Attachment 1 to Report number 13.41

The Costs of Physical Inactivity

Toward a regional full-cost accounting perspective

Wellington Regional Strategy

Waikato Regional Council

Auckland Council

Executive Summary

The scientific and health communities are unanimous in identifying physical inactivity as an important contributor to non-communicable diseases throughout the world. For New Zealand, the total cost of physical inactivity was $1.3 billion for the 2010 year, representing just less than 1 percent of New Zealand's GDP (0.7%).[1]

It is increasingly common that many adults do not do enough physical activity to maintain good health. Doing the recommended thirty minutes of moderate activity, on most if not all days per week reduces the health risks posed by physical inactivity, which is now the fourth leading cause of death worldwide and a global public health priority. Failure to do so increases the chance of developing cardio-vascular diseases, certain cancers, diabetes, osteoporosis and depression. Regular physical activity is beneficial for exercising the heart, maintaining healthy bones and maintaining a healthy mind. Physical activity is not only a form of preventative medicine (in terms of a public health strategy), but it is also considered a treatment in itself. New Zealand is one of few countries that has a system whereby doctors actually formally prescribe physical activity, in the form of "Green Prescriptions" for patients.

Physical inactivity is costly. At an individual level, it can lead to suffering and disruption to a person's life with the onset of a disease that could have been avoided. Ultimately, it can lead to premature death which may impact on household economics and organisation. The premature death of 246 New Zealanders was caused by physical inactivity for the 2009 year. Seventy three of these deaths were in the Auckland region, 21 in the Wellington region and 18 deaths in the Waikato region. These premature deaths were estimated for those aged under 65 years only, although the lives of those over 65, whose death was caused by diseases associated with physical inactivity, may have been prolonged with physical activity. To put these figures into context, there were 420 motor vehicle fatalities and 510 deaths caused by self-harm for that same year. Physical inactivity is at a serious pandemic level in New Zealand, as in other countries. In a recent major report published in The Lancet medical journal, New Zealand was the 27th (out of 122) most inactive country, with nearly 50 percent of the population insufficiently physically active. Australia, our nearest neighbour and oft times benchmark, sdid better than New Zealand, rating 52nd with 38 percent of the population inactive (Lee *et al.,* 2012).

Given that physical inactivity manifests in a range of different diseases and health problems, it requires significant synthesis of research to obtain a complete picture of its effects on society. This report measured the costs of physical inactivity in New Zealand and three regions: Wellington, Waikato and Auckland for the 2010 year. Physical inactivity cost New Zealand $1.3 billion in 2010. The cost of physical inactivity was **$402 million** for the **Auckland region**, **$106 million** for the **Waikato region** and **$141 million** for the **Wellington region**. The costs of physical inactivity are separated into **direct** health costs associated with treatment in the health care system, **indirect** health costs associated with living with

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[1] GDP was $194.7billion in 2010 seasonally adjusted current prices. Statistics New Zealand (2011).

disability/disease and dying prematurely and **other** costs associated with physical inactivity, including promoting activity and information campaigns relating to physical well-being.

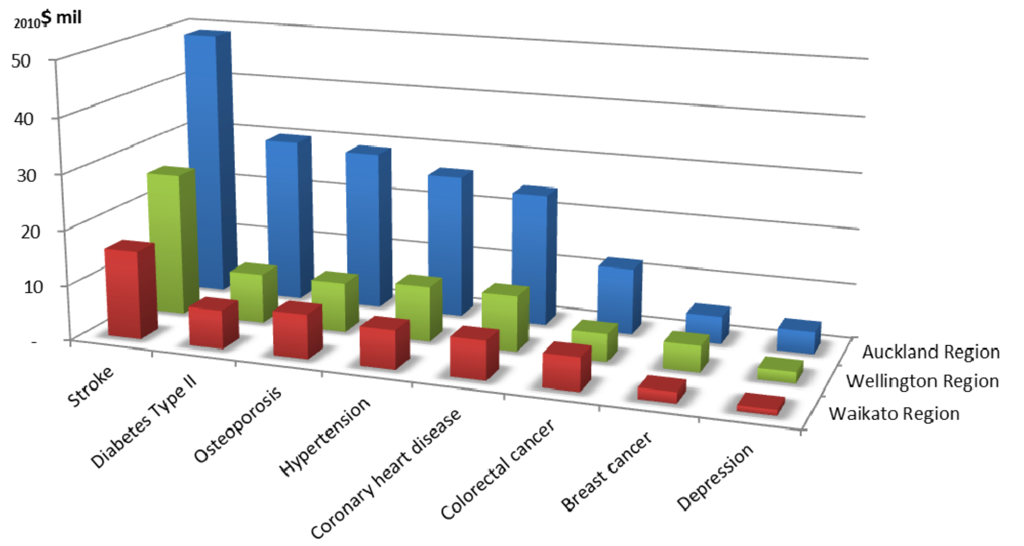
Approximately half of the cost of physical inactivity is actual health expenditure and health promotion costs (i.e. the direct costs of $614m plus other costs of $30m would appear in New Zealand's GDP expenditure accounts). The other half is indirect costs, including monetary values for loss of productivity, pain and suffering. The total costs of physical inactivity were borne by the government (through health expenditure), private individuals (health expenditure, loss of income, disability and suffering), society (loss of productivity) and local government (health promotion and urban design). The total Crown expenditure on health in 2010 was $13.1 billion.[2] Although not all of the **$614m of direct costs** was borne by public expenditure, this figure **represents 4.6 percent of the Crown expenditure on health**.

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					

Direct costs accorded to avoidable diseases (associated with insufficient levels of physical inactivity) were $179 million for Auckland, $54 million for Waikato, $74 million for Wellington and $614 million for New Zealand. The study found that the costs of treating cardiovascular diseases that can be attributed to physical inactivity are the highest (relative to other diseases). Of the cardiovascular diseases, strokes are the costliest (Figure 1). The high direct costs for treating stroke are driven by little change in the incidence of stroke over the last number of years, along with an increase in survival rates of stroke patients, thereby requiring ongoing care. Depression had the lowest direct cost of physical inactivity, largely because not many people are hospitalised for depression and a precise estimate for the costs of treating depression in primary health care has not been undertaken to date in New Zealand.

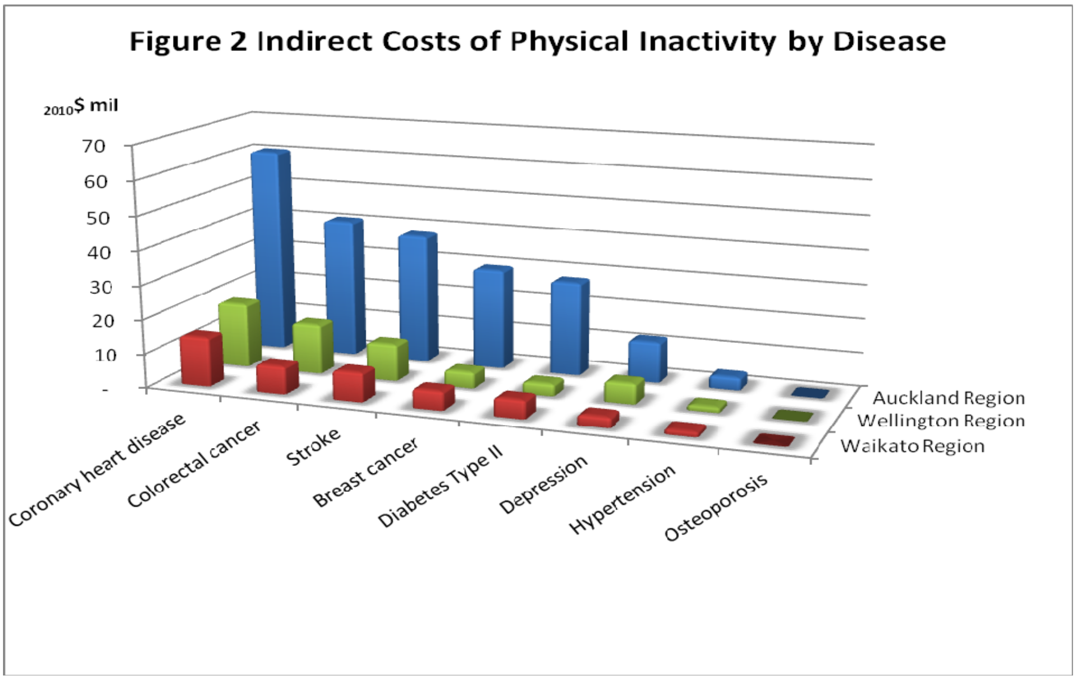
2 TreasuryNZ Financial Statements. http://www.treasury.govt.nz/government

Figure 1 Direct Costs of Physical Inactivity by Disease



Indirect health costs attributed to physical inactivity were $213 million for Auckland, $48 million for Waikato, $62 million for Wellington and $661 million for New Zealand. It is not uncommon for the indirect costs of a disease to be greater than the direct costs, particularly if a person survives the disease but with some form of disability. The indirect costs of physical inactivity were greater than the direct costs for Auckland and New Zealand, but less for Waikato and Wellington. It is difficult to measure intangible costs associated with pain and suffering. Caution is warranted in using these estimates of indirect costs, due to data limitations in our study around the value of a statistical life.

Coronary heart disease had the highest indirect costs for all regions, largely due to the high mortality rates associated with this disease (Figure 2). This was followed by colorectal cancer in Wellington and Auckland, whereas, in Waikato stroke was second highest in terms of indirect costs. The high indirect costs of colorectal cancer can be explained by the relatively high premature mortality rates for the disease. Osteoporosis and hypertension had the lowest indirect costs in all regions, as people tend not to die directly from these illnesses, and therefore the indirect costs of premature death were small.



Other costs associated with physical inactivity were included in the study. These include promotional campaigns to get people more physically active, including programmes aimed to change travel and commuting to active modes. We considered including capital costs and infrastructure expenditure/ investment in resources for sport. But these were not included as they are expenditures on physical *activity* rather than *inactivity*. An attempt was however made to include expenditure on changing sedentary behaviour to more active – getting the recommended weekly 30 minutes of moderate activity 5 times a week. These associated costs are estimated at $10 million in Auckland, $4 million in Waikato, and $5 million in Wellington, shared between central government agencies, local government sports trusts and district health boards.

The costs of physical inactivity have an extensive range, from direct health costs of disease treatment to more indirect effects on the economy (e.g. lost productivity) to the intangible costs carried by the individual (e.g. disability, pain and suffering). The attempt to fully cost physical inactivity in this study is a systemic methodology aiming to capture a snapshot of the complex effects that physical inactivity has on individuals, society and the public purse. Calculating the costs of physical inactivity in such a comprehensive manner highlights the magnitude of the burden on society and should centre the attention on what policy levers can be used to address the issue. Local government has a significant role to play in providing opportunities for residents to increase their physical activity levels. This can be in the form of urban design, transport planning, provision of safe places to exercise and recreate. The health system deals with the effects of physical inactivity, treating patients with diseases that could be avoided with a less sedentary population. The calculation of the costs of physical inactivity in a coherent holistic manner enables a comparison of the far-reaching and serious effects of inactivity. There is a need to mainstream physical inactivity issues into policy decisions at all levels of government.

Contents

Abbreviations

AC – Auckland Council

ADHB – Auckland District Health Board

CDHB – Capital District Health Board

CHD – Coronary Heart Disease

CMDHB – Counties Manukau District Health Board

CVD – Cardiovascular Disease

DALY – Disability Adjusted Life Year

DHB – District Health Board

GP – General Practitioner

GPI – Genuine Progress Index

GRx – Green Prescription

GWRC – Greater Wellington Regional Council

HRC – Health Research Council of New Zealand

ICD 10 – International Statistical Classification of Diseases and Related Health Problems 10th Revision

MET – Metabolic Equivalents

MHRDS – Mental Health Research and Development Strategy

MoH – Ministry of Health

NGO – Non-Governmental Organisation

NZTA – New Zealand Transport Agency

PAF – Population Attributable Fraction

QALY – Quality Adjusted Life Year

SNZ – Statistics New Zealand

WHO – World Health Organization

WRC – Waikato Regional Council

Glossary of key terms as defined with respect to physical inactivity

Burden of Illness studies - also called cost of illness studies, is a generally accepted technique used in health economics. They can be used to assess the impact of a health problem, as measured by financial cost, mortality and morbidity (see MoH, 2008).

Comorbidity – the presence of one or more disorder in addition to the primary disease.

Confounding – a variable that correlates with both the dependent and independent variables.

Direct Cost – the cost of treating a disease in the healthcare system, including hospitalisation, medication, outpatient care, GP visits, screening and research.

Epidemiology – an area within science that attempts to answer questions relating to health-related events in a community. Such studies attempt to ascertain the extent of a disease(s) and the causes of that disease(s). There are a number of factors that increase a person's risk for a particular disease.

Full Cost Accounting – an emerging evaluation technique that identifies the wide range of costs that are caused by the identified effects of a particular phenomenon (Market Economics, 2011).

Green Prescription – a system in operation in New Zealand whereby exercise is prescribed as a treatment/medicine (Ministry of Health, 2012a).

Indirect Cost – the cost of suffering, pain and premature death due to a disease.

Meta-analysis – a systematic process for finding, evaluating and combining the results of data from independent sources (Lee *et al.,* 2012).

Physical Activity – any bodily movement produced by skeletal muscles that result in energy expenditure. It is not limited to sport and exercise, but it is classified as any activity that raises the heart rate (MoH, 2008).

Physical Inactivity – defined by the failure to undertake the recommended physical activity guidelines, which are 30 minutes of moderate exercise, 5 times a week (SPARC, 2005).

Population Attributable Fraction – The proportion of the disease that could have been avoided if the risk factor (physical inactivity) were eliminated (Katzmarzyk, 2000).

Prevalence rate – the number of existing cases of disease in a defined population at a set point in time, divided by the number of persons in the population at that time.

Primary Health Care – In the New Zealand context, it is the professional health care received in the community, usually from a general practitioner (GP) or practice nurse. Primary health care covers a broad range of health and preventative services including health education, counseling, disease prevention and screening.

Relative Risk – the ratio of incidence of disease in the physically inactive group divided by the incidence of disease in the physically active group.

Risk – the likelihood of developing a particular disease.

Secondary Health Care – In the New Zealand context, it is the treatment a patient receives when referred to a specialist, e.g. a clinical psychologist or cardiologist or for short term acute care, e.g. emergency room treatment or outpatient services.

Tertiary Health Care – In the New Zealand context, it is specialised consultative health care, usually for inpatients requiring a hospital stay.

1. Introduction

Physical inactivity is now globally recognised as the fourth leading cause of death worldwide and a global public health priority. It is as serious a risk factor as smoking or obesity for a range of chronic diseases like heart disease, cancer and diabetes. It can lead to premature death (Lee *et al.,* 2012). A special issue of the medical journal “The Lancet” published a series of papers on physical activity mid-2012, exploring the relationship between human beings and their environment and about improving human wellbeing by strengthening that relationship. Physical inactivity is a growing public health issue in New Zealand, as it is in many other developed countries. New Zealand was the 27th (out of 122) most inactive country, with nearly 50 percent of the population insufficiently physically active (Lee *et al.*, 2012). Australia, our nearest neighbour and often our benchmark for international comparisons, did better than New Zealand, rating 52nd with 38 percent of the population inactive.

The impacts of physical inactivity manifest at the personal and family levels when a loved one gets sick or dies. They manifest at the national level when the health system bears the burden of costs for treating the illnesses related to physical inactivity. There are also costs in the form of lost productivity due to those illnesses.

Physical inactivity is considered a modifiable risk factor (MoH, 2003), and therefore the full costs of inactivity could be avoided through lifestyle changes. The New Zealand Physical Activity Guidelines state that adults should participate in at least 30 minutes of moderate-intensity physical activity on most, if not on all days of the week (SPARC, 2005). If these guidelines are not met, a person is considered to be physically inactive. Physical activity is ‘any bodily movement produced by skeletal muscles that results in energy expenditure’ and is positively correlated with physical fitness. It can be incidental, occupational or recreational (MoH, 2008).

Regular physical activity is associated with a reduction in the risk of being diagnosed with coronary heart disease, stroke, hypertension, respiratory diseases, asthma, stress, anxiety and depression, diabetes, obesity, colorectal and breast cancer, dementia, osteoporosis and osteoarthritis (MoH, 2003). Not doing enough regular exercise is a contributing factor to the risk of developing the mentioned diseases, and experiencing disability associated with them. Longevity and quality of life can be enhanced through physical exercise and activity. Physical activity influences brain function and cognition – especially important in the context of an ageing population. It is also crucial during pregnancy, for both baby and mother. Levels of physical activity directly affect the prevalence of disease within a population.

Physical activity is seen as a preventative medicine, and is pursued as a public health strategy for this reason. Physical activity is also considered a treatment in itself (Moore, 2004). It can be effective in treating mild forms of depression, hypertension, obesity and conditions requiring physiotherapy. New Zealand is one of few countries where a “Green Prescription” for patients exists, whereby exercise is prescribed as a treatment/medicine (Box 1.1).

According to the World Health Organization (2009 and 2010), six percent of deaths in 2004 were attributed to physical inactivity, making it the fourth leading risk factor for all deaths (Figure 1.1). This follows high blood pressure (13 percent), tobacco use (9 percent) and is equal to high blood glucose or diabetes (6 percent). Figure 1.1 shows that inactivity is relatively high in middle income countries. More recent estimates published in 'The Lancet' for the 2008 year were higher (Lee *et al.*, 2012), with inactivity causing 9 percent of premature mortality, or 5.3 million of the 57 million deaths that occurred

Box 1.1 Green Prescriptions (GRx)

Physical inactivity is taken seriously by the New Zealand medical profession. New Zealand is one of only a handful of countries that has a **Green Prescription** as a formal referral by GPs to increase the rate of physical activity. Green prescriptions are medical interventions used in primary health care in New Zealand. Adult patients are given advice and a written prescription for physical activity as part of their health management. The prescription is given to the local regional sports trust or primary health organisation who provides a range of support opportunities to increase levels of physical activity.[3]

In the 2011/12 financial year 35,834 patients were supported to get active and improve their nutrition. Twenty percent of these prescriptions were issued where depression or anxiety were present. Many of these patients also suffered from weight problems (64%), stress (54%), sleep problems (37%), back pain or problems (33%), high cholesterol (25%) and high blood pressure or risk of stroke (24%). Green prescriptions are not necessarily used for the treatment of one condition/disease alone, nor are they the only prescription used, but are a component of the care package that is offered to people in the health system.[4] The Ministry of Health pays GRx contract holders $65 per referral.

Green prescriptions are part of an emerging trend that recognises that exercise reduces the demand for medical care (Fries, Koop, Sokolov, Beadle and Wright, 2012; Katzmarzyk, 2011) and that exercise is a form of medicine.

For treating depression/anxiety, the main types of activity recommended for these patients were walking (70 percent), swimming (49 percent), gym exercises (43 percent), and water/pool exercises (40 percent). Of the depression/anxiety patients that have engaged in physical activity as per a green prescription (MoH 2012 survey):

- 67 percent of these patients have noticed positive changes in their health.
- 58 percent of these patients are now spending more time being active.
- 68 percent of these patients have received some advice on healthy eating.
- 66 percent have made changes to their diet since getting their GRx.
- 78 percent are female.
- 50 percent have only secondary education or no qualifications.
- 49 percent are aged 45-64 years. Another 26 percent are aged under 40 years.
- 52 percent also have a long-term disability or impairment.
- 61 percent are of European descent, 17 percent are Māori, and 7 percent are Pacific.
- 66 percent have a Community Services Card.
- 47 percent live in areas with the highest deprivation.

