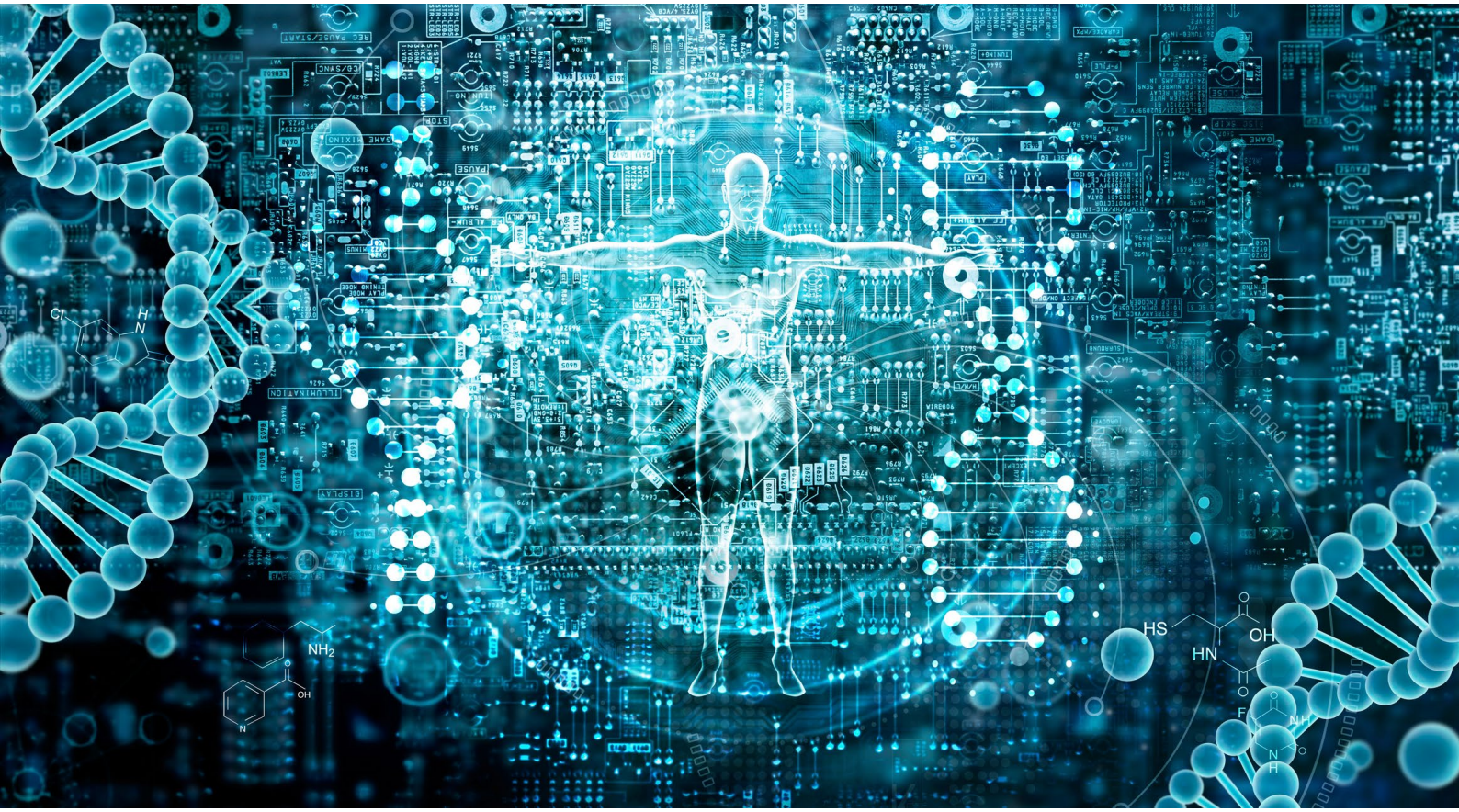
NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH



The cost of long-term conditions in New Zealand

Review of the evidence – 2021 update

NZIER report to the Ministry of Health

February 2022

About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice.

We undertake and make freely available economic research aimed at promoting a better understanding of New Zealand's important economic challenges.

Our long-established Quarterly Survey of Business Opinion and Quarterly Predictions are available to members of NZIER.

We pride ourselves on our reputation for independence and delivering quality analysis in the right form and at the right time. We ensure quality through teamwork on individual projects, critical review at internal seminars, and peer review.

NZIER was established in 1958.

Authorship

This paper was prepared at NZIER by Sarah Hogan and Zhongchen Song.

It was quality approved by Todd Krieble.

The assistance of Sarah Spring is gratefully acknowledged.

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

Long-term conditions are a major focus area for New Zealand

Long-term conditions continue to pose a major challenge for the New Zealand health system. The prevalence of long-term conditions is high and rising, particularly for Māori and Pacific people who experience the onset of disease at a younger age and face a higher risk of complications and early death.

The modifiable risk factors for many long-term conditions – physical inactivity, obesity and poor diet, alcohol, and tobacco consumption – have been major preventable drivers of the rise of long-term conditions in general.

New-Zealand based studies are a small proportion of the international literature

Our search identified a total of 453 studies dating back to 2008 that were assessed for cost-of-illness information for in-scope conditions based on the New Zealand context. Twenty-two studies provided New Zealand-specific cost-of-illness estimates. Additional information was extracted from 18 overseas studies where little or no cost evidence for New Zealand was identified.

No estimate of the overall cost of long-term conditions is available

Despite the high private and public, individual, and societal burden of long-term conditions in New Zealand, no report was identified that summarised or described the social and economic impact of long-term conditions in general in New Zealand.

And methodological variations make comparability challenging

Direct health sector costs were the most commonly reported cost category, with productivity-related costs being a common indirect cost. Few studies included other costs, such as out-of-pocket costs and caregiver costs. Quality of life costs are becoming a more common feature of economic studies of illness, with disability-adjusted life years being the primary measure, but inclusion of such costs presents a risk of double-counting.

Variations in methodologies make comparability challenging. These include variations in the methodology used to calculate health system costs (some of which account more fully for comorbidities), the methodology used to calculate productivity costs and quality of life costs, and the occasional inclusion of additional costs. It would not be possible on the basis of the evidence to identify with confidence how long-term conditions rank in terms of cost for New Zealand.

There are significant gaps but also important contributions in the literature

Significant gaps in the cost-of-illness literature were identified. Cost-of-illness studies in the New Zealand context investigated only eight long-term conditions and three risk factors that were in-scope. One study provided estimates for six conditions, two of which were in-scope and not covered by any other identified study, as well as a range of comorbidity pairings, bringing the total number to 10. However, that study only estimated health system costs. Nevertheless, the broader approach of a study that includes several conditions that often occur comorbidly represents a major contribution due to the

overestimation of costs that frequently occurs when single conditions are analysed using common cost-of-illness methodologies.

In scope long-term conditions where no New Zealand cost-of-illness research was identified included COPD, obstructive sleep apnoea, osteoporosis, type 1 diabetes, gout (except as a non-separable inclusion in an arthritis study), and cardiovascular diseases. In some cases, overseas studies or intervention studies are used to provide some insight; however, these research gaps represent important deficiencies in the evidence on the cost of illness in long-term conditions in New Zealand.

The Ministry of Health has commissioned further research to help fill strategically important gaps in cost-of-illness evidence.

Contents

Figures

Tables

1 Introduction

In 2009, the Ministry of Health published a report on the cost of illness in long-term conditions that summarised the cost-of-illness literature for selected conditions in the New Zealand context (Ministry of Health 2009).

In 2021, 12 years after the 2009 report was published, long-term conditions continue to present major challenges for the health and disability system as well as equity and wellbeing in New Zealand. Māori, Pacific people, and those with lower socioeconomic status experience the highest levels of chronic conditions in New Zealand as well as earlier onset, contributing to higher mortality and morbidity rates in these populations (Sheridan et al. 2011).

The negative impacts of long-term conditions affect the individual, the family/whānau, the community, the public health system, other publicly funded services, and the wider economy.

The Final Report of the Health and Disability System Review (2020) expressed concern that "*the increasing proportion of our population living with chronic conditions will place increasing demands on our health system*" (2020, 81) and called for system change to ensure that services are designed to be effective for the "*increasing number of people living with complex long-term conditions*" (2020, 22).

However, even with major system reforms, resources are scarce and difficult decisions will have to be made. Cost-of-illness studies can be an important input into decision-making processes as they are designed to capture the extent of impacts of diseases insofar as they can be quantified and monetised.

2 General principles underlying cost-of-illness studies

Cost-of-illness studies can be characterised by a small number of methodological principles that should be understood, in order to interpret and compare study results appropriately. These principles are described in this section.

2.1 Purpose

A cost-of-illness study is a type of economic impact study that estimates the burdens associated with an illness or risk factor and converts them into economic and monetary values to measure the socioeconomic costs incurred within an economy. In theory, the estimates derived should support health system decision-makers to design and prioritise policies and interventions and achieve an efficient allocation of resources (Jo 2014). In practice, the estimates derived may be based on widely differing methodologies, perspectives, and scope, requiring careful consideration of comparability.

Studies may implicitly or explicitly ask a range of different questions about macro costs or micro costs of illness, as described by the World Health Organization's Guide to Identifying the Economic Consequences of Disease and Injury (World Health Organization 2009) (see Table 1 below).

Table 1 Illustrative health policy questions addressed by cost-of-illness studies

Level	*Question / topic*
Macro: Society	1. What impact does ill-health have on gross domestic product or its rate of growth? 2. How much does society pay for medical and other expenses because of illness? 3. What is the impact on social product (i.e., both market *and* non-market consumption lost opportunities), or on social welfare more generally?
Micro: Households	1. What impact does ill-health have on a household's income or consumption patterns (over a single year, or for a longer period of time)? 2. How much do households pay for medical or other expenses because of illness (for an episode, over a year, or over a lifetime)?
Firms	1. What impact does ill-health have on a firm's operating costs, output or profit? 2. What is the impact of ill-health on productivity in the work place (including impaired performance while still at work, as well as absenteeism) ?
Government	1. What proportion of government expenditure could have been saved and directed to an alternative use in the absence of illness? *(e.g. what social security payments could be avoided by the prevention of or cure for disease?)* 2. What impact does ill-health have on the government workforce and on the government's ability to provide services?

Source: World Health Organization 2009

As described above, cost-of-illness studies may allow comparison of the economic burdens of health conditions to society, although in reality, not all provide societal values, frequently being limited to health system costs only.

The overall results of cost-of-illness studies are sometimes interpreted as a potential for savings. However, this interpretation is fundamentally flawed because unless interventions can eliminate the health condition entirely and at no cost, those savings will never be realised. Instead, cost-of-illness studies may indicate the *theoretical potential* return on investment of effective interventions. To the extent that a detailed breakdown of costs and the parties bearing those costs are provided, cost-of-illness studies also help to inform questions about where and for whom to target investment if cost-effective interventions exist.

Furthermore, well-detailed cost-of-illness studies can often provide input values for cost-benefit or cost-effectiveness/cost-utility studies that investigate the value of interventions.

2.2 Scope

The scope of a study refers to what is being studied and how it is defined and measured. Cost-of-illness studies seek to identify the economic burden of a health problem (disease, condition or risk factor) by measuring and reporting on the costs associated with that problem in monetary terms.

Most studies focus on a single condition or risk factor, although some focus on groups of conditions, usually those that are closely related or use similar health and disability system resources (e.g. mental illnesses).

2.3 Perspectives of cost-of-illness studies

In general, cost-of-illness studies take one of three perspectives (H. S. Choi et al. 2019):

- the payer perspective
- the patient perspective
- the societal perspective.

Economic evaluation guidelines indicate that all 'relevant' costs should be included in economic cost studies and that principles of welfare economics require that whoever bears the costs should not be relevant. However, published cost studies frequently define a perspective that assumes implicitly that costs other than those borne by the decision-maker's organisation or sector are irrelevant.

In New Zealand, a 'total health system' perspective is sometimes seen. This means including private health system costs as well as public health system costs. This is essentially a limited type of societal perspective as patients and insurers generally incur private health system costs. From a public sector perspective, this is somewhat problematic since public funds are spent to achieve societal objectives.

However, a 'social' or 'societal' perspective, in which all costs are considered, is often difficult to achieve due to a lack of data or evidence, resulting in a considerable need for assumptions around which there can be significant uncertainty. This is especially true for less common diseases as data associated with these diseases are often harder to acquire. The ideal approach for calculating the cost of illness from a societal perspective would also

incorporate measures that account for potential bias while utilising data from all different sources. This may include linking data from registries, surveys, or medical facilities to incorporate both direct and indirect costs. (Onukwugha et al. 2016)

A compromise approach in the published literature often involves the inclusion of health outcomes, including quality-adjusted life years (QALYs), disability-adjusted life years (DALYs), years of life saved (YLS), or other outcome measures, and, occasionally, productivity effects. This approach is generally believed to capture the most important societal impacts and is often referred to as a 'societal perspective' even though some important effects, such as caregiver costs, may not be included.

Another important reason for adopting as wide a perspective as possible is that it also allows researchers and decision-makers to understand how costs may be shifted from one sector to another or from public service funders and providers to service users and their families, communities and employers (Jo 2014).

3 Burden of disease basis

Burden-of-disease studies often provide a foundation for cost-of-illness studies by quantifying the size of the problem in terms of some health outcome measure, such as lives lost, life years lost, or disability-adjusted life years.

Health-Adjusted Life Years (HALYs) are a measure of health in a population, often used in estimating the burden of disease. Two common approaches to measure HALYs are Disability-Adjusted Life Years (DALYs) and Quality-Adjusted Life Years (QALYs). DALYs and QALYs can each be used to compare the health impacts of different diseases because they provide a global measure of disease impacts by combining potential years of life lost as well as impacts on healthy years of life.

3.1 QALYs

QALYs measure both the quantity and the quality of life lived. This measure is typically used to analyse the cost-effectiveness of a specific intervention and is common in health technology assessment. QALYs are calculated by multiplying each year of life by a weight that reflects the quality of life in each year. This weight is estimated based on surveys that ask individuals about their opinions on various health states, using one of a set of validated and largely reliable instruments such as the EQ-5D or the SF-36, which take into account physical, social and mental/emotional aspects of the burden of disease. A year of perfect health is given the value of 1, while death is often given a value of 0. Some value sets include negative values as many people feel that health states are worse than death (Rosser and Kind 1978).

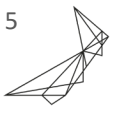
QALYs provide a way to quantify the benefits of an intervention in terms of the gains in the quality of life as well as gains in length of life. However, like all tools, QALYs are also limited:

- It has been argued that the idea of what constitutes a state of perfect health may vary across contexts and cultures, casting doubt on the comparability of results or the appropriateness of benefit transfer based on results obtained in a different context or a group with a different culture.
- QALYs may lack sufficient sensitivity to measure the impacts of mild health problems. The implication for long-term conditions is that quality-of-life measures of conditions with less significant impacts may be unreliable and usually affect people's quality of life while doesn't pose a significant threat to people's survival; this is difficult to be addressed by QALYs (Lajoie 2015).

3.2 DALYs

DALYs are a more recent construct but are currently the most common measure of the burden of disease in published studies. DALYs in burden-of-disease studies measure the difference between the health state of the population and an ideal health state. The ideal health state represents each individual living to the age of standard life expectancy with perfect health.

On an individual level, DALYs measure the total amount of time a certain disease disables an individual in their life. On a population level, DALYs measure the total disability that a disease causes to a population. DALYs are calculated as the present discounted value of all



future years of healthy life lost to morbidity/disability and future years of life lost to premature mortality. DALYs are calculated based on the assumption that 'time' is the most appropriate measure for burden of disease. The greater the time a person or a population lives with a disability, the greater the burden of disease (Lajoie 2015).

A critical difference between QALYs and DALYs is that QALYs represent a measure of the health that a population has, while DALYS represent a measure of the health that a population has lost.

4 Study types

There are two broad categories of cost-of-illness studies: Prevalence-based studies and incidence-based studies.

4.1.1 Incidence-based approaches

The incidence-based approach involves estimating the socioeconomic cost of a given illness throughout the entire lifespan of a patient. This involves estimating the economic burden currently imposed by the illness and the cost of future health-related losses, including those caused by sequela. Incidence-based studies estimate the number of new cases for a disease in a specific year, then apply a lifetime cost estimate to these cases to calculate the overall cost (Jo 2014).

Estimation of lifetime cost associated with a certain disease involves calculating not only the socioeconomic cost currently imposed by the illness but also the potential health expenditure that may be incurred in the future, that are caused by complications of such illness. Because this approach is dependent on the identification of new cases that emerge each year, it doesn't take into account all current cases. This means that the incidence-based approach tends to under calculate the costs associated with a disease that has a low incidence rate but high prevalence rate (H.-J. Choi and Lee 2019).

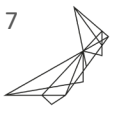
Incidence-based analyses are essential for calculating the value of prevention. To assess lifetime costs without longitudinal data taken over a lifetime, we may need to model a synthetic cohort of people with the illness over time. Although incidence-based cost-of-illness analyses are better tools for knowing what could be saved through prevention efforts, these analyses require more assumptions and perhaps even more sophisticated modelling techniques than other methods.

4.1.2 Prevalence-based approaches

Prevalence-based cost-of-illness analysis includes the total costs of an illness or disease within a specified time period, typically one year, regardless of when the disease first occurred. The question underlying prevalence-based cost-of-illness analysis is: How much do we spend each year caring for individuals with a certain condition? Prevalence-based studies estimate the number of cases of death and hospitalisations attributable to diseases in a given year and then estimate the costs that flow from those deaths or hospitalisations (Jo 2014).

Contrary to the incidence-based approach, the prevalence-based approach considers a cross-sectional view of costs associated with the illness, which considers both existing and new patients at a given time. The prevalence-based approach is very good at calculating the cost of an illness at a specific time, but it doesn't allow researchers to consider the costs accrued throughout the lifespan of the illness. This method’s estimates don't tell us how much can be saved through prevention, as results indicate the annual costs of a disease rather than the costs of a disease over the course of a life. However, prevalence-based studies can nevertheless be strong motivators to invest in prevention to generate a reduction in estimated costs.

The prevalence-based approach is the most popular method used in cost-of-illness studies on long-term conditions. The major reason for this is that monitoring the development of



long-term conditions requires a very long follow-up period, which means that the prevalence-based approach is the only feasible way to measure the real-life impacts of long-term conditions (Jo 2014).

Table 2 Comparison of approaches to estimating the cost of illness

	Incidence-based approach	Prevalence-based approach
Description	• Estimates the economic cost of an illness throughout its lifespan, ranging from the initial stage to the patient's complete recovery (or death).	• Estimates the economic cost of an illness during a certain period of time by taking into account the costs generated by both new and existing patients.
Pros	• Allows the researcher to consider the current cost and the future cost of an illness and the sequela it causes and thereby estimate the economic losses incurred both in the present and the future.	• Better suited to estimating the current cost of an illness. • Allows the researcher to consider both new and existing patients at given point(s) in time.
Cons	• Makes it difficult for the researcher to consider existing patients that are already afflicted with the given illness. • Not applicable to illnesses that, at present, have high prevalence and low incidence rates.	• Makes it difficult for the researcher to estimate the total economic cost of an illness throughout its entire lifespan. • The researcher may not find patients suffering from the given illness if the illness lasts for relatively short spans of time, despite its high incidence rate.

Source: H.-J. Choi and Lee (2019) and NZIER

5 Identifying and quantifying costs

To be useful to decision-making, cost-of-illness studies should describe completely and clearly the data and methods used to estimate costs so that readers can assess how appropriate, accurate and precise these methods are likely to be. This should include identifying what costs are included, what costs are excluded but potentially important, the data and methods used to estimate costs and any discounting applied. However, for various reasons, the reporting of costs and costing methods in cost-of-illness studies often fall short of these general principles.

One reason is that cost accounting terminology is often used inconsistently between researchers. What one calls a direct private cost may be referred to as an indirect cost by another. Bottom-up costing and micro-costing are often conflated in the use of language as well.

A major concern about the descriptions of included and excluded costs and the data and methods used to calculate them is that researchers may fail to identify the assumptions and trade-offs inherent in their choices.

Another major concern is that cost accounting within the health sector does not reflect the opportunity cost of the resources used. In other words, the cost of an illness is not just the amount of resources spent on it or lost to it but also the benefits that could have been gained if those resources were spent elsewhere. In this sense, cost-of-illness studies are not a true representation of 'economic' costs.

5.1 Cost components

Cost-of-illness studies traditionally stratify costs into three categories – direct, indirect, and intangible costs, although there is some inconsistency across studies in the categorisation of all but direct health care costs.

5.1.1 Direct costs

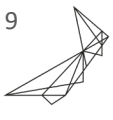
Direct costs are the costs attributed directly to patient care: The cost that is incurred due to medical management of a disease. This can include direct health care costs such as money spent directly on treating the disease at a medical facility, as well as direct non-healthcare costs, such as transportation services or caregiving services required so that the patient can obtain medical care.

5.1.2 Indirect costs

Indirect costs in cost-of-illness studies refer to the productivity or labour loss due to an illness. This includes both the productivity loss for an individual with the illness, as well as the loss of productivity from family and friends because of caregiving. An example of this includes taking sick leave to go to the hospital.

5.1.3 Intangible costs

Intangible costs refer to the changes in the quality of life of patients and their family. It is very difficult to define. Therefore, most cost-of-illness studies forgo estimating this cost.



Examples include the pain and suffering people, and their carers have to go through due to certain illnesses.

Table 3 Stratification of costs in cost-of-illness studies

Direct health care costs	Direct non-healthcare costs	Indirect costs	Intangible costs
Inpatient care costs	Disability benefits	Productivity losses	Impacts on relationships
Outpatient services costs	Time costs	Foregone leisure time	Pain and suffering
GP costs	Transport costs		Subjective wellbeing impacts
Patient co-payments	Cost of childcare		Quality of life impacts
Drug costs			
Ambulance costs			
Community nursing costs			
Laboratory test costs			
Residential care costs			
Medical imaging and diagnostic costs			

Source: NZIER

5.2 Estimating direct costs

In terms of calculating the direct costs associated with illnesses, cost-of-illness studies are typically divided into top-down and bottom-up studies.

5.2.1 Top-down, bottom-up, gross and micro-costing methods

There is a range of methods that can be used to sum up direct costs over a population. Depending on the availability of data and the degree of granularity and detail needed in cost estimates, researchers may choose to use expenditure data collected at an organisational or system-level (top-down) or resource use data collected at the individual level (bottom-up). Within each of these categories, there is the additional option of micro-costing – compiling costs in detail for specific resources (e.g. hours of physiotherapy) or compiling costs at an aggregate level based on an episode of care (e.g. average discharge costs for a specific diagnosis-related group).

Table 4 Health services costing methods

		Level and type of data collected	
		Expenditure data collected at the organisational level	Resource use data collected for each individual patient
Level of identification of resource use	Highly detailed resource use	Top-down micro-costing	Bottom-up micro-costing
	Aggregate resource use	Top-down gross costing	Bottom-up gross costing

Source: Špacírová et al. (2020)

A wide range of terminology is used in top-down and bottom-up costing, which often creates confusion due to similar terms being used with different meanings in other contexts. Cost-of-illness studies are sometimes light on methodology, but where methods are fully described, terms such as those described in Table 5 below are likely to be used.

Table 5 Terminology used in top-down and bottom-up health system costing

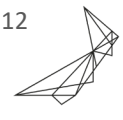
Term	Definition, explanation, example
General terms	
Direct cost	A cost of a resource or activity that is acquired for or used by a single cost object. An expenditure that can be directly traced in the organisation's management accounting system to a particular cost object, e.g. a pharmaceutical that is used exclusively for treating a particular diagnosis-related group (DRG) and no other.
Indirect cost (variable overheads)	The cost of a resource that is acquired to be used by more than one cost object but is a variable cost; that is, the quantity used increases with the number of patients treated. E.g. Expenses which are recorded at a departmental level and are shared between several patients, such as medical staff or nursing staff.
General overheads (fixed overheads)	Expenses that are incurred at an organisational level do not vary with the number of patients treated and are shared between several departments. E.g. amortisation of buildings, staff training costs, cost of water, electricity and heating.
Terms used in top-down costing	
Top-down costing	A costing method where the organisation's direct and indirect costs incurred over a given period are assigned to (or 'absorbed' by) all the cost objects produced by the organisation. Direct costs are identified directly to cost objects. Indirect costs are 'apportioned' to cost objects. In full costing, both variable and fixed overheads will be apportioned to cost objects
Variable top-down costing	A top-down costing method. Organisational direct costs and variable overheads will be assigned to all the cost objects. Fixed overhead costs are not assigned to cost objects. This is sometimes used in decisions where the organisation wishes to estimate the marginal cost of its services.
Full absorption (or full) costing	A top-down costing method. 100 percent of an organisation's costs incurred over a given period are allocated to all the cost objects. Direct costs, variable

Term	Definition, explanation, example
	overheads and fixed overheads are apportioned to cost objects. Sometimes required by financial reporting standards.
Activity-based costing	A method of top-down micro-costing. Indirect expenditure is first allocated to tasks or activities so that it can be apportioned to cost objects at a more detailed level of disaggregation than used in traditional top-down gross costing.
Cost centre	Responsibility centre in an organisation where the cumulative operating expenses of a group of similar activities are recorded over a finite period of time. E.g. a hospital laundry department cost centre might record the costs of staff and consumables used to operate the laundry service over a year. The cost centre would probably not include the costs of general hospital overheads such as maintenance of the building or capital expenditure such as the purchase of machinery.
Activity cost	Measures that identify the linkage between indirect expenditure and cost objects. They serve as quantitative measures of the activity undertaken by cost centres. E.g. The costs of the laundry department might be allocated to cost objects in proportion with the number of days that patients spend in hospital (days in hospital is the activity cost driver for laundry department expenditure).
Terms used in bottom-up costing	
Bottom-up (or variable) costing	Cost components are valued by identifying resource use directly employed by each patient (patient-specific costs).
Cost object	Final product, process or service that are going to be costed. In bottom-up costing, usually only one cost object will be costed, e.g. cost of a specific surgical procedure and associated hospital stay.
Resource	All materials, facilities, personnel, and anything else that is used for providing health care service. Medical, administrative and nurse staff, medical devices, health products, buildings, water, electricity, etc.
Unit cost	Refers to the marginal cost of providing a single unit of resource. Variable and sometimes fixed overheads are often approximately included by applying a percentage “mark-up” on direct cost or by applying an average overhead ‘cost per day’. E.g. One hour of surgeon time, price of a dose of medication, etc.

