Economic impact of excess weight in Aotearoa

Collating, evaluating, and updating the evidence

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Acknowledgements

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Glossary

Abbreviation	Stands for
BMI	Body Mass Index
DALYs	Disability-adjusted life years
CAGR	Compounding Annual Growth Rate
GBD	Global Burden of Disease
GPA	Grade Point Average
IHD	Ischemic Heart Disease
PAF	Population Attributable Fractions
PPP	Purchasing Power Parity
QALYs	Quality-adjusted life years
VOSL	Value of statistical life
VSLY	Value of a statistical life year

Executive summary

Over the last 30 years, numerous credible reports have estimated high costs associated with overweight and obesity, highlighting an urgent need for action.

This report has not conducted any primary research; it has compiled research and data and used a variety of high-level methods to estimate and update costs associated with being overweight or obese. We have included overweight in the estimates rather than just obesity due to the definitions used and mix of approaches found in the literature. We refer to excess weight which captures overweight and obesity and is defined as high Body Mass Index (BMI).

Within health economics, a societal cost burden is typically described as having three components: direct costs, indirect costs and intangible costs. The direct costs represent health care spending, the indirect costs measure productivity losses, and the intangible costs estimate costs from the broadest perspective, attempting to capture wellbeing impacts such as pain and suffering.

Weight stigma is often due to a misunderstanding of the complex causes of obesity and a lack of knowledge on the mix of environmental and biological factors involved. The common narrative results in blaming people with obesity for their health problems and tends to perpetuate stereotyping of people with obesity as lazy and lacking willpower. Compassion and sensitivity are required when discussing the economic impact of excess weight.

The term 'obesogenic environment' was coined to refer to the influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals and populations (Swinburn, Egger, & Raza, 1999). Excess weight is at least partially driven by environmental factors, which constrain individual's ability to adjust personal diet and physical activity decisions (Hobbs & McKenna, 2019). The availability, accessibility, and affordability of energy-dense foods, along with intense marketing of such foods, are examples of environmental factors that contribute to excess energy intake and weight gain (Swinburn, et al., 2011).

Direct health care costs attributable to excess weight are approximately $2 billion per year

The average cost found in global analysis translates to $2 billion of health care costs per year for New Zealand or about 8 per cent of health care spending. Given the higher prevalence of obesity in New Zealand relative to the world average, this could be considered conservative. Analysis of New Zealand studies for obesity-related conditions results in a range of $1.3 billion to $1.8 billion in costs. If these New Zealand estimates captured 90 per cent of the total health care costs, the range would be $1.5 billion to $2 billion. Our use of the upper end of the range indicates we think the estimates would be unlikely to include more than 80 per cent of the costs.

Attribution of direct health care costs to excess weight is variable

Attribution of health care costs to conditions and risk factors is an imprecise exercise. Studies often rely on Population Attributable Fractions (PAFs) to allocate estimates of conditions like diabetes, heart disease, stroke and a range of cancers. We use a range of estimates, including very conservative ones that are likely less applicable to the New Zealand context, meaning our results are conservative.

Indirect and intangible cost estimates vary in magnitude and method

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. High-level figures from global analysis indicate around $7 billion to $9 billion in costs per year from lost productivity and labour output.

Applying a range of costs that represent estimates of different cost categories to the DALYs[1] estimates from the Global Burden of Disease (GBD) (2019) study produces a range of $2 billion to $26 billion per year attributable to the risk factor of high BMI:

- The average amount invested by Pharmac to achieve a gain of one QALY in 2020 was $32,258, adjusting and applying this value to the DALYs estimates results in a $2 to $4 billion range. This is essentially cost-effectiveness analysis or comparing the health benefits and costs of different treatment options, so it best represents the direct health care costs of reducing the DALYs attributable to high BMI.
- Many countries use cost-effectiveness thresholds recommended by the WHO's Choosing Interventions that are Cost–Effective project (WHO-CHOICE) when evaluating health interventions. This project sets the threshold for cost-effectiveness as the cost of the intervention per DALY averted, which is less than three times the country's annual gross domestic product (GDP) per capita. Highly cost-effective interventions are defined as meeting a threshold per DALY averted of the annual GDP per capita (Marseille, Larson, Kazi, Kahn, & Rosen, 2015). Using one to three times GDP per capita results in a range of $4 billion to $25 billion.
- The value of statistical life (VOSL) is maintained by Waka Kotahi (Ministry of Transport) with $4.56 million used to represent the 'social cost' of a road fatality in transport evaluations. We adjust this to reflect the social cost of a DALY and calculate the value of a statistical life year (VSLY) to be $193,737 and equate the VSLY to the value of a DALY incurred. This results in a range of $12 billion to $26 billion.

$4 billion to $9 billion in costs per year can be confidently attributed to excess weight

The range presented indicates the high level of uncertainty involved in the task. To give context to these large numbers, $4 billion to $9 billion is around 1.2 to 2.8 per cent of GDP or $800 to $1,800 per person per year, which equates to around one to two weeks' work at the median wage.

[1] DALYs estimates are commonly used to measure the burden of disease and disability in health economics. They are units of measure of lost health and account for both losses in length (mortality) and quality of life (morbidity).

1. Introduction

Hāpai is part of a working group representing a coalition of non-profit, civil society, academic, and public sector organisations that commissioned Sapere to add to the knowledge base around the impact of New Zealand's obesogenic food environment and policy settings.

1.1 Objectives

The overall objective for this work is to provide a robust estimate of the current cost of excess weight to New Zealand. A broad perspective of costs is used so that the full economic cost borne by society – including the opportunity cost of resources, productivity impacts and wellbeing – is taken into consideration rather than focusing on the direct health care costs.

1.2 Scope

No primary research has been undertaken for this report other than consultation with those familiar with the health care data sets and the costs attributable to obesity. This report collates and updates the available data and examines the strength of evidence to provide an estimate of the current costs of overweight and obesity to New Zealand.