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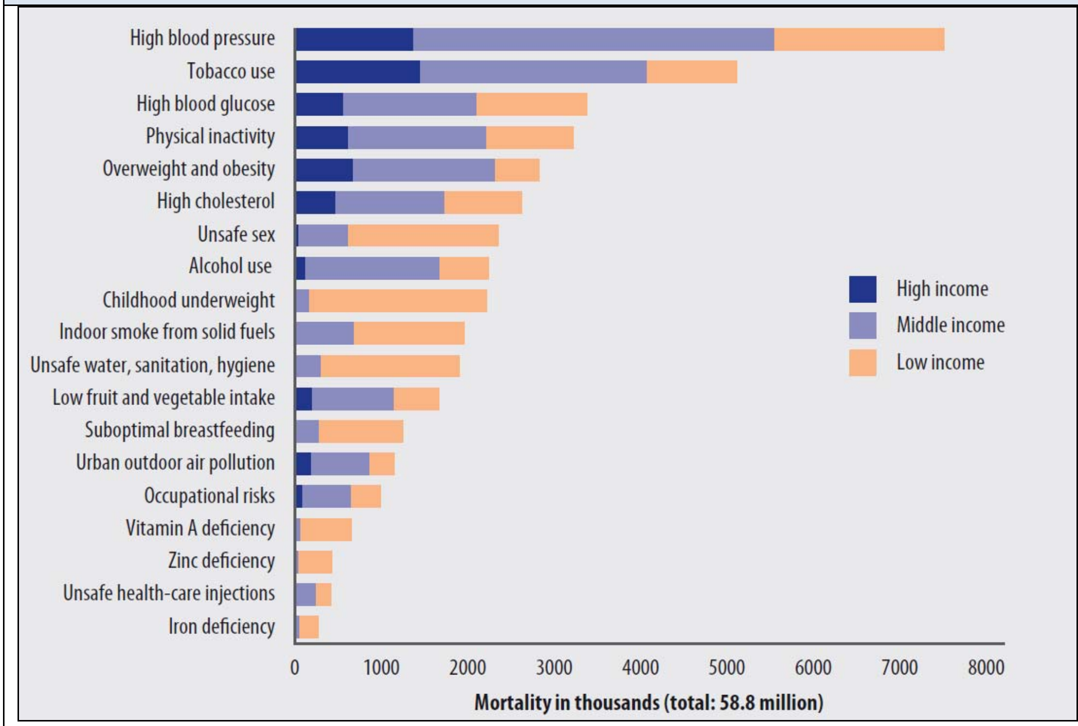
[3] Details can be found on www.moh.govt.nz/greenprescription. See also best practice guidelines on bpac.org.nz, and Pringle (2008).

[4] See the best practice guidelines for NZ primary care relating to depression (including the stepped care approach) on http://www.bpac.org.nz/magazine/2009/adultdep/contents.asp

worldwide in 2008. Clearly physical inactivity is a growing problem with monetary and social costs that could be avoided. Physical inactivity within a population places a 'burden' on society and the economy. Significant reductions in demand for medical care can be made through increased physical activity.

Figure 1.1 Global deaths attributed to 19 leading risk factors, by country income level, 2004



Source: World Health Organization (2009:9)

Undertaking the recommended levels of physical activity is also considered a preventative medicine. Uniquely in New Zealand a 'Green Prescription' can be stipulated by medical practitioners and is an accepted prescription for exercise and physical activity. Doing the recommended levels would improve the health of individuals, quality of life and welfare within society in general (Katzmarzyk, 2011; Fries *et al.* 1998; MoH, 2012a), although caution is warranted over considering it a 'silver bullet' for the disease alleviation.

The last estimate for the costs of inactivity in New Zealand was undertaken over twenty years ago, putting the cost at $179m[5] (Russell *et al.*, 1992). Over the intervening years, health costs have increased significantly over and above the rate of inflation. This is due to advances in the treatment of diseases,

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[5] This is equivalent to $_{2010}$$270m, using Statistics NZ Consumer Price Index as an inflator.

newer techniques, technologies and new medication. It seems that the rates of physical inactivity have increased amongst the New Zealand population over the twenty years.[6] No study to date has estimated the costs at a regional level for New Zealand.

Market Economics Limited (M.E) have been commissioned by Auckland Council (AC), Greater Wellington Regional Council (GWRC) and Waikato Regional Council (WRC) to demonstrate the applicability of a full cost accounting framework to estimate the costs of physical inactivity to their region, incorporating the approach taken by GPI Atlantic in Canada (Colman and Hayward, 2002; Walker and Colman, 2004a&b). This approach estimates the costs of treating diseases that could be avoided if the population had been undertaking the recommended levels of physical activity throughout their lives. This is a 'cost of illness' approach recognising the costs to the public health system. Cost of illness and the broader 'burden of illness' methods are generally accepted techniques used in health economics. They can be used to assess the impact of a health problem, as measured by financial cost, mortality and morbidity. Cost of illness studies are usually calculated for a specific timeframe, usually over a year. This differs from full cost accounting and cost benefit analyses which attempt to capture current and future (lifetime) costs associated with a particular issue or concern.

Undertaking physical activity is a private choice, and can be seen as the individual taking control of their own personal health outcomes. However, the conditions in which people work and live have an impact on their health and wellbeing. While all residents should have the opportunity to make choices that enable them to experience good physical health regardless of where they live and work, some environments and circumstances limit these choices. As the New Zealand government agencies and local government councils acknowledge, there is also a collective responsibility or facilitative role at a societal level for enabling individuals to be physically active (Waikato Regional Council, 2012; Greater Wellington Regional Council, 2012; Auckland Council, 2012; NZTA, 2008; Environment Canterbury *et al.*, 2010, Witten *et al*. 2008). The role manifests through transport policy (ensuring walking, cycling and other forms of active transportation are accessible and safe for all), available public facilities for people to spend their leisure time in active manners and access to up-to-date medical research and information (Ministry of Health, 2003). Supportive environments (physically and socially) and communities with reliable information can increase rates of physical activity. Promoting adequate physical activity among the population is a means of encouraging personal responsibility for health related outcomes. Examples of how local government can influence physical inactivity include provision of safe parks and beaches, sports fields, swimming pools and exercising facilities. How these are provided can overcome equity issues e.g. equal opportunity to access facilities. For individuals with physical disability, urban and street design is important in as much as footpaths and ramps *enable* rather than act as barriers, for wheelchair access or people with limited mobility.

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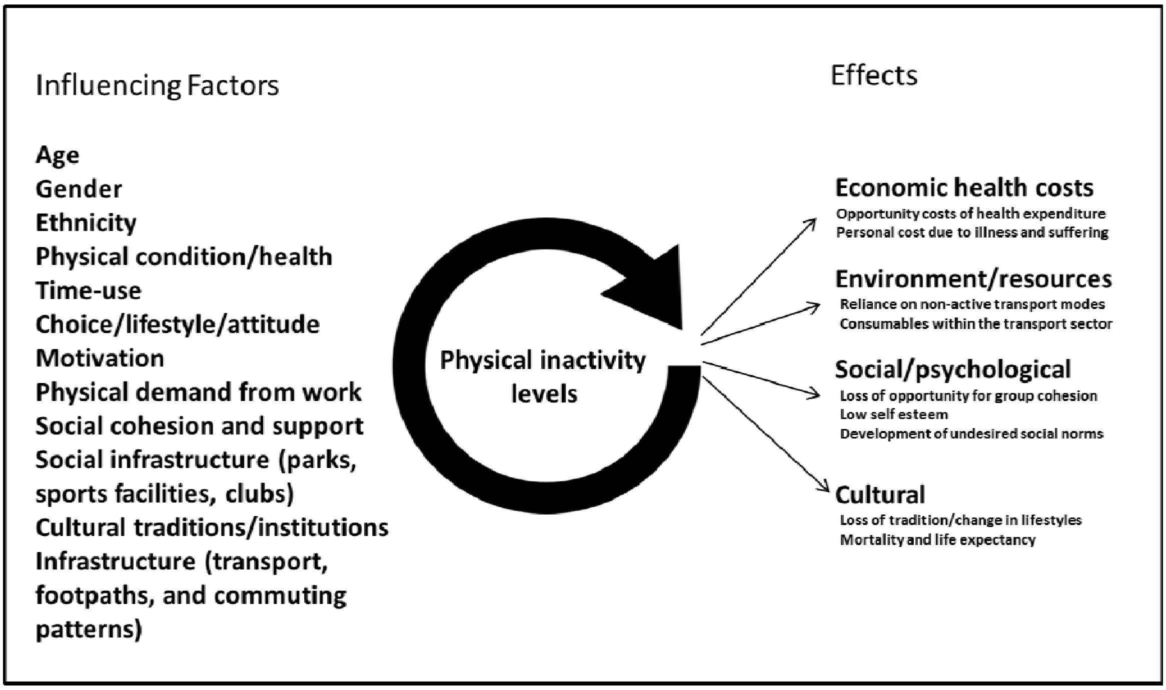
6 Caution is warranted in comparing rates of inactivity from the 1991 study, as the definition of physical inactivity differs from the Russell *et al.* (1992) study to the prevailing recommendations for physical activity. Russell found that 31% of New Zealanders were active for less than three hours per day (at a medium-low intensity level of activity), and based the health costs on this proportion of the population. High levels of activity (maintaining cardiovascular fitness) were defined by Russell *et al. ibid* as participating in high intensity activity on more than two occasions per week, for a total of one or more hours per week.

1.1 Background - Full Cost Accounting (FCA)

This work extends M.E's (2011) report on developing a FCA methodology for an indicator. An indicator summarises complex data into a key measure. A full cost appraisal of an indicator requires the articulation of the *consequences* of particular economic, socio-cultural and environmental effects. FCA has been defined as "a systematic approach for identifying, summing and reporting in an on-going fashion the full costs of particular programmes, services and decisions over a given time. In addition to obvious and direct costs, full cost accounting aims to include any hidden as well as overhead costs involved" (GWRC, 2011). Adopting a FCA framework requires a holistic and systemic analysis of the indicator. The 'accounting' side of FCA requires establishing a thorough causal model (e.g. cause and effect), then selection and justification of measurement of these causes and effects, and finally the estimation of associated costs. FCA does not overcome the barriers that economic analyses traditionally face – such as valuation techniques and available data (M.E, 2011).

Figure 1.2 shows the levels of physical inactivity which could be put in a FCA framework. There is a combination of complex *influencing factors* that determine the levels of physical inactivity, including age, gender, ethnicity, ability, motivation, available infrastructure and resources, social support for physical activity, available time and so on. Dahlgren and Whitehead (1991) categorise the determinants into constitutional factors, individual lifestyle factors, social and community networks, living and working conditions and general socioeconomic, cultural and environmental conditions. Some of these factors are shown on the left hand side. We have categorised the effects into the four well-beings on the right hand side.

Figure 1.2 Physical Inactivity in a Full Cost Accounting Framework



A circular arrow is placed around physical inactivity levels to try to convey that these are not simple linear relationships. For example, initial health status or disability may prevent physical activity, causing further health effects that act as further barriers to being physically active. Psychological and cultural attitudes play an important role in determining rates of activity (Eckersley, 2005; Sullivan, Oakden, Young *et al.,* 2003), while also being affected by the level of physical activity.[7] Certain trends may be discernible in terms of influencing factors associated with physical inactivity levels, and there are many barriers that prevent people from doing the recommended healthy levels of physical activity (Eckersley, 2005; Lutz, Linder and Greenwood, 2002).

In terms of *effects* of physical inactivity levels, a FCA framework explores the effects of the indicator on different levels. This requires thinking holistically and systematically about physical inactivity, integrating theories and empirical evidence to establish causation. In Figure 1.2, the effects are shown as:

- Economic – the costs of treating diseases associated with physical inactivity and personal costs due to illness and suffering;
- Environmental and resource use effects – particularly relating to the effects of transportation as a substitute for active modes of travelling e.g. oil consumption and vehicle emissions;
- Social/psychological – low self-esteem, reduction in civic participation (if physical activity is undertaken as a social or group activity) and the emergence of undesirable social norms (of sedentary behaviour); and
- Cultural – high mortality rates and premature death amongst ethnic groups can impact cultures, traditions and intergenerational knowledge.

Ideally a study on the full costs of physical inactivity would establish the relationship between physical inactivity and the various effects. Within epidemiology, these effects have been studied extensively, and the likelihood of developing certain diseases has been linked to physical inactivity. For environmental effects, the link is not so easy to determine. NZTA (2008) explored the monetary value of active transport modes in New Zealand, and there are cost savings of increasing active transport[8]. However, it is difficult to establish the extent to which physical inactivity *causes* the environmental costs associated with transport. There may be benefits if people substituted car use for active modes of transport (e.g. reduction of oil use, improvement of air quality), but it is vehicle use rather than physical inactivity that directly causes the costly environmental damage. Following this argument, there are broader societal considerations around how society is currently structured, such as access to places of work and the social norms around commuting and distances people are willing to travel to work and to recreate,

7 This is an example of confounding, a statistical term that describes when a variable correlates with both the dependent and independent variable. In epidemiology, confounding can emerge when a variable, such as colour of hair (grey hair), can predict presence of a disease for example dementia. It is not the cause of the disease, but can be a predictor.

8 NZTA estimated health benefits of $0.40 per km for walking and $0.16 per km for cyclists, using health costs saving estimates.

trade-offs in terms of distances travelled and time that people are willing to spend commuting (either using an active or non-active mode). Establishing such a causal link would require a baseline level of vehicle transport (assuming that some level of) over and above which is considered *caused* by physical inactivity.

The social and psychological effects of physical inactivity are also difficult to isolate. Not all physically inactive people feel inhibited by their body/state of health. Low self-esteem can occur when physical inactivity presents in combination with other factors such as diet and nutrition in cases of obesity (NiMhurchu *et al.*, 2004). Equally, not all physically active people benefit from positive social and psychological effects. Physical activity, particularly team based sport, is likely to improve society's sense of community (NZIER, 2000).

The cultural effects of physical inactivity can vary considerably. If particular ethnic groups are disadvantaged because of preventable levels of high mortality, the age structure profiles for these groups can differ from other groups. This could affect cultural traditions, impede learning from elder generations, and contribute to loss of language. There was little published research found on the effects of physical inactivity on cultural institutions, but significant and growing awareness of differences in the health of certain ethnicities, including high mortality rates and prevalence of premature death. Addressing a health issue from an individualised perspective, simply looking at the effects of an illness on a personal level can obscure *te taha whanau* (a family dimension) of health for Māori (Durie, 1985). There are cultural differences in New Zealand in terms of levels of physical inactivity, e.g. higher levels for Māori, lower levels for Asian ethnicities (SPARC, 2008) and differences in life expectancy according to ethnicity. Māori and Pacific Islanders have lower life expectancy (MSD, 2010; ADHB 2008).

1.2 Choice of Method

Within health economics, the cost of illness methodology is a robust approach to calculate the dollar value of a disease(s) on society. Cost of illness studies identify direct and indirect costs of illness. The direct costs relate to the economic health effects in Figure 1.2 above, and are conceptually relatively easy to measure (notwithstanding data constraints). The indirect effects can be economic – in terms of lost earnings, but also embody the social, psychological and cultural costs of pain, suffering, grief and disruption to the individual/household/whanau/wider society. Within cost of illness approaches, the inclusion of indirect costs embodies a wider range of costs brought about by the effect of physical inactivity. However, as shall be seen in Section 2.2.2 they are difficult to measure and it is not entirely clear what is embodied/included in their values. It is difficult to disaggregate these indirect costs into their components, to establish, for example, an actual cultural cost to a group due to premature death, or the value of a change toward undesirable social norms. There is also the problem of drawing boundaries around the effects. Some of the economic costs of a household's lost earning potential due to a premature death may also be a cultural cost. Without having strict boundaries around what is being measured it would be difficult to avoid double counting.

For these reasons we do not claim that this study represents a FCA in strict terms. It instead extends the cost of illness approach to include 'other costs' such as programmes to increase physical activity and health campaigns to raise awareness of the harmful effects of physical inactivity. The cost of illness approach is typically applied to a single illness, but in our analysis we have applied this approach to multiple illnesses – and, in turn, have attempted to explicitly remove any double counting which may exist by doing so. Our study measures costs for one year, 2010. The cost of illness approach was used by GPI Atlantic in their measurement of inactivity in Canadian regions.

1.2.1 The GPI Atlantic Approach

GPI Atlantic estimated the costs of physical inactivity in Halifax Regional Municipality, British Columbia and Nova Scotia. In their methodology, the preventable diseases that could have been avoided with an increase in physical activity were identified as: Cardiovascular disease (Coronary heart disease, Stroke, Hypertension), Colon and Breast cancer, Type II Diabetes and Osteoporosis. In addition, mild to moderate depression has been identified as preventable through increased physical activity. These diseases are not mutually exclusive, and co-morbidity – the presence of one or more diseases in addition to the primary disease – makes the causes of onset of disease difficult to explain. These diseases place a burden on the public health system, and the premise of the approach is that a proportion of the costs of treating these diseases could have been avoided through appropriate physical activity by patients being treated for these illnesses.

Expenditures by healthcare providers are considered to be direct costs. These can include the costs of treating patients in hospital, in the community, research into prevalence and treatment of the disease, screening programmes for disease, private (household) costs of treating these diseases e.g. GP visits. There are indirect costs associated with physical inactivity, including loss of self-esteem, anxiety and depression[9], both short and long term disability and premature death. Such indirect costs are borne by individuals. Society carries some costs in the form of opportunity cost e.g. lower productivity and reduced social contribution from individuals (Cadilhac *et al.,* 2011).

The GPI Atlantic approach calculated costs for a specific timeframe, over a year. This differs from FCA and cost benefit analyses (CBA) which attempt to capture the broad range of lifetime/ future costs associated with the particular issue of concern, discounted and expressed in net present value terms. As with all studies that measure direct and indirect costs and economic values, data quality influences not only the type of valuation techniques that can be applied, but also the level of detail that can be put into comprehensive cost accounts. For example, levels of physical activity/inactivity over a lifetime affect the risk of disease, not just current levels of activity. There are some assumptions that have to be made about levels of behaviour and about the cause and influence of physical inactivity.

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[9] As data on the prevalence of depression in physically inactive people was available, the treatment of depression was considered a direct health cost.

1.2.2 Methodology Used

This report lies within the conceptual framework of genuine progress indicators, but does not formally adopt full cost accounting methodology. Arguably, it is never possible to include all costs, as not all causal effects are discernible. We use GPI Atlantic's approach (Colman and Hayward, 2002; Walker and Colman, 2004a&b) of calculating the avoidable costs of preventable diseases associated with insufficient physical activity within New Zealand regional populations for one year. [10] The 2010 year was chosen given that this was the most recent year for which full hospital costs were available. This corresponds to the economic health costs for one year in Figure 1.2 above. A partial measurement of some of the environmental, social and cultural costs was undertaken where possible, but these costs are described qualitatively throughout the report, rather than captured in dollar values.

This approach implicitly recognises that the level of physical activity/inactivity acts as a lever on the economy, environment, social and cultural structures. The most direct effect is on the economy, through the health care system and therefore the focus of this report concentrates on these.

1.3 Defining Physical Activity

Physical activity is 'any bodily movement produced by skeletal muscles that results in energy expenditure'[11] and is positively correlated with physical fitness. It can be incidental, occupational or recreational (MoH, 2008). It should not be mistaken *only* for sport or exercise, which is a subset of physical activity (Caspersen *et al.* 1985). Physical activity also includes walking, dancing, gardening, stretching, doing household chores, playing etc.