Source: Špacírová et al. (2020)

5.2.2 Attribution of costs to specific conditions

All people incur health care costs at some point. Even being healthy and free of any condition or disease can be associated with the costs of routine prevention and screening. For many people, where there may only be one long-term condition, it is still challenging to identify with certainty from administrative data whether a medical event was due to the condition or to another illness or injury. Cost-of-illness studies attempt to identify the costs of the illness rather than the costs of the people who have the illness, so methods to separate the costs related to the illness from the costs that may be expected without the illness have been developed. These methods are broadly described as attributable risk and excess cost approaches.



5.2.3 Attributable risk approach

The attributable risk approach measures the proportion of a disease or condition that is due to exposure to the disease or its risk factors. The attributable risk approach requires researchers to calculate the population attributable fraction (PAF) – an epidemiological measure that describes the contribution of a single condition or risk factor to the overall burden of disease in a population. PAFs are often subject to assumptions and calculations are data intensive, resulting in a high degree of uncertainty where there are significant gaps in knowledge and data.

5.2.4 Excess cost approach

The excess cost approach is a relatively simple methodology that avoids the difficulty of classifying costs as specific or not specific to a particular disease or condition. Instead, the approach involves dividing the study population into two groups, one with the disease or condition and one without. All in-scope costs for each group and for a defined period of time are then identified and summed for specific demographic groups – usually defined by sex and 5-year age band. For each demographic group, the costs of the group without the disease or condition are then subtracted from the costs of the group *with* the disease or condition to identify the excess cost associated with the disease or condition.

5.3 Measuring indirect costs

Two major methods are typically mentioned and used to measure indirect costs related to productivity – the human capital method and the friction cost method.

5.3.1 Human capital method

The human capital method is the most common method used for estimating indirect costs associated with illnesses. The core principle of this method is to calculate the current value of human capital as discounted future expected income (H.-J. Choi and Lee 2019). In practice, the productivity loss due to illness is approximated by the loss in a person's earnings due to illness, compared to if that person continues to work in full health.

This approach is widely used in existing literature because data is easy to access. By using data on people's income levels, this method also makes it easier to quantify the loss of productivity. In addition, as this method is widely used in the existing literature and the calculation is relatively easy, it's less likely that the researcher will introduce biases.

One assumption made by this method is that future earnings can be used as proxies for future productivity. Therefore, this method is criticised for measuring human life solely based on a person's ability to earn income. This method also tends to be discriminatory against underproductive groups such as students. In addition, this method can potentially underestimate the intangible costs of illness.

5.3.2 Friction cost method

The friction cost method measures the value of loss in productivity by using what is known as a friction period. The friction period is the time it takes for another person to replace the worker who is absent due to illness or for the worker to return to work in full health. The loss of productivity can be estimated by calculating the earnings of the individual over the friction period (Zemedikun et al. 2021).

This method relaxes the strong assumption of the human capital method that a worker cannot be replaced even when the unemployment rate is high. Therefore, the friction cost method is more likely to reflect the true cost of productivity loss for employers.

In practice, the friction cost method is not commonly used because of the limitation it faces in empirically estimating the losses during the friction period. This process requires extensive data to accurately estimate productivity loss in replacing unwell workers during the friction period. Another drawback of the friction cost method is that the assumption that an absent employee may be replaced is only conditionally valid. In reality, an absent worker may only be replaced by a less suitable worker, thus incurring training or recruitment costs (Lensberg et al. 2013).

Table 6 summarises the pros and cons of the human capital method, willingness to pay method (WTP), and friction cost methods.

Table 6 Comparison of different methods used to calculate indirect cost

	Human capital method	Willingness to pay method	Friction cost method
Description	• Assesses the value of one's current life in terms of one's discounted future expected income. • Regards humans as productive actors and estimates the costs of illnesses as losses of working hours or productivity.	• Surveys people on how much they would be willing to pay for certain things. • Estimates the costs of illnesses based on how much individuals would be willing to pay to maintain or improve their health.	• Measures the value of loss in productivity by calculating the earning of an individual replacing the absent worker over the friction period.
Pros	• Ease of accessing required data. • Ease of quantifying losses of productivity caused by illnesses based on patients' income levels. • Results less influenced by personal bias.	• Able to measure the values of even things not easily monetised • Uses people's tacit preferences for certain things to estimate the economic values of those things. • Capable of counting even intangible costs, such as quality of life and psychological suffering.	• Allows a more realistic estimate of productivity loss that reflects the true cost for employers.
Cons	• Discriminatory against underproductive groups, such as students, housewives, seniors, etc. • Minimises human life by measuring it solely based on an individual's ability to earn income. • Incapable of measuring intangible costs of illnesses, e.g. declines in quality of life and psychological suffering.	• Decides the values of things solely based on people's subjective preferences. • Participants may have difficulty monetising things that they usually do not monetise, meaning that their answers may be less than reliable as a result. • More difficult to implement than the human capital method.	• Require extensive data to estimate the loss in productivity during the friction period correctly. • The assumption that an absent employee may be replaced is only conditionally valid.

Source: NZIER, based on H.-J. Choi and Lee (2019), Lensberg et al. (2013) and Jo (2014)

Productivity losses

Examples of productivity losses include days lost from work or other activities associated with the illness itself or receiving treatment for the illness.

Productivity losses are typically estimated using the human capital approach, which calculates a person's production potential based on average wages. Adjustments are sometimes made for household productivity if this is included. Other methods for calculating productivity losses include the friction cost method, which calculates productivity based on what an employer would have to pay to replace you as an employee.

5.4 Willingness to pay method

The WTP method can be used to capture all private direct, indirect, and intangible costs imposed by the disease on the individual. It measures the amount that an individual is willing to pay to reduce the probability of illness or mortality. This is typically done by asking participants how much money they are willing to pay to maintain or improve their health. This approach builds on the assumption that people's estimates of not monetised

things can be used as proxies for the economic values of these things (H.-J. Choi and Lee 2019).

Some drawbacks of this method may include:

- The calculations are based on participants' indication of the amount of money they think is acceptable to pay. This may introduce self-selection bias depending on the disease or the respondent's economic situation.
- Participants may find it difficult to monetise some dimensions of impacts, causing the results to be less reliable.
- This method is relatively more difficult to implement than the human capital method, as extensive surveys are needed to document people's preferences.

5.5 Time horizon and discounting

The time horizon of a cost-of-illness study refers to the period of time over which costs are captured. For long-term illnesses, it is common to see cost-of-illness estimates derived from models that calculate costs over twenty years or even the lifetime of modelled populations.

Discounting in economics means determining the present value of a future income or cost. In general, a given amount of money is worth more today than the same amount would be worth in future due to earning potential in the interim associated with being able to access and invest the money in the present. Discounting is a common way of dealing with flows of money over time in economic studies.

The following equation can be used to derive the present value of future costs or income flows:

$$Present\ value = \frac{Future\ value}{(1 + discount\ rate)^{Number\ of\ time\ periods}}$$

Discounting is frequently applied in cost-of-illness studies due to the frequently long time horizon in models that attempt to capture the lifetime or near-lifetime costs of illness. The longer the duration of illness or its impacts on health system utilisation, employment, income, or quality of life, the more important discounting becomes.

Similarly, future impacts on health and wellbeing are often discounted in the same way as we discount money in health economic analysis. Most economists argue that future impact on health should be discounted because people tend to value their immediate health and wellbeing to future wellbeing. In addition, failure to discount health benefits will result in a very large or even infinite amount of health benefits showing up in the results, which may be confusing for decision-makers. Although whether or not economists should discount health benefits at the same rate as they discount money has always been a constant source of debate (Nord 2011).

Regarding the use of the discount rate, a standard discount rate of 3 percent per annum is used most widely in health economic studies. Three percent per annum is in line with the Accessing Cost-Effectiveness (ACE) Prevention study in Australia. It is also the discount rate recommended by a consensus panel of health economists in the USA for cost-effectiveness analysis. This is also the discount rate used in most of the New Zealand Burden of Disease

Epidemiology, Equity & Cost-Effectiveness (BODE3) program models (Blakely et al. 2012). In New Zealand, the discount rate recommended by the Pharmaceutical Management Agency (PHARMAC) is 3.5 percent and the Treasury apply a default rate of 5 percent in the CBAx tool that agencies use for budget bids.

For international comparison, a discount rate of 3 percent per annum is recommended, while other discount rates should also be examined in sensitivity analysis. Sensitivity analysis is a form of analysis that looks at how different values of explanatory variables affect the outcome variable (Jo 2014). To generate a cost of Illness study that best fits the New Zealand scenario, different discount rates should be used to determine the costs associated with health conditions by adopting sensitivity analysis.

5.6 Recent developments in cost-of-illness approaches

Standardisation of the methodology used to estimate costs has become more and more critical in cost-of-illness studies as standardised studies allow easy comparison between different groups of individuals across different contexts (Brodszky et al. 2019). Although the existing cost-of-illness studies utilise various methods to calculate costs, there are some common trends in the recent literature.

A comprehensive review of existing literature in cost-of-illness studies (Onukwugha et al. 2016) surveyed studies published between 2004 and 2015. They found that most of these cost-of-illness studies include the following approaches, which are now widely considered critical to cost-of-illness studies for long-term conditions:

- Studies consider both direct costs, such as medical costs, as well as indirect costs, such as productivity costs associated with morbidity and mortality. These studies demonstrate that limiting cost-of-illness calculations to only direct costs results in severe underestimation of the true costs of long-term conditions (Pike and Grosse 2018).
- An increasing number of cost-of-illness studies investigate the heterogeneity across different sub-groups in a population and report the estimates across patient sub-groups. Investigating subgroups heterogeneity in cost-of-illness studies represents an increasing interest for researchers.
- A growing number of cost-of-illness studies are estimating the costs associated with a single disease in different countries, consistently applying methods to achieve comparable results.

  (Onukwugha et al. 2016)

6 Using cost-of-illness estimates

While cost-of-illness estimates are often used to inform decisions about investment in prevention or improved management of conditions, the estimates themselves are often not directly useful for this purpose.

Furthermore, when presented with summary information, particularly cost estimates, across a wide range of health conditions and risk factors, it is often tempting to compare results across conditions, aggregate estimated costs across conditions, or make assumptions about local costs based on costs derived in other jurisdictions.

The World Health Organization's guidance (World Health Organization 2009) is clear: comparisons, aggregations and transfers of values are highly fraught and inadvisable.

6.1 Drawing conclusions about investment value

There are several strong arguments against using the results of cost-of-illness studies to justify investment in prevention or improvement management of health conditions. These include:

- Cost-of-illness studies, while having the potential to identify high health system expenditure conditions and conditions that impose a high social and economic cost, do not provide any useful information about health system inefficiency that would allow potential improvements to be identified.
- The appearance of potential cost savings from preventing a condition, or at least reducing its prevalence, are misleading. Even if the most effective prevention interventions were introduced, the cost-of-illness estimates are almost certainly a heavily overestimated measure of the cost savings that would result from such investment. Few conditions can ever be fully prevented and when prevention efforts fail, as they always do to some extent, the marginal cost savings achieved will be lower than what average costs from cost-of-illness studies suggest due the requirement to maintain the fixed cost elements of associated health services.
- The cost of managing and treating health conditions says nothing about the cost of preventing them. Cost-of-illness studies are blind to the costs of prevention and their relative magnitudes, or even to the existence of effective prevention interventions. For many conditions with high costs, the prevention costs could also be high, even higher. Cost-of-illness studies provide no insight into such issues.
- Cost-of-illness studies are also blind to the current state of medical technology. Some high-cost conditions may not currently be amenable to low-cost prevention, management or treatment interventions, while some low-cost conditions could be. Ranking conditions by cost estimates to target investment risks overlooking significant health gains that could be achieved through low cost, effective intervention across a range of relatively low-cost conditions.

Taken to the logical extreme, these arguments may also be valid reasons for not undertaking cost-of-illness studies at all. Indeed, cost-effectiveness analyses of health interventions, which provide estimates of both costs and potential cost-savings realisable through tried and tested interventions, offer far more value to decision-makers.

6.2 Comparing results across conditions

Comparisons of costs of illness are often made to justify the prioritisation of investments. However, two major issues make comparisons fraught:

- Results of cost-of-illness studies are not always presented in comparable terms. While annual costs are a common format for results, other formats include lifetime costs, costs per person per year, and costs over an alternative period (E.g. treatment and follow-up phases of a condition).
- Methodological differences between cost-of-illness studies pose a risk that any prioritisation of investment based on comparisons could be misinformed and even harmful. For example, indirect costs do not always include the productivity of those not in the paid workforce (e.g. unpaid housework and childcare). Consequently, comparing costs of illnesses where indirect costs are calculated differently may result in bias against illnesses that predominantly affect women. Similarly, depending on how lost productivity in paid employment is valued, the lower wages earned by Māori and Pacific people in New Zealand may result in bias against illnesses that affect those populations disproportionately.

6.3 Aggregating results for groups of conditions

Aggregation of costs of illness estimates may be of interest for categories of conditions, such as long-term conditions. But this is also fraught for two main reasons:

- Many cost-of-illness studies exclude some cost categories. These exclusions are sometimes small and insignificant at a specific disease level or large and related to the perspective of the study (E.g. public health system only perspective versus societal perspective). Either way, over multiple conditions and risk factors, these exclusions add up and can become large, resulting in significantly underestimated costs. Because cost-of-illness studies almost always include public health system costs but are less likely to include other fiscal costs, indirect costs, and intangible costs, aggregating by cost category may lead to conclusions that the primary costs of illness are to the public health system, when in reality those costs may be dwarfed by indirect and intangible costs.
- Even with the most careful methods, cost-of-illness studies are likely to capture costs not entirely related to the condition of interest. This will result in double-counting when costs are aggregated across multiple conditions.

6.4 Transferring results from other jurisdictions

Finally, a common reaction to cost-of-illness estimates from other jurisdictions is to draw conclusions about local costs, possibly even using such costs in a cost-benefit analysis or other application. This practice is known as ‘benefit transfer’ and is widely discredited in the economic literature. To apply costs derived in the context of another jurisdiction in a local context, even with adjustments, from currency conversion to converting values into a percentage of GDP or of health system expenditure, or calculating a per person cost, is meaningless when the original context is materially different from the context in which the value is applied. For cost-of-illness studies, the issue may arise because:

- the population affected is different, uses health services differently, has a different mix of comorbidities, has a different employment rate, or different social structures, and different formal and informal social supports
- the funding and provision of health services is different (different co-payments, different use of resources, different service coverage and availability)
- the costs of inputs (workforce, infrastructure, other inputs) are different
- the level of unmet need differs.

Such differences can be large enough to make benefit transfers entirely inappropriate.

7 Determining scope for a 2021 update

Rather than simply providing an update of the literature on conditions included in the 2009 report, the scope of this report was considered in the context of current thinking on long-term conditions, including:

- The World Health Organization (WHO)
- The Global Alliance for Chronic Disease (GACD)
- The evidence on mortality and disability burden of diseases.

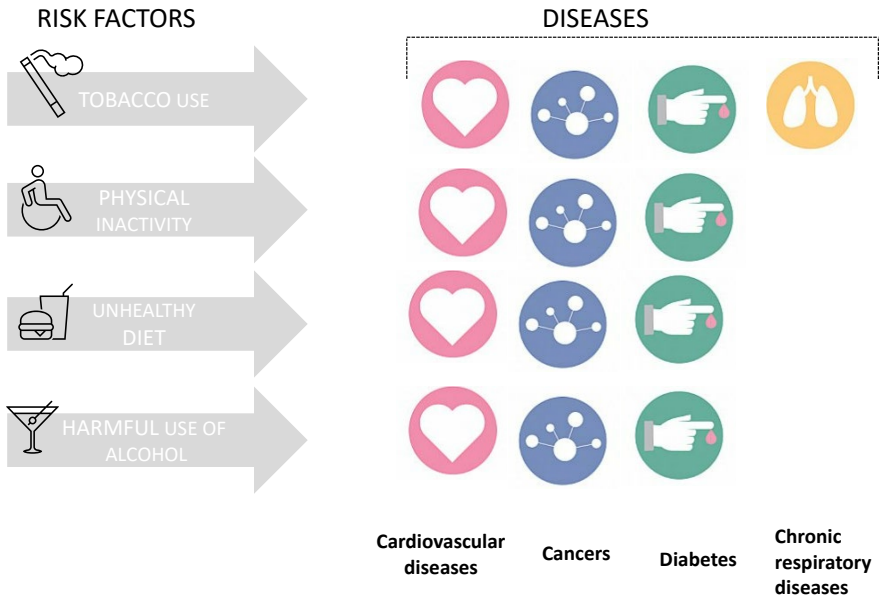
These sources of information and frameworks were considered against the Ministry of Health's priorities, including a particular focus on equity considerations and the major modifiable risk factors for long-term conditions.

7.1 WHO focus on modifiable risk factors

The WHO defines non-communicable diseases (NCDs) (or chronic diseases) as diseases that are typically of long duration and result from a combination of genetic, physiological, environmental, and behavioural factors. The WHO's primary interest in NCDs is the reduction of NCD-related mortality through interventions designed to target the major modifiable risk factors of tobacco use, physical inactivity, unhealthy diet, and harmful use of alcohol.

As a result of this interest, the WHO is primarily focused on cardiovascular disease, cancer, chronic respiratory diseases and diabetes (World Health Organization 2013), with a 25 percent reduction in overall mortality due to these conditions being the outcome indicator for the WHO's NCDs Global Monitoring Framework (World Health Organization 2014).

Figure 1 WHO's focus on modifiable risk factors



Source: GACD (n.d.)

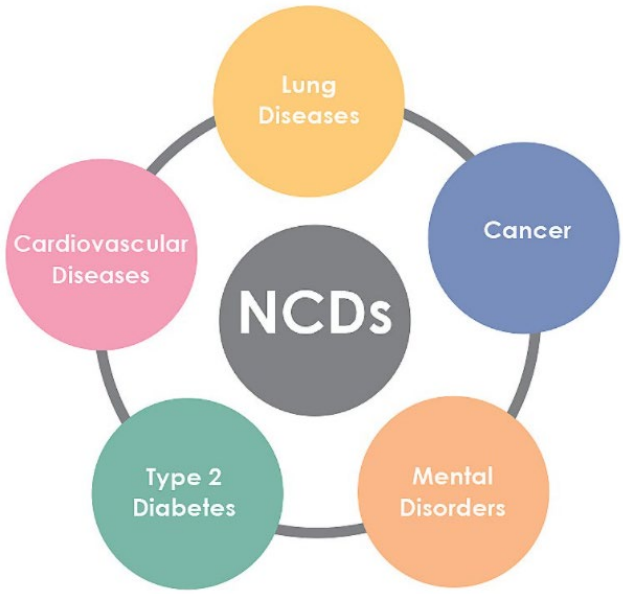
Other components of the WHO's work also acknowledge that many other conditions are important to public health, including other NCDs – renal, endocrine, neurological, haematological, gastroenterological, hepatic, musculoskeletal, skin and oral diseases, and genetic disorders; mental disorders; disabilities, including blindness and deafness; and violence and injuries.

7.2 The Global Alliance for Chronic Disease 5 types of NCDs

The GACD is an organisation that brings together the world's biggest public research funding agencies to coordinate and support research on the prevention and treatment of NCDs. The GACD identifies five major NCD groups of concern:

- lung diseases
- cancers
- cardiovascular diseases
- mental disorders
- type 2 diabetes.

Figure 2 Global Alliance for Chronic Disease 5 types of NCDs

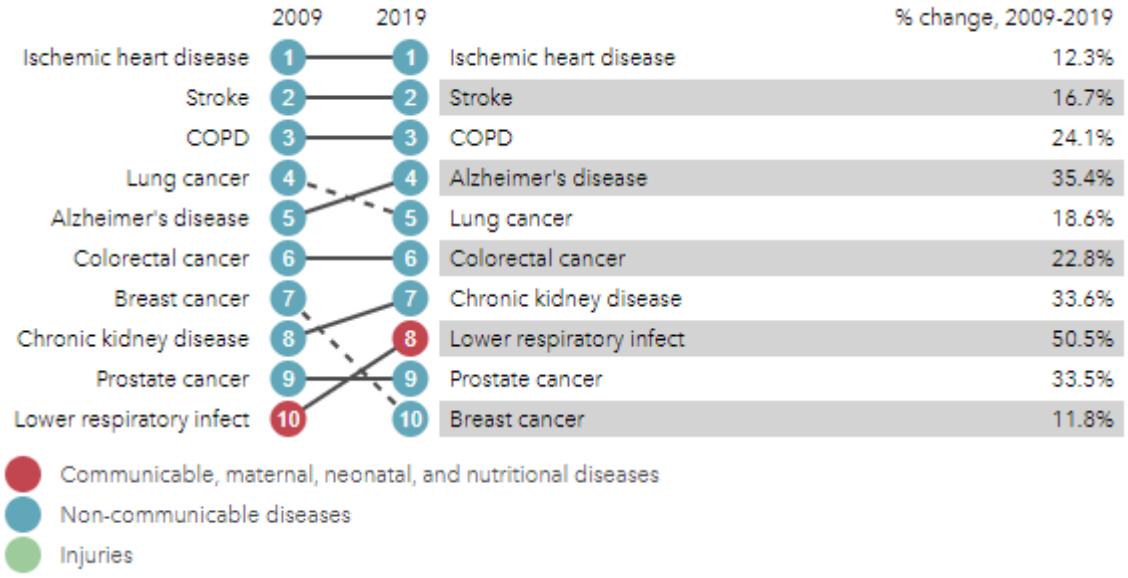


Source: GACD (n.d.)

7.3 Mortality burden

The Global Burden of Disease Study 2009 and 2019 identified the leading causes of death in New Zealand as being almost exclusively non-communicable diseases, with ischaemic heart disease, stroke and COPD forming the top three in both years and lung cancer – in fourth place in 2009 – passed by Alzheimer's disease in 2019. Three other cancers appear in the top 10, confirming cancer's position as a major driver of mortality.

Figure 3 Leading causes of death in New Zealand, 2009–2019

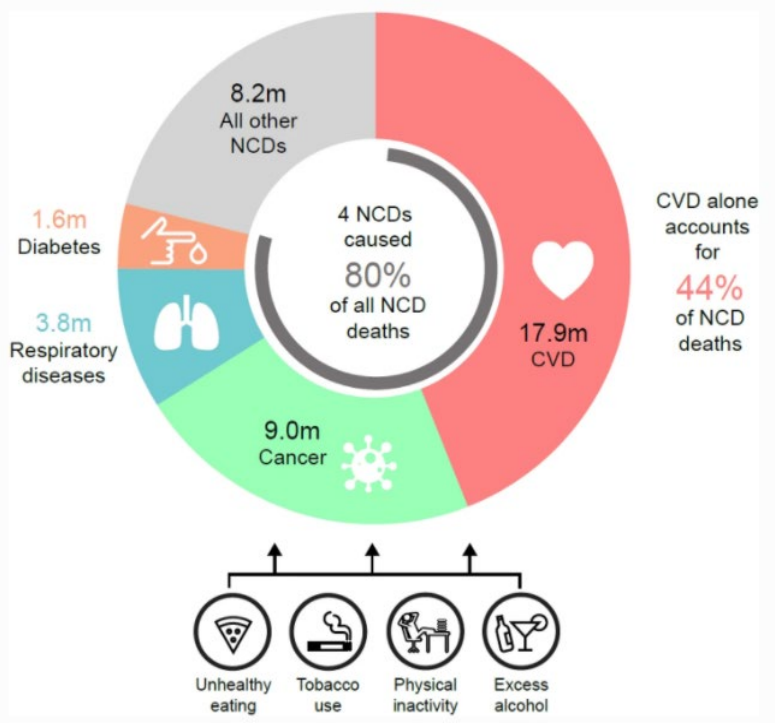


Source: IHME (2015)

7.4 Disability burden

The WHO's focus on the 'big four' NCDs (cancer, chronic respiratory conditions, cardiovascular disease, and diabetes) is largely driven by the role these conditions play in NCD deaths. Together, 80 percent of all NCD deaths are attributed to the big four.

Figure 4 NCD deaths attributable to the 'big four' NCDs



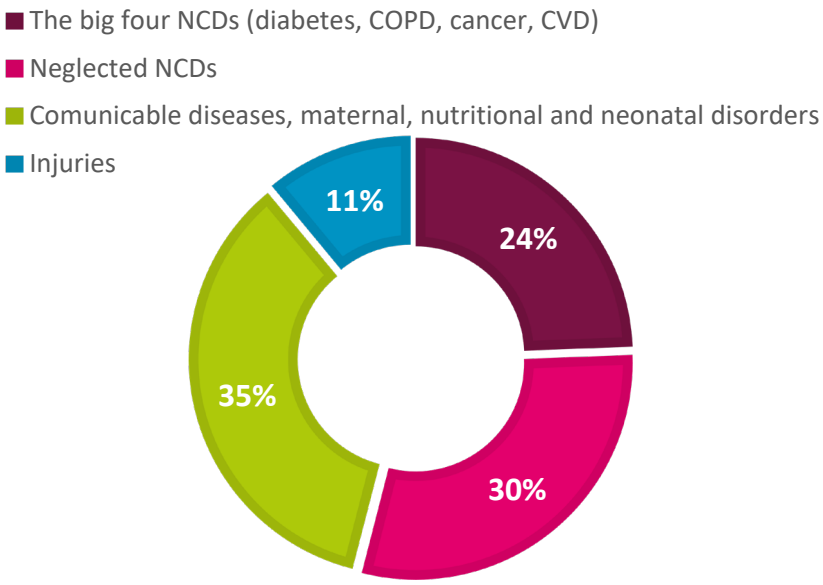
Source: World Health Organization (2018)

However, mortality is only one dimension of the burden of NCDs. Many NCDs with a relatively low mortality burden are nevertheless associated with a significant morbidity burden, which can have substantial social and economic impacts.