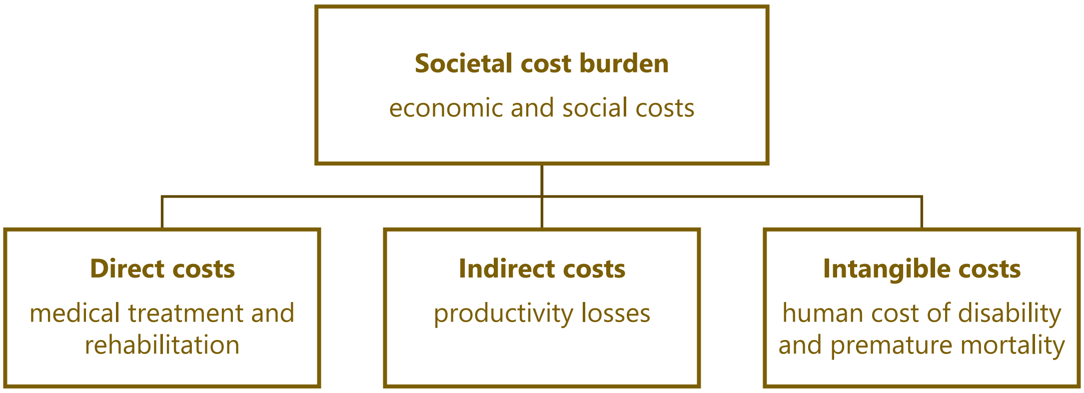
1.3 Method

Within health economics, a societal cost burden is typically described as having three components: direct costs, indirect costs and intangible costs. We estimate the societal cost burden of high BMI (which captures both obesity and overweight) in the form of:

- **Direct costs** – those relating to the medical treatment of obesity and related conditions. These have tended to rely on Population Attributable Fractions (PAFs).
- **Indirect costs** – includes the lost productivity resulting from excess weight.
- **Intangible costs** – the pain, stress, physical limitations, and loss of life as a result of excess weight do not easily translate into dollar terms. However, as the evidence suggests these costs are considerable, we use the Global Burden of Disease (GBD) 2019 study disability-adjusted life years (DALYs) attributed to high BMI and two methods to monetise: the value of a statistical life or a cost to save a life approach.

This guiding framework is shown in Figure 1.

Figure 1: Framework of costs



1.4 Report structure

The report looks at the change in prevalence of high BMI, then estimates the health care costs from both high-level methods and a more granular, condition-based approach. Indirect costs are estimated with a short narrative explaining the mechanisms that contribute to these costs. A variety of methods to monetise the intangible costs are described.

We review three New Zealand studies that estimate the costs of overweight and obesity:

- Swinburn, et al. (1997)
- Lal, Moodie, Ashton, Siahpush, & Swinburn (2012)
- Clough & Destremau (2015).

We apply some of the findings from these New Zealand studies to generate estimates for health care costs of specific conditions. International studies are used to benchmark New Zealand costs and examine the relative strength of previous estimates. A variety of methods are used to update costs, along with a wide variety of literature to sense-check estimates and help with the challenge of attribution.

We apply a range of costings to GBD (2019) data on DALYs attributable to high BMI to illustrate the potential full costs and sense-check other estimates.

2. Prevalence

Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of their height in metres (kg/m^2). The WHO definition is:

- a BMI greater than or equal to 25 kg/m^2 is overweight
- a BMI greater than or equal to 30 kg/m^2 is obesity.

BMI provides a useful population-level measure of excess weight (overweight and obesity) as it is the same for both sexes and for all ages of adults. However, it should be considered a rough guide because it may not correspond to the same degree of excess weight in different individuals (WHO, 2021).

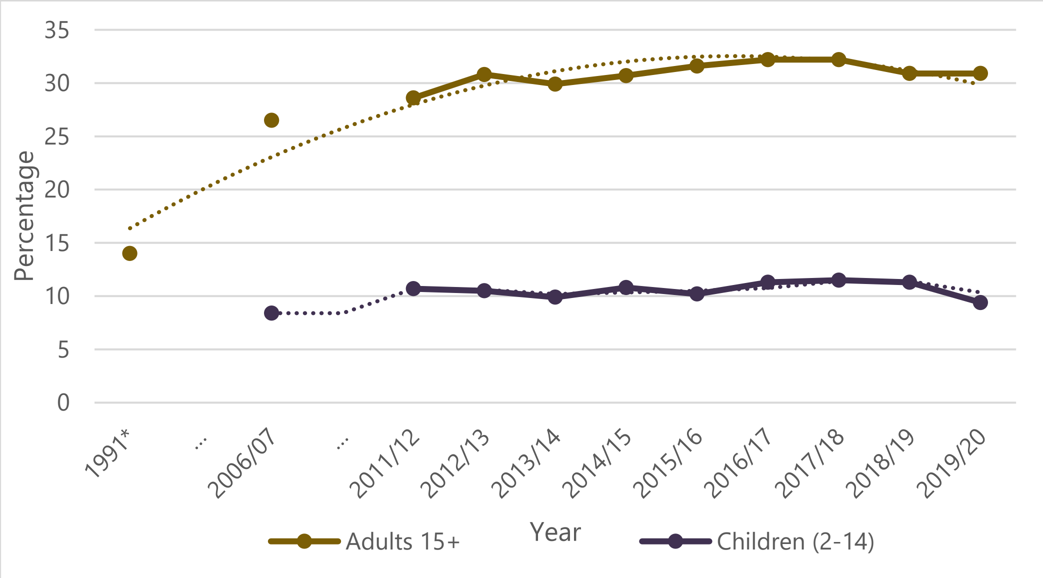
The World Health Organization (WHO) describes the prevalence of obesity as an epidemic.

> New Zealand has the third highest adult obesity rate in the OECD, and our rates continue to increase. One in three adult New Zealanders (over 15 years) is classified as obese, and one in ten children (MoH, 2020).

Recently, obesity rates in New Zealand have been relatively stable with some variance among groups.

- The 2019/20 prevalence of obesity among adults aged 15+ years was 30.9 per cent, which corresponds to an estimated 1.24 million adults. This prevalence has remained relatively stable since 2012/13.
- There has been an increase between 2011/12 and 2019/20 for adults aged 45–54 years and 55–64 years.
- In 2019/20 around 79,000 or 9.4 per cent of children aged 2–14 years were classified as obese. The child obesity rate has decreased since 2018/19, and while this has decreased since last year, it is too early to report a trend (MoH, 2020).

Figure 2: Obesity prevalence changes (percentage of population)



Source: Ministry of Health, * (Swinburn, et al., 1997)[2] Note the gaps in data are filled with trend lines.

Poverty increases likelihood of obesity

The prevalence of obesity varies among New Zealand's different socio-economic groups. Individuals living in socially and economically deprived areas are more likely to have obesity. Pacific peoples and Māori are much more likely to live in socially and economically deprived areas than European/other New Zealanders and are more likely to have obesity. By ethnic group, prevalence is highest among Pacific peoples (63.4 per cent), followed by Māori (47.9 per cent), European/other (29.3 per cent) and Asian adults (15.9 per cent) (MoH, 2020).

After adjusting for age, gender and ethnic differences, children living in the most socioeconomically deprived areas were 2.7 times as likely to have obesity as children living in the least deprived areas.

Māori adults were 1.8 times as likely to have obesity as non-Māori, and Pacific adults were 2.3 times as likely to have obesity as non-Pacific adults, after adjusting for age and gender.

Pacific children were 4.7 times as likely, and Māori children 1.6 times as likely to have obesity as non-Pacific and non-Māori children respectively, after adjusting for age and gender.