Physical activity can occur during work (including domestic work), active transit (walking, cycling, rowing) and during leisure time (sport and recreation). Lifestyle changes over the past century, including how we work, social transformation and how we live, how we get our food, what we do with increasing time spent on leisure, the technology we use, changes in transport modes and changes to our physical environs now means we are less physically active, to the point where it is adversely affecting health (SPARC, 2005). With increasing numbers of people living in urban areas, urban design affects participation in physical activity, particularly relating to physical accessibility to the workplace and amenities, infrastructure and ability to use active modes of transport such as networked footpaths and cycle lanes, and social infrastructure such as safe beaches and parks, sports and recreation facilities. Integrated land use and transport planning is a critical enabler of physical activity in urban built environments. There is a significant difference in infrastructure characteristics between urban and rural

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[10] The Walker and Coleman methodology built on Katzmarzyk *et al.* (2000), who conducted the first study for Canada, which was then replicated for the Canadian regions in their GPI. Of note, there were differences in the definitions of physical inactivity in the various studies.

[11] Definition cited from World Health Organization website, although this may not be the original use of the term.

environments, and all three regions have more rural than urban land areas (although New Zealand is one of the most urbanised countries in the world, with over 85 percent of the population living in urban areas in 2006).[12]

The intensity of physical activity varies between people, and particularly by age. The New Zealand Physical Activity Guidelines state that adults should participate in at least 30 minutes of moderate-intensity physical activity on most, if not on all days of the week (MoH, 2008; SPARC, 2005). Moderate physical activity will cause a slight, but noticeable, increase in breathing and heart rate. Vigorous physical activity involves raising the heart rate to 70 or 80 percent of maximum rate, stimulating the cardio-vascular muscle system (See Appendix 1). Physical activity is not a panacea. Other risk factors may negate any good that exercise does – for example smoking, diet, genetic disposition and age. Physical inactivity is seen in the broader context of overall health, and it is just one risk factor. Epidemiological studies isolate the levels of risk for physical inactivity to each disease. For example, no amount of physical activity may compensate for being a smoker, eating excessively health damaging foods or having a genetic predisposition for certain diseases.

1.4 Physical inactivity and epidemiology

Epidemiology is the study of trends, cause and effect of health and disease in populations. Epidemiological links between physical activity and health outcome were established in the 1950s, pioneered through the work of Jeremiah Morris (Blair *et al*, 2010; Patel, Slentz and Kraus, 2011). The basic premise is that several chronic conditions can be avoided through more physical activity. Over the last 60 years, many studies have explored and elaborated on the extent and risk of contracting certain diseases given levels of activity/inactivity (Lee *et al,* 2012; MoH, 2003; Bouchard *et al*, 2007). Increasing the amount of physical activity reduces the chance of contracting diseases as listed in Box 1.2.

Recent research establishes the links between physical activity, brain function and cognition, given the molecular and cellular processes that occur during physical movement (Kramer, 2012), and our understanding of the beneficial effects of physical activity are deepening. This is of particular importance in the ageing process (Weinstein, Voss, Prakash *et al*., 2012).

Exercise is seen also as a preventative medicine on an individual level. As with all medicines research is focused on the 'dose-response' of physical activity to the disease/condition in question.[13] Physical inactivity is seen as a public health issue, given the increasing demands placed on the health system by inactive people.

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12 Statistics New Zealand circa 2008. New Zealand: An Urban /Rural profile update. http://www.stats.govt.nz/

13 See proceedings for the 'Conference: Symposium on Dose-Response Issues Concerning Physical Activity and health' held in Ontario Canada, October 2000, in the special edition of Medicine and Science in Sports and Exercise (2001) vol.33(6)

Box 1.2: Diseases affected by levels of physical inactivity included in this study
Physical activity is known to reduce the risk of being diagnosed with many diseases. The following are included in this regional NZ study:[14] • Breast cancer • Colorectal cancer • Hypertension • Coronary heart disease • Stroke • Osteoporosis • Diabetes type II • Depression

Insufficient physical activity is a contributor to the rising incidence of particular diseases, and the risk can be expressed in terms of the level of physical activity amongst a general population. The measurement of physical activity and its intensity requires careful design (SPARC, 2003; Shephard, 2001) to assess whether individuals across the population are participating in at least thirty minutes of moderate intensity physical activity on five or more days of the week as per the guideline. This guideline is referred to as the "30 x 5 recommendation." The SPARC 2007/08 Active NZ Survey (SPARC, 2008) monitors participation in sport, recreation and physical activities in New Zealand adults (aged 16 years and older) using a sport and recreation survey and a seven-day physical activity recall.[15] It covered the entire country, enabling a regional comparison of levels of physical activity. Table 1.1 summarises the relevant results from the SPARC study and shows that the levels of physical activity – those that are undertaking the "30 x 5" recommended physical activity – and those that are not.

Despite the acceptance of medical findings linking physical inactivity to certain diseases/poor health, over half of New Zealanders do not engage in enough physical activity (SPARC, 2008).

Of the proportions that are not meeting the guidelines, a proportion were 'inactive' while between 70 and 80 percent of those who did not get sufficient physical activity did however do 'some activity'. For the purpose of this study, the distinction and level of detail on those that 'did some activity' and 'were inactive' is not used, as both categories have a prevalence of risk of contracting a disease. Fulfilling the

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[14] The beneficial aspects of physical activity risk reduction are not limited to these diseases only. This study follows the Coleman and Walker (2004) methodology, which took these diseases into account. In addition, data on relative risk reduction of physical activity on depression was available, so depression was included in our study. Emerging research explores the effects of physical activity on ageing processes and potentially dementia (e.g. Alzheimer's disease) could be included in the disease list, if the relative risk between dementia and inactivity become available. However no reliable relative risk figures for physical activity and dementia were found in the literature searched, and therefore it was not included in this current analysis. For the corresponding list of ICD codes of these diseases that was used in this study, see Appendix 2.

[15] The New Zealand Health Survey measures basic data on adult physical activity also, but was not used in this study as the SPARC study is the most recent.

"5x30" guidelines was used as a cut-off point. It is however acknowledged that there is a scale of activity levels, and many reasons why some people may be on the lower end of inactivity (e.g. physical disability). Equally, people at the high end of physical activity (e.g. professional sports people) may be over ten times more active (in terms of time) than those who just meet the guidelines. The three regions in this study – Auckland, Waikato and Wellington had rates of inactivity just marginally higher than the New Zealand average, although these are not significantly different.

Table 1.1 Levels of Physical Activity/Inactivity in the study regions

	Proportion of population that met the "30 x 5" physical activity guidelines	**Proportion of population that had a prevalence of risk due to insufficient physical activity (P).**
New Zealand	48.2%	51.8%
Auckland Region[16]	47.7%	52.3%
Waikato Region	45.9%	54.1%
Wellington Region	47.6%	52.4%

Source: SPARC, (2008)

Physical inactivity is a significant public health concern (WHO, 2008), with a large proportion of the economic burden associated with treating chronic conditions being attributable to physical inactivity. In most countries, New Zealand included, men are more active than women, and in New Zealand vulnerable or priority groups identified include Māori, older people, children and adolescents and pregnant women (MoH, 2003), although Māori had higher proportions of adults meeting the recommended '5x30 guidelines' than other ethnic groups. Appendix 4 gives more details of regional variations. This report focuses on the total adult population, and does not distinguish between these different groups. Any policy response should consider targeting the increase of physical inactivity amongst different ethnic groups.

As can be seen from this introduction, physical inactivity is a generic term for a complex area of study. The causes and effects of physical activity and inactivity are multifaceted, and may differ according to age cohort. Physical inactivity is seen as a risk factor for disease, whereas physical activity is considered a medicine. Physical inactivity can be a confounding factor in chronic diseases obscuring the cause and effect of the disease.

This report uses secondary data sources for calculating the full cost of physical inactivity, relying on findings from numerous research studies. These studies were published for a variety of purposes, and as such have very different methodological approaches, timing of observation, geographical coverage and

16 The Auckland region contains four regional sports trusts – North Harbour, Waitakere, Auckland and Counties Manukau. The Auckland regional average rate of physical activity was calculated using 2008 adult population estimates for the sports trust areas.

study populations. The following section clarifies the scope of this study. More details about particular datasets are given in the methodology section.

1.5 Scope of Study

M.E was commissioned to scope out the development of a full cost account for physical inactivity for three regions of New Zealand: Wellington, Waikato and Auckland, while explicitly calculating the direct and indirect costs of physical inactivity. The project brief was to undertake a similar study to that completed by GPI Atlantic for physical inactivity in the Canada regions, with the purpose of demonstrating the applicability of the FCA method. The GPI Atlantic (Walker and Colman, 2004) methodology was reviewed and modified to suit the availability of data in a New Zealand regional context. As most data is readily available at a national level in New Zealand, estimates were derived for the New Zealand costs of physical inactivity also. Where possible, regional data was used (e.g. directly from DHBs and using Regional Council boundaries). If regional data was not available, national figures were disaggregated to a regional level, using population weights. In terms of replicating the Walker and Colman (2004) study for the New Zealand regions, it was possible to undertake a meta-analysis of direct health costs associated with physical inactivity (using a prevalence-based approach to the occurrence of disease). Considerable effort went into identifying data sources in New Zealand and extracting the relevant data. Thereafter, the data was thoroughly checked and triangulated, to try to avoid or minimise double counting. This was necessary given that the study relied on published research which had differing purposes, methods, timeframes and research focus. We highlight some exclusions throughout the report, where further work is required to obtain accurate data.

1.6 Information Sources

Various information and data sources were used throughout this project including:

- Ministry of Health (mortality data, minimum dataset Mental Health Survey)
- SportNZ formerly SPARC
- Publications and guidelines from Pharmac and MedSafe
- District Health Board reports and published data
- Reports and academic papers on the burden of illness in New Zealand
- International studies on prevalence of disease and relative risk of physical activity
- Statistics New Zealand (census data, population projections and consumer price index, GDP)
- Medical experts (especially from MoH, CMDHB, ADHB, Pharmac, Clinical Knowledge Solutions)

- Information supplied by Regional Councils, NZTA, Research Council of New Zealand.

2. Conceptual Framework and Methodology

This study sits within an economic valuation framework. While being explorative of the effects of physical inactivity on broader society, an attempt is made to include a broad range of associated costs where possible (full cost accounting). As stated previously, the preferred method of the Councils (who commissioned this work) was to replicate/apply the GPI Atlantic approach to measuring physical inactivity in the three New Zealand regions, while conceptually testing the applicability of the emerging FCA method. The GPI Atlantic approach used a cost of illness method. Cost of illness studies are comprehensive studies that *value* in dollar terms the costs of a particular health problem.

Our study uses a cost of illness method as a point of departure (Section 2.1), estimating the monetary value of disease/illness that can be attributed to physical inactivity on a societal level. Direct health costs and indirect costs of the illnesses associated with physical inactivity are calculated for one year. In an attempt to apply the principles of a FCA method to physical inactivity, a category or 'other costs' was added to the cost of illness study. In addition, the number of premature deaths attributed to physical inactivity is estimated.

Given the levels of physical activity (Section 2.2) in a region, the relative risk (Section 2.3) of developing a particular disease is established within epidemiology, through observation of total population. On a societal level, this relative risk is translated into a quantifiable cause – e.g. articulated as physical inactivity causes a certain proportion of the incidence of that disease. These are expressed as 'population attributable fractions' (Section 2.4) for each disease.

Combining the total cost of treating a disease with the population attributable fraction gives a dollar value for health costs that could have been avoided if people undertook the recommended levels of physical activity. This information can highlight areas where costs can be saved or inefficiencies reduced and provides practical information to guide funding decisions and the policy-making process. The core building blocks for cost of illness studies on physical inactivity include:

- Measuring the prevalence of physical inactivity (based on observed behaviour of population);
- Establishing the relative risk of developing a particular illness, given levels of physical activity (epidemiological studies);
- Calculating the population attributable fractions for each disease (the proportion of incidences of disease that could have been avoided through doing the recommended levels of physical activity); and
- Multiplying the cost spent on treating each disease by the population attributable fraction.

This process is described in this Section, with supporting literature for this method presented in Appendices 2 (review of studies that used cost of illness method) and 3 (review of physical activity surveys undertaken in New Zealand).

2.1 Cost of Illness Methodology

Cost of illness studies identify and quantify the health costs of treating a particular illness. A portion of these treatment costs could have been avoided if people did the recommended levels of physical activity. Physical inactivity is seen in the broader context of overall health, and it is just one risk factor. Epidemiological studies isolate the levels of risk for physical inactivity to each disease. After reviewing available datasets and research reports in New Zealand, the direct and indirect costs associated with diseases that could be avoided with increased physical inactivity were scoped out.

The direct health costs that the community and patients bear are shown in Table 2.1, along with the indirect and intangible costs. Indirect costs are largely associated with lost productivity and earnings as a result of the illness incurred by the patient and informal carers. This is influenced/determined by premature death. Intangible costs are those associated with changes in the quality of life of individuals as a result of the illness, particularly the cost of pain, grief and suffering. Table 2.1 also shows what was out of scope of the current study – notably private hospital costs due to lack of reliable data on their magnitude and the costs of community care for certain diseases (e.g. nursing home costs, meals on wheels etc.). In terms of measuring indirect costs, two techniques were used: a measurement for a preventable fatality and potential life years lost to the disease (premature death).

Table 2.1 Definitions of the type of costs used in cost of illness studies	
Type of costs	***Description***
Direct	Costs associated with the health care system that the community and patients bear directly (i.e. tax transfers and user pay fees). In scope: The costs of hospital stays Pharmaceutical products and medicine Outpatient services Other specific costs identified (e.g. ambulance, transport costs) General Practitioner (GP) and primary health care service, including psychiatrist and counselling Medical research into prevalence/treatment Health Promotion (Public Health) Screening programmes Out of scope: Private hospital care (partially accounted for) Community care (e.g. nursing homes, meals on wheels, home care)* Opportunity costs – money that could have been spent/invested elsewhere with different economic impacts and returns.
Indirect and intangible	Costs largely associated with lost productivity and earnings as a result of the illness incurred by the patient and informal carers. Intangible costs are those associated with changes in the quality of life of individuals as a result of the illness particularly the cost of pain, grief and suffering on individuals and their families, and the cost of disability and loss of quality of life. In scope: Method 1: Value of 'preventable fatality' due to physical inactivity Method 2: Potential 'life years' lost to the physical inactivity disease Out of scope: Willingness to pay value for saving a life due to increasing physical activity (strictly correct method for valuing effects of physical inactivity).
*where possible and when data was available, these figures were included but this was not possible for all diseases	

2.1.1 Prevalence of physical inactivity

The prevalence of a risk factor is the extent to which, in this case, physical inactivity is characteristic of the total population. It measures the proportion of the population that is not undertaking the recommended levels (30min x 5 times a week) of exercise. The standard statistical approach used in different countries is cross-sectional regression of surveys, and many of these studies have found lower rates of activity for women, older people and those in lower income brackets (Lunn, 2009). There is limited time series data on levels of physical inactivity in New Zealand, but Appendix 3 details the published studies that were found in the literature. Reliable data on the prevalence of physical inactivity was obtained from the Sport New Zealand 2007/08 physical activity survey of New Zealand adults. The levels of physical activity for the regions are shown in Table 2.2.

Table 2.2 Levels of Physical Activity/Inactivity		
	Proportion of population that met the "30 x 5" physical activity guidelines	**Proportion of population that had a prevalence of risk due to insufficient physical activity (P).**
New Zealand	48.2%	51.8%
Auckland Region	47.7%	52.3%
Waikato Region	45.9%	54.1%
Wellington Region	47.6%	52.4%

Source: SPARC, (2008)

For the purposes of this study, the overall rate of physical inactivity of the adult population is considered. Sport NZ's survey has a finer breakdown of physical activity rates by sex, age and ethnicity the level of detail which were not drawn upon in this current study, but are shown in Appendix 4. Overall, men had higher rates of physical activity (meeting the recommended 30x5 guidelines) than women; 35-49 year olds had the highest rates of physical activity; Māori, Pacific and NZ Europeans had slightly higher proportions of their population meeting the "30x5" guidelines than the national average, with a higher proportion of Asian adults in the inactive group (SportsNZ, 2010). These findings were confirmed in the Quality of Life survey, along with a finding that people in low income households were more likely to undertake no physical activity.

2.1.2 Relative Risk

To estimate the economic burden of an illness related to physical inactivity, epidemiological evidence showing the link between physical inactivity and various diseases are used. This is expressed as the 'relative risk' of developing a particular disease for a physically inactive person, compared to an active person. This is the second component required for calculating the PAF. Relative risk is a means of measuring the association between physical inactivity and the prevalence of diseases, as evidenced from cohort studies using dose-response analysis. Relative risk represents the probability of developing a disease among physically active people relative to the probability of physically inactive people. Relative risks enable a comparison of how probable individuals are to get a disease if they are physically inactive compared to those who are active.

In order to obtain the relative risks for each disease, which could be ameliorated by more physical activity, a comprehensive literature search was undertaken. There is no published New Zealand specific data on relative risk, although the Ministry of Health is in the preliminary stages of undertaking such a study for various diseases (MoH, personal communication). Ideally relative risks would be calculated from epidemiological studies of New Zealanders and the risks they face with regard to contracting diseases. Such data was not available at the time of undertaking this study, and recourse had to be taken to international figures for relative risk. Most cost of illness studies reviewed used international meta-analyses.

Epidemiological studies provide risk profiles for disease contraction for people exposed and not exposed to a single risk factor. Relative risk consists of two parts: firstly the ratio of occurrence of disease in the segment of the population that does not do the recommended physical activity and secondly the rate of occurrence of disease in the portion of the population that meets physical activity guidelines. The relative risks used in this analysis are shown in Table 2.3, along with the source and study region from where they were calculated. It is assumed the relative risk for each disease is the same for all regions (spatially invariant).

Table 2.3 Relative Risk for each disease

Disease	Relative Risk (RR)	RR - 1	Location/Study areas	Source:
Breast cancer	1.21	0.21	World average based on meta-analyses.*	The New Zealand Breast Cancer Foundation, 2011 and Katzmarzyk *et al.* 2000.
Colorectal cancer	1.66	0.66	World average	Cancer Society of New Zealand, 2009
Hypertension	1.3	0.3	Published for Canadian study, using previously published meta-analyses, using a general variance-based method.	Katzmarzyk *et al.*, 2000 Note the RR for stroke and CHD were the same as those used by Russell *et al.* (1992) in their study of the cost of inactivity in NZ
Coronary Heart Disease	1.45	0.45		
Stroke	1.6	0.6		
Osteoporosis	1.59	0.59		
Diabetes type II	1.5	0.5		
Depression	1.28	0.28	Meta-analysis, using studies predominantly from Finland, with other European and US studies.	Genter *et al.,* 2008, based on meta-analysis of Dunn *et al.* 2001.

** A Meta-analysis is a systematic process for finding, evaluating and combining the results of data from independent sources.*

A relative risk factor of 1.21 for breast cancer means that a physically inactive woman has a 21 percent greater chance of having breast cancer than a physically active woman (hence the presentation of RR-1, which shows the proportional difference between those who are physically active and aren't). Arguably there will be differences in relative risks amongst countries, but given that there is no published data specific for the New Zealand population, this study had to rely on these international epidemiological research findings. As recourse had to be taken to rely on this secondary data, there is the assumption that the relationship between physical inactivity and prevalence of each disease in New Zealanders is similar to that for the risk calculated in other countries.

