish the value of health research from a broad base of representative case studies. Some application of top-down methods could be used to further validate or provide a potential range for estimates.

2 A gradual approach to building the evidence base through individual case studies that contribute to a portfolio of values over time.

3 An alternative framing of the question to "how much do New Zealanders value health research?". This question could be addressed using conjoint analysis and established methods to better understand how much New Zealanders think the Government should invest and what the priority areas for investment should be. A key advantage of this approach is that it offers a future-focused view with direct implications for priority setting.

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