According to Lopez et al. (2014), while cancer, COPD, cardiovascular disease and diabetes cause much health loss worldwide, more of the global NCD burden (55 percent) arises from other NCDs. These include a diverse set of causes and conditions, but among the more important are musculoskeletal disorders, especially low back and neck pain, depression, substance use disorders, cirrhosis of the liver, chronic kidney disease, asthma, various digestive diseases, including peptic ulcer, anxiety disorders, congenital anomalies and haemoglobinopathies.

Unlike the 'big four' NCDs, many of these conditions cause more health loss through chronic disability than premature death.

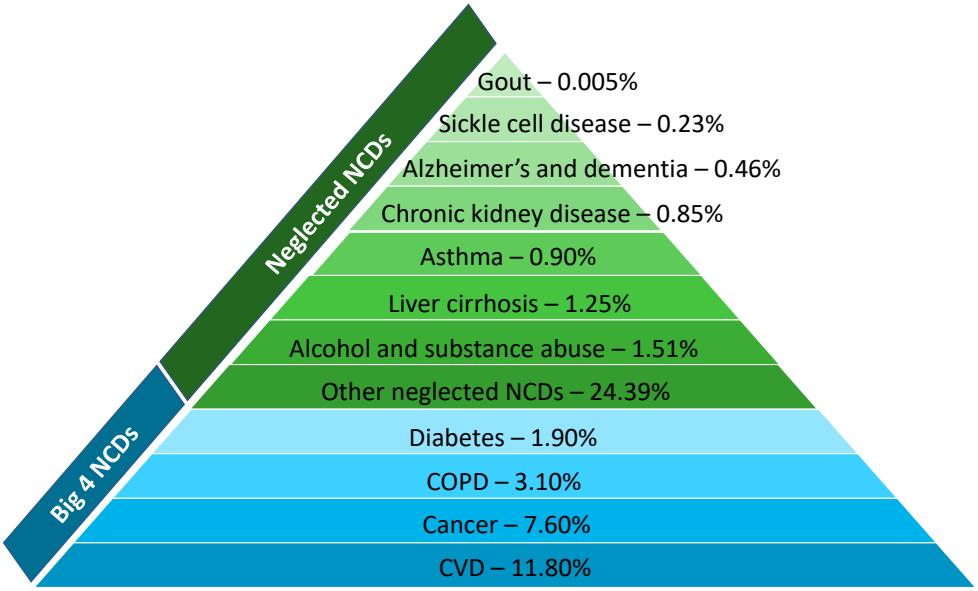
Figure 5 Global burden of NCDs in terms of DALYs



Source: NZIER, based on Lopez et al. (2014)

The so-called 'neglected NCDs' include gout, sickle cell disease, Alzheimer's and dementia, chronic kidney disease, asthma, liver cirrhosis, alcohol and substance abuse, and many others (see Figure 6 below).

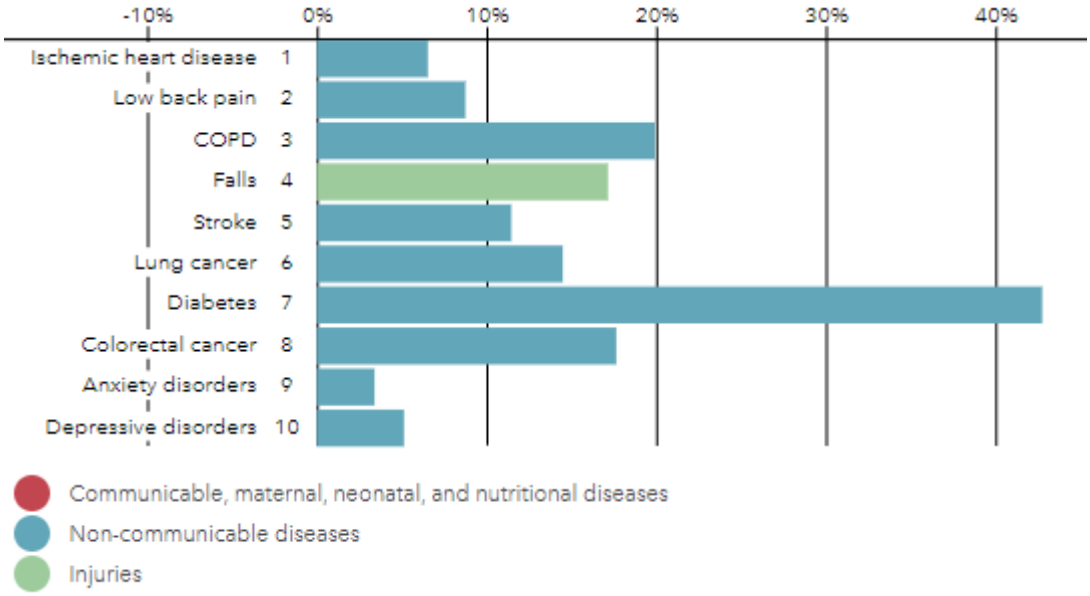
Figure 6 Comparison of neglected NCDs to the 'big four' NCDs



Source: NZIER, based on Lopez et al. (2014)

Between 2009 and 2019, of the top ten leading causes of DALYs in New Zealand, diabetes grew the most, over 40 percent, followed by COPD (20 percent), falls and colorectal cancer (both around 18 percent).

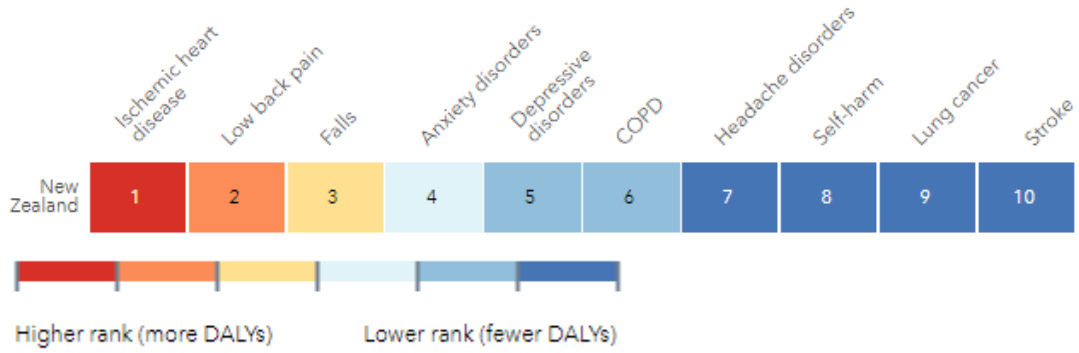
Figure 7 Percentage change in the top 10 causes of DALYs in New Zealand, 2009-2019



Source: IHME (2015)

New Zealand ranks in the top 5 for DALYs against comparable countries for four conditions that are not WHO NCD focus areas: low back pain, falls, anxiety disorders and depressive disorders (see Figure 8 below).

Figure 8 New Zealand's DALY rate rank by condition amongst high SDI* countries



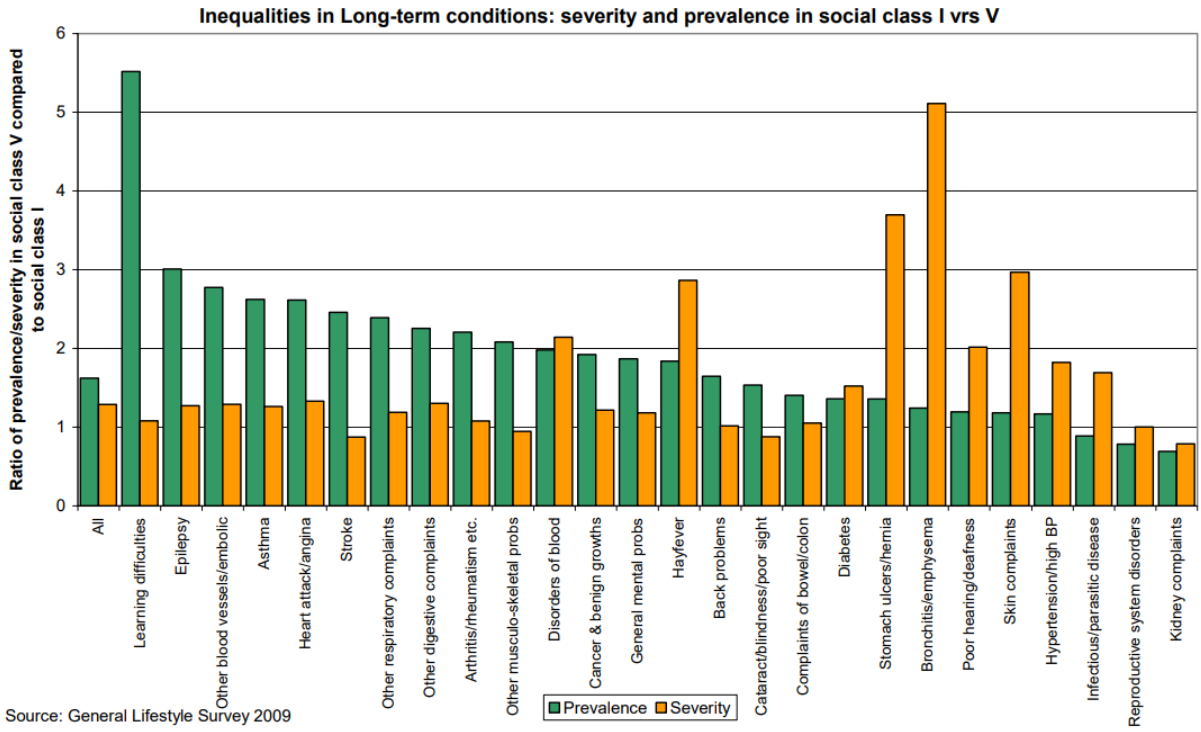
* High SDI (Socio-Demographic Index – a composite indicator of income per capita, years of schooling, and fertility rate in females younger than 25 years) countries include New Zealand, Australia, Austria, Belgium, Brunei Darussalam, Cyprus, Finland, France and the United Kingdom

Source: IHME (2015)

7.5 Equity

Many burden of disease studies internationally have noted the unequal distribution of long-term conditions across socioeconomic groups in terms of both prevalence and severity. For example, the UK Department of Health (2012) used the British General Lifestyle Survey of 2009 to identify that learning difficulties, epilepsy, conditions affecting blood vessels, asthma, and heart attack/angina, stroke, other respiratory complaints, other digestive complaints, arthritis and rheumatism, and other musculoskeletal problems are all more than twice as likely in people from the most deprived group compared with people in the least deprived group. In contrast, kidney complaints, reproductive system disorders and infectious/parasitic diseases are more likely to occur amongst the least deprived (see Figure 9 below).

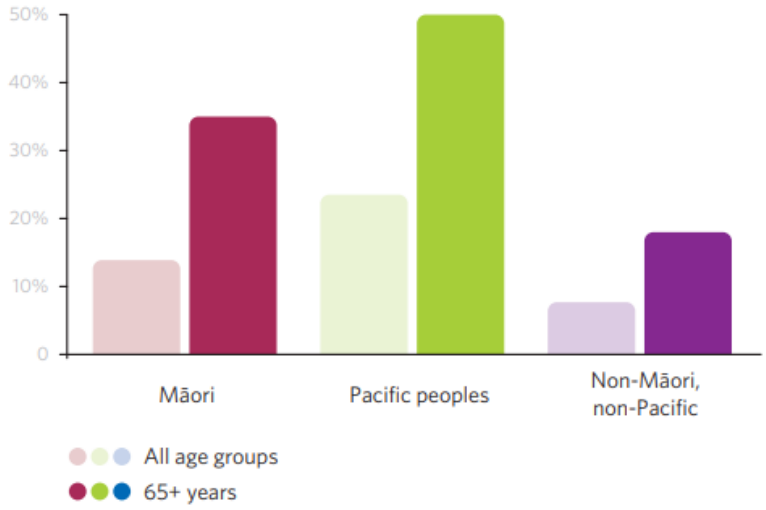
Figure 9 Inequalities in long-term conditions in the UK



Source: Department of Health (2012)

The Health Quality & Safety Commission (HQSC) has noted that Pacific people bear a disproportionate burden of long-term conditions, particularly gout (see Figure 10 below), cardiovascular disease, kidney disease, cancer, asthma, and diabetes (Health Quality & Safety Commission 2021a).

Figure 10 Percentage of men affected by gout in New Zealand, by ethnicity



Source: Health Quality & Safety Commission (2021b)

Similar effects – increased prevalence of risk factors and long-term conditions - are often observed for people living in the most deprived areas. Māori and Pacific people are over-represented in these areas as well as experiencing negative impacts specifically associated with ethnicity (including the legacy effects of colonisation and institutional racism in the health system); these groups are disproportionately affected by the burden of long-term conditions.

Rheumatic fever and rheumatic heart disease (conditions that have been virtually eliminated in most high-income countries) continue at high rates in both Pacific and Māori children and young adults, due in large part to living conditions in highly deprived communities. Some rates have even increased in recent years: 2015/16 to 2017/18 saw increased rates, although rates have stabilised for Māori and decreased for Pacific people since 2017/18). The lack of significant progress resulted in a failure to reach the target of a 2011 national programme to reduce incidence by two-thirds by 2017 (Health Quality & Safety Commission 2021a).

7.5.1 Equity considerations in cost-of-illness studies

While many epidemiological studies on long-term conditions identify equity issues, equity issues are not typically a focus of cost-of-illness studies. One reason for the lack of focus on equity in these studies is that the most common perspective is that of the public health system. From a public health system perspective, only direct health system costs are included in a cost-of-illness study and these costs are not borne by specific communities but by the system itself. There is, therefore, no distributional issue regarding the direct costs of illness in these studies.

Studies that take a public health system or fiscal perspective that might attempt to explore the distribution of costs may face ethical issues. Attributing public health system or social welfare costs to specific groups can be interpreted as blaming and, at worst, could have a negative impact on public and institutional perceptions of ‘high cost’ groups.

In theory, a cost-of-illness study that takes a societal perspective may focus on equity issues by estimating the inequitable distribution of private costs (lost quality of life, lost income, out-of-pocket costs), but quantification of these costs is subject to a high degree of uncertainty. This is especially true in retrospective studies where researchers do not have access to high quality individual data on private costs. Breaking these costs down by ethnicity is likely to reduce the level of confidence in results.

In these studies also, there may be ethical issues: Private costs based on individual data would reflect inequitable economic realities (lower wages and higher baseline unemployment), but the use of average values may lead to erroneous conclusions about the potential value of employment impacts for some groups.

For these reasons, cost-of-illness studies are generally not the most appropriate context for exploring equity dimensions of a disease. Equity is best considered within the context of the burden-of-disease studies that often form the basis of a cost-of-illness study, and where incidence and prevalence by age-ethnicity group as well as quality of life impacts are generally well-described.

7.6 Conditions in scope

In light of the various considerations, and in consultation with the Ministry of Health, the conditions included in the scope of this report were:

- All conditions and risk factors included in the 2009 report search (asthma, arthritis, COPD, CHD, Alzheimer's, HIV/AIDS, ischaemic stroke, obstructive sleep apnoea, osteoporosis, diabetes (including type 2 diabetes), obesity, physical inactivity, tobacco use).
- Alcohol use and unhealthy diet (additional risk factors of strategic interest to the Ministry of Health that did not feature in the 2009 report).
- Cardiovascular disease (including structural heart disease, atrial fibrillation, heart failure, ischaemic heart disease and coronary heart disease) and cancer, which figure amongst the four WHO long-term conditions and were excluded from the 2009 report.
- Gout, osteoarthritis, chronic kidney disease and dementia (conditions not captured in 2009 but related to risk factors of interest or conditions that were captured, and – in the case of gout in particular – of interest from an equity point of view).
- Rheumatic fever (due to the equity issue this condition presents).

Excluded conditions are:

- neurological conditions (e.g. epilepsy)
- neurodevelopmental disorders (e.g. autism)
- other musculoskeletal or chronic pain conditions (e.g. low back pain, chronic pain disorders)

  mental health conditions (e.g. anxiety and depression)
- injuries
- disability.

8 Identifying the literature

8.1 Literature search methodology

Based on the original report being the result of literature searches in 2008, some 2008 publications may not have been identified for that report. So, the search for this update report identified publications that were published from 2008 to 2021. Most of the search was conducted in July 2021, so some July 2021 publications may not have been identified, and any published post-July 2021 are also not included, except for studies using the terms structural heart disease, atrial fibrillation, heart failure, ischaemic heart disease and coronary heart disease, which were added at the Ministry of Health's request in September 2021 and key studies published during the report drafting stages of the project.

A detailed description of the search methodology is included in the box below.

Literature search methodology

We conducted literature searches using the PubMed, Econlit and Proquest Research library databases in July 2021. The focus was to find New Zealand studies, but we also included any relevant international ones that we found in our search results

We used combinations of the following terms to do the searches:

'cost(s)', 'cost-of-illness', 'economics', 'cost analysis', 'burden', 'New Zealand' and combined these with terms in 1 and 2.

1. 'Long term condition*' OR 'Long-term illness*' OR 'Chronic condition*' OR 'Chronic disease*' OR 'Chronic illness*' OR 'Non-communicable disease*' OR LTCs OR NCDs
2. 'Asthma' OR 'Arthritis' OR 'COPD' OR 'chronic obstructive pulmonary disease' OR 'CHD' OR 'coronary heart disease' OR 'Alzheimer's' OR 'HIV/AIDS' OR stroke OR 'Obstructive sleep apnoea' OR 'Osteoporosis' OR 'Diabetes' OR 'Obesity' OR 'Physical inactivity' OR 'Sedentary lifestyle' OR 'Tobacco' OR 'Alcohol' OR 'Diet' OR 'Cardiovascular disease' OR' Cancer' OR 'Gout' OR 'Osteoarthritis' OR 'Chronic kidney disease' OR 'chronic renal failure' or 'Dementia'

Results were limited to 2008 and later, and in English.

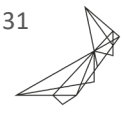
We also did supplementary searches on Google Scholar and Google.

In-scope studies were also subject to citation searches, and we scanned their bibliographies.

In September 2021, we were given additional conditions to search 'CVD'OR 'structural heart disease' OR 'atrial fibrillation' OR 'heart failure' OR 'ischemic heart disease' OR 'coronary heart disease' 'rheumatic/rhematic fever'.

We searched the same databases as in our July search for these additional conditions, and the same search limitations were applied to these searches. We searched these additional conditions with combinations of the following terms: 'cost(s)', 'cost-of-illness', 'economics', 'cost analysis', 'burden', 'New Zealand'.

We managed our search results in the Zotero research tool.



8.2 Sorting published studies

In total, the search generated 463 studies. These were initially sorted by assessing relevance from titles and abstracts. This process resulted in the identification of:

- 31 studies that were related to conditions not in scope (including a New Zealand study on the economic and health burdens of group A Streptococcus)
- 158 studies with other OECD countries as the context, including global and multi-country studies (this category was created to provide a priority set to find evidence where New Zealand evidence was lacking)
- 21 studies from non-OECD countries (considered less relevant for New Zealand)
- 54 studies that were literature reviews or meta-analyses (including six based on New Zealand evidence)
- 58 studies that were burden of disease, intervention studies, or other study types that were not cost-of-illness studies
- 4 studies that were not in the English language
- 2 studies that pre-dated the search timeframe.

Twenty-two studies that provided cost-of-illness evidence from a New Zealand context on in-scope conditions were identified, although not all of these were cost-of-illness studies per se. An additional 18 international studies were included to provide cost-of-illness information on risk factors and conditions for which no New Zealand study was identified or where New Zealand cost-of-illness evidence was more limited. Additional studies that provided information that is relevant to understanding costs of illness were identified opportunistically and included where relevant.

9 Summary of New Zealand literature

9.1 Burden of illness

In 2013, the Ministry of Health published *Health Loss in New Zealand*, a report on the burden of illness, injuries and risk factors based on the New Zealand Burden of Diseases, Injuries and Risk Factors Study (NZBD), which provided estimates for 2006 and projections to 2016 of the fatal and non-fatal outcomes of 217 diseases and injuries and 31 risk factors.

The report estimates that New Zealand lost 955,000 years of healthy life (measured in disability-adjusted life years (DALYs)) in 2006, roughly evenly attributed to deaths (51 percent) and ill health or disability (49 percent). However, sub-group analysis revealed that Māori males lost significantly more DALYs due to fatal outcomes (63 percent) while non-Māori females lost significantly more DALYs due to non-fatal outcomes (57 percent). The study also found that two-thirds of health loss occurred in people aged 45 or older.

The report estimated health loss by condition group, of which there were 16 groups indicated by the NZBD classification system, comprising the 217 specific conditions. In 2006 the condition groups responsible for the most health loss in New Zealand were (numbers in brackets represent the share of health loss attributed to the condition group):

- cancers (17.5 percent), especially lung cancer (3.0 percent), colon and rectum cancers (2.5 percent), female breast cancer (1.9 percent) and prostate cancer (1.0 percent)
- vascular and blood disorders (17.5 percent), especially coronary heart disease (9.3 percent) and stroke (3.9 percent).

Other long-term conditions with significant health loss included:

- Respiratory disorders, collectively accounting for 6.3 percent of health loss, with chronic obstructive pulmonary disease (COPD) accounting for 3.7 percent and asthma accounting for 1.6 percent.
- Musculoskeletal disorders, collectively accounting for 9.1 percent of health loss, particularly due to spinal disorders (2.8 percent), osteoarthritis (2.2 percent), chronic musculoskeletal pain syndromes (1.3 percent) and rheumatoid arthritis (1.1 percent).

Important differences between age groups, sexes and ethnicities are noted, including that Māori experience 2.5 times more health loss than non-Māori for diabetes and vascular disorders.

The report notes that rankings of causes of health loss are partly dependent on how conditions are grouped. Two alternative approaches are tested:

- One approach created 14 condition groups in which one group encompasses both mental and neurological disorder conditions, and the other group encompasses injury and musculoskeletal conditions. Under this grouping, neuropsychiatric conditions, cancers, vascular and blood conditions and musculoskeletal conditions and injuries account for between 17 and 18 percent of health loss each.
- Another approach used an organ system classification which resulted in neuropsychiatric disorders contributing 24.2 percent of health loss and vascular and blood diseases contributing 19.4 percent, while respiratory and gastrointestinal

disorders move up significantly in the rankings to become third and fourth most important sources of health loss.

In terms of specific conditions, 25 were each found to be responsible for more than one percent of total health loss for a total of 58 percent of all health loss, including the following top ten:

- coronary heart disease (9.3 percent of DALYs)
- anxiety and depressive disorders (5.3 percent of DALYs)
- stroke (3.9 percent of DALYs)
- COPD (3.7 percent of DALYs)
- diabetes (3 percent of DALYs)
- lung cancer (3 percent of DALYs)
- back disorders (2.8 percent of DALYs)
- colon and rectum cancers (2.5 percent of DALYs)
- traumatic brain injury (2.3 percent of DALYs)
- alcohol use disorders (2.1 percent of DALYs).

Similar differences by age, sex and ethnicity are noted for specific conditions, with rheumatic valvular heart disease being associated with more relative inequality between Māori and non-Māori than any other specific condition and coronary heart disease being associated with more absolute inequality.

In terms of risk factors, the study identifies that physiological and substance use risk factor clusters account for the greatest health loss, compared with diet and BMI, injury, and low physical activity clusters. The five individual risk factors with the greatest DALYs were found to be:

- tobacco use
- high BMI
- high blood pressure
- high blood glucose
- physical inactivity.

9.2 Cost-of-illness studies by risk factor[1]

9.2.1 Physical inactivity

One cost-of-illness study was found that identified the costs of physical inactivity in New Zealand. Two additional high quality intervention studies in the New Zealand context are included.

A study by **Market Economics (2013)** for three local body agencies[2] estimated the costs of physical inactivity in New Zealand and three regions: Wellington, Waikato and Auckland in

[1] All cost estimates for New Zealand studies are reported in New Zealand dollars unless otherwise stated.

[2] Auckland Council, Waikato Regional Council and the Wellington Regional Strategy Committee.

2010. The estimated cost of physical inactivity was $1.3 billion (NZD 2010 dollars, equivalent to $2.001 billion in 2021).

The major cost component was estimated to be indirect costs (loss of earnings, loss of productivity, premature death), followed closely by direct costs (health system costs) (see Figure below)

Figure 11 Costs attributed to physical inactivity in New Zealand and selected centres

(NZD 2010)

Summary of Direct, Indirect and Other Costs attributed to Physical Inactivity $_{2010}$$ mil					
	Direct costs	Indirect costs	'Other' costs*	Total costs	Premature Deaths
Auckland	179	213	10	**402**	**73**
Waikato	54	48	4	**106**	**18**
Wellington	74	62	5	**141**	**21**
New Zealand	614	661	30	**1,306**	**246**
*Note: 'Other' costs are preliminary estimates ** Totals may not equal, due to rounding					

Source: Market Economics (2013)

In terms of disease impacts, stroke was associated with the highest direct costs of physical inactivity, followed by Type 2 diabetes (see Figure 12 below).