2.1.3 Population Attributable Fraction (PAF)

The PAF is a means of isolating the physical inactivity component out of epidemiological studies, attributing a causal proportion of disease prevalence to physical inactivity. The PAF for physical inactivity is the proportion by which the incidence of a disease in a population could be reduced if physical inactivity were to be at a 'theoretical minimum' (Cadilhac *et al.* 2011), that is, if the population were eliminating the risk of contracting the diseases through activity (Box 2.1).

The PAF recognises that diseases are caused by many factors (e.g. smoking, age, genetics and so on), along with physical inactivity. Individuals could reduce their risk of contracting the diseases associated with physical inactivity, although not eliminate the risk of contracting it completely. In other words, physical activity reduces the risk of contracting these diseases but it is not a cure for or immunization against these diseases.

Box 2.1 The Population Attributable Fraction (PAF)

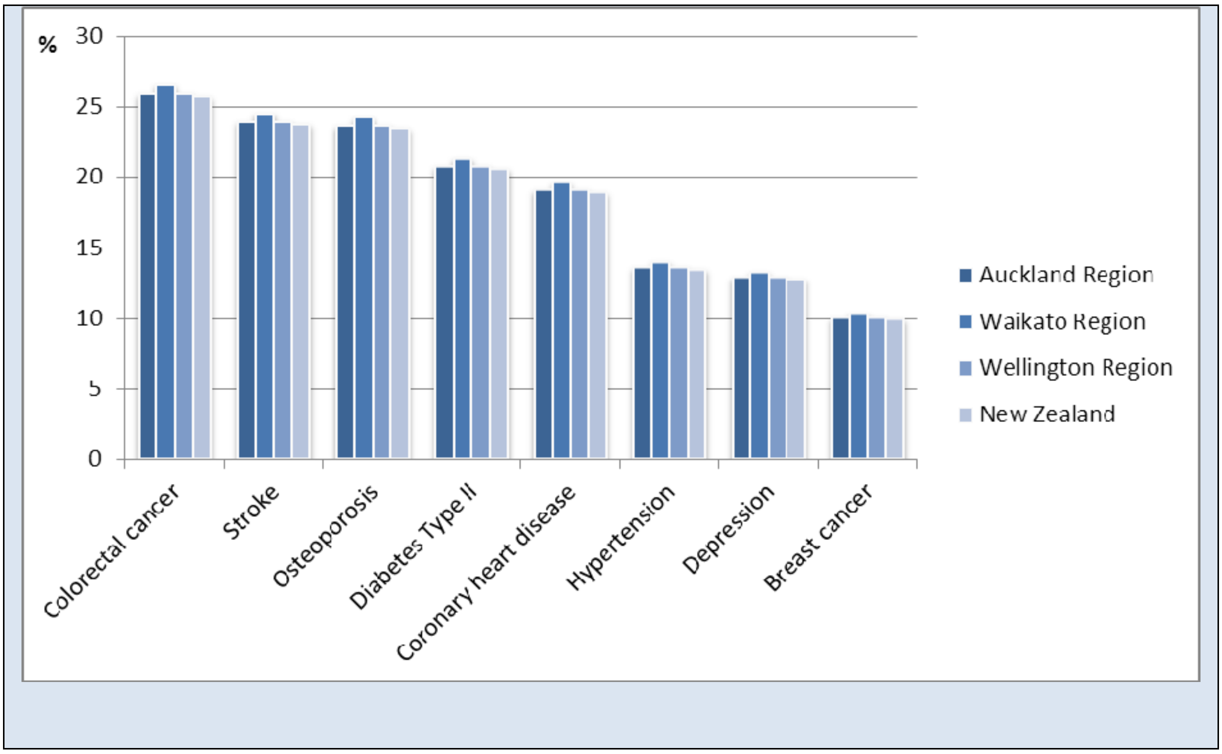
The PAF method estimates the portion of disease costs that are attributable to physical inactivity. Using this approach, the PAF is computed from the population prevalence (P) of physical inactivity and the relative risk (RR) of a given disease associated with physical inactivity:

$$PAF (\%) = [P(RR - 1)] / [1 + P(RR - 1)]$$ (see Appendix 5)

Combining prevalence of physical inactivity and relative risk level (figures from Tables 2.2 and Table 2.3) enables the calculation of the PAF (Table 2.4). We have calculated the PAFs for each region by disease. The PAF is subsequently used to estimate the total cost of treating a particular disease that can be attributed to physical inactivity. The PAF can be interpreted as the proportion of the total cost that could have been avoided if people did the recommended levels of activity.

Table 2.4 PAF Figures

	New Zealand	Auckland Region	Waikato Region	Wellington Region
Breast cancer	9.9%	10.0%	10.3%	10.0%
Colorectal cancer	25.7%	25.9%	26.5%	25.9%
Hypertension	13.4%	13.6%	14.0%	13.6%
Coronary heart disease	18.9%	19.1%	19.6%	19.1%
Stroke	23.7%	23.9%	24.5%	23.9%
Osteoporosis	23.4%	23.6%	24.2%	23.6%
Diabetes type II	20.6%	20.7%	21.3%	20.8%
Depression	12.7%	12.9%	13.2%	12.9%



Colorectal cancer has the highest PAF in all regions. This means that physical activity has the greatest impact on colorectal cancer, out of all the diseases, while breast cancer has the lowest response to physical activity. This could be for any number of reasons, for example the number and combination of other risk factors (e.g. for breast cancer there are unique correlates such as the number of years of breastfeeding that reduce risk of developing the disease). Each disease has differing risk levels, including factors unique to the individual (e.g. genetics/family history), with physical inactivity being just one risk factor. A PAF of 0.213 for Type II diabetes in Waikato means that 21.3% type II diabetes could have been avoided if the Waikato population were undertaking the recommended levels of physical activity. It can also be interpreted that 21.3% of the costs of treating diabetes could have been avoided, through physical activity. Similarly, a PAF of 10% for breast cancer in the Wellington region can be interpreted that one tenth of breast cancer could have been avoided if the entire population met the recommended levels of physical activity. In other words, 10% of costs of treating the disease avoided.

As the prevalence of inactivity was slightly higher for Waikato, the resulting PAFs are marginally higher. This means that a greater proportion of the total cost of treating the diseases in Waikato is attributed to physical inactivity, relative to the other regions. This is only slight, and there is little difference in the PAFs however across the regions.

The values in Table 2.4 show that physical inactivity has the highest influence on colorectal cancer prevalence – or colorectal cancer is the disease that has the highest potential response rate to increased physical activity. As will be shown later, it is not the most costly disease to treat, so more significant cost savings come from other diseases. **These relative PAFs show where the biggest impacts on prevalence of diseases across the population are –** as accorded to the risk factor of physical inactivity.

2.1.4 Confounding

Confounding in epidemiology is a bias due to uncertainty in cause and effect. For example a disease such as diabetes or depression may affect physical inactivity, and hence lead to other diseases, such as heart disease. Association does not necessarily imply causation. A confounding variable is a variable that can cause the disease under study and is also associated with the exposure of interest (in this study physical inactivity). The existence of confounding variables make it difficult to establish a clear causal link between inactivity and the diseases associated with inactivity, as the inactivity may cause more than one disease. For example, people with diabetes have a higher rates of depression (Nichols and Brown, 2003), as do patients with chronic diseases (Oakley Browne *et al*. 2006). Confounding will affect the level of risk, and epidemiology studies try to eliminate confounding for the populations under study. It is however beyond the scope of this current study to make adjustments for confounding in epidemiology.

Cases where patients are being treated for more than one disease at a time is called co-morbidity; a thorough attempt was made in this study to eliminate any double counting that could arise from co-morbidity. In a recently published international study on relative risks due to physical inactivity, adjustments were made for this co-morbidity by country (Lee, Shiroma, Lobelo *et al.* 2012). However, as the rationale or method was not detailed for the actual adjustments made for the NZ data (Lee *et al.* adjusted the overall population attributable factor for a few but not all of the diseases under consideration in this study – CHD, Diabetes, Breast and Colon cancer), and given that the data obtained for our study could identify co-morbidity from individual hospital records of the eight diseases, it was the cost of each patient that was included, and a portion of the cost of stay in hospital attributed to each disease, if co-morbidity was present. This avoids double counting in our estimates. For these reasons, the more recent PAFs in Lee *et al.* (2012) were not used, but are mentioned as they mark a methodological advancement of incorporating confounding issues in epidemiological studies of PAFs.

2.2 Methods for Estimating the Cost of Diseases

Once the PAF is calculated, it is multiplied by the total cost incurred when treating each disease within a discrete timeframe. As stated, Appendix 2 reviews this approach, giving examples from studies undertaken in other jurisdictions and the particular types of costs that can be associated with each disease. Costs are divided into direct (Section 2.2.1), indirect and intangible costs (Section 2.2.2). In our analysis, indirect and intangible are estimated together (Section 2.3.3). *Direct costs* are relatively straightforward and intuitive to understand, although data is not always collected on them or available in a concise and consistent manner. These limitations are discussed, and the approach taken to address data gaps detailed. Indirect and intangible costs are more complex to measure, and therefore difficult to incorporate into economic burden/cost of illness studies. *Indirect costs* are those associated with loss of output and productivity (a human capital approach to illness), whereas *intangible costs,* such as pain or suffering, are very specific to the individual and depend on how resilient a person and their family/household is in the face of an illness. Methodologically these indirect and intangible costs were the most challenging for this study, as there is a lack of New Zealand data on valuation of human life. Health economics tends to move away from putting a dollar value on life, but instead focuses on the value of health outcomes, as measured for example through years of life saved and quality of those years.

2.2.1 Direct costs

Referring back to Table 2.1, any expenditure by healthcare providers on treating a particular disease is considered a 'direct cost' and includes hospital treatment, outpatient care, and drug costs. Direct costs also include the private (household) costs of treating these illnesses such as GP visits, psychiatrist and counseling services, ambulance and emergency service costs, research and screening programme's costs.

This study used hospitalisation data from the Ministry of Health's inpatient data set to estimate the direct costs. Called the National Minimum Data Set, this data contains all the discharge records from all events in public hospitals, which are hospitals run by the District Health Boards (DHBs). Confidentialised patient records were obtained for the eight diseases, detailing the conditions that were recorded on discharge of the patient. A patient could have more than one disease listed on their discharge record, hence enabling an adjustment for co-morbidity. That had been a criticism of earlier cost of illness studies (MoH, 2009). This ensured that there was no double counting of diseases and costs, in cases where a patient was being treated for more than one of the diseases. The extent of comorbidity in the records obtained for the purpose of this study can be seen in Table 2.5. Note, patients may have been treated for other diseases that were not associated with physical inactivity during their stay at hospital e.g. diseases of the nervous system. However, comorbidity with the diseases, other than the eight physical inactivity related ones, could not be discerned from our dataset. The data showed comorbidities between the eight conditions only, not comorbidities with *other* conditions.

The dataset contained 130,550 hospital discharge records, focused on the eight diseases, covering all public hospitals and was for 2010.

Table 2.5 Proportion of hospital discharges where only one of the physical inactivity disease/illnesses were being treated (All New Zealand, 2010).		
	"Unique" treatment of disease	**Number of times disease appeared on discharge form**
Breast cancer	95%	8,630
Colorectal cancer	92%	12,892
Hypertension	24%	67,528
Chronic heart disease	43%	38,608
Stroke	40%	13,993
Osteoporosis	74%	2,459
Diabetes Type II	29%	37,726
Depression	84%	6,477
		188,300

Source: MoH inpatient dataset

A total 188,300 diseases were listed on the discharge data. The total number of discharge records may not correspond to individual people – as a person may have more than one episode in hospital during a year, and be treated for multiple diseases per hospital visit. Both breast and colorectal cancer patients were more likely to be treated only for cancer (i.e. low levels of co-morbidity), whereas the cardiovascular and diabetes patients were more likely to be treated for more than one illness during their hospital stay/episode. With reference to depression, 84 percent of hospital patients being treated 'uniquely' for depression is misleading because most people with depression are not treated in hospital. Depression is a condition that has high co-morbidity with chronic and terminal illnesses.

The number of hospital discharges, after adjusting for co-morbidity is given in Table 2.6 - this table is not the number of patients/discharges but a weighted sum of treating the disease, to take into account the existence of co-morbid cases. Therefore the totals of Tables 2.5 and Table 2.6 do not reconcile.

Table 2.6 Weighted number of hospital discharges, after adjusting for co-morbidity				
	Auckland region	**Waikato region**	**Wellington region**	**New Zealand**
Breast cancer	2,186	1,084	847	8,520
Colorectal cancer	2,816	1,938	1,001	12,791
Hypertension	25,506	6,444	6,760	79,761
Chronic heart disease	8,388	2,163	3,228	38,367
Stroke	2,259	647	1,042	9,552
Osteoporosis	598	78	175	1,976
Diabetes Type II	13,014	2,355	2,244	31,321
Depression	1,409	468	573	6,026

Private hospital costs are not included in this study, although they may account for over 21 percent of total hospital health care costs.[17] MoH report that there were over 71,000 privately funded discharges (for all diseases, not only the eight diseases used in this study) from hospitals for 2008/09, but also note that this is a partial estimate as not all private hospitals report their data to the Ministry of Health.[18]

It was not possible to get a breakdown for private hospital treatment of the physical activity related illnesses for the 2010 year, which means that the total hospital costs are underestimated, by possibly up to 21 percent. However, it is uncertain as to whether this 21 percent is uniform across the diseases in this study, and more work is required to get a reliable breakdown of the private hospital data. For example, it has been estimated that the private hospital discharge costs for colorectal cancer was 11.6% of public hospital discharge cost, and 13.9% for breast cancer (MoH, 2011). The model developed for calculating the costs of treating diabetes does not distinguish between private and public hospital costs – it is built up from an average cost per patient, irrespective of where treatment occurred (PWC, 2006).

As the 21% of total hospital care costs in private hospitals may include more elective surgery, this would skew the number of private hospital treatments for the eight diseases above if used. As a sensitivity test/or to lessen the undercount, the hospital costs were increased by 10% to account for private hospital care.

On discharge from hospital, each patient is allocated a 'case weight' which can be directly converted to a dollar value, given the resources that were used during the hospital visit. The method used to calculate hospital costs is outlined in Box 2.2.

Box 2.2 Calculating Hospitalisation Costs (Case Weights)

The costs of treating patients with the non-communicable illnesses associated with physical inactivity were obtained from the Ministry of Health inpatient data set - the National Minimum Data Set. This data contains the discharge records (called an event) from all public hospitals. DHBs are the Crown entities administering publicly funded health and disability support services for the population of a specific geographic area in New Zealand. There are currently 20 DHBs in New Zealand.

In addition to the public hospital system, there are private hospitals who administer care, primarily funded by medical insurers (private health insurance). Private hospitals can be contracted by the DHBs to perform surgery

[17] Medical Technology Association of New Zealand website. Overview of the NZ Healthcare Market for 2007. http://www. http://mtanz.org.nz/NZ-Market-The-NZ-Healthcare-Market/Overview-6374.htm

[18] See the Ministry of Health's webpages for more details. http://www.health.govt.nz/publication/privately-funded-hospital-discharges-1-july-2009-30-june-2010

when they require additional capacity. It is estimated that publicly-funded healthcare represented a 79.2 percent share of total NZ healthcare, with private healthcare holding a share of 20.8 percent.[19] This report includes publicly funded health costs only, as reliable data on the treatment of disease in the private sector was not available, nor a breakdown of the proportion of diseases treated in private hospitals. Upon discharge from a hospital event, a *case weight* for each patient is calculated and recorded by MoH. A case weight measures the relative resources required by the hospital in treating the patient. It includes costs incurred by all the department(s) that the patient was in/used (e.g. radiology; physiotherapy), surgical costs and length of time in theatre, length of stay in hospital. Each discharge record had a case weight value, which can be directly converted into dollar values. The conversion factor of case weight value and cost is $4,469.74 (provided by MoH).

An event may include the treatment of more than one condition per hospital visit (co-morbidity). If the patient has an underlying condition, this will also be recorded in the National Minimum Data set. As recommended by Pharmac (2012), an adjustment was made to the co-morbid cases such that each case was weighted according to the number of discharges under each Diagnosis-related group (DRG code us a system to classify hospital cases), as it was not possible to determine from the dataset what the primary condition being treated was in co-morbid cases. The dataset chronicles the weighted value of the treatment administered and records the ICD-10 conditions for that event and the cost weight is determined by the DHB accordingly.[20]

This database was queried for each of the diseases using the International Statistical Classification of Diseases and Related Health Problems Tenth Revision (ICD-10 – See Appendix 6), which is a medical classification list of the WHO and is used, by convention, in New Zealand.[21] Selection of the ICD-10 codes for inclusion in this study was decided in consultation with medical practitioners in various disciplines and Ministry of Health experts.

Data was extracted from the inpatient data set for the 2010 calendar year, only for patients over 25 years of age.

Drug costs were obtained from the MoH pharmaceutical dataset, which includes all records of prescribed drugs.[22] The main drugs (as identified through their chemical name) administered for each disease were identified in consultation with medical and clinical experts, and the value of the drugs dispensed in each region (DHBs) were extracted. The list of drugs is shown in Appendix 6. It deliberately excludes palliative care-related and pain medications (e.g. morphine, ketamine or benzodiazepines) on the basis that they are used in the treatment of many diseases, and it was not possible to determine what proportion of the drug was used for treating one particular disease, and therefore exclusively for physical inactivity. The list is for 2010, and it is acknowledged that some newer drugs have been introduced to treat the diseases in the intervening period, but they were not available/administered in 2010.

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19 See http://www.mtanz.org.nz for an overview of the NZ healthcare market. In 2007, total health expenditure (public and private) was worth $16.2 billion.

20 Discharges collected in the National Minimum Dataset (NMDS) have a cost-weighted discharge value calculated when the data is submitted by DHBs. Cost weights are then applied to the national inter-district flow (IDF) price for secondary services, which is decided by the National Pricing Programme. The methodology for calculating cost weights can be found online at: http://www.moh.govt.nz/moh.nsf/Files/ncamp2011/$file/wiesnz11-version 8.pdf

21 http://www.health.govt.nz/nz-health-statistics/classification-and-terminology/icd-10-am-achi-and-acs

22 http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/pharmaceutical-collection

Hospital *<u>outpatient costs</u>* are not included in the Diagnostic Related Group (DRG) prices, used in the calculation of hospital costs. Hospital outpatient costs can be greater for the treatment of certain diseases/illnesses than the hospitalisation itself. This is particularly the case for treating depression and diabetes. Hospital outpatient costs may include (Pharmac, 2012):

- Outpatient clinic appointments/services
- Laboratory and diagnostic tests
- Community nursing services provided by the hospital/DHB
- Hospital based outpatient programmes.

In addition, *<u>ongoing care for patients</u>* in the aftermath of hospitalisation can be significant. This is particularly the case for stroke survivors (Scott, 1994) who may require continued institutional care or home help due to loss of physical capability.

In New Zealand, primary health care relates to professional health care administered in the community, usually from a medical general practitioner (GP), nurse or other medical professional. Primary health care is usually the first point of contact for a person with the health system. The District Health Boards fund Primary Health Organisations (PHOs) to provide many essential medical services. There is no centralised database in New Zealand containing details of each primary health consultation.

An extensive search was undertaken of the New Zealand literature to source data on the cost of outpatient services, rest homes, community care and primary care. It was not recommended that cost data from overseas be used in cost calculations due to potential differences in clinical practice, community care and differences in absolute and relative prices (Pharmac, 2012).

The most relevant reports for this study, published within the last five years, detailing the costs associated with different diseases in New Zealand were:

- Ministry of Health (2011) for both colorectal and breast cancer (Box 2.3)
- PricewaterhouseCoopers (2007) for diabetes costs (Box 2.4)
- Osteoporosis NZ (2007) for the costs of treating osteoporosis (Box 2.5).