[2] The prevalence of obesity (BMI>30 kg/m2) for the population in 1991 was taken from two sources: the Life in New Zealand study (n=3204), which reported a prevalence of 13.1% for men and 14.7% for women aged 25–65+ y, and the Auckland Heart and Health Survey of 1993/4 (N=2518) which showed a prevalence of 13.8% for men and 15.6% for women aged 35–84 y. An overall value of 14% was therefore used as the prevalence of obesity in the population developing obesity-related diseases (Swinburn, et al., 1997).

3. Direct health care costs

Treatment for overweight and obesity itself is rarely a public cost, thus the costs associated with excess weight are largely those that come from treating diseases linked to high BMI. Methodological issues and an expanding list of medical conditions associated with excess weight make it difficult to accurately estimate the full cost.

Excess weight is associated with many health conditions, including type 2 diabetes, cardiovascular diseases, several types of cancer, musculoskeletal disorders, osteoarthritis, sleep apnoea, depression, and reproductive abnormalities in adults. The additional cost increases with BMI, so people with severe obesity face the highest health care costs (Effertz et al., 2016, cited in Vuik et al., 2019).

Two previous NZ estimates of health care costs are based on data when the obesity prevalence was significantly lower.

> Swinburn, et al., (1997) provided a snapshot of the estimated costs of obesity in a single year. The 1991 health care costs of non-insulin dependent diabetes, coronary heart disease, hypertension, gallstone disease, post-menopausal breast cancer and colon cancer were estimated and multiplied by the population attributable factor for obesity for each condition. This produced an estimate of $135m or about 2.5 per cent of health care costs.
>
> Lal, Moodie, Ashton, Siahpush, & Swinburn, (2012) used 2006 data on health care costs attributable to overweight and obesity to estimate NZ$624m or 4.4% of New Zealand's total health care expenditure in 2006.

These estimates are comparable as Swinburn, et al., (1997) only estimate the costs of obesity while Lal, et al., (2012) count the costs of overweight and obesity. Based on 2020 health care expenditure of $22 billion these estimates of obesity-related healthcare costs of 2.5 and 4% of health expenditure translate into current costs of between $560 million and almost $1 billion. These updated estimates do not factor in the change in overweight and obesity prevalence since the previous reports were undertaken. Prevalence of obesity has increased by around 120 per cent since 1991 and by about 17 per cent since 2006. Prevalence of overweight and obesity has increased by around 6 per cent since 2006.

An Australian estimate by Colagiuri et al. (2010) put the total annual excess direct cost of overweight and obesity in Australia in 2005 at $10.7 billion. A direct adjustment for only population differences equates to around $2.1 billion for New Zealand

Colagiuri et al. (2010) estimate costs due to overweight and obesity relative to the normal-weight population, whereas Swinburn, et al., (1997) and Lal, et al., (2012) rely on Population Attributable Fractions (PAFs), a common and useful method of quantifying the burden of disease attributable to a specific risk factor. PAFs take into account both the strength of the association between the risk factor and disease and the wider population health exposure or prevalence of that risk factor (Tunaiji, Davis, Mackey, & Khan, 2014).

A review of PAF estimates concludes that PAFs for obesity may be best considered as indicators of association but are interpreted as causal in the analyses (Flegal, Panagiotou, & Graubard, 2015). For obesity relative to cancer, diabetes, cardiovascular disease and all-cause mortality, there is considerable variability among studies regarding the methods used for PAF calculation and the selection of appropriate counterfactuals. The reported estimates ranged from 5 per cent to 15 per cent for all-cause mortality, -0.2 per cent to 8 per cent for all-cancer incidence, 7 per cent to 44 per cent for cardiovascular disease incidence, and 3 per cent to 83 per cent for diabetes incidence (Flegal, Panagiotou, & Graubard, 2015). This is not surprising given the different contexts of the studies and differences in prevalence of high BMI across countries, ethnicities, sex and age. The prevalence of high BMI in New Zealand makes the lower end of these ranges less relevant.

Vuik, Lerouge, Guillemette, Feigl, & Aldea (2019) look across 52 countries, to find excess weight is on average responsible for 70 per cent of all diabetes-related health expenditure and will account for 23 per cent of cardiovascular disease (CVD) related health expenditure, 9 per cent for cancers and 18 per cent for dementia. The high-level suggestion is that countries will spend around 8 per cent of their health care budget on treating excess weight and related conditions, or around $1.8 billion based on 2020 New Zealand government health expenditure.

The rest of this section examines recent cost estimates for conditions and groups of conditions associated with high BMI to provide a bottom-up estimate to compare with the high-level updates and comparisons summarised above.

3.1 Diabetes

Type 2 diabetes is a preventable, complex, progressive and chronic disease characterised by elevated blood glucose levels over an extended time period. There are a wide range of serious complications associated with the condition.

PwC (2021) reports publicly funded health costs borne by the Government of approximately $1 billion, which are projected to increase by approximately $857 million over the next 20 years.

While there is a concerning trend of children and young people developing type 2 diabetes, the risk of type 2 diabetes increases with age and excess weight (Mayo Clinic Staff, 2021; PwC, 2021).

New Zealand has a serious and growing diabetes problem

The number of New Zealanders with type 2 diabetes in 2018 was estimated to be 228k, which equates to a population prevalence of 4.7 per cent. The number of people with type 2 diabetes is projected to increase by between 70–90 per cent by 2040, to a total of between 390-430k people, a population prevalence of 6.6–7.4 per cent (PwC, 2021).

The Ministry of Health (MoH) type 2 diabetes proxy reports a slightly higher prevalence of 5.9 per cent in 2019/20, based on the New Zealand Health Survey.

Table 1: Diabetes prevalence in New Zealand

Year	Diabetes	NZ Population	Prevalence
2018	228,000	4,841,000	4.7%
2021	245,000	5,122,600	4.8%

Source: (PwC, 2021), Statistics New Zealand (2021)

To calculate the 2021 prevalence, we use the lower range of the PwC forecast Compounding Annual Growth Rate (CAGR) of 2.4 per cent and the Statistics New Zealand population in June 2021.

We use the same method to update the health care costs to 2021-dollar terms.

Table 2: Total annual cost of type 2 diabetes in New Zealand ($ millions)

Category	2020	% change per year	2021 (forecast)
Medications	$197	3.0%	$203
Laboratory costs	$59	2.9%	$61
Secondary care costs	$607	3.2%	$626
Primary care costs – publicly funded	$136	3.0%	$140
Primary care costs – self funded	$68	3.0%	$70
Total costs	$1,066	3.1%	$1,099

Source: (PwC, 2021)

Recent analysis of the excess cost of diabetes for Counties Manukau health finds the health care costs for people with diabetes aged 15-64 in metro Auckland are $3,359 higher per year per person than the health care costs for people without diabetes. Adjusting this figure to 2021-dollar terms and scaling for the total number of people with diabetes in New Zealand produces a total cost of around $870 million (Jackson, 2021).