Figure 12 Health system costs of physical inactivity by disease

(NZD millions, 2010)

Source: Market Economics (2013)

Mizdrak et al. (2019) used New Zealand Health Survey and New Zealand Household Travel Survey data and a multi-state life table model to estimate changes in physical activity and distance travelled by mode for hypothetical unspecified interventions. Results were estimated for trips under 1km switching from using a car to walking and for trips under 5km switching from using a car to walking and cycling. Impacts on air pollution were also estimated as an additional benefit.

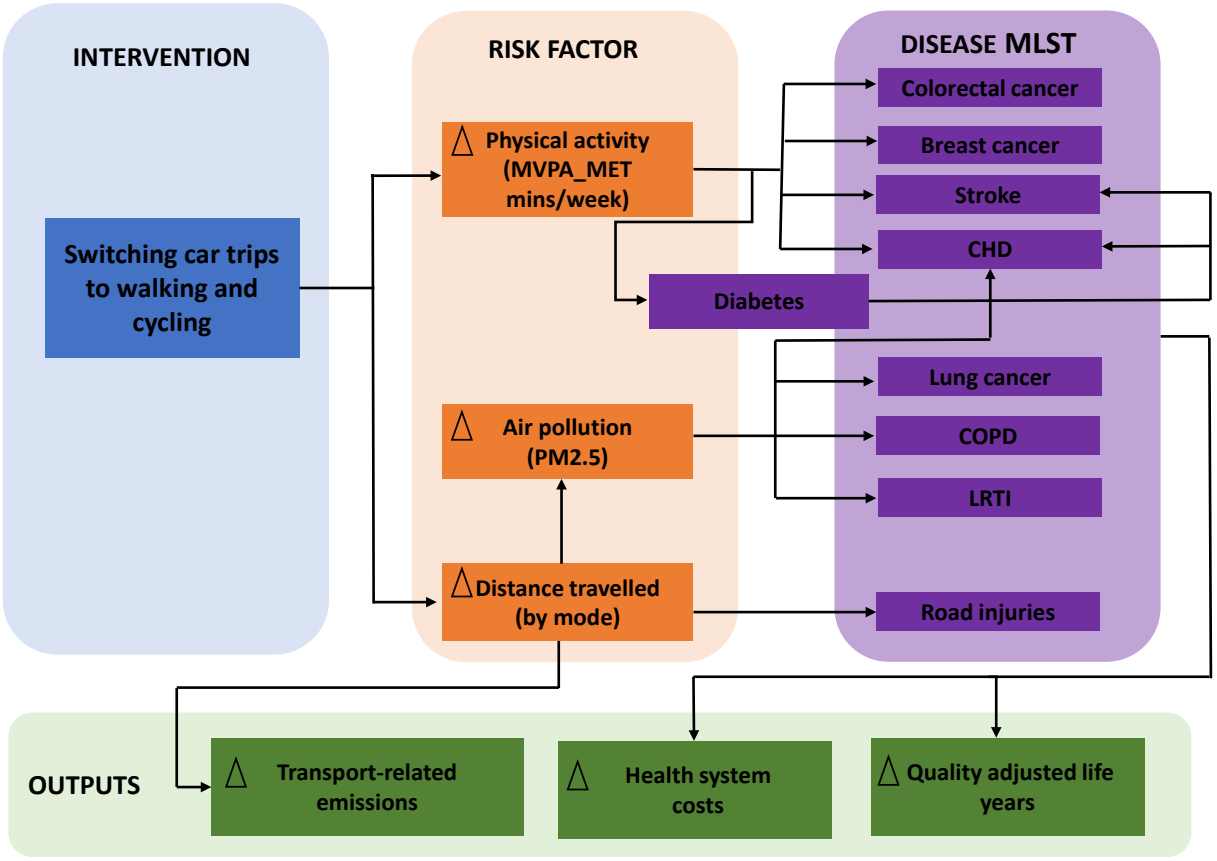
Uptake levels of 25, 50 and 100 percent were modelled with an assumption that behaviour change was permanent. Modelling also assumed no impact on BMI, consistent with published evidence, although the authors note conflicting evidence on this matter. Costs were calculated as excess annual health system costs associated with cancers, stroke, CHD, diabetes, COPD, lower respiratory tract infections (LRTI) and road injuries.

The health gains from modelled scenarios indicated between 1.61 and 25.43 QALYs per 1000 people, with total QALYs up to 112,020 (based on 100 percent uptake for all trips up

to 5km) over the remaining lifespan of the 2011 New Zealand population, which formed the study population. The resulting healthcare cost savings were estimated at NZ$127 million to NZ$2.1 billion (taking into account an offset from increased road injuries).

The authors did not assess interventions or intervention costs to confirm the conclusion that infrastructure improvements and other interventions to encourage walking and cycling would be cost-effective from a population health perspective.

Figure 13 Conceptual framework of the Mizdrak et al. (2019) physical inactivity model



Source: Mizdrak et al. (2019)

Mizdrak et al. (2021) used a proportional multi-state life table model (the BODE3 Physical Activity and Active Transport Model (PAATM)) to estimate the health and economic gains over the lifetime of the 2011 New Zealand population if the Global Action Plan for Physical Activity (GAPPA) target was reached. The study took two different approaches: an equal shift in which physical activity increases by the same absolute amount for everyone and a proportional shift in which physical activity increases proportionally to current activity levels.

Results indicate that meeting the GAPPA target would result in 158,000 to 197,000 health-adjusted life-years (HALYs) gained and health system cost savings of US$1.29 to 1.57 billion, with the equal shift resulting in the largest impacts.

Figure 14 Results of Midzrak et al. (2021) for Health-adjusted life years gained

	Equal shift	Proportional shift
Main result	185,000	158,000
10% relative reduction in physical inactivity prevalence	139,000	104,000
20% relative reduction in physical inactivity prevalence	224,000	213,000
Instant implementation of 15% GAPPA target	223,000	202,000

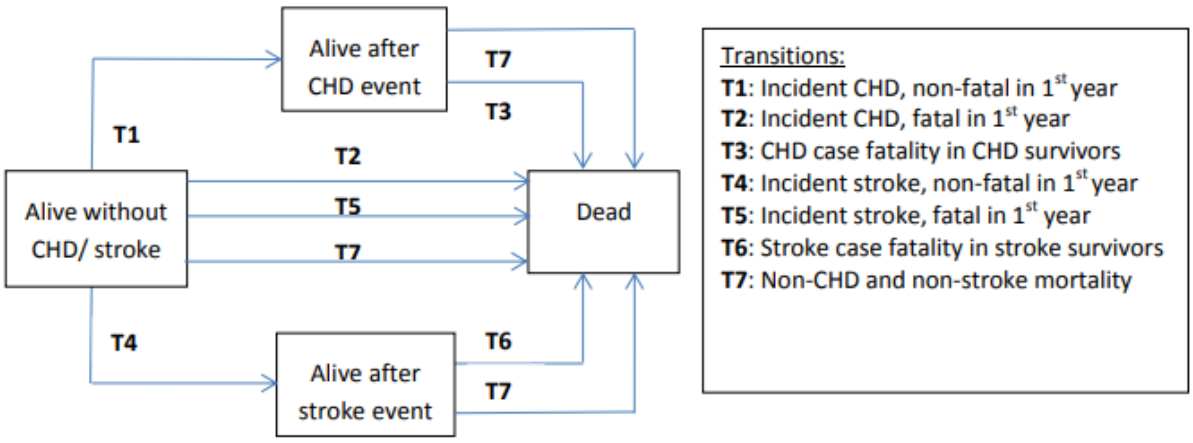
Source: Midzrak et al. (2021)

9.2.2 Unhealthy diet

No cost-of-illness studies were identified that estimated the cost of an unhealthy diet. However, one high quality intervention study provided relevant evidence.

Nghiem et al. (2015a) used a Markov-macrosimulation model (the BODE3 CVD model) to compare the impact of eight sodium reduction interventions against a 'do nothing' comparator. The population modelled was the New Zealand adult population aged 35+ years, modelled from 2011 to death or age 100. The model involved four primary health states, with annual transition rates capturing incidence and case-fatality for coronary heart disease (CHD) and strokes (see Figure 15 below). The study takes a health system perspective and includes health system costs arising from the additional years of life afforded by successful interventions.

Figure 15 Structure of the BODE3 CVD model



Source: Nghiem et al. (2015b)

The study found that the CVD health system costs of the 'Do nothing' comparator were NZ$16,000 and the non-CVD health system costs were NZ$54,500, for a total of NZ$70,500 per adult in 2011, or NZ$162,000 million in total health system costs across the cohort's remaining life.

Wilson et al. (2016) used the BODE3 dietary sodium intervention model – a Markov model based on the 2011 New Zealand adult (age 35+) population – to evaluate ten interventions aimed at reducing sodium intake on coronary heart disease and stroke outcomes with

results presented by sex, ethnicity, and age-group. Lifetime impacts were modelled and discounted at a rate of three percent per annum.

Interventions were based on salt reduction targets for the food industry partly informed by the UK Salt Reduction Targets for 2017, where a "full target" of 35 percent reduction in dietary salt was assumed to provide a margin of error to ensure the WHO recommendation of a 30 percent reduction could be achieved. Both mandatory and voluntary reductions were modelled.

For each intervention, the reduction in dietary sodium was modelled to produce a reduction in systolic blood pressure (BP) based on the results of regression modelling in a previously published study.[3] Reductions in systolic blood pressure reduced the probability of coronary heart disease and stroke based on risk values from a previously published meta-analysis of 61 prospective studies.[4] QALYs gained, and health system costs were estimated from changes in disease status and extended life.

Costs were estimated as the sum of intervention costs and health system costs through the lifespan of the modelled population, including additional health system costs associated with extended life resulting from the interventions.

A blunt scaling factor was applied to health system costs due to the source of cost data (Health Tracker) only providing public health system costs. Scaling costs up by 20 percent was used to reflect that private health service costs account for approximately 17 percent of total health spending. Additional scaling was applied to older age groups to reflect disability support services not captured by the cost data.

The "full target" was defined as an overall 35 percent reduction in dietary salt intake, which would be achieved through:

- mandatory maximum levels of sodium in packaged foods
- reduced sodium in fast foods/restaurant food
- reduced discretionary intake.

The "full target" was estimated to generate 235,000 additional QALYs over the lifetime of the cohort.

Specific target components were estimated to provide between 6100 QALYs gained by reaching the snack foods target and 122,000 QALYs gained by reaching the packaged foods salt reduction target. Health gains were greater for men and Māori.

All ten target interventions were found to be cost saving, with the greatest costs saved when the "full target" was reached (NZ$1260 million (US$820 million)).

9.2.3 Alcohol

No cost-of-illness study focusing on alcohol consumption in New Zealand was identified. However, one study presented evidence of the burden of alcohol-related presentations to a hospital emergency department.

[3] Law MR, Frost CD, Wald NJ. By how much does dietary salt reduction lower blood-pressure? 1. Analysis of observational data among populations. BMJ. 1991;302(6780):811–5.

[4] Lewington S, Clarke R, Qizilbash N, Peto R, Collins R. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002;360(9349): 1903–13.

Svensen, Kool, and Buller (2019) conducted a cross-sectional observational study to quantify the impact of alcohol-related presentations on the emergency department at Auckland City Hospital from November 2017 to October 2018. 7 percent of 73,381 presentations (5,130) were alcohol related, with more frequent alcohol-related presentations at night, during the weekends, on public holidays and during the summer.

In addition, 16 percent of injuries were alcohol-related and people who presented to the ED for an alcohol-related issue had a longer length of stay than people whose presentations were not alcohol-related.

No costs were estimated in this study.

9.2.4 Tobacco

No study on the cost of illness from tobacco use in New Zealand was identified. However, two studies provided useful context. One was an intervention study, and one was a burden of disease study. An additional global study is also summarised.

In an intervention study that provides useful context for the costs of illness related to tobacco, Van der Deen et al. (2018) used two models – a dynamic population forecasting model and a closed cohort multi-state life table model – to analyse the impacts of five strategies designed to reduce smoking prevalence on quality-adjusted life years.

The models estimated the impacts of:

- a 10 percent annual tobacco tax increase
- a tobacco-free generation
- a substantial outlet reductions strategy
- a sinking lid on tobacco supply
- a combination of a 10 percent annual tobacco tax increase, a tobacco-free generation and a substantial outlet reduction strategy.

A reduction in smoking prevalence and gains in quality-adjusted life-years were observed for all strategies, from a baseline of 34.7 percent smoking prevalence in Māori and 14.1 percent smoking prevalence in non-Māori to:

- 16 percent in Māori and 6.8 percent in non-Māori as a result of tax increases
- 11.2 percent in Māori and 5.6 percent in non-Māori as a result of the tobacco-free generation
- 17.8 percent in Māori and 7.3 percent in non-Māori as a result of outlet reduction
- 0 percent in all groups as a result of the sinking lid
- 9.3 percent in Māori and 4.8 percent in non-Māori as a result of the combined strategy described above.

These impacts were estimated to be achieved by 2025.

QALYs gained were modelled across the 2011 population and over the remainder of the population's lives and discounted at three percent per annum. Strategies generated between 28,900 and 282,000 QALYs.

Mason and Borman (2016) used comparative risk assessment methods to estimate the disease burden in children and non-smoking adults attributable to second-hand tobacco smoke. Diseases included were asthma, lung cancer, stroke, ischaemic heart disease, lower respiratory infections, otitis media, sudden unexpected death in infancy (SUDI), and low birth weight at term.

The study estimated the burden from mortality and DALY data. Second-hand smoke was estimated to be the causal factor in 104 deaths in 2010, resulting in 2,286 DALYs in 2006. Ischaemic heart disease and stroke were the main disease areas associated with these outcomes, although children also bore a significant burden in SUDI, which contributed to 34 percent of health loss attributed to children. Age-standardised results indicated that Māori experienced five times the health loss of non-Māori.

Table 7 Estimated DALYs attributable to second-hand smoke, 2006

Health outcome	Age group	Total estimated DALYs in children and non-smoking adults	DALYs attributable to second-hand smoke (2006)						
			Number (%)		DALYs per 100,000*	% of total DALYs in non-smokers	% of DALYs that were fatal	DALYs in Māori (% of total)	
Ischaemic heart disease	15+ years	68,820	1,033	(45)	31.4	1.5	86	207	(20%)
Stroke	35+ years	30,379	389	(17)	18.1	1.3	79	57	(15%)
Lung cancer	15+ years	4,377	96	(4)	2.9	2.2	98	20	(21%)
SUDI	0 year	5,289	596	(26)	997.5	11.3	100	505	(85%)
Asthma	0–14 years	2,969	93	(4)	10.5	3.1	7	44	(47%)
Lower respiratory infections	0–1 year	1,387	42	(2)	14.7	3.1	96	31	(73%)
Otitis media	0–14 years	1,189	31	(1)	3.5	2.6	0	17	(56%)
Low birthweight at term	0 year	244	6	(<1)	10.3	2.5	100	2	(34%)
Total		**114,654**	**2,286**	**(100)**	**54.7**	**2.0**	**85**	**883**	**(39%)**

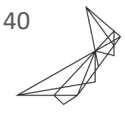
Source: Mason and Borman (2016)

9.2.5 Obesity

Barton and Love (2021) compiled research and data and provided updated estimates of the costs associated with being overweight or obese in New Zealand using a range of "high-level methods".

Considering global estimates of the cost of obesity, and based on a similar prevalence of obesity, the estimated cost for New Zealand is $2 billion in health care costs alone per annum, or approximately eight percent of health expenditure. However, the authors note that the prevalence of obesity in New Zealand is relatively high. Nevertheless, estimates based on a range of New Zealand studies (with published values between $1.3 billion and $1.8 billion in health care costs) resulted in an updated estimate of $1.5 to $2.0 billion. The authors estimate that this cost reflects approximately 80 percent of the actual health care costs of obesity.

In terms of indirect costs, the authors note: "The literature seems to be converging on a consensus that indirect costs are at least as high as direct costs and are probably more



likely to be 2-3 times direct costs." This leads to estimates of $7 billion to $9 billion per annum in lost productivity. A further $2 billion to $26 billion in intangible costs is estimated to result from the disability-adjusted life years associated with obesity, with the wide range being due to multiple values used to calculate intangible costs (QALY[5]-based value, GDP per capita value, and value of a statistical life (VOSL)).

Lal et al. (2012) used a prevalence-based approach to estimating the costs of health care and lost productivity attributable to overweight and obesity in New Zealand in 2006. Population attributable fractions (PAFs) were calculated based on relative risks from a range of large cohort studies and the prevalence of overweight and obesity in New Zealand. The productivity costs associated with premature mortality were estimated using both the human capital approach (HCA) and the friction cost approach (FCA).

The health system costs attributable to overweight, and obesity were estimated to be NZ$624 million (4.4 percent of New Zealand's total health care expenditure in 2006). Costs attributable to overweight and obesity amongst Māori and Pacific people amounted to 10.5 percent and 18.5 percent of the total costs, respectively.

The productivity costs – including both permanent productivity losses and short-term absenteeism – were estimated to be NZ$98 million using the FCA and NZ$225 million using the HCA. The biggest discrepancy between the FCA and the HCA was on the estimation of permanent productivity losses, with the HCA-based estimates being eight times higher than the FCA-based estimates.

In total, the societal costs of overweight and obesity were estimated at NZ$722 to NZ $849 million (NZD 2006).

Table 8 Health sector and productivity costs of overweight and obesity in New Zealand

NZD 2006

Cost Type	Mean (95% confidence interval)
Health sector costs	624 (540-698)
Productivity losses HCA	
Premature deaths	145 (136-155)
Short-term absenteeism costs	80
Total productivity losses HCA	225 (216-236)
Productivity losses FCA	
Premature deaths	9 (7-12)
Recruitment and training costs	9
Short-term absenteeism costs	80
Total productivity losses FCA	98 (96-101)
Total health and productivity costs HCA	849 (716-934)
Total health and productivity costs FCA	722 (636-799)

Source: Lal et al. (2012)

[5] Quality-adjusted life year

The diseases with the highest PAFs were also the diseases with the highest costs:

- Type 2 diabetes had the highest PAF and was estimated to be responsible for the largest portion of costs at 38 percent of the total.
- High blood pressure had the second highest attributable cost at 27 percent, and the third highest PAF.
- Osteoarthritis had the second highest PAF and the third highest cost at 23 percent.

Colorectal cancer was the most significant cancer cost associated with overweight and obesity and amounted to one percent of total costs.

9.3 Cost-of-illness studies by disease or condition[6]

9.3.1 Multiple NCDs and multi-morbidity

Blakely et al. (2019) used linked data for publicly-funded events, including inpatient, outpatient, community pharmaceutical, community laboratory tests, and primary care from 1 July 2007 to 30 June 2014 and case definition algorithms to identify people with any of six NCDs (cancer, cardiovascular disease (CVD), diabetes, musculoskeletal conditions, neurological conditions, and a chronic lung, liver, or kidney (LLK) disease) and 15 possible comorbidity pairings. The study used the excess cost approach to identify excess annual public health system expenditure associated with these conditions and comorbidities.

The study found that 59 percent of health expenditure was associated with NCDs, with the highest expenditure in the years of diagnosis and death. Combinations of NCDs generally led to higher costs than the sum of costs for the individual conditions, consistent with the additional complexity of managing multiple NCDs. Cancer with CVD was the only exception to this rule.

Nearly a quarter of all NCD health expenditure (23.8 percent) was estimated to be attributable to the additional costs of multi-morbidity (in excess of individual disease costs). The remaining costs were attributed to the six NCDs, as shown in Table 9 below.

Table 9 Breakdown of NCD public health system costs

Condition	Total NCD cost attribution (%)
Multi-morbidity	23.8
Heart disease and stroke	18.7
Musculoskeletal conditions	16.2
Neurological conditions	14.4
Cancer	14.1
Chronic lung, liver, or kidney disease	7.4
Diabetes	5.5

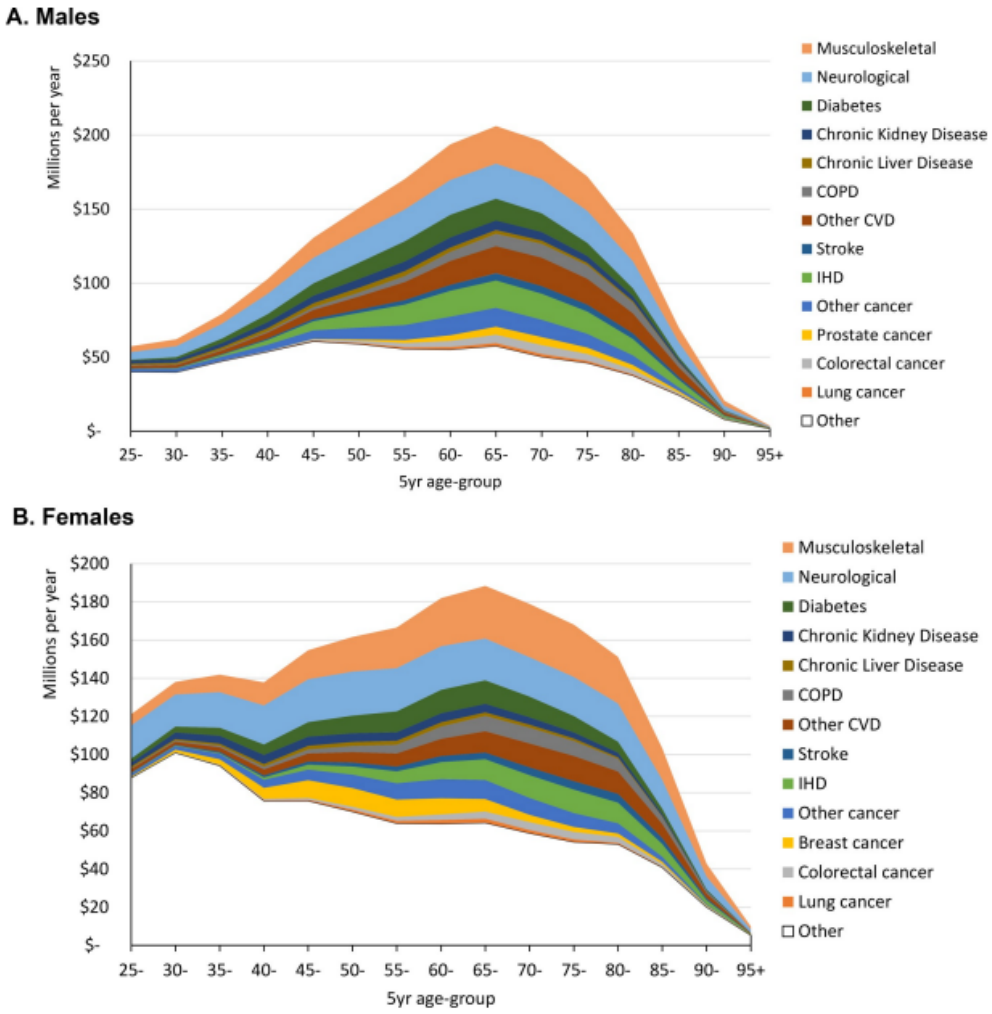
Source: Blakely et al. (2019)

[6] All cost estimates for New Zealand studies are reported in New Zealand dollars unless otherwise stated.

A major finding of the study was that the cost of simultaneously having two NCDs was generally superadditive (more than the sum of the costs of having each NCD alone). This effect was most pronounced in younger adults. The authors speculate that the latter effect may be due to more aggressive treatment approaches being used in younger groups.

The authors conclude that health system expenditure on musculoskeletal and neurological conditions warrants more policy and planning consideration as well as more research than is currently the case and that the cost of multi-morbidity highlights the need for better planning for an ageing population with comorbidity.

Figure 16 Age profile of disease costs for males and females



Source: Blakely et al. (2019)

9.3.2 Alzheimer's disease and dementia

Ma'u et al. 2021 estimated the 2020 cost of dementia including medical costs, social care costs, unpaid care costs, productivity losses and income support costs.

Health care costs were estimated based on the number of public and private discharges with any diagnosis of dementia. These were identified as the 25,827 hospitalisations for people who had a diagnosis of dementia in any health data set. Costs were calculated using

the WEIS 2020 case weight for dementia and other chronic disturbances of cerebral function (1.76).

The total hospitalisation cost associated with dementia was estimated as:

- $34.2 million for dementia as the primary discharge diagnosis
- $136.1 million for dementia as one of the diagnoses on discharge
- $237.1 million for dementia diagnosis present but not coded at hospital discharge.

Outpatient costs were estimated based on Australian data due to the lack of diagnosis codes in outpatient data in New Zealand. Estimated outpatient costs amounted to 9.5 percent of total medical costs.

Primary care visit costs were estimated using evidence from Australian studies and based on the GP consultation subsidy plus average co-payment. Pharmaceuticals for people with dementia were calculated based on four specific medications (Donepezil 5mg, Donepezil 10mg, Rivastigmine 4.6mg patch, and Rivastigmine 9.5mg patch). Allied health, pathology and imaging costs were estimated based on previous reports and data provided by the Ministry of Health.

The major results of the study were:

- The total economic cost of dementia is estimated to be $2.46 billion in 2020.
- The total fiscal cost (including public health system costs, foregone tax revenue, social and community care costs and income support payments) of dementia is estimated to be $2.24 billion or $32,150 per person living with dementia.
- Direct health care costs are estimated to be $274.2 million ($3,930 per person).
- Aged residential care costs ($1,206.8 million or $17,310 per person) and transfers ($1,867.8 million or $26,790 per person) represent the most significant cost components for dementia.

A major contribution of the study is its findings on equity considerations. Compared to New Zealand Europeans for whom the social care cost is $20,530 per person, the social care cost per person for Māori is only $15,870 and for Pacific people is only $16,020, while for Asian people it is $10,090. The differences were identified as predominantly due to the lower utilisation of publicly funded Aged Residential Care (ARC) by these groups. Consistent with these findings, the burden of unpaid care was estimated to be 11 percent higher for Māori, 12 percent higher for Pacific people, and 21 percent higher for Asian people.