Appendix 8 shows the figures that were used for this study, taking the ratios of hospital, drug, outpatient and primary care costs and aligning them with the data obtained from MoH for 2010. In calculating the costs of disease, all cost estimations were carefully checked to eliminate double counting (e.g. if hospital and drug cost estimates were included in the reports, data was triangulated with the actual treatment and drug costs obtained from MoH for the 2010 year). It was assumed for studies published in the last ten years that the structure of care (e.g. outpatient clinics, frequency of GP visits) remained the same for the illnesses.

With the full cost accounting approach, an attempt was made to identify all associated costs of each disease, although some of these costs are very small and their magnitude do not significantly alter the total cost. Two significant costs that were included were: research and screening (Appendix 9). Data gaps were identified, particularly for the direct costs of treating hypertension, CHD and depression. The method used to estimate these costs are shown in Appendix 10.

2.2.2 Indirect costs

Indirect costs include: the human cost of the injury, in terms of disability and disruption to a normal functioning life; the loss of potential earnings to the patient and loss of productivity to the economy/society[23]; and the cost of premature death. Stress, grief and suffering affect families in the face of illness and death. These are intangible effects of disease and premature death. There is much debate in the literature about inclusion of indirect costs (Appendix 10). Intuitively, indirect costs are direct causal effects of the burden of disease and seem relatively straightforward. When it comes to quantifying and measuring indirect costs however, many conceptual and philosophical issues emerge.

As this study was replicating the GPI Atlantic approach (Walker and Colman, 2004), their method of measuring the indirect costs of physical activity at a regional level was explored. Comprehensive indirect costs of illness measures with consistent approaches across the studies were not available for New Zealand, so it was not possible to simply apply the GPI Atlantic approach. Some alternative approaches were identified following a review of measuring indirect costs of illness, both within national and international literature. In the literature, indirect costs are measured using two methods:

- The human capital method
- The contingent valuation method ('willingness to pay')

The **human capital method**, recognises that an illness affects the earning power of an individual for the rest of their working life. This was the method used by Russell *et al.* (1992) in the previous estimation for physical inactivity in New Zealand. They estimated lost earnings for a five week period for those adults in the working age population that were hospitalised. No value was put on the indirect costs to people aged over 65. They conclude that this was a conservative approach, and an underestimate of the true costs. The human capital approach is not without critics, as it values life at market earnings for those individuals in the labour market only. It is biased against retired people, unemployed, homemakers and those unable to work. This means that the value of a child or elderly person is not as high as for people within the working age cohort, which raises thorny ethical issues, not handled well within economic analyses (Baker *et al.,* 2009).[24] Some productive activity takes place outside the formal labour market and is not recorded in conventional economic statistics. These include voluntary work, housework and childcare, which contribute to the overall economy (e.g. affecting the overall supply of labour, and

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[23] This assumes that the patient is in productive employment, that their absence from the workplace is detrimental, either in the short run until a replacement can be found, or in some cases the long run if the expert skills of the person are in short supply.

[24] See proceedings from the workshop "Valuing health for environmental policy with special emphasis on children's health protection' for a discussion on differences in valuing life, particularly by age. http://epa.gov/ncer/publications/workshop/pdf/EE-0475-01.pdf

participation rates in the labour market). Any disability caused by illness may require a change of internal household economics, in terms of who within the household goes to work/paid employment. The approach is also criticised as it does not take into account the intangible costs of pain and suffering or the change in quality of life through for example a disability (Sanderson *et al.* 2007). A human capital approach was considered but not undertaken, as it assumes that the individual indirect costs are limited to lost earnings only, whereas developing a disease can have much greater financial impact, and the cost of suffering and pain is not accounted for through lost earnings.

The second approach uses contingent valuation and reflects a '**willingness to pay'** to **avoid a loss of life** or an illness/disability. This approach measures what people would be willing to pay for reducing the probability of a fatality or contracting a particular disease. This approach was first endorsed through Shelling's (1968) discussion of the economics of life-saving. Putting a monetary value on a premature death raises issues about how to value a life, which is much more than the lost potential earnings of the person who died. The value of a life is so unique and not just the sum of earning potential (as counted in the human capital approach). The cost to society of the death of a prominent and respected leader may be greater than that of a relatively unknown person. It is not ethical to make value judgments over value of life in a society that has egalitarian principles. The effects of a death of a retired person who is active and transformative within their community will not be captured in an estimation of market wages. The costs of grief and suffering over a premature death are certainly not zero, as they can lead to depression and disruption. As stated above, the costs of suffering is intangible. Academic and research interest has moved into valuing life, and valuing an average or 'statistical' life.

The estimation of indirect costs is highly dependent on the assumptions that are embodied in their calculation. Two different methods were used to calculate the indirect costs of the diseases relating to physical inactivity. The approaches taken, along with their strengths and weaknesses is given below.

- Method 1. Value of preventable fatality
- Method 2. Valuing potential life years lost to disease

Method 1. Value of Preventable Fatality (value of the life)

Our first approach used the MoH Mortality Data on causes of death, as officially published in each region (by DHB) and applied the PAF ratios on the number of deaths (by disease) that are associated with physical inactivity (Table 2.7). This method assumes that a proportion of deaths could have been avoided, if people were undertaking the recommended levels of physical activity. In other words it estimates the number of deaths by disease due to physical inactivity.

The number of avoidable deaths for each disease is then multiplied by the value of a statistical life (VoSL). [25] This method gives the value of preventable/avoidable fatalities, per disease. This approach assumes that the value of a life is equal for all people, regardless of their age at death.

The main drawback and limitation of this approach is that there is no agreed value for a statistical life in New Zealand. Due to lack of any other data, NZTA's proxy measure for the value of a statistical life was used. As acknowledged, this value estimates the willingness to avoid an injury death from traffic/transport. The value of $_{2010}\$3.5$m was used. This returned a very large value for the indirect cost of a preventable fatality due to physical inactivity, and the arguments for and against using such an approach are given in Appendix 10. The preventable fatality approach (method 1) includes all deaths due to the disease, regardless of age. It was thought that this approach could over value the attribution of physical inactivity. People have to die at some time, and an analysis on age of death was undertaken (Table 2.7). The value of indirect cost was then recalculated for the value of preventable fatalities for those aged under sixty five years of age.

Method 2. Valuing Potential Life Years Lost to Disease

The Ministry of Health's inpatient data set (National Minimum Data) contained information on whether the patient was well enough to be discharged or if the patient passed away during the time in hospital. It also contained data on the age of patient at discharge. Thus it was possible to calculate the age at death and the condition(s)/disease(s) that the patient had. The average age of death for all diseases in the hospital data was 65 or over. The number of premature deaths could be calculated – that is deaths that occurred to people younger than 65. The age of 65 was chosen because it is the current retirement age in New Zealand.[26] The number of years lost was calculated for each disease, which is how many years away from 65 the person was at death. This was expressed as a ratio of the average years lost per premature death, by disease.

It was assumed that the age and incidences of death for each disease in the hospital data was representative of deaths in each region.[27] The proportions of premature deaths in hospital to the number of hospital deaths where that disease was present (not necessarily the cause of death, but due to co-morbidity in the data) was applied to the MoH Mortality data, giving an estimation of the number of premature deaths, per disease.

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25 It was not possible to use this data to calculate the indirect costs of depression. As noted before, the data on hospitalisations for depression are not reliable due to co-morbidity, and the limited service provision for depression patients in tertiary care (hospitals).

26 It is not inferred that the value of life over 65 is any less valuable. An alternative approach would be to use the life expectancy, which would increase the value of the indirect costs.

27 This may not be the case, as there may be age biases in the hospital data (e.g. older people may not go to hospital, as are in care elsewhere), but there was no evidence found to contradict this assumption.

The next step was to multiply the average years lost per death (by disease) by the estimated number of premature deaths in each region (by disease). This gave an estimation of the total number of potential years lost to each disease. This total was then linked with (multiplied by) the population attributable fraction for each disease, to estimate that number of potential life years that could have been saved if people were physically active.

Measuring the potential life years lost was an important method if using the human capital approach, as the value of a statistical life is predicated on potential life earnings. Taking this approach reduces the indirect costs attributed to each disease, but it takes into account the age of death for each disease thereby recognising the potential impacts of reduced earnings and lost (economic) productivity. It is not intended to diminish the value of those lives lost, and/or their contribution to society (in terms of contribution to the informal economy and society) which is probably greater than under 65s, as they have more time to contribute to society.

The proportion of people aged over 65 who died while in hospital was over 80 percent for the deaths related to diseases associated with physical inactivity in New Zealand. Breast cancer is the exception, where 59 percent of hospital deaths were for women in retirement age.

The potential number of life years that could have been saved if people were physically active had to then be converted into monetary values. This was done using the VoSL of $_{2010}$\$3.5m. As this VoSL is a dollar amount for a *statistical life,* it had to be converted to an annualised value of statistical life years, converted to present (discounted) values. It was assumed that the VoSL had an expected lifespan of 40 years, and a discount rate of 3.8% was applied.[28]

The estimated indirect and intangible costs are highly dependent on the VoSL estimates used. These in turn are dependent on many factors including market wages, expected earnings over life, quality of life after an illness, severity of disability etc. The indirect and intangible costs calculated for this study range from a conservative low to a high value. The range is drive by the assumptions about how the attributable deaths are monetised i.e. reflecting the age and earning potential variables. It is for this reason that cost utility analysis moves away from a monetary value for a life, but rather creates an index of quality of life, severity of disability and mortality rates/likelihood.

More precise estimates on willingness to pay for avoiding diseases through undertaking appropriate physical activity would be of use to this study, and the most correct method to value indirect costs. Such a survey was out of scope of this project, requiring significant resources to undertake. Calculations for the value of a statistical life are identified as a gap in the NZ literature.

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[28] This was a method used in Access Economic (2006). The choice of discount rate for converting the value of a statistical life into the value of a statistical life per year varies significantly with the discount rate (Parker, 2009). The original 1991 study on the value of a statistical life for the NZ transport sector found that the value of a statistical life does not differ significantly by age, suggesting that a young person has a much lower value per year of life than an older person, as the young person has a life expectancy greater than an older person.

Table 2.7 Number of deaths, average years lost to the diseases and official mortality data										
		Inpatient Data Set (DHB Hospitals)						Official Mortality Data	
		Total no. deaths*	Deaths age <65	Years lost	Average age all deaths	Age range	Average years lost per death age <65	Official recorded cause of death (2009)	Of which age <65 (estimated)
Auckland region	Breast Cancer	74	37	503	65	34-99	14	207	104
	Colorectal Cancer	102	23	202	76	46-100	9	282	64
	Hypertension	807	120	1174	79	28-101	10	75	11
	CHD	618	58	546	82	31-101	9	1338	126
	Stroke	490	63	663	80	27-100	11	473	61
	Osteoporosis	67	1	7	88	58-101	7	7	0
	Diabetes	427	99	962	74	26-101	10	226	52
	Actual number of hospital deaths	1,746					Number of recorded deaths	2,608	
Waikato region	Breast Cancer	19	8	97	68	37-82	12	46	19
	Colorectal Cancer	44	5	37	76	50-94	7	115	13
	Hypertension	202	23	224	79	31-98	10	32	4
	CHD	167	12	80	82	45-100	7	449	32
	Stroke	153	13	155	80	31-98	12	148	13
	Osteoporosis	11	0	0	85	68-98	0	2	0
	Diabetes	103	16	111	77	47-98	7	73	11
	Actual number of hospital deaths	504					Number of recorded deaths	865	
Wellington region	Breast Cancer	36	12	150	72	44-97	13	50	17
	Colorectal Cancer	38	6	78	76	44-98	13	128	20
	Hypertension	279	35	338	79	41-100	10	39	5
	CHD	249	19	142	83	48-105	7	542	41
	Stroke	217	20	227	81	41-104	11	185	17
	Osteoporosis	23	1	1	88	64-99	1	2	0
	Diabetes	119	12	107	78	44-99	9	67	7
	Actual number of hospital deaths	682					Number of recorded deaths	1,013	
New Zealand	Breast Cancer	314	128	1599	69	34-100	12	665	271
	Colorectal Cancer	574	100	944	75	36-101	9	1244	217
	Hypertension	2806	340	3351	79	25-104	10	331	40
	CHD	2238	170	1469	82	31-105	9	5553	422
	Stroke	1989	211	2296	80	25-106	11	2000	212
	Osteoporosis	238	2	8	87	58-101	4	24	0
	Diabetes	1351	232	2067	76	26-104	9	782	134
	Actual number of hospital deaths	6,675					Number of recorded deaths	10,599	

When looking at Table 2.7 the issue of co-morbidity and its importance becomes clear. This is because multiple conditions at death are recorded on the hospital discharge dataset. The sum of deaths per disease is greater than the actual number of hospital deaths. This detail is lost in other datasets, such as MoH's Mortality data, where each death is attributed to one cause. For example, in all regions the number of deaths where hypertension was present and part of the co-morbidity mix far outnumbered the number of deaths attributed to hypertension in the MoH Mortality database. People do not necessarily die from a disease such as hypertension, even though it is present and is a contributing factor to/associated with other diseases.

Another comparison of the two datasets (MoH Mortality and National Minimum Dataset) showed that 63 percent of deaths, that had diseases associated with physical inactivity, occurred in hospital. Waikato was below this national average, with 58 percent of deaths associated with the 7 diseases occurring in hospital, while Auckland and Wellington were above the average, with 67 percent.[29]

Overall 2,121 of deaths per year can be attributable to physical inactivity (Table 2.8). This figure is estimated by multiplying the number of deaths from diseases that are associated with physical inactivity by the PAF (for each disease and region). The result reflects the number of deaths that could have been avoided through an increase in physical activity. In Wellington 204 deaths are attributable to physical inactivity, Waikato has 179 deaths and Auckland 521 deaths attributable. It is not possible to delay death indefinitely, and the question arises as to for how long death can be avoided? The age at death is important to clarify, as it influences the total cost of the disease. For this reason, an estimate for the number of premature deaths due to physical inactivity was calculated.

Table 2.8 Deaths attributable to physical inactivity by diseases (2009)

	Auckland	Waikato	Wellington	New Zealand
Breast Cancer	21	5	5	66
Colorectal Cancer	73	30	33	319
Hypertension	10	4	5	45
CHD	255	88	103	1,050
Stroke	113	36	44	474
Osteoporosis	2	-	-	6
Diabetes	47	16	14	161
Total	**521**	**179**	**204**	**2,121**

Number of deaths where disease associated with physical inactivity was the cause of death, multiplied by the PAF for physical inactivity
Source: MoH mortality data, multiplied by the PAF for each disease and region

The recorded cause of death from the Official Mortality Data is given (right hand side of Table 2.7). Beside this, the *estimated* age of these people under the age of 65 is shown, based on the profile of patients who passed away in hospital from these diseases. We calculated the number of deaths of the diseases associated with physical inactivity where the person was under 65 years of age, and classified these as 'premature deaths from physical inactivity'. This was considered a more realistic presentation of physical inactivity impact.

Overall 246 *premature* deaths (aged <65) can be attributable to the diseases associated with physical inactivity for New Zealand for one year (Table 2.9).

Table 2.9 Premature Deaths (<65) attributed to diseases associated with physical inactivity (2009)

	Auckland	Waikato	Wellington	New Zealand
Breast Cancer	4	2	2	27
Colorectal Cancer	6	3	5	56
Hypertension	16	1	1	5
CHD	11	6	8	80
Stroke	15	3	4	50
Osteoporosis	0	0	0	0
Diabetes	21	2	1	28
Total	**73**	**18**	**21**	**246**

Source: MoH mortality data, multiplied by the PAF for each disease and region

These are calculated by multiplying the number of premature deaths by the PAF for each disease and region. In Wellington 21 premature deaths are attributable to physical inactivity, Waikato had 18 premature deaths and Auckland 73 premature deaths attributable. It is interesting to note that the proportion of deaths in these three regions is lower than the proportion of NZ population residing in each region (e.g. Auckland had 24 percent of total deaths attributable to physical inactivity in New Zealand, yet it has 34 percent of the total population). This could reflect access to hospitals and healthcare, and travel distances to receive medical attention. To put the 246 avoidable deaths associated with physical inactivity in perspective, there were 420 deaths due to motor vehicle accidents and 510 deaths caused by self-harm in the 2009 year (MoH, 2012). [30] These are out of a total of 29,204 total deaths recorded in New Zealand for that year. Therefore 0.8 percent of deaths could have been

[29] Note that although the costs of 8 diseases are calculated in this study, depression was omitted from the mortality analysis due to the aforementioned treatment in primary care. Also, depression may be a contributing factor to death, but may not be cited as the cause.

[30] Admittedly, some of these figures for death by intentional self-harm should be included in the deaths attributed to physical inactivity, given that depression is one of the diseases associated with physical inactivity. This data/level of detail could not be extracted from the MoH Mortality and Demographic Dataset by ICD code and DHB area however.

avoided. The number of avoidable premature deaths due to physical inactivity is 60 percent of the number of avoidable deaths to motor vehicle accidents, yet the public awareness campaigns differ in terms of ability to target (e.g. billboards on roads for drivers) and the budgets allocated to each risk factor.

The lives of those who died aged over 65 may have been prolonged for any number of years (depending on age at death) if there were higher rates of physical activity amongst this group, but it was considered more meaningful to consider only deaths before 65 premature and to link only premature deaths to physical inactivity.

Missing Data

The indirect costs of treating depression were not included in the above method. It is estimated that the economic costs of depressive disorders to individuals, family, health services and society are enormous. Costs are due in part to:

- Increased morbidity and mortality;
- Impaired social, family, educational and work functioning;
- Increased substance abuse (particularly alcohol) and accident rates; and
- Increased outpatient and inpatient treatment.

No quantitative study on the cost of depression in New Zealand was found. From a US study, it was estimated that the direct costs of treating depression are only about 25 percent of the total costs, with medication a very small proportion of this. The economic cost from depression related mortality is estimated to make up about 15 percent of the total costs. The largest cost of depression (approx. 60 percent) is due to reduced labour productivity manifesting through increased sick days, absenteeism and impaired work performance. In other words, the indirect cost of depression can be put at three times the direct cost. This ratio was applied to the direct cost of treating depression. This, however, does not include other costs such as suffering, decreased quality of life, informal care and/or other family burdens and lower educational achievements.

2.2.3 Other Costs Associated with Physical Inactivity

In addition to the main costs outlined above there are also other costs associated with physical inactivity. Burden of illness studies calculate the health costs, and can also be considered to calculate the economic component of the four well-beings: economics, social, cultural and environmental. The effects of physical activity/inactivity in a population also impact the other well-beings. For example, if the rate of physical activity increases dramatically due to mode shift towards more active transportation (i.e. from cars to walking and cycling), then this would decrease emissions and improve air quality. By the same token, it could decrease expenditure on fuel, and increase expenditure in another part of the economy.

Ethnic differences in health outcomes can have cultural and social impacts. These can impose costs on those ethnic groups, and have detrimental cultural effects. If premature mortality rates due to physical inactivity are particularly high for some ethnicities, this can change the population structure for that group. Depending on the role of older people in each cultural group (e.g. respected elders, community leaders, native speakers of language, gatekeepers of knowledge and customs), this can be a significant cost. For Māori, as Mana Whenua, health outcomes affect the number of Te Reo speakers, and the intergenerational handing down of Tikanga (customs and traditions).