Population Attributable Fractions (PAFs)

As seen in the discussion above, there is little consensus on the value and accuracy of PAFs. We present the impact of different PAFs on the health care cost estimates in the table below. Note some of the PAFs relate to obesity and others include overweight.

Table 3: Diabetes range of Population Attributable Fractions for high BMI ($ millions)

Obesity PAFs	PAFs	Costs
(Swinburn, et al., 1997)	69%	758
(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	45%	499
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019)	70%	769
(Flegal, Panagiotou, & Graubard, 2015)	3%	33
	83%	912

Flegal, Panagiotou, & Graubard's (2015) review finds almost all studies show relatively high attributable fractions for diabetes. The lowest 3 per cent reported in the table above is for women in the United States in 2002 and is much less applicable to the New Zealand context. Most estimates reviewed are over 40 per cent with about half in the 50–70 per cent range.

Based on PWC estimates of the total costs of diabetes in NZ, the proportion attributable to obesity provides a range of obesity-related diabetes costs of $499 million to $769 million.

3.2 Cardiovascular disease

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels.

CVD accounted for $501 million worth of New Zealand public hospital casemix discharges in 2011/12 (National Health Committee, 2013). Lal et al., (2012) estimates of total health care costs indicate casemix discharges represent about 29 to 41 per cent of the total health care cost for CVD (stroke, ischaemic heart disease and hypertensive heart disease). This indicates a range of $1,219 million to $1,854 million for total CVD healthcare costs.

We adjust for growth in total health expenditure from 2012 to 2020 and adjust for inflation to give a range of $1,873 million to $2,848 million in 2021-dollar terms.

Blakely, Kvizhinadze, Atkinson, Dieleman, & Clarke (2019) estimated disease-specific health system expenditure for many diseases simultaneously, finding publicly funded health events from New Zealand total allocated expenditure across seven years of $26.4 billion (in USD 2016 dollar terms), with CVD responsible for 12.5 per cent or about US$3.3 billion. Simply using the 12.5 per cent of 2020 total health expenditure and inflating to 2021-dollar terms results in $2.9 billion. Another method divides the seven-year value by seven to get a yearly amount that is then converted to NZ dollars and inflated. This produces a value of $835 million.

We present the range of $835 million to $2,895 million and the average of the estimates to get a central estimate of $2,113 million and apply the variety of available PAFs below.

Table 4: Cardiovascular disease range of Population Attributable Fractions for high BMI ($ millions)

Study		PAFs	Low	Central	High
(Swinburn, et al., 1997)	Coronary heart disease	24%	200	507	695
	Hypertension	32%	267	676	926
(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	Ischaemic heart disease	12%	100	254	347
	Hypertensive heart disease	32%	267	676	926
	Hypertension	33%	276	697	955
(Flegal, Panagiotou, & Graubard, 2015)	Cardiovascular disease	7%	58	148	203
		44%	367	930	1,274
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019)	Cardiovascular disease	18%	150	380	521
Average			**211**	**534**	**731**

Flegal et al., (2015) found PAF estimates for CVD were variable across studies, reflecting differences in populations studied, the outcome studied, the prevalence of obesity and differences in the methods used. The 7 per cent relates to a study of women in Demark so is likely the least relevant.

Taking a simple average of all PAFs presented in the table above produces $211 million to $731 million of costs attributable to high BMI. Excluding the lowest estimate of 7 per cent for coronary heart disease (CHD) in Denmark in 2002 increases the range to $233 million and $806 million.

The central result is $534 million, which increases to $589 million with the exclusion of lowest PAF.

3.2.1 Ischemic heart disease (IHD)

Coronary artery disease, also called ischaemic heart disease, happens when the major blood vessels in the heart get narrow and stiff. The prevalence of IHD in New Zealand adults was 5.5 per cent of the population in 2011-2012 (193,000 individuals). In 2011/12, $228 million was spent on 30,745 hospitalisations for 21,764 individuals with IHD (National Health Committee, 2013).

While the 2019/20 prevalence has reduced to 4.4 per cent or 177,000 adults, the health care spending may not have dropped due to people living longer and therefore consuming more health care.

To estimate the current total health care spend, we use Lal et al.'s (2012) proportion of total costs that are for hospitalisations, index for the growth in total health expenditure from 2012 to 2020 and adjust for inflation to $595 million.

Table 5: IHD range of Population Attributable Fractions for high BMI ($ millions)

Study	PAF	Costs
(Swinburn, et al., 1997) for CHD	24%	143
(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	12%	71
(Flegal, Panagiotou, & Graubard, 2015) range for CVD	7%	42
	44%	262
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019) for CVD	18%	107
Average	**21%**	**125**

Taking a simple average of all PAFs presented in the table above produces $125 million of costs attributable to high BMI. Excluding the lowest estimate of 7 per cent for coronary heart disease (CHD) in Denmark in 2002 increases the value to $146 million.

3.2.2 Stroke

Stroke represents a significant disease burden for New Zealand. It is the third highest cause of death, accounting for 8.2 per cent of all deaths in New Zealand and 4.2 per cent of all premature deaths. In 2020 dollars, these costs total $30,436 per stroke and imply an annual cost per year of $389 million for 12,410 projected stroke hospitalisations in 2020. Excluding the costs of lost productivity, premature death and quality of life, the total cost of one year of strokes in New Zealand is over $642 million (Hogan & Siddharth, 2020).[3]

Table 6: Stroke range of Population Attributable Fractions for high BMI ($ millions)

Study	PAF	Cost
(Swinburn, et al., 1997) for CHD	24%	154
(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	11%	71
(Flegal, Panagiotou, & Graubard, 2015) range for CVD	7%	45
	44%	282
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019) for CVD	18%	116
Average		**133**

Taking a simple average of all PAFs presented in the table above produces $133 million of costs attributable to high BMI. Excluding the lowest estimate of 7 per cent for CHD in Denmark in 2002 increases the value to $177 million.

3.2.3 Hypertension

High blood pressure (hypertension) is a major risk factor for heart attack and stroke. In the 2012–2016 period, one in three adults (31 per cent) could be classified as having hypertension (Ministry of Health, 2016). The condition is often under-treated, with only 14 per cent of New Zealand males and 16 per cent of females reporting use of an antihypertensive medicine (McLean, Williams, & Mann, 2013).

Literature review turned up limited information on the costs of hypertension. The most recent estimate was part of a cost of physical inactivity study which estimated direct health care costs for hypertension to be $609 million in 2010 (Market Economics, 2013).

> (Swinburn, et al., 1997) reported $116 million with $37 million attributable to obesity.
>
> (Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012) found $512 million with $167 million attributed to high BMI.

The $609 million estimate is updated by indexing to 2020 health expenditure and adjusting for inflation to $1,021 million.