Productivity losses and income support costs were also found to be significantly higher for Māori, Pacific, and Asian people ($9,200, $8,940 and $8,050 per person per year, respectively, compared with $3,380 for New Zealand Europeans), due to earlier onset of dementia and resulting impacts on working-aged people.

Overall, the report found that while the total economic cost per person for New Zealand Europeans ($35,250), Māori ($35,680) and Pacific peoples ($35,570) are similar, and that the total cost for Asian people ($27,650) is significantly lower, the minority groups face a greater economic disadvantage associated with dementia due to greater productivity costs and reduced use of social care.

9.3.3 Arthritis

A **2018 report by Deloitte Access Economics** estimated the economic cost of arthritis (including gout, rheumatoid arthritis and osteoarthritis) in New Zealand in 2018, including health sector costs, productivity losses, caregiver costs, and loss of wellbeing (in terms of DALYs).

The study based prevalence estimates on the 2016-17 New Zealand Health Survey data, except for gout, which was based on HQSC data. DALYs were valued using the value of a statistical life (VoSL) converted based on the average of 45.4 years of expected life remaining for the average New Zealander, resulting in a value of NZ$176,480 per DALY (2018 dollars).

Health system costs were estimated using a methodology described as "a collation of available information from various sources" which included national collections data, expert opinion, interviews/surveys of key practitioners, averages for length of stay and cost per stay by collating available information on relevant ICD-10 codes, Australian outpatient costs for arthritis, GP utilisation as reported in the NZHS, Health Research Council research grants, medicines, estimates from published studies and various estimates derived for the 2005 report. Capital expenditure was assumed to be 5.4 percent of total health expenditure for arthritis based on a high-level OECD estimate.

Health system costs amounted to $992.5 million in 2018, with inpatient costs, allied health costs, and outpatient costs being the major cost components (see Figure below).

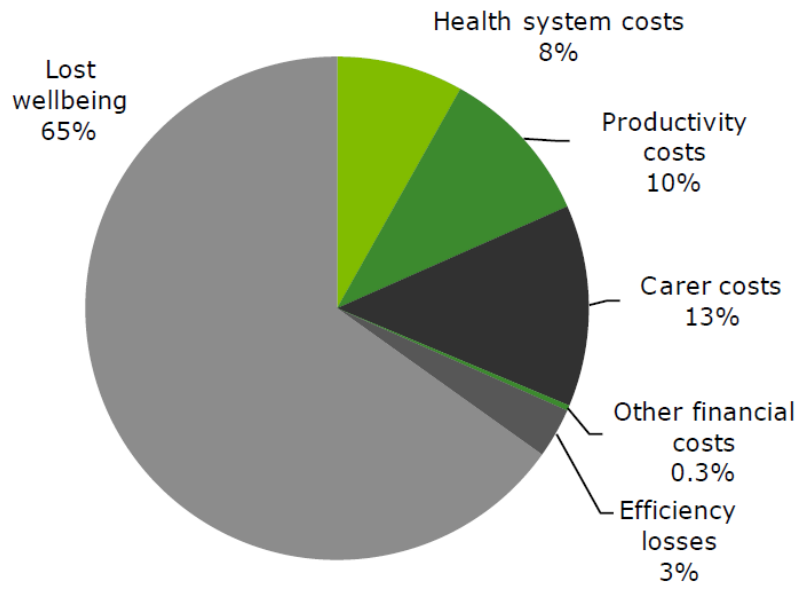
Figure 17 Health system costs of arthritis in New Zealand

Health Sectors	Total expenditure ($ million)	Percentage of total
Hospital inpatient costs	321.0	32%
Hospital outpatient costs	102.7	10%
GP visits	34.9	4%
Medical specialists	40.4	4%
Allied health	169.6	17%
Aged Care	97.9	10%
Research	6.6	1%
Pharmaceuticals	69.5	7%
Pathology	21.4	2%
Diagnostic imaging	75.0	8%
Other costs	53.5	5%
Total	**992.5**	**100%**

Source: Deloitte Access Economics (2018)

The total cost of arthritis in New Zealand is estimated to be NZ$12.2 billion in 2018, including nearly NZ$8 billion in lost wellbeing, NZ$3.3 billion in private costs (productivity losses and caregiver costs), and less than one billion dollars of health sector costs (public and private combined).

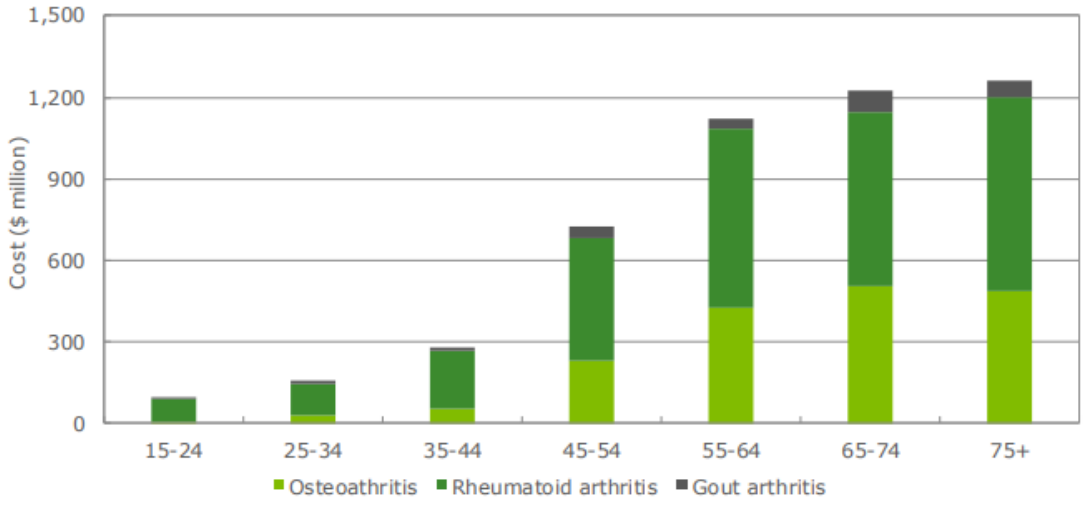
Figure 18 Breakdown of estimated 2018 costs of arthritis in New Zealand



Source: Deloitte Access Economics (2018)

Costs for gout, osteoarthritis and rheumatoid arthritis were not separately estimated, except for the loss of wellbeing cost where rheumatoid arthritis and osteoarthritis account for the bulk of total costs (see Figure below).

Figure 19 Breakdown of estimated 2018 costs of arthritis in New Zealand



Source: Deloitte Access Economics (2018)

9.3.4 Asthma

Telfar Barnard et al. (2015) reported incidence, prevalence, risk and determinants, and costs using data on pharmaceutical prescriptions, hospitalisations, and mortality from 2000 to 2013.

The study found that hospitalisation rates increased over the study period for bronchiectasis, childhood bronchiolitis and total respiratory disease, while rates remained constant for asthma and COPD. Hospitalisation rates for childhood pneumonia declined over the study period. Mortality rates declined or remained constant, with asthma mortality being in the latter category with COPD.

Ethnic and socioeconomic inequalities were observed, with Pacific people's respiratory health being consistently poorest across all indicators, except for COPD, where Māori experienced higher rates.

Medicated asthma prevalence remained constant for the study period in both adults and children. Asthma mortality rates, however, declined to 1.6 deaths per 100,000 in 2011, from 1.9 in 2000. Asthma prevalence, hospitalisation and mortality were significantly higher in Māori, and in more socioeconomically deprived areas, with asthma hospitalisation rates over three times higher in NZDep2006 quintiles 9 and 10, and twice as high in NZDep2006 quintiles 7 and 8, compared with NZDep2006 quintiles 1 and 2.

Costs were estimated from a societal perspective, including both public and private health costs as well as the cost of days off school, days off work.

Private costs associated with asthma were estimated using pharmaceutical data only. Individuals who were dispensed pharmaceuticals for asthma were assumed to pay a 'patient contribution' as recorded in the data, as well as paying for a GP visit for every non-repeat prescription with costs estimated based on New Zealand Health Survey 2011/12 data.

Public costs were estimated using pharmaceutical, emergency department, outpatient, hospitalisation, and mortality data.

Mortality costs were estimated from years of life lost based on average life expectancy at the age of death, multiplied by a value per life year of NZ$150,000. Years of life lost to disability (YLDs) were estimated based on figures from a previously published report with adjustment for population growth and an updated value for a year of life.

Overall, the cost of asthma to New Zealand was estimated at NZ$799,652,689. See Table 10 below for the cost breakdown.

Table 10 Estimated cost of asthma in New Zealand

	Childhood (0-14) asthma	Adult (15+) asthma	Total asthma
Work days lost	$3,645,334	$10,700,000	$14,345,334
Doctors' visits:	$5,378,617	$19,003,872	$24,382,489
Prescriptions:	$7,797,831	$52,038,964	$59,836,795
ED and OP visits:			$53,247,616
Hospitalisations:	$7,557,144	$9,927,261	$17,484,405
YLDs			$429,159,550
Mortality:	$0	$201,196,500	$201,196,500
TOTAL:	$24,378,926	$292,866,597	$799,652,689

Source: Telfar Barnard et al. (2015)

Carswell et al. (2015) estimated the non-healthcare costs of childhood hospitalisations for asthma, including parents' expenses, time off work and intangible costs such as stress and anxiety.

Direct healthcare costs of hospitalisation used for contextualisation of the non-healthcare costs were derived from Telfar Barnard et al. (2015) and quoted as NZ$2,026.04 per hospitalisation (NZ$1.397.24 per day of hospitalisation based on the average length of stay for such hospitalisations of 1.45 days).

Non-healthcare cost data was obtained from expenditure and WTP surveys of parents of hospitalised children. Parents were asked to recall the direct costs to them of the most recent hospitalisation event for a child, including time off work, transport, parking, childcare, accommodation, food, and miscellaneous costs. The cost of a day off school was assumed to be the average cost to the Ministry of Education for a day of schooling for a child. Participants were asked how much they would be willing to pay to avoid the stress and anxiety associated with a 24-hour hospitalisation of their child for asthma. The median non-healthcare cost of hospitalisations was estimated at NZ$380.74 per night (an additional 30 percent over the healthcare costs).

Table 11 Cost estimates per day of hospitalisation for childhood asthma

Variables	Median	Lower 95% CI limit	Upper 95% CI limit
Intangible (WTP)	$100.00	$100.0	$200.00
Lost Work	$105.00	$40.00	$155.00
Expenses	$28.45	$22.50	$34.17
Schooling	$0.00	$0.00	$31.80
Total	$380.47	$289.28	$505.70

Source: Carswell et al. (2015)

The analysis also identified differences between Māori and non-Māori, with Māori having lower intangible costs (WTP).

On a national level, based on the 3,730 asthma hospitalisations of children under 15 in 2013:

- The healthcare cost of hospitalisation was NZ$7.6 million
- The non-healthcare cost of hospitalisation was NZ$2.1 million.

The authors argue that the results are relevant for policy decision-making given the Howden-Chapman et al. (2007) study that showed retrofitting homes with insulation could reduce hospitalisations at the cost of NZ$1,800 per participant: The intervention benefit-cost ratio of 1.87:1 would improve to 2.25:1 if non-healthcare costs of NZ$380.47 per night of hospitalisation are included in a societal cost-benefit analysis.

Telfar Barnard and Zhang (2019) updated the earlier report (Telfar Barnard et al. 2015) on respiratory illness with an extended study period (2000 to 2017). A major finding was a reduction in ethnic and socioeconomic inequalities, although disparities remained high.

The study found that the hospitalisation rate for asthma peaked in 2009 at 218 per 100,000 people but had declined slightly over the total study period. Asthma mortality rates that

had been reported as declining in the earlier report were found to have returned to earlier high levels, reaching a maximum of 2.0 deaths per 100,000 in 2014.

Total costs of asthma to society were estimated at $1,017,924,605 (see Table 12 below for cost breakdown).

Table 12 Estimated cost of asthma in New Zealand

	Childhood (0-14) asthma	Adult (15+) asthma	Total asthma
Work days lost	$39,347,086	$4,232,557	$43,579,643
Doctors' visits:	$2,754,175	$18,856,970	$21,611,144
Prescriptions:	$2,102,368	$35,557,064	$37,659,432
ED and OP visits:			$121,993,745
Hospitalisations:	$7,360,497	$9,716,840	$17,077,337
YLDs			$536,641,796
Mortality:	$27,665,440	$220,316,800	$247,982,240
TOTAL:	$78,297,057	$280,992,007	$1,017,924,605

Source: Telfar Barnard and Zhang (2019)

Schlichting et al. (2021) described trends in the number of asthma hospital admissions, health system costs, and asthma prescriptions for children aged 0 to 14 years between 2010 and 2019 using public hospital admission data and pharmaceutical prescription data. The study found that between 2010 and 2019, a 45 percent reduction in the number of asthma hospitalisations was observed, along with an 18 percent reduction in prescriptions attributable to asthma. These reductions were observed for both Māori and non-Māori children, although Māori children continued to be hospitalised at twice the rate of non-Māori children, including more readmissions. Similarly, asthma admission rates were nearly three times higher for children from the most deprived areas than those living in the least deprived areas.

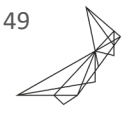
In terms of costs, the study estimated that asthma hospitalisations and prescriptions generated a cost of NZ$165 million – or NZ$103 million and NZ$62 million, respectively.

9.3.5 Cancer

Lao et al. (2021) estimated the mean costs of breast cancer in New Zealand's public health system using data on 22,948 women diagnosed with invasive breast cancer between 1 July 2010 and 30 June 2018.

The mean public health cost of breast cancer was estimated at $44,954 per patient for the period covering three months preceding and five years following cancer diagnosis. This cost was broken down into:

- the treatment phase (from three months preceding diagnosis to 12 months post-diagnosis), accounting for 70 percent of the total cost
- the follow-up phase (the second to fifth years post diagnosis), accounting for 30 percent of the total cost
- each stage of the follow-up phase (year 2 (FU2), year 3 (FU3), year 4 (FU4) and year 5 (FU5) post diagnosis).



Over 70 percent of total costs were in the treatment phase. Surgery, diagnostic tests, and immunotherapy were the most significant cost components overall.

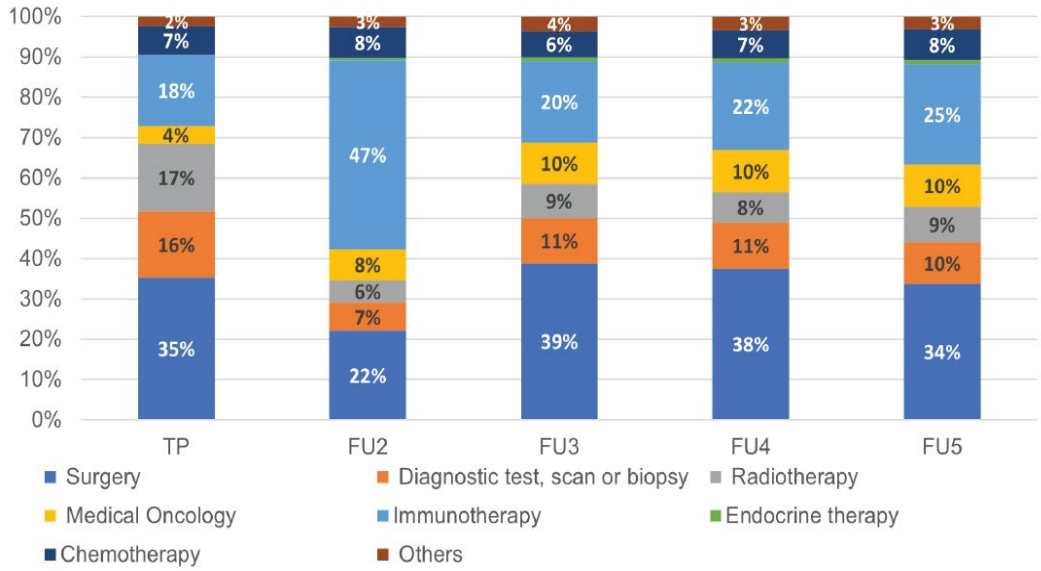
Results are broken down by age group, showing that costs tend to decrease with older age. Those not surviving 5 years were excluded from the cost analysis, so increased mortality in older age groups did not explain this result. Rather, the authors indicate that older age was associated with decreased use of surgery, adjuvant radiotherapy, endocrine therapy and chemotherapy, even after adjusting for stage and level of co-morbidity. The highest costs were associated with women under 45 years ($69,121), and the lowest with those aged 80 or over ($23,805 on average).

Costs in each phase were:

- $31,599 for the treatment phase, in which surgery costs were the most significant component at 35 percent of total costs
- $13,355 for the follow-up phase, in which surgery costs were the most significant component at 33 percent of total costs
- $6,181 for FU2, in which immunotherapy costs were the most significant component at 47 percent of total costs
- $3,008 for FU3, in which surgery costs were the most significant component at 39 percent of total costs
- $2,721 for FU4, in which surgery costs were the most significant component at 38 percent of total costs
- $2,364 for FU5, in which surgery costs were the most significant component at 34 percent of total costs.

(see Figure 20 below)

Figure 20 Proportion of each cost component in different phases of breast cancer



Source: Lao et al. (2021)

Blakely et al. (2015) linked New Zealand cancer registry data to inpatient, outpatient, general practice, community pharmaceutical and community laboratory data from 2006 to 2011. This study used the excess cost approach to calculate the excess costs of cancer. The estimates include only public health and disability system costs and exclude major cost categories, including lost productivity, private health care costs, informal caregiver costs and wellbeing impacts. Furthermore, some categories of public health and disability system costs are excluded: maternity care outside of hospitals, mental health, disability support services, and injuries (ACC data).

Results indicate that the first adult cancer diagnosed is associated with an excess cost per person of between US$3400 and US$4300 (2011 dollars) in the first month after diagnosis, falling to US$50–US$150 per month by 2 or more years later (excluding deaths). Excess costs increased by US$3800–US$8300 in the last month of life for those who died with cancer. Variations by cancer site included brain cancer excess costs being 20 times as high as prostate cancer excess costs. Based on total excess cost per diagnosed case, results ranged from US$8000 for melanoma to US$98,000 for bone and connective tissue cancer. Overall, excess costs attributed to cancer accounted for $880 million in 2011, or 6.5 percent of health system expenditure (Vote: Health 2011/12).

Excess costs per diagnosed case are summarised in the table below for the five most common cancers by incidence rate.

Table 13 Excess costs of five highest incidence cancers, 2010-2011

(2010 dollars)

Site	ICD 10 Code	Incidence rate[1]	Total excess costs ($ millions)	Excess costs per diagnosed case
Breast	C50	48.2	$126.7	$45,000
Prostate	C61	46.9	$48.6	$16,000
Colorectal and anus	C18-21	45.0	$129.7	$43,000
Melanoma	C43	39.4	$18.1	$8,000
Lung, trachea, bronchus	C33-34	29.5	$55.9	$29,000

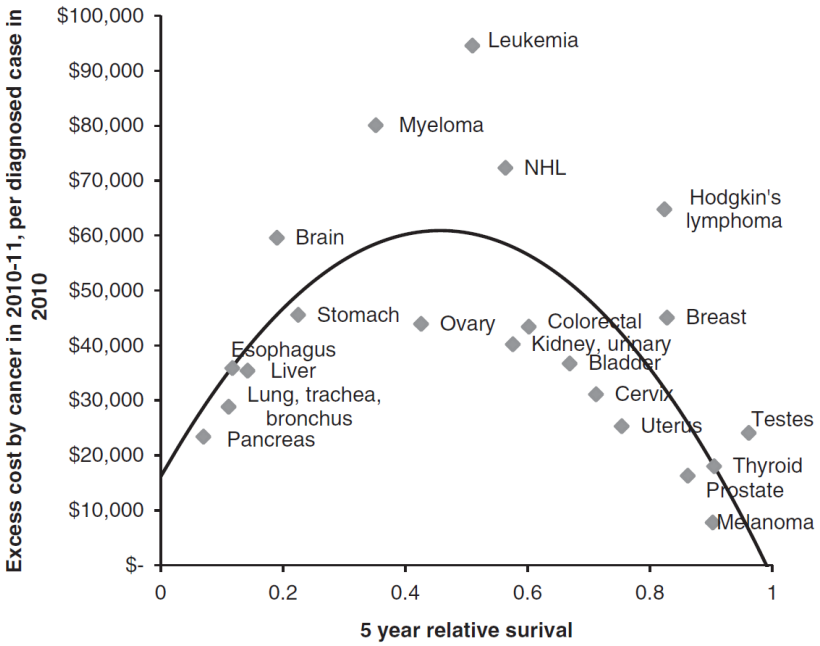
1 Age-standardised to the world population, per 100,000 population, 2010

2 All prevalent cases, $NZ (2011)

Source: Blakely et al. (2015)

The study also found an inverted U-shaped relationship between cost and relative survival, with cost per diagnosed case increasing up to relative survival of 0.4 before decreasing with improved survival.

Figure 21 Association of annual excess costs per diagnosed case with 5-year relative survival ratio, by cancer site



Source: Blakely et al. (2015)

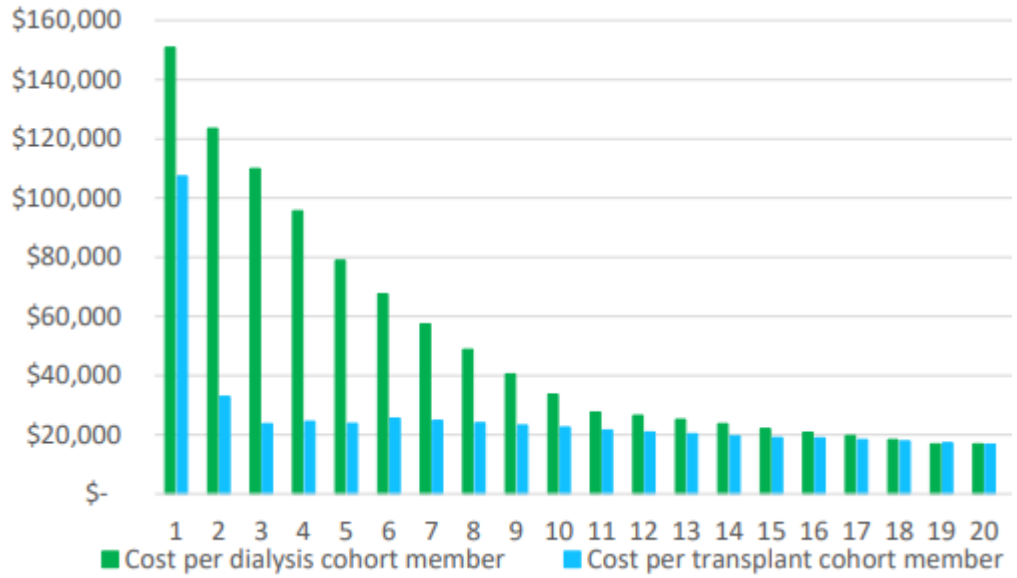
9.3.6 Chronic kidney disease

Although no New Zealand-based cost-of-illness study on chronic kidney disease (CKD) was found for the period covered by this review, a report comparing the cost of kidney dialysis to the cost of kidney transplantation over a patient's lifetime identified differences in treatment costs by modality that are relevant to CKD.

Hogan and Tuano (2021) took a public health system perspective as well as a societal perspective. Costings were based on a top-down gross costing method following a cohort of patients who started kidney dialysis in 2014/15 and a cohort of patients who received a kidney transplant in 2014/15. The analysis compared public health system costs over the following five years. The analysis included the full cost of transplantation, including organ retrieval and donor work-up, and found that the excess treatment cost associated with transplantation is paid for within one to three years due to the high health system costs of people who receive kidney dialysis and the marked reduction in health system costs once the transplant patient is discharged from hospital post-transplant. The first year of dialysis was associated with total patient costs of $150,878 of which $115,712 were dialysis costs.

Projected costs over the expected life expectancy of each cohort indicate that in total, over 20 years, the expected costs of a dialysis patient amount to $1,040,927 while the expected costs of a transplant patient amount to $538,074, generating savings of $502,854. These savings are achieved alongside a significant increase in life expectancy associated with transplantation. In the first ten years, to the extent that expected costs decrease for the dialysis cohort, this was largely due to death rather than reduced health system utilisation, while the opposite was true for transplant patients.

Figure 22 Expected total annual public health system costs per person over 20 years



The study identified that Māori and Pacific New Zealanders represent over 60 percent of dialysis users, with this proportion projected to increase as total dialysis numbers increase by a projected 30 percent to 2031/32.

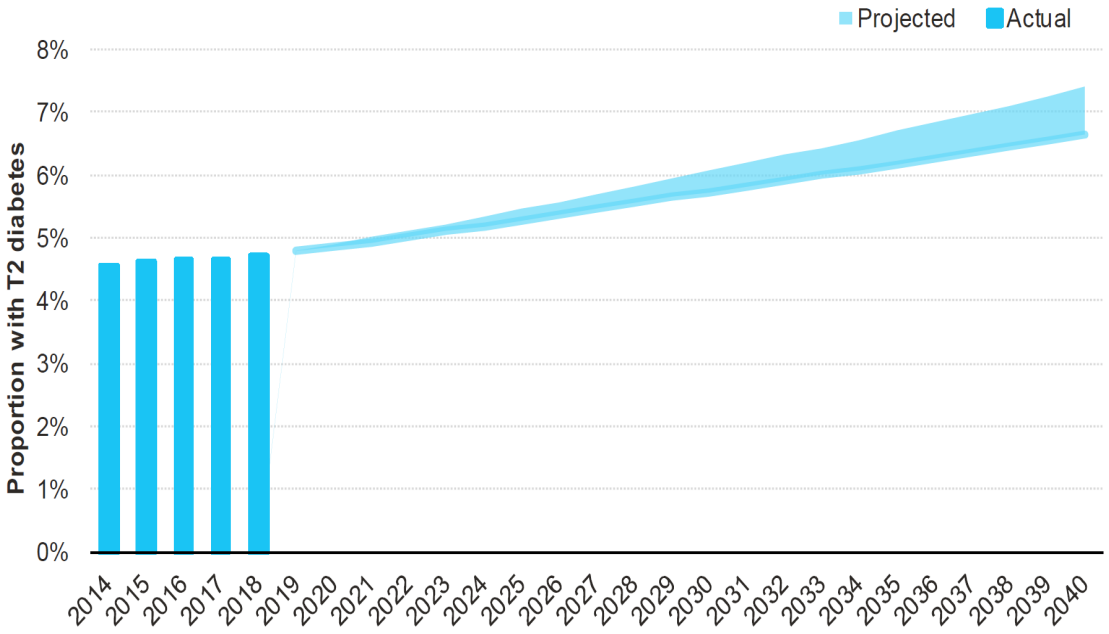
Based on previously published estimates of average life expectancy on dialysis and post-transplant, the study estimated that the value of additional quality of life and length of life from transplantation could be up to $495,808 per person. While the report did not directly identify productivity impacts, it estimated that people who are out of work due to the requirements of dialysis impose an additional fiscal cost of $47,026 per year.