There are **transaction costs** associated with physical inactivity. Transaction costs are largely defined by costs associated with information. For physical inactivity, health campaigns and dissemination of research findings to the general public constitute such costs. Central government agencies assume a role in this regard, in terms of the health promotion activity of MoH, active transport mode advocacy and provision by NZTA and promotional work undertaken by SportNZ, the government agency who 'promote, encourage and support physical recreation and sport in New Zealand'. The Regional Sport Trusts operate throughout New Zealand, delivering local projects for SportNZ. DHBs run targeted programmes on specific disease, or have campaigns targeted at particularly vulnerable people within their areas. Local government – Regional Councils and Territorial Authorities play a considerable role in promoting physical activity, in terms of infrastructure that is provided, overall planning of towns, cities, connectivity and transport.

There is considerable capital investment in regions into sports grounds, sport and recreational facilities, walking paths and cycle ways and footpaths. These costs were initially considered for inclusion in this analysis, but in the end it was decided against such inclusion as it is expenditure on physical activity rather than inactivity. Sport and recreation amenities do not determine rates of physical activity. Determining the causal mechanisms between sport and recreation facilities (infrastructure) and community use (physical activity) are beyond the scope of this study. Other studies explore the issue and factors inhibiting physical activity. We assume that a person would choose to keep physically active, irrespective of available facilities (e.g. there is enough alternative sporting and recreation facilities for people to choose from – this is supported by the fact that the most popular physical activity in New Zealand is walking, which requires only maintenance of places to walk). It can be argued that there are limits to personal choices, especially in deprived areas, however no direct causal link between deprivation and physical inactivity was found in the literature. It is possible for some correlation to exist, but finding and assessing such a link is beyond the scope of the project.

A pragmatic approach was taken in the collection of data for these wider costs. The wider costs are insubstantial compared to the health costs included in this assessment. The project focused on collecting data on the main/largest costs, with less emphasis on data collection of the smaller costs, without compromising assessing their relative magnitude. They are listed qualitatively, and should be monitored in case the expenditure on them increases significantly.

The next section outlines the study's results.

3. Results: The Cost of Physical Inactivity

This section presents the estimated cost of physical inactivity in the three regions and an estimate for New Zealand. These estimates capture the proportion of total direct and indirect costs by disease that can be attributed to physical inactivity. It is based on the costs that could be saved if the population did the recommended levels of physical activity and the envisaged health effects occurred. Other cost, such as expenditure on active transport and health promotional campaigns are also included. Table 3.1 summarises these costs. The table shows the range identified.

Table 3.1 Summary of Direct, Indirect and Other Costs attributed to Physical Inactivity $_{2010}$\$m

	Direct Costs *(range)*	**Indirect Costs** *(range)*	**Other Costs**	**Total**
Auckland Region	179 *(+2%)*	213 *(-54% to 133%)*	10	**402**
Waikato Region	54 *(+2%)*	48 *(-58% to 138%)*	4	**106**
Wellington Region	74 *(+2%)*	62 *(-50% to 131%)*	5	**141**
New Zealand	614 *(+2%)*	661 *(-55% to 135%)*	30	**1,306**

Physical inactivity cost New Zealand $1.3 billion in 2010, representing 0.7 percent of New Zealand's GDP.[31] Approximately half of the costs of physical inactivity are actual health expenditure and health promotion costs (i.e. the direct costs of $614 million plus other costs of $30 million would appear in New Zealand's GDP expenditure accounts – government, private healthcare and household expenditure). The other half is indirect costs including monetary values for loss of productivity, pain and suffering. The total costs of physical inactivity were borne by the government (through health expenditure), private individuals (health expenditure, loss of income, disability and suffering), society (loss of productivity) and local government (health promotion and urban design). The total Crown expenditure on health in 2010 was $13.1 billion.[32] Although not all of the $614 million of direct costs was borne by public expenditure, this figure represents 4.6 percent of the Crown expenditure on health.

Physical inactivity cost the Auckland region $402 million in 2010, which is 31 percent of the New Zealand total. For the Waikato region, the cost of physical inactivity was $106 million or 8 percent of the New Zealand total. Physical inactivity cost the Wellington region $141 million, which is 11 percent of the country's total cost. Clearly, the costs are not uniformly spread throughout the country on a per capita basis. Auckland has 34 percent of population, but only accounts for 31 percent of the costs, Waikato has

[31] GDP was $194.7billion in 2010 seasonally adjusted current prices (Statistics New Zealand, 2011).

[32] TreasuryNZ Financial Statements. http://www.treasury.govt.nz/government

over 9 percent of population, but only 8 percent of physical inactivity costs, whereas Wellington's physical inactivity costs are proportionate with its population.

The figures in brackets for direct and indirect costs in Table 3.1 show the range in values after undertaking sensitivity testing. As mentioned earlier, costs incurred in private hospitals were imputed. For indirect costs, a range of methods were explored to estimate the indirect costs. The large variance in indirect costs shows the sensitivity of the underlying assumptions and the model framework's sensitivity.

3.1 Direct Health Costs

The estimates for direct costs of the eight diseases associated with physical inactivity are given in Table 3.2.

Table 3.2 Summary of Direct Health Cost for the diseases associated with Physical Inactivity $_{2010}$\$m

	Hospitalisation costs (public)		Drug costs		Outpatient, GPs, Primary Health Care		Research and screening		Total direct costs		Total Cost attributed to physical inactivity
Auckland	476	(30%)	106	(29%)	315	(27%)	13	(34%)	910	(30%)	**179**
Waikato	131	(8%)	31	(8%)	101	(9%)	4	(9%)	266	(9%)	**54**
Wellington	194	(12%)	36	(10%)	143	(12%)	4	(11%)	377	(12%)	**74**
New Zealand	1,595	(100%)	370	(100%)	1,161	(100%)	38	(100%)	3,061	(100%)	**614**

Total direct costs of treating the diseases associated with physical inactivity were \$910m in Auckland, with **\$179m** of this considered avoidable or attributable to physical inactivity. For the Waikato region, the total direct costs of treating the diseases associated with physical inactivity was \$266m, with **\$54m** attributable to physical inactivity. The Wellington region had \$377m total direct costs of the physical inactivity associated diseases in 2010, with **\$74m** of this total attributable to physical inactivity.

For the illnesses associated with physical inactivity in New Zealand, the greatest direct health cost component was the \$1.6 billion spent on hospital costs in 2010. This was 52 percent of the total direct costs of \$3.61 billion (there were similar direct cost to total ratios for Wellington and Auckland, but Waikato was slightly less, just under 50 percent). Primary health care, outpatient and GP consultations are the next largest group of direct costs (with \$1.16 billion or 38 percent of total direct costs for New Zealand), followed by drug costs (12 percent of NZ total) and research and screening (1 percent of NZ total). Note, the research and screening costs were allocated on a per capita basis, so align with population proportions, whereas the hospital and drug costs are figures of what was actually spent in the DHB area/regions. The share of each region's direct costs relative to the New Zealand total is given in brackets besides the dollar value in Table 3.2. Auckland had only 30 percent of the country's hospital costs for the diseases associated with physical inactivity, even though it had 34 percent of the country's population. The research expenditure figures are for actual spend during 2010, although the research projects are usually multi-year running over three years.

As noted previously, the hospitalisation costs were for public hospitals only. Private hospitals were included by adding 10 percent to the costs, although these are not included in the summary tables of this report. This increased total direct costs of treating physical inactivity in Auckland by $9m; by $2.5m in the Waikato region; by $3m in Wellington and $29m in New Zealand. These estimated additional private hospital costs equate to approximately 2 percent of total direct health costs.

Table 3.3 presents a breakdown of these direct costs by disease associated with physical inactivity in the three regions and New Zealand as a whole. The right hand column gives the cost that is attributed to physical inactivity.

In terms of hospitalisation costs, patients being treated for hypertension cost the public hospital the greatest amount out of all the diseases. This is not surprising given that there were 67,528 discharges for hypertension. It must be remembered that there is significant co-morbidity between hypertension and the seven other physical inactivity associated diseases, as well as other illnesses (that were not explored in this study). Hypertension is usually treated with medication, but when it presents with other diseases it can complicate the case mix. It is for this reason that an 'adjusted' PAF would be prudent to use (Lee *et al.,* 2012), to reduce/eliminate confounding in co-morbid cases. Our method identified co-morbidity within the eight diseases, but not cases where hypertension presented with other illnesses (not on the physical inactivity list). The money spent on hypertension medicine was the greatest out of all the individual diseases.

Nationally, coronary heart disease had the second highest hospitalisation costs, unsurprisingly as it had the second highest number of discharges from the inpatient hospital dataset. The drug costs for stroke and hypertension are presented together, given that there is some overlap in the administration of medicines for heart conditions, and it would have been difficult to allocate to either one or the other disease.

In Auckland and Waikato, osteoporosis had the second highest hospitalisation costs, while osteoporosis had third highest hospitalisation costs for New Zealand. It was somewhat surprising that the public hospitalisation costs for chronic heart disease in Auckland ($77m) was only 26 percent of the NZ total ($298), given that there are specialised heart units located there. Similar lower hospitalisation cost ratios were evident for stroke, but hypertension cost ratios were more in line with population proportions. More information is required as to the drivers affecting these outcomes but possible reasons include: efficiencies and economies of scale in the Auckland region's treatment of CHD and stroke patients or perhaps there are more patients treated for CHD in the private sector.

Table 3.3 Direct Health Cost by disease, by region in $_{2010}$\$million

Region	Disease	Hospitalisation costs (public)	Drug costs	Outpatient, GPs and Primary Health Care	Research and screening	Total direct costs	Attributed to physical inactivity
Auckland Region	Breast cancer	14	6	23	4	48	5
	Colorectal cancer	20	3	21	3	46	12
	Hypertension	143	38	9	<1	190	26
	Coronary heart disease	77	33	11	4	125	24
	Stroke	57	*merged with chd	146	<1	203	49
	Osteoporosis	79	8	36	<1	122	29
	Diabetes Type II	67	16	59	1	142	30
	Depression	19	3	11	<1	33	4
	Total Direct Costs	476	107	316	12	909	**179**
Waikato Region	Breast cancer	5	2	9	1	17	2
	Colorectal cancer	10	1	10	1	22	6
	Hypertension	35	11	2	<1	49	7
	Coronary heart disease	21	9	3	1	34	7
	Stroke	18	*merged with chd	47	<1	65	16
	Osteoporosis	22	2	10	<1	34	8
	Diabetes Type II	14	4	17	<1	35	7
	Depression	5	1	3	<1	9	1
	Total Direct Costs	130	30	101	4	266	**54**
Wellington Region	Breast cancer	7	3	12	1	24	2
	Colorectal cancer	8	1	9	1	20	5
	Hypertension	59	12	4	<1	75	10
	Coronary heart disease	36	11	5	1	53	10
	Stroke	31	*merged with chd	78	<1	109	26
	Osteoporosis	26	2	12	<1	40	9
	Diabetes Type II	19	5	20	<1	44	9
	Depression	7	2	4	<1	13	2
	Total Direct Costs	193	36	144	4	378	**74**
New Zealand	Breast cancer	54	21	89	12	177	18
	Colorectal cancer	91	10	94	10	205	53
	Hypertension	448	132	29	<1	609	82
	Coronary heart disease	298	117	43	11	468	89
	Stroke	232	*merged with chd	590	1	823	195
	Osteoporosis	233	24	106	<1	363	85
	Diabetes Type II	171	50	177	3	401	82
	Depression	68	15	35	1	119	11
	Total Direct Costs	1,595	370	1,161	38	3,165	**614**

Nationally the cost of treating stroke was the fourth highest in terms of hospital costs. The three cardiovascular diseases combined (hypertension, coronary heart disease and stroke) make up 61 percent of all the hospital costs associated with physical inactivity, and therefore this is the most important disease grouping. Physical activity positively impacts a healthy heart, and significant cost savings of treating cardiovascular patients could be made.

The two types of cancer – colorectal and breast made up less than 10 percent of total hospital costs. Colorectal cancer is however the second most common cancer for both men and women in NZ, with approximately 2,300 new cases and over 1,200 deaths from the disease each year (Pharmac, 2012).[33] Although the PAF for colorectal cancer was the highest (indicating that it is the disease that increasing physical activity would have greatest impact in reducing the prevalence of the disease), it is not the disease where the greatest cost savings could be made.

As noted before, the hospital costs of treating depression are included in the analysis (as extracted from the inpatient hospital dataset). However, they are not reliable, in terms of how the treatment of depression is structured. Very few people with depression are hospitalised for depression alone – there are high instances of depression co-morbidity with chronic and terminal diseases, where the patient would be hospitalised and perhaps treated with anti-depressants as part of their complete treatment. The cost of treating depression patients in hospital is probably accounted for in the cost of treating the main/other disease (with depression secondary). No further breakdown of co-morbidity with diseases outside of the eight associated with physical inactivity was extracted from the dataset, so there is no further information on what these diseases were. Costs estimates for drug treatment of depression are accurate.

In terms of outpatient costs, primary healthcare and GP costs, it is interesting to see that the cost of treating some of the diseases is greater in the primary and secondary health system, than in the tertiary (hospitals). This is the case for breast cancer, for colorectal cancer and diabetes (costs are roughly the same) and for stroke patients (they are double the hospital costs). These findings reflect the in-depth studies where the data was taken from, that capture the total cost of these diseases (e.g. for cancer, an 'incidence' measure was used to calculate costs to the patient for the six years after diagnosis of the disease, as costs extend beyond one calendar year). For stroke patients, given the increase in survival rates, patients are living longer with, in some cases, disability, requiring additional care, usually in the community or in primary/secondary care. This is also the case for diabetes patients, but the relative costs of primary/secondary to hospital care are less pronounced.

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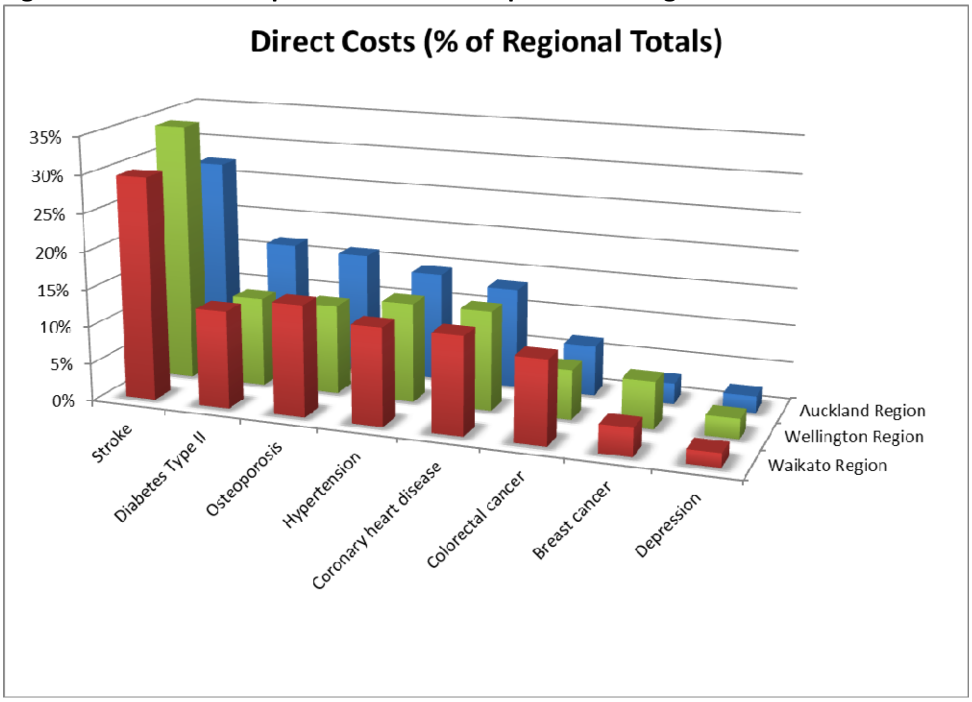
[33] Pharmac now subsidise the drug Capecitabine, which is a substitute for another chemotherapy treatment that had to be administered by infusion in hospital. Capecitabine can be self-administered which will reduce the burden of colorectal cancer on hospitalisation costs. Such changes in medical practice can have significant effect on total costs.

The proportions of each region's direct costs for each disease attributable to physical inactivity are shown in Figure 3.1. The most significant avoidable costs associated with physical inactivity can be attributed to the three cardiovascular diseases – in all regions they constitute between 55 and 61 percent of the total direct costs. The higher the value for the population attributable fraction, the higher the potential savings to the health system that could be made in terms of increased physical activity. Depression was the disease with the lowest proportion of direct cost in each region, but as evidenced from the literature, it is a disease where indirect costs are often greater than the direct costs.

Figure 3.1 Direct Costs per Disease as a Proportion of Regional Total Indirect Costs



In terms of regional costs per capita (direct costs), the cost of physical inactivity was $153 per head of the Wellington population, $132 in Waikato, and $130 in Auckland. Overall, the direct costs were $141 per capita for New Zealand.

3.2 Indirect Health Costs

Indirect costs are an integral component of full cost accounting as it includes a set of costs that is wider than just direct economic health costs. It incorporates the costs associated with disability, loss of earning potential, loss of independence, suffering and other consequences of the disease. In reality there is no robust process to estimate the value (in monetary terms) of these costs, and all methods are open to some form of criticism. Irrespective of the weaknesses, we attempted to monetise some of these indirect costs. We used two methods and the results vary substantially depending on the method used. Table 3.4 presents the results.

Table 3.4 Summary of Indirect Costs for the diseases associated with Physical Inactivity $_{2010}$\$mil

Area	Estimated Number of premature deaths	**Low (Method 2)** Using value of annualised VoSL of \$109,166	**Medium (Method 2)** Using value of annualised VoSL of \$165,403	**Medium (Method 1)** Value of Preventable Fatality <65	**High (Method 1)** Value of Preventable Fatality	Average of Medium (Methods 1&2)
Auckland	73	98	142	284	1,835	**213**
Waikato	18	20	29	66	635	**48**
Wellington	21	31	43	81	725	**62**
New Zealand	246	295	429	893	7,456	**661**

* Table 3.4 does not correspond to the totals in Table 3.5 which excludes the indirect costs for depression

Indirect costs fall in a wide range with \$295 million at the low end to up to \$7.5 billion. This range is driven by the assumptions used and specifically the age at death. Caution is warranted when interpreting these results (see Appendix 11 for a description of the reasons). Method 1 (high) applied a uniform Value of a Statistical Life (VoSL) to all deaths attributed to physical inactivity. Method 1 (medium) applied the value of a statistical life only to premature deaths (aged less than 65 years) attributed to physical inactivity. Method 2 discriminated the deaths attributable to physical inactivity as measured by the life years lost to the disease – for example the death of a 30 year old has greater cost than the death of a 50 year old. A sensitivity analysis is undertaken by changing the value of each year lost to the disease.

Overall in New Zealand, it is estimated that there were 246 premature deaths due to physical inactivity. Seventy three of these were in the Auckland region, 21 in Wellington region and 18 in the Waikato region. Forty five percent of premature deaths attributed to physical inactivity occurred in the three regions of this study, although they account for 54 percent of the total NZ population.

For reporting purposes we averaged the medium values obtained from both methods. A breakdown of the indirect cost calculations is given in Table 3.5. It presents the calculations for indirect costs, by disease (excluding depression) and region. CHD, stroke and colorectal cancer have the highest rates of indirect costs.