Table 7: Hypertension range of Population Attributable Fractions for high BMI ($ millions)

Study	PAF	Cost
(Swinburn, et al., 1997) for CHD	32%	327

[3] Updated to 2021 dollar terms

(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	33%	337
(Flegal, Panagiotou, & Graubard, 2015) range for CVD	7%	71
	44%	449
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019) for CVD	18%	184
Average		**274**

Continuing with a simple average of all PAFs presented in the table above gives $274 million of costs attributable to high BMI. Excluding the lowest estimate of 7 per cent for CHD in Denmark in 2002 increases the value to $324 million.

3.2.4 Other CVD

Other CVD associated with high BMI had $7 million to $37 million in hospitalisation costs in 2011/12. Following the same updating approach used above to expand for all health care cost and update for changes in health care spending and inflation gives a range of $33 million to $81 million.

Using Vuik et al., (2019) PAFs for all CVD gives a range of $6 to $15 million.

3.2.5 Summary CVD

The high-level estimate for all CVD aligns well with estimates of the main diseases that fall under the category as seen in the table below. Note the actual range of estimates is much wider than reported in the table below.

Table 8: Summary of CVD estimates ($ millions)

Disease	Low	High
CVD total	**534**	**589**
Ischemic heart disease (IHD)	125	146
Stroke	133	177
Hypertension	274	324
Other CVD	6	15
Total	**538**	**662**

3.3 Cancers

Cancers for which there is convincing scientific evidence of a causal link with obesity include; oesophageal adenocarcinoma and cancers of the colon, rectum, kidney, pancreas, gallbladder, postmenopausal breast, corpus uteri, and ovarian.

Blakely, et al. (2015) found that the total public health system cost of treating cancer was $880 million annually and that excess cancer costs made up 6.5 per cent of total Vote: Health expenditure in 2010–2011. This would be around $1.5 billion based on 2020 government health expenditure, with colorectal (14.7 per cent) and breast (14.4 per cent) the top two contributors.

Blakely, Kvizhinadze, Atkinson, Dieleman, & Clarke (2019) estimate of 8.9 per cent of health care costs adjusted as in section 3.2 gives $2.1 billion.

Arnold et al. (2014) find 3.6 per cent of all new cancer cases in adults (aged 30 years and older) in 2012 were attributable to high BMI. This indicates a range of $53 million to $63 million, but if we look at Oceania rates, the average is more like 5 per cent or $77 million to $93 million.

3.3.1 Colorectal cancer

14.7 per cent of total cancer cost estimates is $214 million to $303 million. Applying a range of PAFs gives $19 million to $27 million attributable to high BMI.

Table 9: Colorectal cancer cost and Population Attributable Fractions for high BMI ($ millions)

Study	PAF	Low	High
(Swinburn, et al., 1997)	4%	9	12
(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	12%	26	36
(Arnold, et al., 2014) Colon and rectum average	11%	24	33
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019)	8%	17	24
Average		**19**	**27**

3.3.2 Breast cancer

14.4 per cent of the total cancer estimate is $210 million to $296 million. Applying a range of PAFs gives $18 million to $25 million.

Table 10: Breast cancer cost and Population Attributable Fractions for high BMI ($ millions)

Study	PAF	Cost	
(Swinburn, et al., 1997)	5%	11	15
(Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012)	9%	19	27
(Arnold, et al., 2014)	12%	25	36
(Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019)	8%	17	24

Average		**18**	**25**

3.3.3 Other cancers

Studies have attributed values to a range of other cancers, including endometrial cancer, kidney cancer and gallbladder cancer, as these make a small portion of the total burden of cancers, and given the uncertainty in the method, we have not tried to produce estimates. We feel the high-level cancer range provides sufficient guidance on the cost range attributable to all cancers.

3.4 Osteoarthritis

Osteoarthritis is the most prevalent form of arthritis in New Zealand. The risk of developing hip and knee osteoarthritis has been found to increase by 11 per cent and 35 per cent, respectively, when there is a 5-unit increase in BMI (Jiang et al, 2011, Jiang et al, 2012, cited in Deloitte Access Economics, 2018).

The total health care cost of arthritis was estimated to be $993 million in New Zealand in 2018 (Deloitte Access Economics, 2018). Updated for inflation, this is around $1035 million in 2021.

The PAFs associated with overweight or obesity differ between continents, largely depending on the prevalence of obesity. Meta-analyses in 2011 and 2014 reported PAFs ranged from 8 per cent in China to 50 per cent in the United States; and for overweight, it ranged from 13 per cent in China to 30 per cent in Norway, and in developed countries from 24 per cent to 30 per cent (Hunter & Bierma-Zeinstra, 2019).

Given the New Zealand prevalence of high BMI, using the developed countries' range of PAF produces $248 million to $310 million, which looks conservative. Given our prevalence is closer to the United States, the cost could be closer to $0.5 billion.

3.5 Summary

The sum of the costs estimates gives a range of $1.3 billion to $1.8 billion. This range fits well with the high-level estimates presented at the beginning of this section.

Table 11: Summary of direct health care cost ($ millions)

Disease/condition	Low	High
Diabetes	499	769
CVD	534	662
Cancer	53	93
Osteoarthritis	248	310
Total	**1,334**	**1,834**

3.5.1 Other diseases/conditions

We look at the top 15 GBD DALYs causes and find they are responsible for 90 per cent of all DALYs. Looking directly at the top DALY conditions that roughly align with what we have estimated, about 62 per cent of the total DALYs attributable to high BMI as shown in Table 12.

If the health care costs for diseases and conditions estimated above captured 90 per cent of the total cost, the range would increase to $1.5 billion to $2 billion. If these attempts only captured 62 per cent of the costs, the range would be $2.2 billion to $3 billion.

Table 12: Top DALY causes for high BMI that relate to healthcare cost estimates

Rank	Cause	DALY's
1	Ischemic heart disease	23,588
2	Diabetes mellitus	16,967
3	Stroke	10,788
8	Osteoarthritis	3,673
12	Hypertensive heart disease	1,684
11, 14, 15	Range of Cancers	4,600
Sum		**61,300**
Percent of total		62%

4. Indirect costs

Indirect costs relate to the loss of opportunity and productivity as a consequence of excess weight. Much of this loss can be linked to weight stigma and discrimination. People with excess weight face a disproportionate level of discrimination in the work force, education and in healthcare settings, which affects health and wellbeing over and above the effects of excess weight. This reduces an individual's opportunity to fulfil their potential, prosper and participate in the social, economic, political and cultural life of their communities and nation.

Using 2006 data, Lal et al. (2012) estimated the lost productivity costs attributable to excess weight (overweight or obese) in New Zealand lay between $98 million to $225 million, with the health costs estimated to be $624 million. Clough & Destremau (2015) used two Australian studies to suggest the non-health impacts could be much higher than the health impacts:

> Medibank Health Solutions (2010) estimate that in Australia the loss in productivity in 2008/09 due to obesity through absenteeism, presenteeism and premature death is $6.4 billion a year. In comparison, their total direct medical cost estimate of obesity was $1.3 billion. Another study by Access Economics (2008) for Australia has estimated the loss in productivity at $3.6 billion and the direct medical cost at $2 billion in 2008.