9.3.7 Diabetes

PwC (2021) estimated the cost of type 2 diabetes in New Zealand based on modelling of the prevalence of type 2 diabetes to 2040 on the assumption that 90 percent of diabetes in New Zealand is type 2 (assumed due to the Virtual Diabetes Register not distinguishing between types). Costs were estimated using bottom-up gross costing. Indirect costs included productivity costs as well as costs due to lives lost early, including lost income and lost tax revenue.[7]

[7] Inclusion of lost tax revenue is questionable, particularly without the inclusion of fiscal costs such as health services costs that would have been incurred if individuals had not died prematurely.

Figure 23 Projected prevalence of type 2 diabetes in New Zealand to 2040



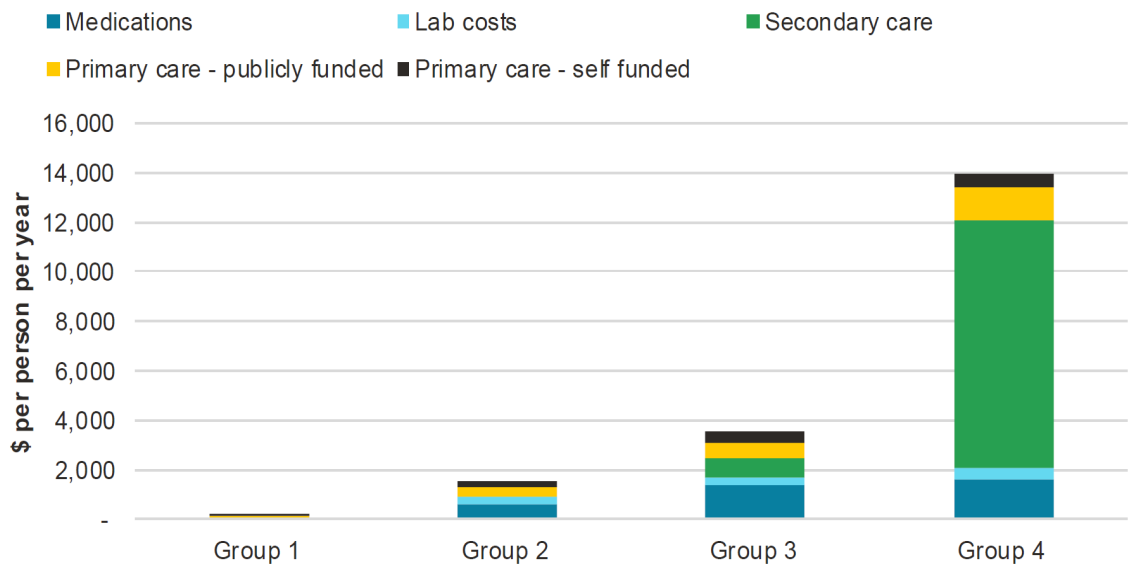
Source: PwC (2021)

Health costs per person were estimated by grouping people as:

- People with pre-diabetes, at risk of developing type 2 diabetes (Group 1)
- People with confirmed diabetes with no clinical complications but may have other risk factors for future complications (Group 2)
- People with confirmed diabetes with one or more clinical complications that are stable and controlled (Group 3)
- People with confirmed diabetes with one or more clinical complications that are unstable or severe (Group 4).

The most marked difference between groups was the increasing significance of secondary care costs, which represent more than all other health care costs combined in Group 4.

Figure 24 Health costs per person of diabetes patient groups

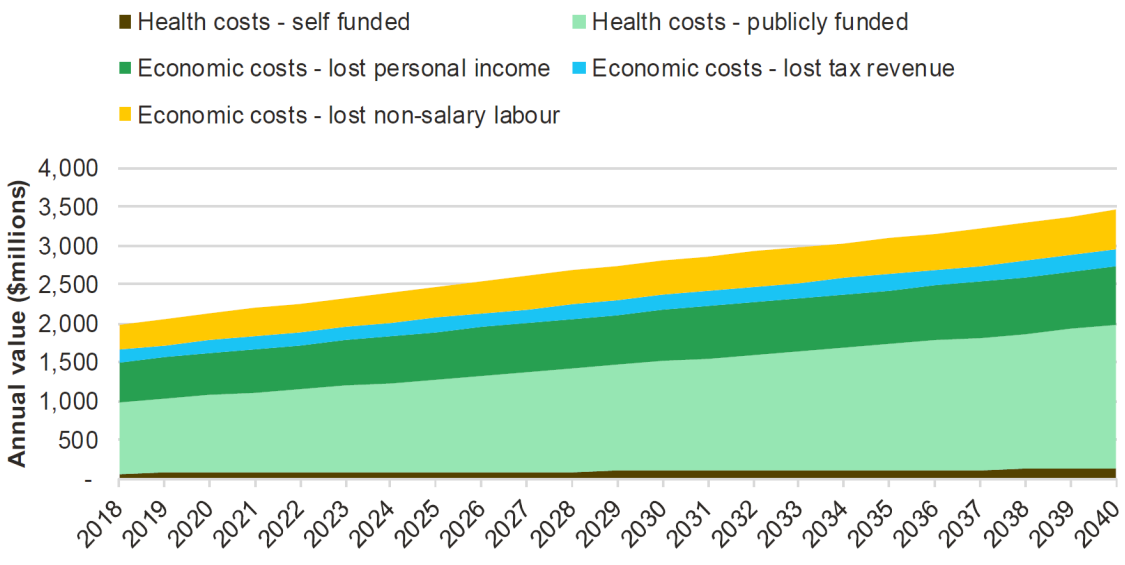


Source: PwC (2021)

Economic costs were estimated for the value of lives lost early, the value of reduced productivity and the value of disability impacts of diabetes. Relative impact scores were used to weight economic costs for each of the patient groups.

The total annual cost of type 2 diabetes in New Zealand was estimated to be NZ$2.1 billion, or 0.67 percent of GDP. This cost was projected to increase 63 percent to $3.5 billion by 2040. The bulk of costs were direct public health system costs, but economic costs to individuals and their families were also substantial (see Figure below).

Figure 25 Total annual costs of type 2 diabetes in New Zealand



Source: PwC 2021

Specifically, the publicly funded health care costs associated with Type 2 diabetes were estimated at $1.0 billion and were projected to almost double to $1.857 billion over 20 years.

9.3.8 Osteoarthritis

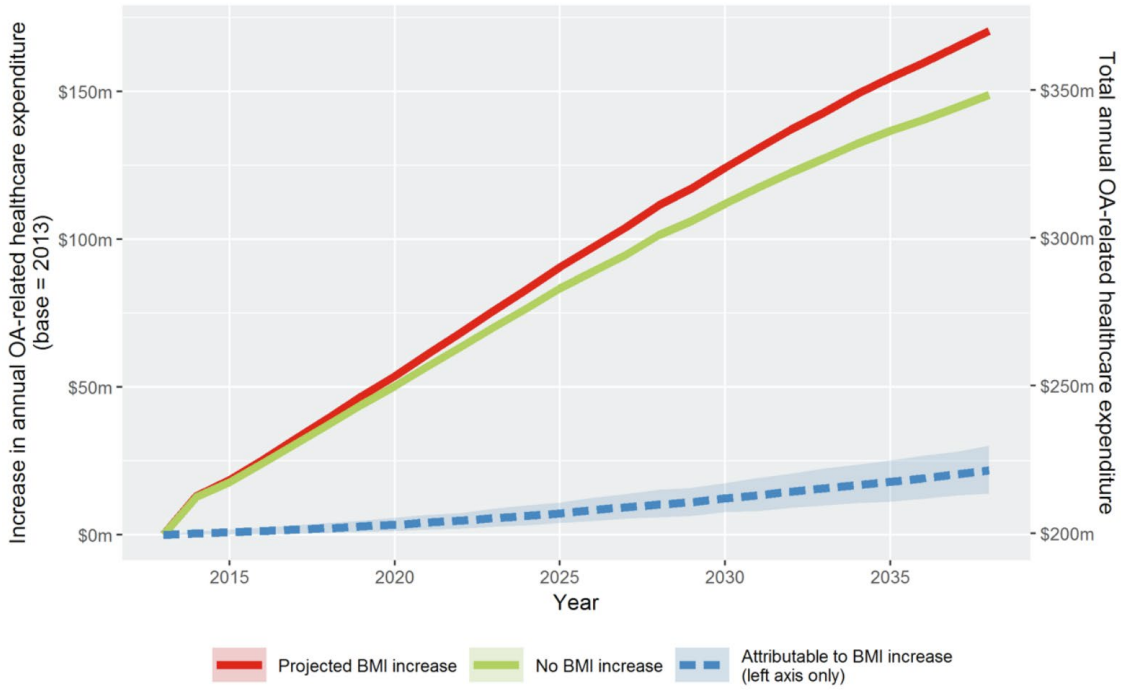
Wilson and Abbott (2019) used a microsimulation model (NZ-MOA) of knee osteoarthritis in the New Zealand population to estimate the direct healthcare costs and demand for total knee replacement (TKR) over 25 years from 2013 to 2038 associated with knee osteoarthritis and the contribution of obesity to these costs.

The direct health care costs of osteoarthritis (OA) treatment were based on the provision of usual medical care, assumed to consist of GP consultations, analgesic medication, and referrals to physical therapy for some patients.

Model outcomes were estimated under two scenarios: continuing projected trends in population obesity and population obesity remaining at 2013 levels.

In 2013, 5,070 patients had a first total joint replacement for knee OA resulting in a health system cost of NZ$199 million. Annual TKR incidence was projected to increase to 9,040 over the modelled period (increasing the rate from 174 t0 221 per 100,000 population), with associated health care costs estimated to increase to NZ$370 million in 2038. Increases in population obesity rates contributed 25 percent of the increase in costs and 47 percent of the increase in TKR rates, respectively.

Figure 26 Projected health system costs of knee osteoarthritis in New Zealand, 2013–2038



Source: Wilson and Abbott (2019)

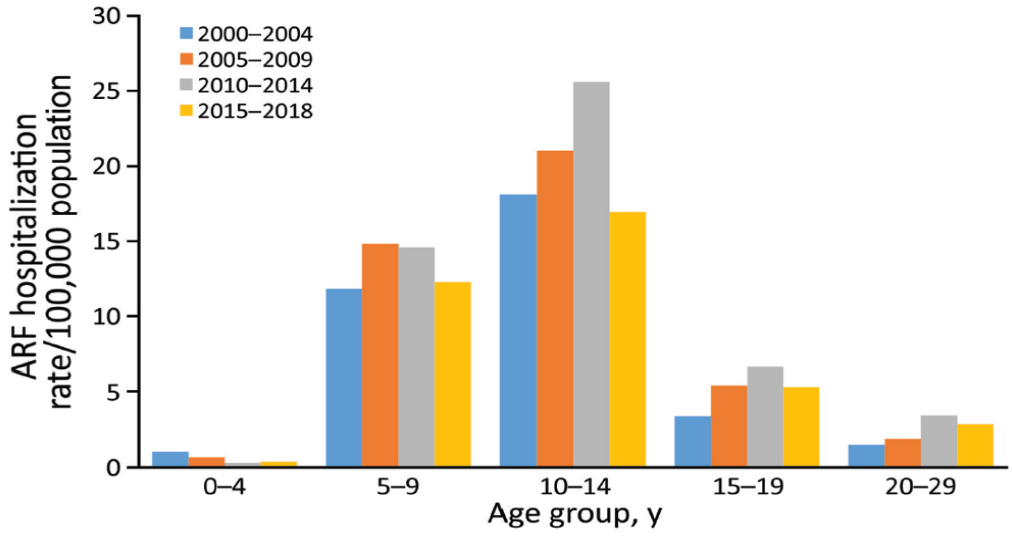
While not a cost-of-illness study, a policy brief (Abbott, Wilson and Chua, 2020) on the MOA (Management of Osteoarthritis) trial indicated that the most recommended treatment (exercise therapy) could produce cost savings compared with usual care. This statement is based on a 5-year follow-up of the MOA trial and extrapolation of results to a national programme estimated to offer a net monetary benefit of $10,700 per capita, $24.1b over the lifetime of the adult population with osteoarthritis. This evidence illustrates that, while significant savings can be achieved with cost-effective interventions, the potential for savings is often small relative to the total costs associated with long-term conditions.

9.3.9 Rheumatic fever

Although Bennet et al. (2021) did not present cost estimates, their analysis of acute rheumatic fever (ARF) and rheumatic heart disease (RHD) hospitalisations from 2000 to 2018 as well as RHD and mortality from 2000 to 2016 provides useful descriptive data on New Zealand trends. The study compares rates of initial ARF and initial RHD hospitalisations, as well as RHD deaths for Māori and Pacific people and for people from high-deprivation areas to the rates of non-Māori, non-Pacific New Zealanders, and people from less deprived areas.

The study found that from 2000 to 2018, most (93.4 percent) ARF cases were in people aged less than 30 years, with over 40 percent of these being people in the 10-to-14-year age group (see Figure 27 below).

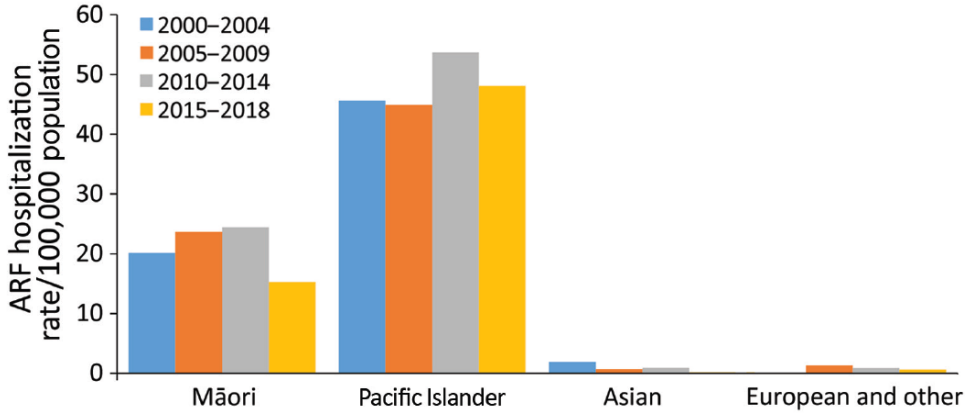
Figure 27 Incidence of initial acute rheumatic fever (ARF) hospitalisations by age group and time period, New Zealand, 2000–2018



Source: Bennet et al. (2021)

Approximately 93 percent of initial ARF cases in people aged under 30 years were among Māori or Pacific people, with Māori accounting for 49 percent of these and Pacific people accounting for 44 percent (see Figure 28 below).

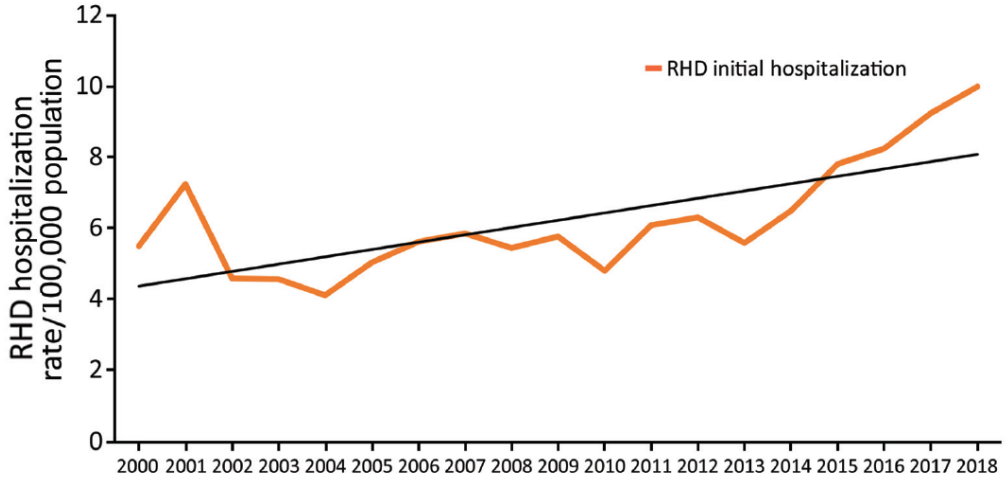
Figure 28 Incidence of initial acute rheumatic fever (ARF) hospitalisations by major ethnic group and time period among persons <30 years of age, New Zealand, 2000–2018



Source: Bennet et al. (2021)

The study found that between 2000 and 2018, there was a total of 12,094 hospitalisations with a principal diagnosis of RHD, with a significant increasing trend and a range of annual RHD hospitalisation rates from 4.1 to 10.0 cases per 100,000 population (see Figure 29 below).

Figure 29 New Zealand annual incidence rates of initial RHD hospitalisations, all ages, 2000–2018



Source: Bennet et al. (2021)

Milne et al. (2012) used data on hospital admissions from 2000 to 2009 with a principal diagnosis of acute rheumatic fever or rheumatic heart disease and deaths from 2000 to 2007 with rheumatic heart disease as the underlying cause to estimate the annual mortality and cost of hospital admissions for acute rheumatic fever and rheumatic heart disease. The cost of hospitalisation was estimated in 2009/2010 dollars using DRG-specific cost weights and national price for the same year.

The average annual cost of hospital admissions for acute rheumatic fever and rheumatic heart disease was NZ$12 million, with 28 percent of admissions and 71 percent of total cost attributable to heart valve surgery. Two-thirds of the cost associated with acute rheumatic fever and rheumatic heart disease occurs after the age of 30.

The study found that there were 159 rheumatic heart disease deaths each year on average, resulting in a mean annual mortality rate of 4.4 per 100,000 cases. Age-adjusted mortality revealed a five to ten times higher mortality risk for Māori and Pacific people than for non-Māori, non-Pacific people. The mean age at death for those who died of rheumatic heart disease was 56.4/58.4 (male/female) for Māori, 50.9/59.8 (male/female) for Pacific people and 78.2/80.6 (male/female) for non-Māori, non-Pacific people.

9.3.10 Stroke

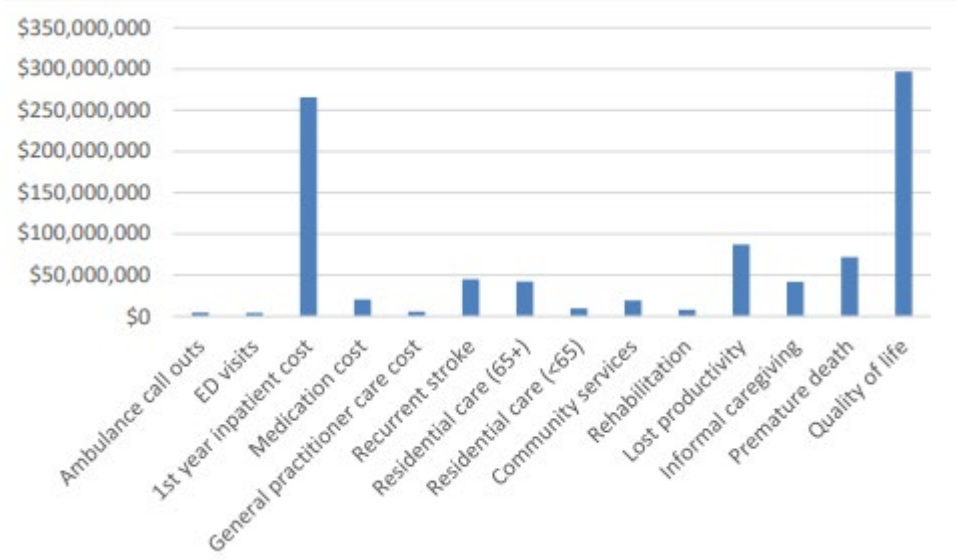
In a report for the Stroke Foundation, **Hogan and Siddharth (2018)** estimated the social and economic costs of stroke in New Zealand from a societal perspective. The study takes an incidence-based approach, based on the number of hospitalised strokes in 2014, limited to the first five years after a stroke, a compromise approach to avoid necessarily attributing longer-term effects to a stroke in the absence of sufficiently granular and linked data to support long-term cost attribution.

In terms of health and disability system costs, the study included ambulance, ED, first-year inpatient costs, costs of secondary stroke prevention, recurrent stroke costs, the cost of aged residential care for older stroke victims, the cost of long-term residential care for younger stroke victims, the cost of community-based support services, and the cost of rehabilitation services.

Non-health and disability system costs included productivity losses, the burden for informal caregivers, the value of lost caregiving by the stroke victim, the value of life years lost prematurely and the value of lost quality of life.

The study found that on average, a hospitalised stroke in New Zealand is associated with an expected cost of NZ$60,000 to NZ$99,000 over five years and that, based on 9,583 hospitalised strokes in 2014, the total discounted cost over five years would be approximately NZ$900 million (and still over half a billion dollars of quality of life and premature death costs are excluded). The two major cost categories are first-year inpatient costs and quality of life costs.

Figure 30 Breakdown of the 5-year costs of an annual cohort of strokes in New Zealand



Source: Hogan and Siddharth (2018)

The study notes that estimates are conservative due to:

- Conservative costing approaches
- Exclusion of non-hospitalised strokes, which may nevertheless be associated with both health system and private costs
- Exclusion of quality of life and mortality costs for people aged 75 and over
- Exclusion of all costs beyond the first five years.

The 2018 report was updated in 2020 (**Hogan and Siddharth 2020**). In the updated report, stroke costs were projected to 2023 and 5 yearly to 2038, equity impacts were analysed to identify the disproportionate impact of stroke on Māori and Pacific people, and a new section was added on acute stroke services with a focus on thrombectomy, including volumes and costs, projected through to 2038, and estimates of cost impacts associated with increased thrombectomy rates.

The updated report estimated that:

- An annual cohort of strokes in New Zealand based on the 2020 projected cohort was expected to incur over NZ$1.3 billion in social and economic costs (including the value of lost quality of life and life-years lost prematurely) over the next five years (discounted to 2020).
- The discounted expected cost of a stroke over five years was approximately NZ$105,000.
- The cost of stroke to New Zealand in 2020 was approximately NZ$1.1 billion, projected to increase to NZ$1.7 billion by 2038.

10 International evidence

The international evidence search focused on the most relevant evidence to provide insights for the New Zealand context for conditions for which New Zealand cost-of-illness studies were not found. Evidence from non-OECD countries was excluded.

10.1.1 Alcohol

Although not a cost-of-illness study itself, Laramée et al. (2013) conducted a systematic literature review to identify publications reporting the economic burden of alcohol dependence in European countries. The publication year of included studies ranged from 1968 to 2010. Evidence reviewed indicated that alcohol dependence in Europe is associated with annual total direct costs at a national level between €1 billion and €7.8 billion 2012, or 0.04 to 0.31 percent of a country's annual GDP.

A report for the Scottish Government (**Scottish Government Social Research, 2010**) estimated the societal costs of alcohol misuse in Scotland in 2007. Included costs comprised health care costs, social care costs, criminal justice system costs, productivity costs, and intangible costs of premature mortality. The midpoint cost estimates were:

- £267.8 to health services (with non-psychiatric inpatient days being the most significant component)
- £230.5 to social care services (with most of this being social care services for children and families)
- £727.1 in crime costs of alcohol-specific offences
- £865.7 in foregone productivity (including presenteeism, absenteeism, unemployment, and lost production due to premature mortality)
- £1,464.6 in costs related to premature mortality (intangible social costs, lost unpaid work by non-participants in the workforce)

Overall, alcohol misuse was estimated to cost Scottish society between £2.4 and £4.6 billion in 2007 at 2007/08 prices, with a mid-point of £3.6 billion.

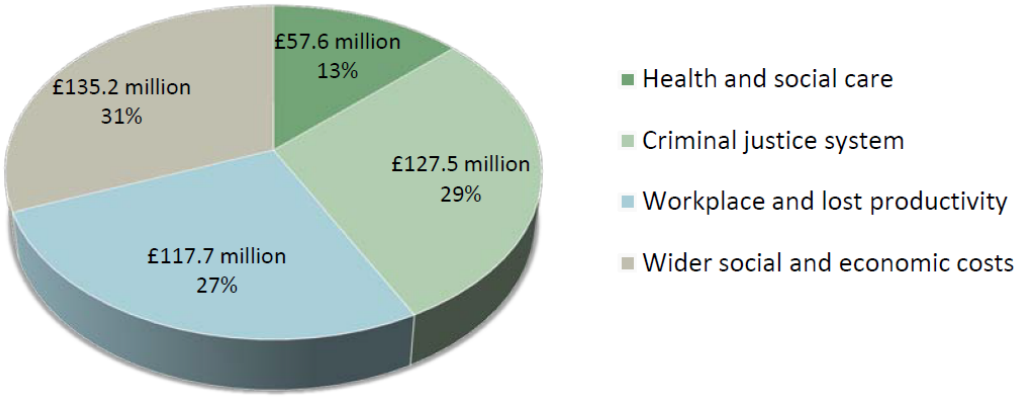
Jones et al. (2010) estimated the economic and social costs of alcohol-related harm in Leeds in 2008/09 (population 646,500). Costs included costs to the health system, social care costs, criminal justice system costs, social care costs, productivity costs, and wider social and economic costs such as alcohol-related litter, fire service attendances, school failure and reduced educational attainment.