Table 3.5 Indirect Costs of Physical Inactivity *

		Indirect Costs $_{2010}$\$millions					
		Method 1		Method 2 Potential life years lost to disease			
						Indirect cost NZ$ $_{2010}$mil	
		Value of Preventable Fatality	Value of Preventable Fatality <65	Potential life years lost to disease	Life years lost, due to physical inactivity (Using PAF)	Using value of annualised VoSL of $165,403	Using value of annualised VoSL of $109,166
New Zealand	Breast Cancer	230	94	3386	335	55	37
	Colorectal Cancer	1,118	195	2046	525	87	57
	Hypertension	156	19	395	53	9	6
	CHD	3,676	279	3645	689	114	75
	Stroke	1,660	176	2309	547	91	60
	Osteoporosis	20	0	1	0	0	0
	Diabetes	563	97	1196	246	41	27
	Total	**7,423**	**860**		**Total**	**396**	**262**
Auckland region	Breast Cancer	72	36	1407	141	23	15
	Colorectal Cancer	256	58	558	144	24	16
	Hypertension	36	5	109	15	2	2
	CHD	893	84	1182	225	37	25
	Stroke	396	51	640	153	25	17
	Osteoporosis	6	0	1	0	0	0
	Diabetes	164	38	509	106	17	12
	Total	**1,823**	**272**		**Total**	**130**	**86**
Waikato region	Breast Cancer	17	7	235	24	4	3
	Colorectal Cancer	107	12	97	26	4	3
	Hypertension	16	2	35	5	1	1
	CHD	308	22	215	42	7	5
	Stroke	127	11	150	37	6	4
	Osteoporosis	2	0	0	0		0
	Diabetes	54	8	79	17	3	2
	Total	**631**	**62**		**Total**	**25**	**16**
Wellington region	Breast Cancer	18	6	208	21	3	2
	Colorectal Cancer	116	18	263	68	11	7
	Hypertension	19	2	47	6	1	1
	CHD	362	28	309	59	10	6
	Stroke	155	14	194	46	8	5
	Osteoporosis	2	0	0	0	0	0
	Diabetes	49	5	60	13	2	1
	Total	**721**	73		**Total**	**35**	**23**

* note the indirect cost for depression was not calculated using this method, and are not included here.

Method 1 applies the value of $3.5m for a statistical life to **each preventable fatality** accorded to physical inactivity. These indirect costs are estimated at $7.4 billion for New Zealand in total, $1.8 billion for Auckland, $631million for Waikato and $721million for Wellington. These indirect costs are much higher than the direct costs of the diseases. However, given that individuals have to die of something, and that the average age of death (as found from the deaths in hospital) was quite high, these figures potentially overestimate the costs by millions, and even billions for CHD, stroke and colorectal cancer.

By taking the age of the deceased into account, and valuing only **premature deaths using Method 1**, the indirect costs drop nearly tenfold. Indirect costs for preventable fatalities for those aged less than 65 drop to $860m for New Zealand; $272m for Auckland; $62m for Waikato and $73m for Wellington. [34] Auckland accounts for 32 percent of New Zealands's indirect cost, Waikato 7 percent, and Wellington 8 percent. These proportions are less than what would be expected on a per capita basis, perhaps suggesting that people in these three regions survive these diseases at a higher rate than in other regions of New Zealand.

Using Method 1 (of measuring preventable fatality), but taking age into account, gives a considerably lower figure. Premature death is defined purely for the purpose of this report as death below the age of 65. The indirect values for colorectal cancer, stroke and CHD drop down from the billions into millions, using this method. The value of a preventable fatality for diabetes drops to approximately 20 percent across all age cohorts/groups. This variance highlights the complexities associated with measuring the indirect costs. Estimates are based on a set of value judgements, and can be contested.

In this method, only valuing those aged under 65 gives a zero value to the pain and suffering caused by the disease to those aged over 65. The values of the former method (valuing all preventable lives equally, regardless of age at death) seems inconceivable in magnitude, compared to the tangible, direct costs. There is subjectiveness in valuing intangibles, and for this reason health economic professionals are moving away from trying to find a common monetary metric for pain, diability and premature death. These results do not show the effect that a change in the value of a statistical life would have on the data, although such a sensitivity test was undertaken for the second method.

Method 2 estimates the actual number of life years lost to the diseases – that is how many years from 65 the person was at death, and valuing those years only. The basis for the estimations is still the VoSL of $3.5m. However, this value was discounted and an annualised VoSL was calculated ($165,403), showing that the value of future (distant) years is less than next year or the year after. [35] Method 2

[34] Premature death is defined purely for the purpose of this report as death below the age of 65.

[35] The value of the annualised VoSL was calculated using discount rate of 3.8% over an average of 40 years expected lifespan. This method was the same as that followed by Access Economics (2006) in the measurement of indirect costs of injury in New Zealand.

returns more conservative estimates for indirect costs. In this method, the three same diseaseses CHD, stroke and colorectal cancer still have the highest indirect costs of the illnesses.

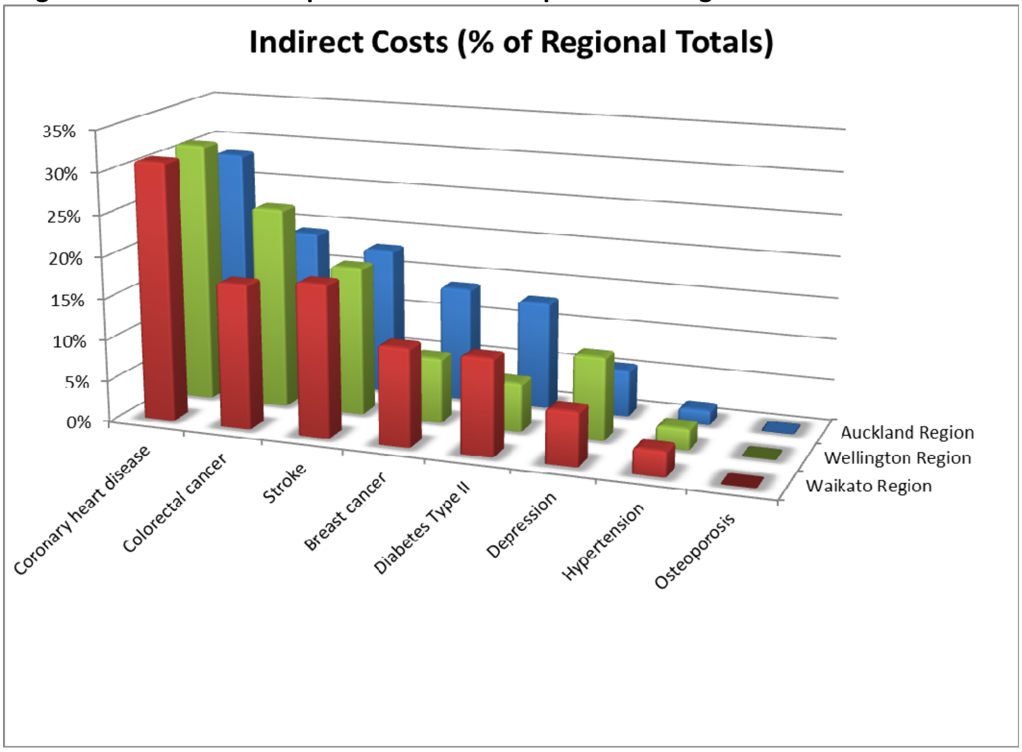
Using **Method 2**, for New Zealand as a whole, indirect costs attributable to physical inactivity amount to $396m; for the Auckland region, they account for $130m, Waikato $25m and Wellington $35m. There is an ongoing debate about using/transferring the value of a statistical life, as measured using a willingness to pay method for transport, in other sectors. We acknowledge that this method (metric) has limitations, but due to lack of other data, it was the only figure that was available. However, from Sanderson (*et al.*, 2007) , there was a discussion about people's willingness to accept a risk (such as road transport) where they had little control over the actions of other drivers/road users. They found that a person's willingness to pay for an event, when the person affected by the event had an element of control over (i.e. when they could presonally reduce the risk of that event happening to them – the case they were looking at was fire safety in their own home) was lower than when the person had little control over the event happening (i.e. meeting an unsafe road user). They deflated the value of the wilingness to pay, as people also are not so willing to pay for other people's chosen behaviour. For this reason, it was decided to use the Sanderson (2007) method of (arbitrarily) apportioning only two thirds of the annualised value of a statistical life. This is a lower bound estimate of willingness to pay. With a lower VoSL of $109,166, the indirect costs of the physical inactivity diseases are $262million for New Zealand; $86million for Auckland; $16million for Waikato and $23million for Wellington.

Given the range of indirect costs, it was decided to take an average of the two medium values. These are shown in Table 3.6. Figure 3.2 shows the average indirect costs in each region as a proportion of total indirect costs per disease.

Table 3.6 Indirect Costs per disease: Average of medium values $_{2010}$$m

	Auckland Region	Waikato Region	Wellington Region	New Zealand
Coronary heart disease	61	14	19	196
Colorectal cancer	41	8	15	141
Stroke	38	9	11	133
Breast cancer	30	5	5	75
Diabetes Type II	28	5	4	69
Depression	12	3	8	33
Hypertension	4	1	2	14
Osteoporosis	<1	<1	<1	<1
Total Indirect Costs	213	46	62	661

Figure 3.2 Indirect Costs per Disease as a Proportion of Regional Total Indirect Costs



3.3 Other Costs

This section describes some activities occurring at a regional level with regards to physical inactivity. This list is indicative, showing the range of activities that are being undertaken within the regions. Often programmes to increase physical activity are collaborative and inter-agency projects that have a number of objectives, with increasing physical activity being one of them. This makes explicit identification of the amount of money that is attributed specifically to physical inactivity difficult because it is not possible to isolate spending on physical inactivity from the wider project spending. Examples of other costs/programmes incurred/implemented in addressing physical inactivity in society are outlined below.

National Campaigns and Programmes

Sport New Zealand is a Crown entity whose functions include developing national policies and strategies for physical recreation and sport, promotion and advocacy on the importance of participation in physical activity by all New Zealanders for their health and well-being. Sport New Zealand have set up Regional Sport Trusts, with an overall budget of $21m in 2009/2010. Not all their work relates to physical inactivity, as they support sport and recreation, including high performing sports. As stated previously in the context of investment in sport and recreation capital and resources, these are for physical activity, rather than inactivity. Nevertheless a proportion of their budget is allocated to promoting activity, and in particular establishing healthy levels of activity from a very early age.

Public health campaigns are largely run at a national level. MoH is responsible for the “Healthy Eating Healthy Action Strategy”, which was then promoted by DHBs. Programmes and campaigns under the National Depression Initiative such as “Beating the Blues®” and “Getting Thru” were also funded by MoH, with project partners. Considerable resources are invested in online facilities for self-management of depression. Again these are funded out of central government funding. Another health awareness programme relating to physical inactivity is the diabetes advocacy “Get Checked Programme”. In addition, some charities and trusts run awareness campaigns. The Mental Health Foundation runs campaigns and services covering all aspects of mental health. There are non-governmental organisations such as Diabetes New Zealand, Osteoporosis New Zealand, and the Stroke Foundation of New Zealand, as well as charities such as the Heart Foundation who fund, research and promote heart health. A proportion of the costs of running these NGOs can be attributed to physical inactivity.

NZTA funds active modes of transport projects throughout the country. In 2010 NZTA co-funded between $12 and $15m for projects within the National Land Transport Programme (including Walking School Buses). Over the last three years, $51million has been allocated to this – usually with matching funds from local territorial authorities/regional councils. NZTA also fund walking and cycle ways, estimated at $80m for the last year. This funding would appear in the budgets of larger projects (e.g. the walking/cycling component of the Waterview project in Auckland). The budget for supporting active transport is relatively small in the context of overall total transport expenditure, which tends to focus on capital projects (infrastructure delivery and maintenance). In 2010 NZTA was responsible for operating revenues and expenditure of $2 billion, and total assets of $25.3 billion in 2010 (NZTA, 2010).

Auckland

In Auckland there are four Regional Sports Trusts. In the 2009/2010 year, they had a combined budget of $6.3 million. The Sports Trusts partner with Auckland Council in a number of programmes.

DHBs in Auckland run targeted programmes on specific diseases, or target particular vulnerable people that have been identified within the DHB. Examples of these include the “Lets beat diabetes plan” developed by Counties Manukau DHB, the Crisis-line service with 24 hour counseling run by Auckland DHB. These campaigns are not exclusively about physical inactivity.

Auckland Transport fund programmes such as the Walking School Bus, encouraging children and parents to have active modes to and from school (channeling the NZTA funds).

From a community development perspective Auckland Council has a role in providing recreational opportunities and provides: community and recreation leases (e.g. sports clubs, BMX tracks, sports fields and outdoor courts); partnership funding to clubs and organisations; community funding for discretionary projects; community loans for recreation groups; Council owned recreation and aquatic facilities (e.g. parks and swimming pools); and a number of programmes such as subsidising learning to swim classes

Waikato

Sport Waikato had a budget of $1.6 million in the 2009/2010 year. "Project Energise" was a flagship project in primary and intermediate schools to improve physical activity and nutrition. It was formed as a partnership of Sport Waikato and the Waikato DHB along with universities. Expenditure in 2010 was $1.9m from the Waikato DHB on Project Energise. There were many components to this project, including nutrition and nourishment, alongside the focus on physical activity.

Hamilton City Council spent $269,000 on travel planning in 2010 which included NZTA subsidy. It also spent $461,750 on road safety campaigns, which promoted safety aspects of walking, cycling, drink driving, young drivers, speeding, and intersections. They estimated that an attribution of $92,350 for the walking and cycling component of the campaign was appropriate. Hamilton City Council also spent about $733,000 on walking and cycling infrastructure for that year. The reminder of the Waikato region allocated $746,000 for walking and cycling infrastructure. Compared to other modes of transport, investment in active transport is very small, e.g. cycling infrastructure in 2012/13 only 0.5% of total transport infrastructure spending.[36]

Wellington

Sport Wellington had a budget of $1.6 million in the 2009/2010 year. A Healthy Eating Healthy Action Strategic plan was developed for Capital and Coast DHB. Greater Wellington Regional Council funded programmes for 'active forms of transport' including the School Travel plan, promotion of walking and cycling among other public awareness campaigns promoting active forms of transport. These projects were co-funded by NZTA, and amounted to just over $1 million in the last financial year (2011). Wellington City administers community grants for safe and sustainable transport community programme and are supporting walking school buses within the city. Walking school buses also operate in Hutt City, and a cycling strategy was developed. Hutt City subsidise employees with up to $200 for membership fees for any club that supports physical activity and offers a $50 annual health check subsidy.

3.4 Summary

Health costs were identified as a substantial component of the total costs of physical inactivity - $1.3 billion for the whole of New Zealand. The costs of physical inactivity are separated into **direct** health

[36] Waikato Regional Land Transport Programme 2012/13 – 2013-14: http://www.waikatoregion.govt.nz/Council/Policy-and-plans/Transport-policy/RLTP/

costs associated with treatment in the health care system, **indirect** health costs associated with living with disability/disease and dying prematurely and **other** costs associated with physical inactivity, including promoting activity and information campaigns relating to physical well-being. The cost to the Auckland region of physical inactivity was $402 million, $106 million for the Waikato region and $141 million for Wellington.

Direct costs were just over 50 percent of the total for physical inactivity in Waikato and Wellington, and less than half for Auckland and New Zealand (44% and 47% respectively). Indirect costs were relatively greater for Auckland and the New Zealand total, and this was due to the number of deaths and age of death associated with the diseases linked to physical inactivity. It is not clear whether the relatively lower number of deaths in Wellington and Waikato is due to population attributes to due to differences in health care provision that would affect the calculation of indirect costs used in this study (e.g. if relatively more deaths associated with physical inactivity disease occur in the home). There were slight differences in physical inactivity rates in the regions (Waikato having the highest rate), but these were not significant differences, and would not explain the lower indirect costs in the Waikato region. Other costs associated with public sector expenditure on physical inactivity were estimated. They comprise of between 3 and4 percent of the region's total costs attributed to physical inactivity.

4. Discussion

Physical inactivity is at a serious pandemic level in New Zealand, as in other countries of the world. In a recent publication (in The Lancet), New Zealand ranked 27th out of 122 countries for being physically inactive, with nearly 50 percent of the population not engaging in sufficient physical activity. Australia, our nearest neighbour and ofttimes benchmark, did better than New Zealand, ranked 52nd with 37.9 percent of the population inactive (Lee *et al.*, 2012).

The direct and indirect costs of treating diseases attributed to physical inactivity highlight the economic implications of the physical inactivity problem and the burden it places on society. Physical inactivity is a generic term for a complex area of study. The causes and effects of physical activity and inactivity are multifaceted, and may differ according to age cohort, social norms, genetics, environmental conditions, availability and type of employment, urban planning etc. Physical inactivity and public health is an emerging discipline, spanning several areas of specialisation including: epidemiology, exercise and sport science, behaviour science, and environmental health science amongst others. Taking a holistic perspective on the health effects of physical inactivity, this study has built on international literature and best practice of cost of illness studies, and applied them in a New Zealand context. This section discusses the magnitude of the problem in New Zealand, and policy responses to addressing physical inactivity (Section 4.1), while also discussing the merits of the full cost accounting methodology that were used (Section 4.2).

4.1 Addressing the Costs of Physical Inactivity

Physical inactivity is the fourth leading cause of death worldwide and The Lancet journal refers to it as 'the pandemic of physical inactivity that should be a public health priority' (Kohl, *et al.*, 2012). It certainly is a public health issue, becoming more conspicuous when the costs of treating diseases that could be avoided are summed. The total Crown expenditure on health in 2010 was $13.1 billion.[37] Physical inactivity cost New Zealand $1.3 billion in 2010, representing 0.7 percent of New Zealand's GDP.[38] Approximately half of the costs of physical inactivity are *direct* (e.g. opportunity cost of expenditure exists) health expenditure and health promotion costs. The direct costs of $614 million plus other costs of $30 million would appear in New Zealand's GDP expenditure accounts. The other half is indirect costs including monetary values for loss of productivity, pain and suffering. The total costs of physical inactivity were borne by government (through health expenditure), private individuals (health

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[37] TreasuryNZ Financial Statements. http://www.treasury.govt.nz/government

[38] GDP was $194.7billion in 2010 seasonally adjusted current prices. Statistics New Zealand (2011).

expenditure, loss of income, disability and suffering), society (loss of productivity) and local government (health promotion and urban design).

Physical inactivity cost the Auckland region $402 million in 2010, which is 31 percent of the New Zealand total. For the Waikato region, the cost of physical inactivity was $106 million or 8 percent of the New Zealand total. Physical inactivity cost the Wellington region $141 million, which is 11 percent of the country's total cost. These costs are not uniformly spread throughout the country on a per capita basis. Auckland has 34 percent of population, but only accounts for 31 percent of the costs, Waikato has over 9 percent of population, but only 8 percent of physical inactivity costs, whereas Wellington's physical inactivity costs are commensurate with the its population proportion. This indicates that the other regions of New Zealand (not specifically identified in this study) bear a disproportionate higher indirect cost of physical inactivity, relative to their populations. It was through the calculations for indirect costs that this regional discrepancy emerged, and we suggest this is due to higher mortality rates associated with the illnesses in other regions. Although beyond the scope of this study, proximity to medical services (particularly emergency treatment) may influence the mortality rate, especially for stroke and CHD.