Clough & Destremau (2015) also cite INSPQ (2014), which reports on numerous US and Canadian studies that estimate both health and non-health impacts of obesity and finds that indirect costs, are at least as high as costs related to health care.

Recently, the OECD produced analyses of the burden of obesity and overweight in 52 countries, showing how excess weight reduces life expectancy, increases healthcare costs, decreases workers' productivity and lowers GDP. The work finds on average, OECD countries will lose USD PPP $863 per capita per year in labour market output due to excess weight. For New Zealand the estimate is slightly higher at almost $1,000 USD per person per year, with presenteeism accounting for nearly half of the lost output. Absenteeism and employment rate account for roughly a quarter each (Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019).

Table 13: Impact on per capita labour market output based on average wages, per year (USD PPP, average 2020-2050)

	Absenteeism	Early Retirement	Employment Rate	Presenteeism	Total
NZL	-227	-17	-258	-490	-992.5

Source: (Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019)

Converting this estimate to NZD at a rate of 1.401132 sourced from XE.com gives a value of $1,390, which results in a value of around $7.1 billion.

Vuik, Lerouge, Guillemette, Feigl, & Aldea, (2019) provide another useful high-level method to cost obesity in their finding that the combined effects of excess weight on life expectancy, health expenditure and the labour market result in GDP being 3.3 per cent lower on average in OECD countries. This would be around $10.7 billion for New Zealand. This could be considered conservative given the relatively high prevalence of high BMI in New Zealand.

Employment and wages are suppressed

If employed, individuals with a chronic disease have about 1.5 per cent more days off work due to illness. Diabetes has the most detrimental effect, increasing absenteeism by 3.4 per cent in women. Obesity increases the likelihood of absences by about 1 per cent and individuals with at least one chronic condition are almost 20 per cent more likely to retire early than those without chronic conditions (Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019).

Analyses on longitudinal datasets covering 27 European countries, Japan, the United Kingdom and Mexico were combined to understand these impacts. It was found that having at least a chronic disease is associated with an 8 per cent decrease in the probability of being employed in the following year compared to individuals with the same age and level of education that do not report a chronic disease. Individuals with at least two chronic diseases are about 17 per cent less likely to be in the workforce. (Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019).

Productivity loss, discrimination and lower educational attainment lead to lower wages and fewer education employment opportunities for workers with excess weight. There is substantial evidence that excess weight negatively impacts wages (Clough & Destremau, 2015).

Output drops

As excess weight reduces the likelihood of being employed, OECD countries will see, on average, a 0.43 per cent decrease in labour market output due to overweight-related unemployment. Excess weight also increases the number of people who retire early, decreasing the labour market output by 0.05 per cent average in OECD countries (Vuik, Lerouge, Guillemette, Feigl, & Aldea, 2019).

The next generation is disadvantaged

There is a greater likelihood within a family of children developing excess weight if their parents have excess weight. Gorstein & Grosse (1994) and Murasko (2009) find that excess weight is inversely related to family socio-economic status as measured by poverty status (or in the case of New Zealand, measured by the NZDep2006, University of Otago; see White et al. (2008), cited in Clough & Destremau (2015)).

5. Intangible costs

Valuing health and life is contentious, with little consensus on how to attribute a monetary value to DALYs. While the costs presented in this section are best thought of as illustrative, they represent the best available estimate of society's willingness to pay to save lives and improve the quality of lives.

We use Global Burden of Disease study (2019) estimates for New Zealand disability-adjusted life years (DALYs), a measure of morbidity and mortality) attributable to the risk factor of a high BMI, (defined as >= 25 kg/m^2 for adults) to update health burden estimates.

Table 14: Disability-adjusted life years attributable to high Body Mass Index for New Zealand

	Lower	Central	Upper
DALYs	64,447	98,852	135,994

Source: http://ghdx.healthdata.org/gbd-results-tool

Monetising DALYs

The most common methods used to monetise DALYs fall into two categories.

- Willingness-to-pay (WTP) methodologies. These methodologies typically estimate the value of health or life through either revealed preference or stated preference approaches. The monetised value is the result of the question, "How much are you willing-to-pay for…?" In this case, it would be, "How much are you willing to pay to reduce a specified loss in health?"
- Cost-effectiveness threshold methodologies. These methodologies are typically used in health economics to help determine if a health intervention would be considered cost-effective, or 'value for money'. For instance, the United Kingdom's National Institute for Health and Care Excellence typically considers an intervention cost-effective if it would cost between £20-30,000 per quality-adjusted life year (QALY), or of course, less.[4] Similarly, the WHO has often used the concept that a health intervention is cost-effective if it would cost between one and three times the annual GDP per capita per QALY.

In many ways these are similar approaches. The cost-effectiveness threshold methodologies are assumed to implicitly have answered the willingness-to-pay value for a DALY averted/QALY gained. That is, a society is willing to pay up to the threshold for a DALY averted/QALY gained.

Where the approaches differ is what is considered within the "value" of a QALY gained versus the value of a DALY averted.[5] Cost-effectiveness thresholds are typically used where the only societal

[4] A quality-adjusted life year (QALY) is similar in concept to a DALY. It also accounts for quality and length of life, although does so on the opposite scale, that is one QALY is equal to one year lived in perfect health, whereas one DALY is one year of perfect health lost. Due to the nature of the measures, QALYs are typically used for health technology assessments which ask the question, "How much health can we gain (and for what cost)?" DALYs on the other hand are typically used in burden of disease studies, which ask the question, "How much health are we losing?"

[5] See Appendix A for description of DALYs and QALYs.

benefit is the health benefit itself, the QALYs gained, and typically only to the individual treated. The willingness-to-pay methodologies are more likely to include wider societal factors such as the value of lost productivity into the value of a DALY averted.[6]

Willingness-to-pay approaches are widely used outside of health, and therefore may provide a better comparison to non-health valuations.

Willingness-to-pay approach

The most common willingness-to-pay figure in New Zealand is the value of a statistical life (VOSL), maintained by the Ministry of Transport. This value represents the willingness-to-pay to avoid a fatality from a road crash. It was originally estimated in 1991 and updated by indexing to average hourly earnings. The most recent value published in the Treasury's Cost Benefit Analysis (CBAx) Tool 2021 is $4.56 million.

The total $4.56 million is used to represent the 'social cost' of a road fatality. We therefore need to adjust this to reflect the social cost of a DALY. We calculate the value of a statistical life year (VSLY) to be $193,737 using the information in Table 15 to convert from the VOSL. We equate the VSLY to the value of a DALY incurred.