The cost of alcohol-related harm in Leeds was estimated to be £438.0 million in 2008/09 with costs to the National Health Service (NHS) alone in excess of £20 million. A total of 5,235 years of life were estimated to be lost due to premature mortality in Leeds yielding intangible or human costs between £92.3 million and £153.9 million, with a midpoint of £123.1 million.

Of the total costs, 13 percent were attributed to expenditure on health and social care services, 29 percent were attributed to crime, 27 percent were attributed to lost productivity and 31 percent were attributed to the wider social costs of alcohol misuse (see Figure 31 below).

Figure 31 Attribution of costs of alcohol-related harm in Leeds, UK

2008/09



Source: Jones et al. 2010

A report from Northern Ireland (**McClure Walters, 2010**) estimated the societal costs of alcohol misuse in Northern Ireland for 2008/09. Bottom-up gross costing provided the basis of health system costs, while top-down methods were the primary method for estimating other costs. Results indicate that:

- Health system costs were between £90 million and £158 million
- Social care costs were between £34 million and £82 million
- Costs to the fire service and police were between £168 million and £279 million
- Costs to the justice system were between £64 million and £104 million
- The value of lost productivity was between £145 million and £258 million

A Portuguese study (**Cortez-Pinto et al. 2010**) estimated the burden and costs of diseases attributable to alcohol consumption.

Based on the sum of death and disability DALYs, liver diseases represented the main contributor to the burden attributable to alcohol with 31.5 percent of total DALYs, followed by traffic accidents (28.2 percent) and cancer (19.2 percent). The study estimated that, the cost of hospital-based health services for alcohol-related ill health was equivalent to 0.13 percent of GDP and 1.25 percent of total health expenditure in Portugal.

10.1.2 Tobacco

Goodchild, Nargis, and Tursan d'Espaignet (2018) used a cost-of-illness approach to estimate the global economic costs of smoking-attributable diseases in 2012, using data from 152 countries representing 97 percent of the world's tobacco smokers.

Total health expenditure was obtained from the WHO Global Health Expenditure database and the smoking attributable fraction was extracted from published studies. The study estimated that the amount of health care expenditure due to smoking-attributable diseases amounted to US$422 billion in 2012, representing 5.7 percent of health expenditure globally.

Productivity losses were estimated using the human capital approach. Adding productivity losses to the cost estimate generated an estimate of total economic cost equal to US$1436 billion in 2012 or 1.8% of the world's annual gross domestic product (GDP). In high income countries, smoking was found to be associated with total costs amounting to 2.2 percent of those countries' GDP.

10.1.3 Cardiovascular diseases

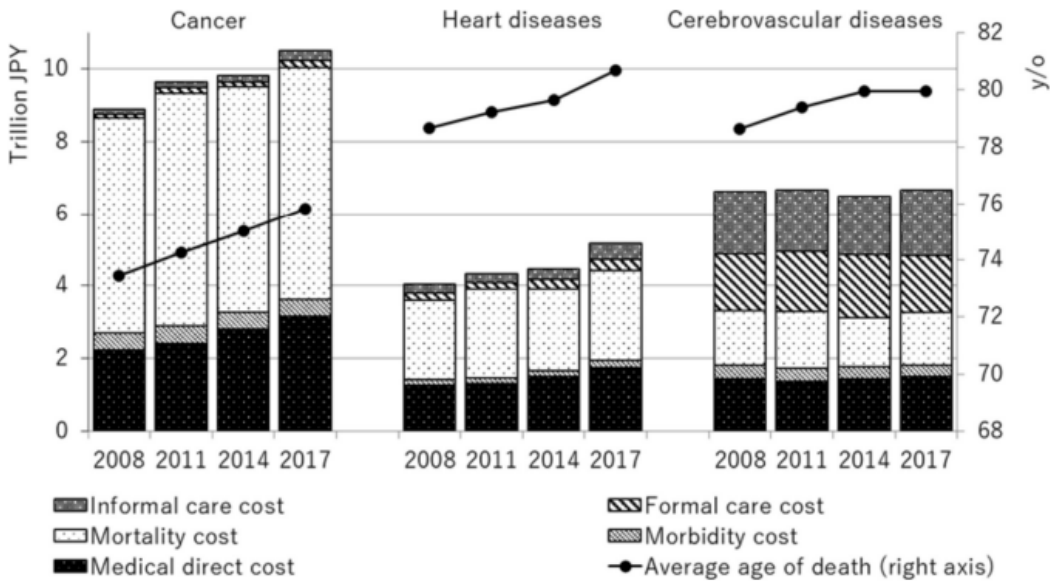
One global report on the economic burden of heart failure in 2012 (**Cook et al. 2014**) used World Bank data to interpolate the economic cost of heart failure in 2012 for countries where no published data existed. 197 countries were included in the analysis, covering 98.7 percent of the global population. Costs were derived from previously published studies, administrative data, and other reports, with some estimates dating back as far as 1990 (the only New Zealand study included) and the most recent being 2012 estimates. Costs were expressed as percentages of each country's total health expenditure (public and private) and in US dollars.

The overall economic cost of HF in 2012 was estimated to be 1.32 percent of total health system expenditure on average across all countries, or 1.42 percent for high income countries. Global per capita spending on heart failure was estimated at approximately $23.81 per annum based on 2012 expenditure. Total global expenditure on heart failure was estimated at $108 billion per annum, with direct costs accounting for approximately 60 percent ($65 billion) and indirect costs accounting for approximately 40 percent ($43 billion).

A study of the social burden of three major diseases in Japan (**Hirata et al. 2021**) included heart disease along with cancer and cerebrovascular diseases and analysed health system costs along with morbidity and mortality costs, and formal and informal long-term care costs. Health system costs were estimated using bottom-up gross costing; formal care costs were extracted from administrative databases; and average wages were used to estimate morbidity, mortality, and informal care costs.

The study found that cardiovascular diseases were associated with a lower economic burden than either cancers or cerebrovascular diseases (see Figure 32 below).

Figure 32 Total annual costs in Japan of 3 major diseases



Source: Hirata et al. 2021

The total annual economic cost of cardiovascular diseases in Japan was estimated to be JPY 5,159 billion per annum, with direct medical costs accounting for 30 percent of total costs.

A Danish study (**Bundgaard et al. 2019**) used national registries to analyse the societal costs associated with heart failure using the excess cost approach. A total of 176 067 heart failure patients from 1998 to 2016 were matched.

The study found that health care costs were highest in the year of diagnosis, with an average cost per patient of €17,039 (2016 prices) in total annual direct and indirect costs that year, compared with only €5,936 for the matched controls, for a difference of 70 percent of total costs were direct medical costs. Relatively low indirect costs (productivity loss) were related to the high average age of heart failure patients, however indirect costs also included transfers (subsistence allowance, social security, social assistance, etc). The majority of direct costs for the heart failure patients were attributed to inpatient admissions

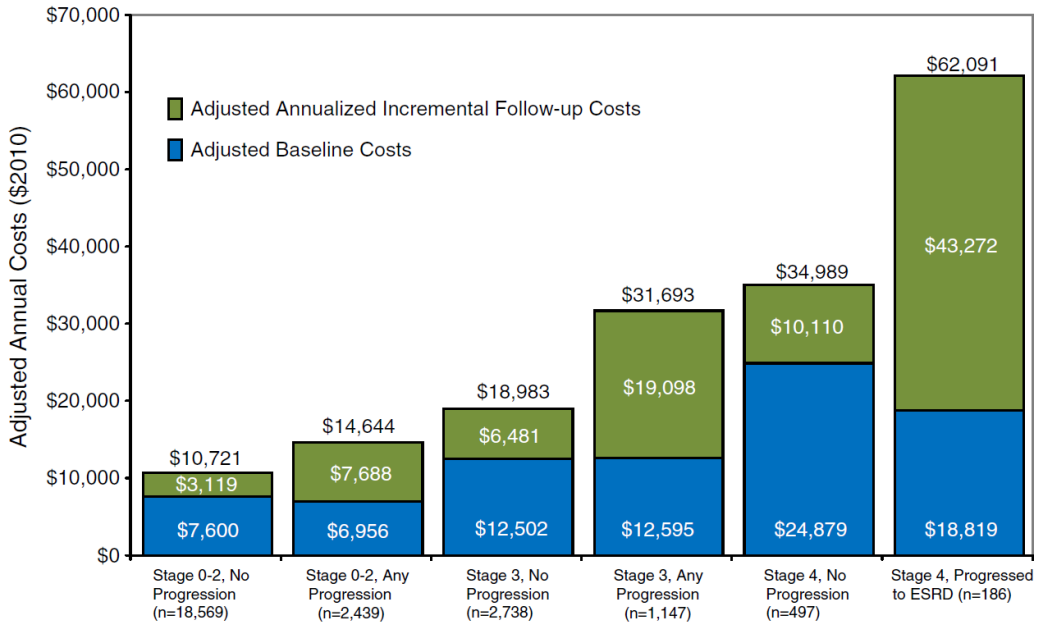
10.1.4 Chronic kidney disease (CKD)

A US study (**Vupputuri et al. 2014**) conducted a retrospective cohort analysis of over 25,000 members at Kaiser Permanente who had type 2 diabetes and at least one serum creatinine measurement in 2005. Only health care costs were estimated. The study found that across all stages of CKD, those who progressed to a higher stage of CKD from baseline had 2 to 4 times higher annual health care costs than those whose CKD did not progress.

Annual costs associated with CKD were estimated at $10,721 to $62,091 ($US, 2010) per person, depending on stage and progression (see Figure 33 below).

Figure 33 Annual per person health care cost implications of CKD progression

$US, 2010



Source: Vupputuri et al. (2014)

Another study (**Kent et al. 2015**) drew on an international cohort of 7,246 patients from Europe, North America and Australasia associated with the Study of Heart and Renal Protection (SHARP) randomised trial. Between 2003 and 2006, patients from 18 countries were randomised and followed for a median of 4.9 years until the study ended in 2010. The study collected information on kidney disease progression, serious adverse events and hospital care use in a cohort of patients with moderate-to-severe CKD and analysed the impact on hospital costs (inpatient and outpatient). Bottom-up gross-costing methods were used to estimate costs. All costs were reported in 2011 prices.

The study found that the average annual cost of hospital care (including routine dialysis costs) was £9,977. Costs ranged from £1,055 for patients at CKD stages 1-3B to £12,952 for those with CKD stage 5 and not on RRT, and £20,511for those on maintenance dialysis. A substantial portion of costs were associated with the additional complexity of CKD occurring comorbidly with diabetes or vascular disease: CKD patients without diabetes or vascular disease incurred annual hospital costs ranging from £403 to £525, depending on the stage of disease.

Results comparing treatment groups (dialysis versus transplantation) indicated that patients on kidney dialysis incurred annual hospital costs of £18,986 in the year that dialysis was initiated and £23,326 annually thereafter while patients with a functioning kidney transplant incurred higher costs in the year of transplantation (compared with initiation of dialysis) £24,602 but lower costs thereafter (£1,148 annually). Non-fatal major vascular events increased annual costs in the year of the event by £6,133 (5,608-6,658) for patients on dialysis and by £4,350 (3,819-4,880) for patients not on dialysis, and were associated with increased costs, though to a lesser extent, in subsequent years.

10.1.5 Chronic obstructive pulmonary disease (COPD)

A report on the global economic burden of COPD (**Ehteshami-Afshar et al. 2016)** comprised a review of international literature and summarised the findings in terms of direct costs, cost components, and indirect costs. Evidence for the review consisted of 16 reports (7 from North America, 8 from Europe, and 1 from South-East Asia) published between January 2008 and January 2015. All costs were presented in US dollars for 2014.

The study found that the approaches to estimating direct costs varied significantly, making a comparison of results fraught. In particular, COPD is associated with a significant number of comorbid conditions, but studies did not account fully for these in cost estimation, resulting in probable underestimation. Studies that used the excess cost approach described in Section 5.2.2, on the other hand, tend to overestimate the costs attributable to the condition as much of the comorbidity cost may be attributed to COPD.

One study reviewed (a US study) used statistical adjustment to account for comorbidities in an excess cost-based analysis, and this adjustment reduced the excess costs associated with COPD from US$6,213 per person per year to US$536 per person per year. In another study, the researchers decided to exclude patients with major comorbidities due to the difficulties in distinguishing between COPD-attributable costs and costs attributable to the major comorbid conditions.

European studies included found direct medical costs for COPD ranged from $679 to $2,865 with similar variation in other cost categories. This was largely due to differences in the study population (different age groups, different health status) as well as methodological differences and health system differences. The authors also note that COPD remains underdiagnosed in many countries and that studies are based on diagnosed COPD. However, they also note that one study identified that inpatient and outpatient visits were 1.5 times higher in the 12 months prior to a COPD diagnosis, but the attribution problem applies to this result too.

It is unclear whether studies analysing differences between severity stages are relatively unaffected by the comorbidity attribution problem. However, several studies that reported costs across the Global Initiative for Chronic Obstructive Lung Disease (GOLD) severity stages found that costs among patients in the GOLD III/IV groups were two to six times higher than for patients in the GOLD I/II groups. In these analyses, it was also the case that methodological differences led to wide variation in results.

A German study (**Kirsch et al. 2019**) analysed health system claims data for patients enrolled in a COPD disease management plan, including inpatient, outpatient, medication, medical aids, and rehabilitation. Bottom-up gross costing methods were used to estimate costs. Indirect costs were estimated for patients aged under 65 to provide a societal perspective. Productivity losses were calculated based on average wages and absenteeism only. Early retirement also counted towards lost productivity.

Results were reported by GOLD grade and reported in 2018 Euros. More severe COPD was significantly associated with higher health service utilisation, work absence, and premature retirement. Annual per patient direct costs for GOLD grade 1 to 4 were €3809, €4284, €5548, and €8309. Annual per patient indirect costs for GOLD grade 1 to 4 were €11,784, €12,985, €15,805, and €19,402.

10.1.6 Gout

A Taiwanese study **(Lee et al. 2018)** compared the health care utilisation and costs of people with a primary or secondary diagnosis of gout to matched controls within one year if the index date (date of diagnosis), defined as a health event with an initial diagnosis of gout for 2011, having had no prior health event recorded with a diagnosis of gout from 2008 to 2010.

Gout patients were found to have more all-cause health services utilisation than matched controls, with approximately 50 percent more hospital attendances (based on the median), the majority of these being outpatient visits (as opposed to inpatient admissions or ED visits). Gout patients also had approximately 27 percent to 60 percent higher annual health care costs on average compared with matched controls (a mean of USD $1,684 versus $1,331 and median of USD $716 versus $446).

A US study (**Jackson et al. 2015**) on the healthcare utilisation and costs of patients with gout used administrative data from a large US health plan for 102,703 people with gout to identify the frequency of gout flares, and the costs and resources associated with gout flares from 2009 to 2012.

The study found that higher frequency of flares was associated with higher costs: The average annual gout-related health care costs among patients with 3+ flares were US$4,490 compared with US$2,939 for those with two flares and US$1,792 for those with zero to one flare.

A Dutch study (**Spaetgens et al. 2015**) applied micro-costing methods to identify the health care costs as well as informal care, home help, and productivity costs of 126 patients with longstanding gout under the care of a rheumatologist in the Netherlands in 2011/12. The average age of the same was 67 years. Friction cost methods were used to estimate absenteeism and presenteeism-related productivity losses.

Total direct costs per person were estimated to be €5,647 on average, however this included the cost of home help and informal care by family and friends. Within the direct costs, health care costs amounted to €2,470 per person on average. When productivity losses were included, the total cost per person per year attributed to gout was €10,894. Higher direct and indirect costs were associated with CVD, functional disability, and female sex.

10.1.7 HIV/AIDS

Krentz, Vu, and Gill (2020) analysed the HIV-related drug, laboratory, outpatient, and inpatient costs for HIV infected patients from 2006 to 2017 to identify the public health system costs of people with HIV/AIDS in Canada. Costs were compared against the previous costs incurred by the same population prior to HIV-infection diagnosis.

The study found that the number of HIV-infected patients had doubled from 2006 to 2017 while total health care costs had more than doubled from $12.4 to $30.1 million (all costs reported in 2014 Canadian dollars). Antiretroviral (ARV) drugs made up 79 percent of costs in 2017. Outpatient and laboratory costs declined in importance over the period from 12 percent to 8.5 percent of total costs, while inpatient costs varied from year to year. The average cost per person per year increased from $1,316 in 2006 to $1,712 in 2014, before declining to $1,446 in 2017. The study also found that higher costs were associated with CD4 counts below 200 cells/µL.

10.1.8 Osteoporosis

One study was identified that provided cost-of-illness estimates for osteoporosis. **Marcellusi et al. (2020)** estimated the health system and social security costs of osteoporosis in Italy using a bottom-up gross costing approach supplemented by values derived from previously published literature to derive indirect costs (social security costs, including disability allowance and pensions). The reference year for the model data was 2017.

An average annual economic burden of osteoporosis in Italy was estimated to be €2.2 billion, with 80 percent of this being the cost of inpatient hospitalisation, 16 percent being the cost of pharmacological treatments, 3 percent being the cost of outpatient care, and 1 percent being social security costs. Just over half of inpatient hospitalisations in this group were due to fractures. The highest annual cost of hospitalisation was associated with patients aged 75+ whose hospitalisation costs were nearly 20 percent higher than those of people aged 60 to 74 and 50 percent higher than those of people aged 45 to 60. The average annual cost per patient was estimated to be €8,691, but the study noted that people with severe osteoporosis had significantly higher costs – this group estimated to have costs of €12,336 per person (44 percent more than the general osteoporosis population).

10.1.9 Rheumatic fever

An Australian study (Cannon et al. 2018) summarised in a report (**Wyber et al. 2018**) estimated projected health care costs of acute rheumatic fever (ARF) and rheumatic heart disease (RHD) amongst Aboriginal and Torres Strait Islander people to 2031. In Australia, 94 percent of new ARF cases occur in Aboriginal or Torres Strait Islander people.

The study identified that 4,539 people were living with RHD or the effects of ARF in the Aboriginal and Torres Strait Islander populations in 2016.

Bottom-up gross costing methods were used to identify the health care costs of people with RHD and ARF and, along with disease progression modelling, these costs were applied to a projected population developing RHD and ARF from 2016 to 2031.

The study found that if no further prevention action is taken, a further 10,212 Aboriginal and Torres Strait Islander people would develop RHD or ARF by 2031, including 4,885 projected to develop ARF and 5,326 people projected to develop RHD with no history of ARF. Of these people:

- 1,370 will need heart surgery
- 563 with RHD will die
- $317 million will be spent on medical care for incident cases
- $27 million will be spent on medical care for the current population living with ARF or RHD

In total $344 million was the projected cost of health services for ARF and RHD from 2016 to 2031.

A South African study (**Hellebo et al. 2021**) analysed a randomly selected sample of 100 patient medical records from the Global Rheumatic Heart Disease Registry (REMEDY study) to identify health system costs associated with RHD. Bottom-up micro-costing methods

were used to estimate costs of hospital-based care. Including outpatient care, inpatient care, surgery, diagnostics and medications in a tertiary hospital context.

The estimated total cost of tertiary-hospital-level health care for RHD was $2 million (2017 USD) in 2017. Surgery costs accounted for 65 percent of the total cost. The average cost per-patient amounted to $3,900.

11 Summary of studies

The table below summarises the included cost-of-illness studies with summary results converted from the original currency to New Zealand dollars using OECD purchasing power parities (PPP) and inflated to 2021 New Zealand dollars using average annual inflation (CPI) since 2000 published by the Reserve Bank (2.15 percent per annum).

Table 14 Summary of cost-of-illness studies

Risk factor or condition	Reference	Year of data	Year and currency of reported monetary values	Direct health system costs ($NZ 2021)	Indirect costs ($NZ 2021)	Total societal cost ($NZ 2021)	Approach	Perspective
New Zealand evidence								
Physical inactivity	Market Economics 2013	2009-2010	NZD 2010	$776m	$835m	$1.6b	Prevalence based Top-down gross costing	Societal
Physical inactivity	Mizdrak et al. 2019	2003-2012	NZD 2011	$157m to $2.6b			Incidence based Multi-state life table scenario modelling Top-down gross costing	Public health system
Physical inactivity	Midzrak et al. 2021	2003-2012	NZD 2011	$1.45b to $3.1b			Incidence based Multi-state life table scenario modelling Top-down gross costing	Public health system
Unhealthy diet	Ngheim et al. 2015a	2011	NZD 2011	$200b total $87200 per adult in 2011			Incidence based Markov macrosimulation modelling	Public health system

							Top-down gross costing	
Unhealthy diet	Wilson 2016	2011	NZD 2011	$1.56b potential savings from NZ reaching UK Salt Reduction Targets for 2017			Incidence based Markov macrosimulation modelling Top-down gross costing	Public health system
Obesity	Barton and Love (Sapere) 2021	2019 and earlier data from previously published reports	NZD 2021*	$2b 8% of health expenditure	$7b	$19b 3% of GDP	Prevalence based Top-down mixed methods	Societal
Obesity	Lal et al. 2012		NZD 2006	$859m 4.4% of total health care expenditure	$135m - $310m	$993m to $1168m	Prevalence based	Societal
Multiple NCDs/ multimorbidity	Blakely et al. 2019	2007-2014	USD 2016	Included NCDs account for 59% of all health system spending with nearly ¼ of this due to multi-morbidity			Prevalence based Bottom-up gross costing Excess costs	Public health system
Alzheimer's and Dementia	Ma'u at al. 2021	2018-2020	NZD 2020	Health care: $280.1m ARC: $1.233m	Transfers: $1.908m	$2.51b	Prevalence based Bottom-up gross costing	Societal
Arthritis	Deloitte Access Economics 2018	2014/19	NZD 2018	$1.058b (32% hospital costs)	$1.13b	$13b	Prevalence-based Top-down gross costing Attributable costs	Societal
Asthma	Telfar Barnard et al. 2015	2000-2013	NZD 2011	ED and OP: $65m Inpatient: $21m GP: $30m	Productivity: $17m YLDs: $531m	$990m	Prevalence based Bottom-up gross costing	Societal

				Prescriptions: $74m				
Asthma	Carswell et al. 2015		NZD 2013	$9m	$2.5m	$11m	Prevalence based Survey-based study Gross costing	Societal
Asthma	Telfar Barnard and Zhang 2019	2000-2016	NZD 2015	ED and OP: $139m Inpatient: $19m GP: $25m Prescriptions: $43m	Productivity: $50m YLDs: $610m	$1.156b	Prevalence based Bottom-up gross costing	Societal
Asthma	Schlichting et al. 2021	2010-2019	NZD 2019	Total: $172m Hospitalisations: $107 m Prescriptions: $65 million			Prevalence based Bottom-up gross costing	Public health system (hospitalisations and prescriptions only)
Cancer (Breast)	Lao et al. 2021	2010-2018	NZD 2019/20	$24,317 to $70,607 PPPY (age dependent)			Incidence based (8-year time horizon) Bottom-up gross costing	Public health system
Cancer	Blakely et al. 2015	2006-2011	NZD 2011	$1.089b 6.5% of Vote: Health 2011/12			Prevalence based Excess cost approach Bottom-up gross costing	Public health system
Chronic kidney disease	Hogan and Tuano 2021	2014-2020	NZD 2021	$502,854 per person lifetime savings associated with renal transplant vs dialysis			Incidence-based cohort model	Public health system
Diabetes	PwC 2021	2014-2019	NZD 2020	$1.0b Projected to rise to $1.897 by 2040		$2.1 b 0.67% of GDP Projected to increase to $3.6b by 2040	Prevalence based Top-down gross costing	Societal
Osteoarthritis	Wilson and Abbott 2019	2013	NZD 2018	$212m cost of first total knee replacement for OA patients			Incidence-based cohort	Public health system