Table 15: Conversion of Value of Statistical Life to Value of Statistical Life Year

Metric	Value
VOSL	$4.56 million
New Zealand median age	37.6
Remaining life expectancy (for median age)	
Male	44.7
Female	47.7
Average (simple 50:50 weighting)	46.2
Discount rate	3.50%
Discounted remaining life expectancy	23.5
VSLY	$193,737

Source: CBAx 2021, Statistics New Zealand 2021

The VSLY multiplied by the central DALYs results in a value of around $19.2 billion.

[6] Alternatively, the willingness-to-pay to avert a DALY could be considered the compensation value for incurring a DALY.

Discount rate

It is unknown what discount rate was intrinsically attached to the original VOSL estimate.

In economics, discounting is commonplace and widely accepted. It is based on the concept that people would generally prefer to receive a benefit now, rather than the same benefit in the future, or alternatively incur a cost in the future rather than the same cost now. It allows comparison of different valuations where the time horizon is different.

Where there is less consensus is around the 'correct' discount rate. High discount rates would often penalise long-term prevention strategies which are required for a sustainable health sector. As such, due to the relatively long-term outcomes often seen in health, health economists typically argue for relatively low discount rates. For instance, Pharmac uses a 3.5 per cent per annum discount rate in its cost-effectiveness analyses (Pharmac, 2015), while the default Treasury rate is currently 5 per cent per annum for "most social sector projects".[7]

Given the VOSL measures the societal cost of a fatality, which includes lost years of life far into the future, we opt to use the lower Pharmac rate. This is used to discount the remaining life expectancy. Using the 5 per cent Treasury rate decreased the remaining life expectancy to 18.8 and therefore raises the value of a statistical life year to $242,609 and the total value of DALYs attributable to high BMI to almost $24 billon.

Cost-effectiveness approach

Pharmac's average cost per QALY for new investments has ranged from $4,200–$32,300 (Pharmac, 2016-2020).[8] CBAx has assumed the highest $ per QALY over these years, which is more aligned internationally. The Treasury's CBAx Tool ($32,258) represents the average amount invested by Pharmac to achieve a gain of one QALY in 2020, adjusted for inflation to 2021-dollar terms.

This value multiplied by the central value for DALYs lost results in a value of around $3.2 billion.

Many countries use cost-effectiveness thresholds recommended by the WHO's Choosing Interventions that are Cost–Effective project (WHO-CHOICE) when evaluating health interventions. This project sets the threshold for cost-effectiveness as the cost of the intervention per DALY averted less than three times the country's annual gross domestic product (GDP) per capita. Highly cost-effective interventions are defined as meeting a threshold per DALY averted of once the annual GDP per capita (Marseille, Larson, Kazi, Kahn, & Rosen, 2015).

Table 16: NZ GDP per capita

	Value

[7] https://www.treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates

[8] In 2019/20 Pharmac funded proposals with a Net Present Value of 31 QALYs per million dollars spent; in 2018/19 the figure was 118 QALYs per million dollars spent; in 2017/18 the figure was 238 QALYs per million; in 2016/17 the figure was 37 QALYs per million dollars spent; in 2015/16 the figure was 52 QALYs per million dollars.

NZ GDP	$325 billion
NZ population	5,122,600
GDP per capita	**$63,444**

Source: Statistics New Zealand June 2021

Using the NZ GDP per capita as a proxy for cost-effectiveness produces a value of around $6.3 billion. Curiously, three times NZ GDP per capita ($190,333) used as a threshold for cost effectiveness is surprisingly close to the value derived through the VOSL approach both producing a central estimate of around $19 billion.

5.1 Summary of intangible costs

It is contentious and difficult to put a monetary value on avoiding premature death or disability. However, to make decisions on the cost society is willing to incur to improve road safety, or to fund new drugs or health technology, policymakers need estimates of the potential benefits, which often requires monetary values to be placed on saving lives.

In the context of public investment in transport infrastructure and services, the VOSL is a tool to help show society's willingness to pay for projects that will reduce premature fatalities and injuries to people on and around that infrastructure.

It has been argued that a higher VOSL should be used outside the transport sector. For example, in the prevention of cancer death, a higher value would take into account the pain and suffering associated with the disease (Baker, Chilton, Jones-Lee, & Metcalf, 2009).

Table 17 illustrates how combining best estimates increases the range of results. Applying a range of costs that represent estimates of different categories of costs to the DALYs[9] estimates from the Global Burden of Disease (GBD) (2019) study produces a range of $2 billion to $26 billion attributable to the risk factor of high Body Mass Index (BMI).

We used a range of factors to provide cost estimates to quantify the burden of high BMI, including disability adjusted life years (DALY), quality adjusted life years (QALY), value of statistical life (VOSL) and Gross Domestic Product (GDP). Combining QALY and DALY estimates represents cost effectiveness measures based on the health benefits of interventions. The GDP and VOSL estimates illustrate the social and indirect costs associated with interventions.

Table 17: High level cost range ($ NZ)

	Value	Lower	Central	Upper
GBD (2019) estimates	DALYs	64,447	98,852	135,994

[9] DALYs estimates are commonly used to measure the burden of disease and disability in health economics. They are units of measure of lost health and account for both losses in length (mortality) and quality of life (morbidity).

Cost estimates applied		($ billions)		
Cost per QALY	$32,258	2.1	3.2	4.4
GDP per capita	$63,444	4.1	6.3	8.6
3*GDP per capita	$190,333	12.3	18.8	25.9
VOSL	$193,737	12.5	19.2	26.3

Using the Cost per QALY approach produces an estimate in the $2 to $4 billion range

The $32,258 represents the average amount invested by Pharmac to achieve a gain of one QALY in 2020, adjusted for inflation to 2021-dollar terms.

This is essentially cost-effectiveness analysis or comparing the health benefits and costs of different treatment options, so it best represents the direct health care costs of reducing the DALYs attributable to high BMI.

Using GDP per capita produces a range of $4 billion to $25 billion

Many countries use cost-effectiveness thresholds recommended by the WHO's Choosing Interventions that are Cost–Effective project (WHO-CHOICE) when evaluating health interventions. This project sets the threshold for cost-effectiveness as the cost of the intervention per DALY averted, which is less than three times the country's annual gross domestic product (GDP) per capita. Highly cost-effective interventions are defined as meeting a threshold per DALY averted of once the annual GDP per capita (Marseille, Larson, Kazi, Kahn, & Rosen, 2015).

This value represents both the health care costs and the indirect costs such as lost productivity.

Using the VOSL produces a range of $12 billion to $26 billion

The value of statistical life (VOSL) is maintained by Waka Kotahi (Ministry of Transport) with $4.56 million used to represent the 'social cost' of a road fatality in transport evaluations. We adjust this to reflect the social cost of a DALY and calculate the value of a statistical life year (VSLY) to be $193,737 and equate the VSLY to the value of a DALY incurred.

This method captures costs in the broadest sense, including all the indirect cost productivity impacts and the intangible costs, such as wellbeing and health care costs for conditions that have not been estimated, such as depression.