				Projected to increase to $394m by 2038			microsimulation model	
Rheumatic fever	Milne et al. 2012	2000-2009	NZD 2009/10	$15m per year hospital costs			Prevalence based Bottom-up gross costing	Public health system
Stroke	Hogan and Siddharth 2018	2014	NZD 2018			5-year dis-counted cost of an annual stroke cohort: $959m	Incidence-based Bottom-up gross costing	Societal
Stroke	Hogan and Siddharth 2020	2020	NZD 2020	5-year discounted cost for the 2020 stroke cohort: $523.3m		5-year dis-counted cost of an annual stroke cohort: $1.3b Annual cost of stroke overall: $1.1b Projected to $1.7b by 2038	Incidence- and prevalence based Bottom-up gross costing	Societal
International evidence								
Alcohol (Scotland)	Scottish Government Social Research 2010	2007	GBP 2007	$982	$3175	£8.8b to £16.9b	Prevalence-based Mixed methods (some top-down, some bottom-up) gross costing Attributable costs	Societal
Alcohol (Leeds, UK)	Jones et al. 2010	2008/09	GBP 2008	$69m	$407	$1510m	Prevalence-based Mixed methods (some top-down, some bottom-up) gross costing Attributable costs	Societal
Alcohol (Northern Ireland)	McClure Walters 2010	2008/09	GBP 2009	$241m-$423m	Lost productivity: $388m-$690m	Social care: $91m-$219 Fire & police: $450m- $747m Justice: $171m-$278m	Bottom-up (health) and top-down macro-costing	Societal
Alcohol (Portugal)	Cortez Pinto et al. 2010	2005	Euro 2005	0.13% of GDP			Bottom-up gross costing Alcohol	Public health system (hospital costs only)

							attributable risk-based	
Tobacco (Global)	Goodchild, Nargis, and Tursan d' Espaignet 2018		USD 2012	$631 5.7% of health spending globally, 6.5% for high income countries	$1516b	$2146b 1.8% of GDP globally, 2.2% for high income countries	Meta analysis Attributable costs	Societal
Cardiovascular diseases – Heart failure (Global)	Cook et al. 2014	1990-2013	USD 2012	$97b per annum globally	$64b per annum globally	$161b per annum globally	Meta analysis Attributable costs	Societal
Cardiovascular diseases (Japan)	Hirata et al. 2021	2007-2017	JPY 2017	$24b per annum	$36.5b per annum	$70.48b per annum	Prevalence-based bottom-up gross costing	Societal
Cardio-vascular diseases (Denmark)	Bundagaard et al. 2019	2019	Euro 2016	$13,490 PPPY excess cost	$6,146 PPPY excess cost	$19,636 PPPY excess total cost	Bottom-up gross costing Excess costs	Societal
Chronic kidney disease (US)	Vupputuri et al. 2014	2010	USD 2010	$18,802 to $108,890 PPPY			Retrospective cohort analysis Bottom-up gross costing Excess costs	Health system (public + private)
Chronic kidney disease (multi-country)	Kent et al. 2015	2003-2010	GBP 2010/11	$27,036 PPPY			RCT-based costing study Top-down gross costing Attributable costs	Public health system (hospital costs only)
COPD (Global)	Ehsteshami-Afshar et al. 2016	2001-2009	USD (year not stated)	$1,400-$5,920 PPPY	$256-$7,757 PPPY		Literature review Attributable costs and excess costs	Societal
COPD (Germany)	Kirsch et al. 2019	Not stated	Euros 2018	GOLD grade 1 to 4 costs PPPY were $8,115, $9,127, $11,820, and $17,703	GOLD grade 1 to 4 costs PPPY were $25,107, $27,666,		Bottom-up gross costing	Societal

					$33674, and $41,338			
Gout (Taiwan)	Lee et al. 2018	2008-2010	USD 2011	$2,637 average (mean) cost compared with $2,084 for matched controls				Public health system
Gout (US)	Jackson et al. 2015	2009-2012	USD 2011	$2,806 to $7,031 PPPY depending on flare frequency			Retrospective cohort analysis Bottom-up gross costing	Health plan
Gout (Netherlands)	Spaetgens et al. 2015	2011-2012	Euro 2014	$4,591 PPPY	$9,752 PPPY	$20,247 PPPY (incl. home help and informal care)	Bottom-up micro-costing	Societal
HIV/AIDS	Krentz, Vu and Gill, 2019	2006-2017	Cdn2014	$2,488 PPPM (2017)				Health system
Osteo-porosis (Italy)	Marcellusi et al. 2020	2017	Euro 2017	$3.1 billion inpatient costs per annum (80% of total fiscal costs)		$3.8 billion per annum (including health system and social security)	Prevalence-based Bottom-up gross costing	Health system + social security (disability allowance and pensions)
Rheumatic fever (Australia)	Wyber et al. 2018	2014-2016	AUD 2015	$33 m (future health care costs of current ARF and RHD population) $421m (cost of health care for new cases of ARF and RHD from 2016 to 2031)			Prevalence and incidence-based disease trajectory model Bottom-up gross costing	Public health system
Rheumatic fever (South Africa)	Hellebo et al. 2021	2017	USD 2017	$3 m tertiary hospital costs only for 100 patients per annum $6,000 PPPY			Bottom-up micro-costing	Health system

Notes:
Studies are listed in the order they appear in the report. See section 6 on considerations for comparing cost-of-illness estimates.
* Barton and Love (Sapere) 2021: Values are published as 2021 New Zealand dollars and have not been converted for this table.
RCT: Randomised controlled trial; PPPM: Per person per month; PPPY: Per person per year; YLDs: Years lost to disability; ARC: publicly funded Aged Residential Care
Indirect costs may include: Productivity costs (absenteeism, presenteeism, reduced employment), informal caregiver costs. Total costs include direct health system costs and any indirect and intangible costs (reduced quality of life, disability, morbidity and mortality costs) included in the study.

Source: NZIER

12 References

Abbott, J. H., Wilson, R., & Chua, J. (2020). Management of Osteoarthritis in the NZ Public Health System (MOA Working Papers No. 01.1/2020). Centre for Musculoskeletal Outcomes Research. Retrieved from http://hdl.handle.net/10523/10422

Barton, Ben, and Tom Love. n.d. 'Economic Impact of Excess Weight in Aotearoa', 37.

Bennett, Julie, Jane Zhang, William Leung, Susan Jack, Jane Oliver, Rachel Webb, Nigel Wilson, Dianne Sika-Paotonu, Matire Harwood, and Michael G. Baker. 2021. 'Rising Ethnic Inequalities in Acute Rheumatic Fever and Rheumatic Heart Disease, New Zealand, 2000-2018'. *Emerging Infectious Diseases* 27 (1). https://doi.org/10.3201/eid2701.191791.

Blakely, Tony, June Atkinson, Giorgi Kvizhinadze, Nick Wilson, Anna Davies, and Philip Clarke. 2015. 'Patterns of Cancer Care Costs in a Country With Detailed Individual Data'. *Medical Care* 53 (4): 302–9. https://doi.org/10.1097/MLR.0000000000000330.

Blakely, Tony, Rachel Foster, Nicholas Wilson, and Roy Costilla. 2012. *Burden of Disease Epidemiology, Equity and Cost-Effectiveness (BODE^3) Study Protocol*. Wellington, N.Z.: Dept. of Public Health, University of Otago, Wellington.

Blakely, Tony, Giorgi Kvizhinadze, June Atkinson, Joseph Dieleman, and Philip Clarke. 2019. 'Health System Costs for Individual and Comorbid Noncommunicable Diseases: An Analysis of Publicly Funded Health Events from New Zealand'. *PLOS Medicine* 16 (1): e1002716. https://doi.org/10.1371/journal.pmed.1002716.

Brodszky, Valentin, Zsuzsanna Beretzky, Petra Baji, Fanni Rencz, Márta Péntek, Alexandru Rotar, Konstantin Tachkov, Susanne Mayer, Judit Simon, and Maciej Niewada. 2019. 'Cost-of-Illness Studies in Nine Central and Eastern European Countries'. *The European Journal of Health Economics* 20 (1): 155–72.

Bundgaard, Johan S., Ulrik M. Mogensen, Stefan Christensen, Uffe Ploug, Rasmus Rørth, Rikke Ibsen, Jakob Kjellberg, and Lars Køber. 2019. 'The Economic Burden of Heart Failure in Denmark from 1998 to 2016'. *European Journal of Heart Failure* 21 (12): 1526–31. https://doi.org/10.1002/ejhf.1577.

Carswell, Alexandra C, Niamh F Hammond, Wan N Ab-Halim, Olivia P Badcock, TA Brownlee, Sarah MJ Bush, Samuel CD Clark, et al. 2015. 'Costs of Childhood Hospitalisation for Asthma'.

Choi, Hye Sook, Chin Kook Rhee, Yong Bum Park, Kwang Ha Yoo, and Seong Yong Lim. 2019. 'Metabolic Syndrome in Early Chronic Obstructive Pulmonary Disease: Gender Differences and Impact on Exacerbation and Medical Costs'. *International Journal of Chronic Obstructive Pulmonary Disease* 14: 2873–83. https://doi.org/10.2147/COPD.S228497.

Choi, Hyeon-Jin, and Eun-Whan Lee. 2019. 'Methodology of Estimating Socioeconomic Burden of Disease Using National Health Insurance (NHI) Data'. In *Evaluation of Health Services*. IntechOpen.

Cortez-Pinto, Helena, Miguel Gouveia, Luís dos Santos Pinheiro, João Costa, Margarida Borges, and António Vaz Carneiro. 2010. 'The Burden of Disease and the Cost of Illness Attributable to Alcohol Drinking--Results of a National Study'. *Alcoholism, Clinical and Experimental Research* 34 (8): 1442–49. https://doi.org/10.1111/j.1530-0277.2010.01229.x.

Deen, Frederieke S. van der, Nick Wilson, Christine L. Cleghorn, Giorgi Kvizhinadze, Linda J. Cobiac, Nhung Nghiem, and Tony Blakely. 2018. 'Impact of Five Tobacco Endgame Strategies on Future Smoking Prevalence, Population Health and Health System Costs: Two Modelling Studies to Inform the Tobacco Endgame'. *Tobacco Control* 27 (3): 278–86. https://doi.org/10.1136/tobaccocontrol-2016-053585.

Deloitte Access Economics. 2018. 'The Economic Cost of Arthritis in New Zealand in 2018'. A report for Arthritis New Zealand. https://www.arthritis.org.nz/wp-content/uploads/Economic-Cost-of-Arthritis-in-New-Zealand-2018.pdf.

Department of Health. 2012. *Long Term Conditions Compendium of Information*. Third. United Kingdom: Department of Health.

E Ma'u, S Cullum, S Yates, G Cheung, V Burholt, M Dudley, R Krishnamurthi, and N Kerse. 2021. 'Dementia Economic Impact Report 2020'. University of Auckland. https://cdn.alzheimers.org.nz/wp-content/uploads/2021/09/Dementia-Economic-Impact-Report-2020.pdf.

Ehteshami-Afshar, S., J. M. FitzGerald, M. M. Doyle-Waters, and M. Sadatsafavi. 2016. 'The Global Economic Burden of Asthma and Chronic Obstructive Pulmonary Disease'. *The International Journal of Tuberculosis and Lung Disease: The Official Journal of the International Union Against Tuberculosis and Lung Disease* 20 (1): 11–23. https://doi.org/10.5588/ijtld.15.0472.

GACD. n.d. 'Key Facts and Figures'. GACD. Accessed 22 October 2021. https://www.gacd.org/about/what-we-do/what-are-ncds/key-facts-and-figures.

Goodchild, Mark, Nigar Nargis, and Edouard Tursan d'Espaignet. 2018. 'Global Economic Cost of Smoking-Attributable Diseases'. *Tobacco Control* 27 (1): 58–64. https://doi.org/10.1136/tobaccocontrol-2016-053305.

Health and Disability System Review. 2020. 'Health and Disability System Review - Final Report - Pūrongo Whakamutunga'. Wellington: HDSR. https://systemreview.health.govt.nz/assets/Uploads/hdsr/health-disability-system-review-final-report.pdf.

Health Quality & Safety Commission. 2021a. 'Bula Sautu – A Window on Quality 2021: Pacific Health in the Year of COVID-19'. Wellington: Health Quality & Safety Commission.

———. 2021b. 'Gout: Key Findings 2019'. 2021. https://www.hqsc.govt.nz/assets/Health-Quality-Evaluation/Atlas/Gout/Infographic_gout_Mar_2021.pdf.

Hellebo, Assegid G., Liesl J. Zuhlke, David A. Watkins, and Olufunke Alaba. 2021. 'Health System Costs of Rheumatic Heart Disease Care in South Africa'. *BMC Public Health* 21 (1): 1303. https://doi.org/10.1186/s12889-021-11314-6.

Hirata, Koki, Kunichika Matsumoto, Ryo Onishi, and Tomonori Hasegawa. 2021. 'Changing Social Burden of Japan's Three Major Diseases Including Long-Term Care Due to Aging'. *Public Administration and Policy* 24 (2): 152–64. https://doi.org/10.1108/PAP-04-2021-0025.

Hogan, Sarah, and Prince Siddharth. 2018. 'The Social and Economic Costs of Stroke in New Zealand'. A rpeort for the Stroke Foundation. Wellington: NZIER.

———. 2020. 'The Social and Economic Costs of Stroke in New Zealand - 2020 Update'. A rpeort for the Stroke Foundation. Wellington: NZIER. https://nzier.org.nz/publication/the-social-and-economic-costs-of-stroke-in-new-zealand-2020-update.

Howden-Chapman, Philippa, Anna Matheson, Julian Crane, Helen Viggers, Malcolm Cunningham, Tony Blakely, Chris Cunningham, et al. 2007. 'Effect of Insulating Existing Houses on Health Inequality: Cluster Randomised Study in the Community'. *BMJ (Clinical Research Ed.)* 334 (7591): 460. https://doi.org/10.1136/bmj.39070.573032.80.

IHME. 2015. 'New Zealand'. Institute for Health Metrics and Evaluation. 9 September 2015. http://www.healthdata.org/new-zealand.

Jackson, Robert, Aki Shiozawa, Erin K. Buysman, Aylin Altan, Stephanie Korrer, and Hyon Choi. 2015. 'Flare Frequency, Healthcare Resource Utilisation and Costs among Patients with Gout in a Managed Care Setting: A Retrospective Medical Claims-Based Analysis'. *BMJ Open* 5 (6): e007214. https://doi.org/10.1136/bmjopen-2014-007214.

Jo, Changik. 2014. 'Cost-of-Illness Studies: Concepts, Scopes, and Methods'. *Clinical and Molecular Hepatology* 20 (4): 327–37. https://doi.org/10.3350/cmh.2014.20.4.327.

Jones, Lisa, Geoff Bates, Ellie McCoy, Claire Tiffany, Clare Perkins, and Mark Bellis. n.d. 'The Economic and Social Costs of Alcohol-Related Harm in Leeds 2008-09', 76.

Kent, Seamus, Iryna Schlackow, Jingky Lozano-Kühne, Christina Reith, Jonathan Emberson, Richard Haynes, Alastair Gray, et al. 2015. 'What Is the Impact of Chronic Kidney Disease Stage and Cardiovascular Disease on the Annual Cost of Hospital Care in Moderate-to-Severe Kidney Disease?' *BMC Nephrology* 16 (1): 65. https://doi.org/10.1186/s12882-015-0054-0.

Kirsch, Florian, Anja Schramm, Larissa Schwarzkopf, Johanna I. Lutter, Boglárka Szentes, Manuel Huber, and Reiner Leidl. 2019. 'Direct and Indirect Costs of COPD Progression and Its Comorbidities in a Structured Disease Management Program: Results from the LQ-DMP Study'. *Respiratory Research* 20 (1): 215. https://doi.org/10.1186/s12931-019-1179-7.

Krentz, H. B., Q. Vu, and M. J. Gill. 2020. 'Updated Direct Costs of Medical Care for HIV-Infected Patients within a Regional Population from 2006 to 2017'. *HIV Medicine* 21 (5): 289–98. https://doi.org/10.1111/hiv.12824.

Lajoie, Julie. 2015. 'Understanding the Measurement of Global Burden of Disease'. NCCID Project No. 147. National Collaborating Centre for Infectious Diseases. https://nccid.ca/publications/understanding-the-measurement-of-global-burden-of-disease/.

Lal, Anita, Marj Moodie, Toni Ashton, Mohammad Siahpush, and Boyd Swinburn. 2012. 'Health Care and Lost Productivity Costs of Overweight and Obesity in New Zealand'. *Australian and New Zealand Journal of Public Health* 36 (6): 550–56.

Lao, Chunhuan, Mohana Mondal, Marion Kuper-Hommel, Ian Campbell, Michael P. Cameron, and Ross Lawrenson. 2021. 'Breast Cancer Costs in New Zealand's Public Health System'. *The New Zealand Medical Journal* 134 (1545): 36–46.

Laramée, Philippe, Jeanette Kusel, Saoirse Leonard, Henri-Jean Aubin, Clément François, and Jean-Bernard Daeppen. 2013. 'The Economic Burden of Alcohol Dependence in Europe'. *Alcohol and Alcoholism (Oxford, Oxfordshire)* 48 (3): 259–69. https://doi.org/10.1093/alcalc/agt004.

Lee, Yi-Yun, Chao-Hsiun Tang, Jin-Hua Chen, Li-Na Kuo, and Yu Ko. 2018. 'Evaluation of Healthcare Costs and Utilization for Patients with Gout: A Population-Based Matched Cohort Study'. *Current Medical Research and Opinion* 34 (4): 735–40. https://doi.org/10.1080/03007995.2017.1417826.

Lensberg, Benedikte R., Michael F. Drummond, Natalya Danchenko, Nicolas Despiégel, and Clément François. 2013. 'Challenges in Measuring and Valuing Productivity Costs, and Their Relevance in Mood Disorders'. *ClinicoEconomics and Outcomes Research: CEOR* 5: 565.

Lopez, Alan D., Thomas N. Williams, Adeera Levin, Marcello Tonelli, Jasvinder A. Singh, Peter GJ Burney, Jürgen Rehm, Nora D. Volkow, George Koob, and Cleusa P. Ferri. 2014. 'Remembering the Forgotten Non-Communicable Diseases'. *BMC Medicine* 12 (1): 200. https://doi.org/10.1186/s12916-014-0200-8.

Marcellusi, Andrea, Maria Assunta Rotundo, Claudia Nardone, Paolo Sciattella, Simone Gazzillo, Maurizio Rossini, Mario Barbagallo, Amalia Antenori, Domenico Valle, and Francesco Saverio Mennini. 2020. 'Osteoporosis: Economic Burden of Disease in Italy'. *Clinical Drug Investigation* 40 (5): 449–58. https://doi.org/10.1007/s40261-020-00904-8.

Market Economics. 2013. 'The Costs of Physical Inactivity: Toward a Regional Full-Cost Accounting Perspective'. A Report Prepared for Auckland Council, Waikato Regional Council and the Wellington Regional Strategy Committee. https://www.waikatoregion.govt.nz/assets/PageFiles/25488/The_Costs_of_Physical_Inactivity.PDF.

Mason, Kylie, and Barry Borman. 2016. 'Burden of Disease from Second-Hand Smoke Exposure in New Zealand'. *New Zealand Medical Journal* 129 (1432). https://www.nzma.org.nz/journal-articles/burden-of-disease-from-second-hand-smoke-exposure-in-new-zealand.

Milne, Richard J., Diana Lennon, Joanna M. Stewart, Stephen Vander Hoorn, and Paul A. Scuffham. 2012. 'Mortality and Hospitalisation Costs of Rheumatic Fever and Rheumatic Heart Disease in New Zealand'. *Journal of Paediatrics and Child Health* 48 (8): 692–97. https://doi.org/10.1111/j.1440-1754.2012.02446.x.

Ministry of Health. 2009. ‘Report on New Zealand Cost-of-Illness Studies on Long-Term Conditions’. Wellington: Ministry of Health. https://www.health.govt.nz/publication/report-new-zealand-cost-illness-studies-long-term-conditions.

———. 2013. *Health Loss in New Zealand: A Report from the New Zealand Burden of Diseases, Injuries and Risk Factors Study, 2006-2016*. https://www.health.govt.nz/system/files/documents/publications/health-loss-in-new-zealand-final.pdf.

Mizdrak, Anja, Tony Blakely, Christine L. Cleghorn, and Linda J. Cobiac. 2019. ‘Potential of Active Transport to Improve Health, Reduce Healthcare Costs, and Reduce Greenhouse Gas Emissions: A Modelling Study’. *PLOS ONE* 14 (7): e0219316. https://doi.org/10.1371/journal.pone.0219316.

Mizdrak, Anja, Ding Ding, Christine Cleghorn, Tony Blakely, and Justin Richards. 2021. ‘Hitting the Target but Missing the Point? Modelling Health and Economic Impacts of Different Approaches to Meeting the Global Action Plan for Physical Activity Target’. *Sports Medicine* 51 (4): 815–23. https://doi.org/10.1007/s40279-020-01398-2.

Nghiem, Nhung, Tony Blakely, Linda J. Cobiac, Amber L. Pearson, and Nick Wilson. 2015. ‘Health and Economic Impacts of Eight Different Dietary Salt Reduction Interventions’. *PLOS ONE* 10 (4): e0123915. https://doi.org/10.1371/journal.pone.0123915.

Nghiem, Nhung, Nick Wilson, and Tony Blakely. 2015. ‘Online Report: Technical Background to the Cardiovascular Disease Model Used in the BODE3 Programme’.

Nord, Erik. 2011. ‘Discounting Future Health Benefits: The Poverty of Consistency Arguments’. *Health Economics* 20 (January): 16–26. https://doi.org/10.1002/hec.1687.

Onukwugha, Eberechukwu, Jacquelyn McRae, Alex Kravetz, Stefan Varga, Rahul Khairnar, and C. Daniel Mullins. 2016. ‘Cost-of-Illness Studies: An Updated Review of Current Methods’. *PharmacoEconomics* 34 (1): 43–58. https://doi.org/10.1007/s40273-015-0325-4.

Pike, Jamison, and Scott D. Grosse. 2018. ‘Friction Cost Estimates of Productivity Costs in Cost-of-Illness Studies in Comparison with Human Capital Estimates: A Review’. *Applied Health Economics and Health Policy* 16 (6): 765–78. http://dx.doi.org.ezproxy.canterbury.ac.nz/10.1007/s40258-018-0416-4.

PwC. 2021. ‘The Economic and Social Cost of Type 2 Diabetes’. This study was conducted by PwC and funded by: Diabetes New Zealand; Edgar Diabetes and Obesity Research Centre (University of Otago); Healthier Lives – He Oranga Hauora National Science Challenge and Tony & Heather Falkenstein.

Rosser, R, and P Kind. 1978. ‘Scale of Valuations of States of Illness: Is There a Social Consensus? | International Journal of Epidemiology | Oxford Academic’. *International Journal of Epidemiology* 7 (4). doi: 10.1093/ije/7.4.347.

Schlichting, D, T Fadason, C Grant, and J O’Sullivan. 2021. ‘Childhood Asthma in New Zealand: The Impact of Ongoing Socioeconomic Disadvantage (2010–2019)’. *New Zealand Medical Journal* 134 (1533). https://www.proquest.com/openview/905c8051372286893abd56115c4c5543/1?pq-origsite=gscholar&cbl=1056335.

Sheridan, Nicolette F., Timothy W. Kenealy, Martin J. Connolly, Faith Mahony, P. Alan Barber, Mary Anne Boyd, Peter Carswell, et al. 2011. ‘Health Equity in the New Zealand Health Care System: A National Survey’. *International Journal for Equity in Health* 10 (1): 45. https://doi.org/10.1186/1475-9276-10-45.

Špacírová, Zuzana, David Epstein, Leticia García-Mochón, Joan Rovira, Antonio Olry de Labry Lima, and Jaime Espín. 2020. ‘A General Framework for Classifying Costing Methods for Economic Evaluation of Health Care’. *The European Journal of Health Economics* 21 (4): 529–42.

Špacírová, Zuzana, David Epstein, Leticia García-Mochón, Joan Rovira, Antonio Olry de Labry Lima, and Jaime Espín. 2020. ‘A General Framework for Classifying Costing Methods for Economic

Evaluation of Health Care'. *The European Journal of Health Economics* 21 (4): 529–42. https://doi.org/10.1007/s10198-019-01157-9.

Spaetgens, Bart, José M. A. Wijnands, Caroline van Durme, Sjef van der Linden, and Annelies Boonen. 2015. 'Cost of Illness and Determinants of Costs among Patients with Gout'. *The Journal of Rheumatology* 42 (2): 335–44. https://doi.org/10.3899/jrheum.140679.

Svensen, Georgina, Bridget Kool, and Sarah Buller. 2019. 'The Burden of Alcohol-Related Presentations to a Busy Urban New Zealand Hospital Emergency Department'. *The New Zealand Medical Journal* 132 (1504): 56–66.

Telfar Barnard, Lucy, Michael Baker, Nevil Pierse, Jane Zhang, and Asthma and Respiratory Foundation of New Zealand. 2015. 'The Impact of Respiratory Disease in New Zealand: 2014 Update'.

Telfar Barnard, Lucy, and Jane Zhang. 2019. 'The Impact of Respiratory Disease in New Zealand: 2018 Update'. This report was prepared for the Asthma and Respiratory Foundation NZ. https://www.asthmafoundation.org.nz/assets/images/NZ-Impact-Report-2018_FINAL.pdf.

Vupputuri, Suma, Teresa M. Kimes, Michael O. Calloway, Jennifer B. Christian, David Bruhn, Alan A. Martin, and Gregory A. Nichols. 2014. 'The Economic Burden of Progressive Chronic Kidney Disease among Patients with Type 2 Diabetes'. *Journal of Diabetes and Its Complications* 28 (1): 10–16. http://dx.doi.org.wcl.idm.oclc.org/10.1016/j.jdiacomp.2013.09.014.

Wilson, Nick, Nhung Nghiem, Helen Eyles, Cliona Ni Mhurchu, Emma Shields, Linda J. Cobiac, Christine L. Cleghorn, and Tony Blakely. 2016. 'Modeling Health Gains and Cost Savings for Ten Dietary Salt Reduction Targets'. *Nutrition Journal* 15 (1): 44. https://doi.org/10.1186/s12937-016-0161-1.

Wilson, Ross, and J. Haxby Abbott. 2019. 'The Projected Burden of Knee Osteoarthritis in New Zealand: Healthcare Expenditure and Total Joint Replacement Provision'. *The New Zealand Medical Journal* 132 (1503): 53–65.

World Health Organization. 2013. 'Global Action Plan for the Prevention and Control of NCDs 2013-2020'. https://www.who.int/publications-detail-redirect/9789241506236.

———. 2014. 'Noncommunicable Diseases Global Monitoring Framework: Indicator Definitions and Specifications'. 2014. https://www.who.int/nmh/ncd-tools/indicators/GMF_Indicator_Definitions_Version_NOV2014.pdf.

———. 2018. 'Noncommunicable Diseases: Key Facts'. 2018. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.

Wyber, Rosemary, Jeffery Cannon, Judith Katzenellenbogen, Catherine Halkon, Kate Harford, Catalina Lizama, and Caroline Wise. 2018. 'Cost of Inaction on Rheumatic Heart Disease', 22.

Zemedikun, Dawit T., Jesse Kigozi, Gwenllian Wynne-Jones, Alessandra Guariglia, and Tracy Roberts. 2021. 'Methodological Considerations in the Assessment of Direct and Indirect Costs of Back Pain: A Systematic Scoping Review'. *PloS One* 16 (5): e0251406.