6. Discussion

This report has investigated a variety of ways to provide a reliable estimate of the costs of excess weight to New Zealand. The numbers are large and the differences between direct, indirect and intangible cost confusing, making it hard to draw robust conclusions or defend an exact figure. While we recognise a wide range is not the most useful to policy makers and advocates, we have not landed on a single figure as this would imply greater certainty than the evidence suggests.

Conservatively, we estimate $2 billion in direct health care costs per year and $7 billion in indirect costs per year such as productivity losses. Monetising Global Burden of Disease estimates with willingness to pay estimates suggests the total cost of excess weight could be over $19 billion per year, with the caution that willingness to pay values reflect what society thinks about costs rather than actual financial costs. Sometimes what society thinks about costs is not plausible, and these measures likely lose meaning when applied in different contexts. The VOSL figure is the result of trying to estimate the value of the impact of excess weight on quality of life and length of life. So, the intangible estimate is not directly comparable to the real costs estimated and should not be combined with these estimates.[10]

Intangible costs are social, emotional and human costs; they're not related to money and aren't directly measurable. Intangible costs are about the suffering associated with health conditions related to excess weight.

Excess weight and its associated chronic diseases have a significant negative impact on an individual's ability to live a long and productive life and this has consequences for society, the health system and the economy.

> Excess weight and related diseases reduce life expectancy by around 2.9 years, GDP by over 3 per cent, and consume over 8 per cent of health care spending (OECD, 2019).

The case for investing in initiatives to reduce excess weight is strong, with analysis suggesting up to 5.6 dollars in economic benefits are realised per dollar spent. The cost of implementing food advertising restrictions, mass media campaigns, menu labelling and workplace programmes to reduce sedentary time is no more than 20 per cent of estimated benefits (OECD, 2019).

Equity is a major issue as communities with relative socio-economic disadvantage are much more likely to suffer the physical, financial, mental, and emotional burden, and stigma of excess weight. This disadvantage starts early in life with the evidence showing that children with excess weight are more likely to live in the most deprived neighbourhoods in New Zealand. The many factors that contribute to excess weight and related health issues are complex and include broader social issues, such as low

[10] WTP methods can estimate how much a person is willing to pay to reduce their risk, or how much premium they would require to accept additional risk. This can then be used to determine the monetary value that a person assigns to their own life.

income, poor housing conditions, lack of basic household equipment like fridges, food insecurity, and the high cost of healthy food.

Methods used and the data available are not perfect

While cost of excess weight studies are helpful for health care planning in terms of quantifying the magnitude of the problem and setting funding priorities, the results of these studies merit cautious interpretation.

Health service and societal costs of excess weight are typically estimated by top-down approaches which derive Population Attributable Fractions (PAFs) for a range of conditions associated with increased body fat or bottom-up methods based on analyses of cross-sectional or longitudinal datasets.

Estimation of the costs based on PAFs depend primarily on four core inputs, which vary considerably in the precision of estimates and the inclusion criteria applied in different studies: the estimated prevalence of excess weight, the list of co-morbid conditions linked to excess weight, the relative risk estimates used to calculate PAFs, and the availability and quality of national cost data. There are additional concerns in relation to the PAF-based approach, including the problem of double counting due to multi-morbidity.

As BMI increases so do direct healthcare costs and indirect costs relating to reduced productivity and early death. Determining precise estimates for the increases is not possible due to the high degree of heterogeneity among the available literature estimating costs.

Making sense of the numbers

The direct health care costs of approximately $2 billion represent about 8 per cent of the 2021 Vote Health budget. This is more than three times the costs attributable to respiratory disease and twice the costs of type 2 diabetes.

- Research conducted for the Asthma foundation finds the total cost of respiratory disease per year: including private costs (doctors' visits, prescriptions) and public costs (years of life lost, hospitalisations) to be $6.7 billion of this, $6.08b were indirect costs from mortality and disability affected life years, and the remaining $590.5m were direct costs from hospitalisations, prescriptions and doctors' visits (Barnard & Zhang, 2021).
- The total current annual cost of type 2 diabetes in New Zealand is estimated to be $2.1 billion, which represents a 0.67 per cent of New Zealand's total Gross Domestic Product (GDP). Of the different health and economic components of this cost, publicly funded health costs borne by the Government, currently estimated to be approximately $1.0 billion (PwC, 2021).

The indirect productivity costs of $7 billion to $9 billion equates to 2.2 percent to 2.8 percent of GDP.

This number for indirect costs attempts to monetise the physical impacts of excess weight on a person's ability to participate in the workforce and the effects of weight stigma that limit opportunities to participate in the workforce and can reduce productivity. The estimates often either explicitly or implicitly assume full employment, which is perhaps reasonable given the current labour market but could overstate the true impact.

The intangible costs of $19 billion may seem implausibly high, and given the issues with WTP methods and the translation of context, they should only be considered an expression of what society thinks about the value of life and the impact excess weight has on life including physical and mental health, social life, family, employment, and the emotional cost including stigma and bias against excess weight.

In the context of this study, we conservatively state we can confidently attribute $4 billion to $9 billion in direct and indirect costs per year to excess weight. While not directly comparable, the intangible cost estimate indicates society could be willing to pay an order of magnitude more to reduce the prevalence and harm associated with excess weight.

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Appendix A: QALYs and DALYs

Quality-Adjusted Life Year (QALY) and Disability-Adjusted Life Year (DALY)

QALYs and DALYs are units of measure of lost health commonly used in health economics to assist policy makers to make informed decisions, and countries to choose cost-effective health care. QALYs are a measure of years lived in perfect health gained, whereas DALYs are a measure of years in perfect health lost.

A DALY can be thought of as a modified version of QALY that measures the gap between the population's current state of health and that of an ideal population in which everyone experiences long lives free from illness or disability. In burden of disease studies, the term 'disability' refers to any short-term or long-term health loss other than death. In other words, disability includes any impairment, functional limitation, dysphoric affective state (e.g. depression) or symptom (e.g. pain). The DALY integrates information on both fatal outcomes (early death) and non-fatal outcomes (illness or disability) in a similar way, so that one DALY represents one year of healthy life lost.

The DALY is made up of two components:

- Years of life lost (YLL). This component represents the loss in health from premature mortality. It is estimated as 'remaining life expectancy' at the age of death.
- Years lived with disability (YLD). This component represents the loss in health from decreased quality of life. It is the combination of the length of time lived in a 'health state' (measured in years) and the severity of that health state, the 'disability weight'. A disability weight is measured on a scale from 0 (perfect health) to 1 (a health state equivalent to death).

The 0 to 1 scale for disability weights means that YLL and YLD are commensurate. For instance, under the DALY framework, one year of life lost due to premature mortality is equivalent to two years of life lived in a health state with a disability weight of 0.5. The two components add together to form the DALY loss.

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