Physical inactivity is costly both financially and in terms of quality of life. It seems these costs are increasing over time, and studies published in The Lancet confirm that that physical inactivity is increasing in middle-income countries, such as New Zealand. The only other study that measured the health costs of physical inactivity in New Zealand was undertaken in 1991 (Russell *et al*., 1992) and the cost of physical inactivity was estimated at $_{1991}\$179$ million, which is equivalent to $_{2010}\$270$m[39]. Russell *et al.* (1992) used a different definition of inactivity, estimated that only 28 percent of New Zealanders engaged in physical activity at the level recommended to develop and maintain cardio-respiratory fitness, and 31 percent of New Zealanders were active for less than three hours per day, and based the health costs on these proportions for their study. In contrast, our study found that approximately 50 percent of New Zealanders did sufficient exercise to complete the 30 minutes of moderate activity 5 times a week. Although the two studies (this current one and Russell, 1992) are not directly comparable, there is nearly a five-fold increase in costs of physical inactivity between the two periods. The differences in magnitude of costs can partly be explained by an increase in medical costs over and above the inflation rate, advancements in medicine, better treatment for diseases, newer health equipment, research and the general cost of care (including embodied capital costs of infrastructure such as hospitals etc). The difference can also partly be explained by the different methods used to calculate the indirect costs – Russell *et al.* used a human capital approach which returns lower indirect values, whereas we used more encompassing methods to value a statistical life, as defined by what people would be willing to pay for avoiding death or injury. These two reasons are not sufficient to explain the large discrepancy in costs over time, and more work is required to accurately verify the extent to which physical inactivity is becoming more costly to society as a whole. We recommend the ongoing monitoring of costs and inactivity to enable robust time series comparisons.

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[39] The 1991 value expressed in 2010 terms.

The total cost of physical inactivity ($1.3 billion) to New Zealand was in part paid for by New Zealand taxpayers, through the health system. Costs were also borne at an individual level, as physical inactivity can lead to suffering and disruption to a person's life with the onset of a disease that could have been avoided. Ultimately, it can lead to premature death which may impact on household economics and organisation. The premature death of 246 New Zealanders was caused by physical inactivity for the 2009 year. Seventy three of these deaths were in the Auckland region, 21 in the Wellington region and 18 deaths in the Waikato region. To put these figures into context, there were 420 deaths due to motor vehicle accidents and 510 deaths caused by self-harm for that same year - although these were for all ages: the equivalent figure for the number of deaths that could be attributed to physical inactivity using PAF was 2,121, which is five times the number of deaths from motor vehicle accidents and four times the number of deaths from self harm. The problem of using/citing this higher value of deaths attributed to physical inactivity is that many of the deaths were of elderly people. Increased physical activity cannot prolong life forever.

Estimating the costs of physical inactivity raised some interesting dialogue between public and private responsibility for health. This study forced an exploration of whose costs were being considered – the individual's (private household expenditure) or the State's (through tax expenditure)? Our current state of medical knowledge, which has advanced dramatically over the last 50 years, often places responsibility for medical treatment in the hands of experts. The depth of knowledge embodied in current treatment requires this level of specialisation. Yet, physical activity is a personal choice, placing the responsibility for good health outcomes on the individual. What then becomes important is whether the individual is aware of the effects of physical inactivity on their health outcomes.

Tackling the burden of physical inactivity in terms of addressing who should pay for it and how to safeguard society in terms of its future costs requires carefully-crafted integrated policy intervention (Heath, Parra, Sarmiento, *et al.*, 2012). Responsibility for undertaking the recommended levels of physical activity rests at different governance levels. Psychological effects (motivation, belief sets and understanding of the effects of physical inactivity) place responsibility clearly at an individual level. Cultural norms and institutions determine whether behavioural change at a societal level could occur, although operations at this level are hard to identify and influence (e.g. social support from family members to become more physically active). The local environment plays a significant role in terms of providing safe opportunities for people to be physically active. It is at this level where local government has levers of influence. Regional and national policy is another level where rules (laws) and agencies can affect levels of physical inactivity through the health and education sectors, transport policy and transport system (e.g. driving door to door versus using public transport that usually requires some active mode, such as walking between bus/train stations), economic policies (e.g. effects of removing import duty on new imported vehicles in the 1980s led to an increase in car ownership by making ownership affordable), economic activities in the workplace and household (e.g. moving from agrarian to service economies affects the level of physical activity undertaken while at work; many household appliances reduce the physical effort required). Global factors play their role too, in terms of global prices affecting demand (e.g. for oil/fuel) and global innovation determining how we live (e.g. virtual worlds encourage more sedentary lifestyle). The challenge is to mainstream policies to address the factors that affect levels of physical inactivity. Some levels will be fall beyond the mandate of government agencies, but, in areas where government agencies can influence the levels of inactivity, the health and wellbeing of society can be improved.

At an individual level, adults cannot be forced or coerced into exercising and being more active. It can be argued that the levels of physical inactivity are chosen by individuals with government unable to determine the levels. However a critical component of such an argument is that the free choice should be well informed. Individuals should be aware of the health risks associated with a sedentary lifestyle, how costly it can be for themselves and for society. There are 'market failures' with regard information for many health issues, largely because the effects of behaviour do not manifest in the timeframe immediately after a certain behaviour. There is a lag or delay in the onset of many diseases/health issues – for example the onset of lung cancer is often years after the person starts to smoke. Similarly, the effects of physical inactivity may not be felt immediately – particularly the effects on the cardio-respiratory system, if cardio fitness is not maintained, the heart muscle deteriorates over time. Therefore the detrimental effects of physical inactivity could be discounted in daily decision making processes. People need to be informed about why they should be physically active, alongside other lifestyle choices such as nutrition, and avoiding other risks such as bad air quality etc. Understanding the health issues of physical inactivity, which are changing with increased research into this area, requires good communicaiton and dissemination. This will not occur in and of itself, due to information failure. There is a need for government agencies to communicate the message that physical activity has benefical health outcomes. Promotional health messages are however costly to undertake and maintain.[40]

This FCA study of physical inactivity *is not* a cost-benefit of physical inactivity. Further work would be required to evaluate effects of investment (e.g. promotional campaigns) aiming to increase physical activity levels. By understanding the efficacy of such investment a cost-benefit ratio could be estimated by combining it with health spending that has been avoided. This study is a first step in measuring these costs. Invariably the issue of cost benefit and cost effectiveness of expenditure on physical inactivity will arise and need to be addressed, given that the majority of $614 million of direct health costs are borne by the state/taxpayers through the health system.

This study has looked at the costs of physical inactivity for adults. The behaviour/levels of activity in children is important, given the practices and social norms that are formed in childhood and get carried through to adulthood. Indeed it is argued that early development *in utero* affects inactivity levels through gene switches (Barouki, R., Gluckman, 2012). Mainstreaming physical activity throughout the formal education curricula is a means of influencing behaviour, and an area that could be assessed in terms of costs and benefits of outcomes. More work would be required to measure the extent to which children carry their behavioural patterns into adulthood, the extent to which this has been influenced by

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[40] Listen to RadioNZ's Smart Talk series on 'gluttony' for a discussion of the politics and costs of public health messages vis-a-vis private company's advertising costs that have damaging health implications if the advertising campaign is successful.

specific intervention in the education system over and above how the child would have behaved in its absence. Again, these are complex areas of influence, and the ability to move out of (inherited) social norms or patterns of behaviour set by family and social circles may determine the future levels of inactivity for New Zealand.

Local government has a significant role to play in terms of enabling and facilitating physical activity. Planning (both urban and rural) in terms of neighbourhood walkability, public transport and overall design can facilitate safe passages and places for physical activity (Witten *et al.*, 2008). In New Zealand, local government provide parks, open public spaces, beaches and build/maintain infrastructure such as sports fields, swimming pools, skate parks, mountain biking tracks, cycle ways and footpaths that collectively enable decisions to be taken to be physically active on a daily basis. Local government can influence the aesthetics and amenity of areas where physical activity will take place, while incorporating safety issues at the design stage. Transport policy is determined at both local and national government level, and possibly has become the single most important lever to change levels of physical inactivity in New Zealand society. Interestingly it was NZ Transport Agency (2008) that has completed the only substantial study, other than Russell (1991), on physical inactivity (albeit with a strict cost-benefit focus on measuring costs per kilometer walked or cycled, as estimated through health benefits).[41] Traditionally transport impact assessments focused on safety (injuries or fatalities) and environmental effects (noise and air pollution). A wider appreciation of impacts/costs is now being taken, including physical inactivity, but systematic monitoring is required.

The FCA approach to physical inactivity has identified a wider set of costs associated with physical inactivity, including loss of quality of life, suffering and loss of income. Indeed some of the cultural costs of physical inactivity could be at a societal level – if cultural norms changed significantly away from physical activity, there could be far-reaching and unknown effects at a societal level.

This FCA approach addresses the cost of physical inactivity, but does not cover the benefits of physical inactivity. Arguably there could be more injuries and deaths brought about by increases in physical activity – if, for example, commuting patterns changed significantly to active modes of walking and cycling then there could be more accidents between vehicles and pedestrians/cyclists (who are unprotected). It should be mentioned that there are benefits of inactivity – not everyone likes physical activity: pain and suffering may be *avoided* by people who do not like to be physically active. It is however worth noting that such avoided costs are likely to be relatively small in comparison to the health costs associated with inactivity.

There is a need for integrated policy in the area of physical inactivity. In New Zealand policy was originally devised and concentrated in the health sector, where the effects of physical inactivity materialise and are treated. The Hillary Commission for Sport Fitness and Leisure was established in the 1980s, and was instrumental in the establishment of Sport and Recreation New Zealand, which is now

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41 These are outlined in the Economic Evalation Manual under Traffic Demand Management.

called SportNZ. The aim of SportNZ is to create a world class sports system at all levels, getting people of all ages participating in sport.

There is the danger of focusing on sports as a physical activity, rather than addressing the growing problem in inactivity. In the calculation of 'other' costs for this study, it was difficult to apportion the specific amount that the agencies spent on physical inactivity, rather than activity. The distinction is subtle, but important at a population health level when sedentary lifestyles begin to impact the overall health of the population. The health sector (Ministry of Health, District Health Boards, Primary Healthcare Organisations, GPs etc) are aware of physical inactivity issues, but cannot tackle the pandemic alone. The complex factors that contribute to levels of physical inactivity lie beyond the scope of the health sector's activities, or indeed for that matter any one sector's activity. DHBs monitor, protect and promote the public's health in their regions. Many other agencies play a role in levels of physical inactivity, prior to the resultant patients presenting for treatment in the health system. Socio-economic factors play a large role in the prevention, control and management of diseases and chronic disorders associated with physical inactivity.

4.2 Applicability of the Full Cost Accounting Method

Although this report aimed to measure the costs of physical inactivity, the sub heading is 'toward a full cost accounting approach'. Part of the project brief was to demonstrate the applicability of FCA to physical inactivity. We describe our method as attempting to use a FCA approach. This section focuses on the choice of methodology, discusses the limitations encountered and potential improvements for future work.

Use of the term 'full' is somewhat of a misnomer, as there are methodological limitations in establishing causality of effects (Market Economics, 2011). This is an ubiquitous problem facing any economic valuation methodology – causal mechanisms do not always follow simple, singular, deterministic or linear paths (Reiss, 2008) and the effects may be unintended and unknown. There are many unintended and unknown consequences of physical inactivity that by definition cannot be measured. There may be effects in changes of behaviour that have time lags involved and that will remain unknown for some time. Such lags are evident in natural systems (e.g. sedimentation or organic material resulting from land clearance of forest can take between 50 to 100 years to migrate through a water catchment and into an estuary) and in human biological systems (e.g. the length of time it took to discover that smoking causes lung cancer or that thalidomide caused birth defects).

Changes to more sedentary behaviour at a societal level may have human evolutionary impacts. Emerging research indicates effects on gene expression (Barouki and Gluckman, 2012). Patterns may emerge in the future rendering apparent or obvious the causal linkswhich remain obscured at present. We are limited by a lack of full information, and so models are never complete or full. This is epistemological and central to how we undertake research, develop models, test hypotheses and establish facts and knowledge. It is certainly not unique to economic valuation. However, usage of the term 'full cost accounting' may create a pretence that the methodology in some way overcomes information gaps, or bounded rationality (Simon, 1957). In reality, we cannot make decisions based on full/complete information, but gather what we consider enough information to make a decision; what Simon (1957) termed 'procedural rationality'. All economic valuations are based on procedural rationality – the valuations include what is considered enough information to be defendable/robust enough.

Notwithstanding the intractable methodological limitation, FCA provided a useful framework for measuring the costs of physical inactivity, which is just one risk factor or variable associated with an increased risk of developing disease. Building on the GPI Atlantic approach for measuring the costs of physical inactivity (Walker and Colman, 2004; Katzmarzyk *et al.* 2000) a cost of illness methodology was used in this study. In terms of the direct costs of treating illnesses, epidemiological studies isolate the proportion of a disease that is caused by risk factors, such as inactivity through population attributable fractions. In theory, these PAFs provide a robust scientific evidence base of causality. In practice there was missing data for New Zealand, and our study relied on international studies to derive relative risk (and hence PAFs). This study was a meta-analysis in that it relied on previously published research from a variety of sources. While this enabled the studying of physical inactivity, it was not without its challenges. There is a lack of New Zealand studies on the relative risk of contracting diseases. We augmented and addressed any data gaps with published international studies, after examining their applicability to the New Zealand context. In particular, gaps were identified in estimating the cost of treating depression in New Zealand. An attempt was made to calculate these costs, but the resulting proxies are conservative and do not include government funding part of which is reflected in the MoH hospitalisation database (which has overhead costs incorporated) nor have they explicitly incorporated a cost of suicide, akin to premature death in the method used for measuring indirect costs in the other diseases.[42]

Applying a FCA method measurement of the cost of diseases resulting from physical inactivity is similar to life-cycle assessment of the diseases. The cost of illness approach measures (direct) effects for a discrete timeframe (one year). There are a lot of assumptions embodied in this calculation, particularly around patterns of behavior identified in the 2007-08 physical activity survey. The medical treatment of patients in 2010 (for which the study was calculated) is a result of individual behaviour throughout their lives. It was not possible to verify rates of activity over time. Establishing longitudinal datasets in the area of physical activity/inactivity would enable such analyses in future.

It is not possible to say whether the burden of costs will increase over time, although there is evidence that people are becoming more sedentary. However, the costs of treatment may also decrease over time or medications may change – indicating there are a lot of dynamic variables in the estimation of these costs. The example given in the study on stroke survivors reinforces this point. The prevalence of

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[42] Lindsay (2007) argues that currently in NZ, major depression is likely to be the second leading cause of burden of illness (as measured by Disability Adjusted Life Years), after the ischemic heart disease burden. Our figures do not reflect this, and further analysis is required to validate the estimates of cost of treating depression in this study.

stroke has remained constant over time, yet the survival rates have increased, given medical interventions, which is a good health outcome. However, the downside is that the survivors face disability and may require additional care for long periods of time. The cost of illness method used by MoH for the treatment of cancers in New Zealand differed in this respect, as it measured the costs over the course of treatment of the disease (e.g. the cost of treating cancer ranges up to six years for an individual patient). The indirect cost of disease was also calculated (as part of the cost of illness approach).

The indirect costs cover the costs of premature death (including loss of income and intangible costs), the cost of disability and loss of quality of life. Monetising the indirect costs for physical inactivity required 'borrowing' the value of a statistical life from another study area (transport), and use of the statistic in such a manner is not without its critics (Guria *et al*., 2003). This monetisation could be greatly improved by conducting a willingness to pay survey for avoiding the diseases associated with physical inactivity; this however was beyond the scope of this project. We recommend that an official value for a statistical life be published by Statistics New Zealand, which could be used generically in policy evaluations. There are generic problems with using willingness to pay methods for constructing such a value, as they rely on people's cognitive ability to value avoiding the relevant disease. This again links with the information and knowledge that people have about the links between inactivity and disease risk.

The focus of our study was primarily on the health costs (direct and indirect) of treating the diseases associated with physical inactivity. The study incorporated a category of 'other' costs (resulting in the FCA approach), which included expenditure on physical inactivity – such as programmes to increase physical activity, health campaigns to raise awareness of the harmful effects of physical inactivity. These were funded by central and local government, the DHBs and NGOs. The costs are largely policy costs, but do not have to be limited to this. If additional effects of inactivity were quantifiable they could be included in this category. This category of 'other' costs paled in comparison to health costs. It is acknowledged that other marginal costs are associated with the diseases such as transporting patients to and from hospital or disease screening programmes. Where possible these costs were included, but it was recognised that while these costs do exist, they are in relative terms minimal in comparison to the bulk of the health costs. A pragmatic approach was taken in terms of trying to obtain accurate data for these marginal costs with due consideration of the potential influence on likely impact on the project/research results and project timeframe (an example of procedural rationality). The costs are however important, and part of the process of FCA is to identify these costs, which may not be apparent or obvious at first. Nevertheless, a total assessment of all costs is fraught with methodological and data availability difficulties, including difficulty in putting boundaries around cost and double counting the effects.

The study faced the problem of finding relevant datasets. The public expenditure on treating physical inactivity is 'relatively' accessible from official databases (although data is not always collected or collated in a manner appropriate to precisely answer the research questions that were posed by this study). Private expenditure was more difficult to measure because there is no centralised dataset in New Zealand with the level of detail on the costs of treating specific illness, that is required for our approach.

Indirect cost measurement can be complex: it is an art-form and not a science. The dollar value for indirect costs attempts to capture this loss of life to the disease, along with the disabling effects, and value placed on leading a healthy life. As mentioned earlier, the Value of Statistical Life used here was not constructed to measure physical inactivity, but was constructed for road safety, and the value people put on avoiding road crashes and deaths. Recall that indirect costs were measured in two ways, the first method putting a value on preventable fatality, using a value of a statistical life ($3.5m) for that fatality (regardless of age). Alternatives to measurement of indirect costs include the 'Disability Adjusted Life Year' (DALY) approach. The Ministry of Health (2001) estimated that 7 percent of DALYs were attributed to physical inactivity in that year in New Zealand. In other words 7 percent of the total burden of disability could have been avoided if the population were undertaking the recommended levels of physical activity. No calculation (monetary value) of the full cost of disability in New Zealand was found in the literature. If an estimate of such a cost were available, 7 percent of this could be attributed to physical inactivity, based on this DALY.

The question arises as to what extent society (individuals) are willing to pay for reducing their risk of developing diseases that are attributable to physical inactivity? Implicitly, this could be seen as being revealed through expenditure on being physically active (gym membership, equipment, walking shoes etc.), and also through time commitment that physically active people assign (given that physical activity does not necessarily have a financial cost for the individual), but more research is required into the health expectations of those that are physically active and inactive. The motivation of people is important to understand, and then the trade-offs and hence value attributed to physical (in)activity can be gauged. For example, this study did not measure the negative suffering and pain that people may endure by becoming physically active.[43] Furthermore the study measured total cost, without looking at inequalities in the effect of physical inactivity. Any policy response requires inclusion of broader socio-economic factors, such as poverty and physical inactivity while linking with broader health issues such as nutrition and physical inactivity.

Kohl *et al*. 2012 called for a systems approach to physical (in)activity in an effort to understand the unintended consequences of human behaviour and development. The FCA method identifies the broader systemic effects of physical inactivity, as identified in Figure 1. The FCA approach attempts to cast its net out wide and integrate a broad set of effects. From this perspective FCA is a useful *ex ante* (before the event) policy tool. Prior to a policy change it is good to consider or envisage the likely effects. Even if the effects are not measurable, a qualitative description can inform the decision making process.

FCA is similar in approach and breadth to cost benefit analysis, but it measures the cost side only. It was designed to measure costs associated with physical inactivity and the results can be used to measure the relative cost of physical inactivity in comparison to other social and health problems, and it can be used to monitor the cost of inactivity over time. This study identified that there is expenditure on policies to

[43] Perhaps this is at the thought of becoming physically active, given that endorphins are released when exercising!

address physical inactivity. In order to be used for Cost Benefit Analysis e.g. to evaluate return on investment for reducing physical inactivity, the benefit side would need to be clarified and quantified. In light of the findings of this study, it seems a 'double negative' to describe the benefits of physical inactivity, but there may be an increase in sports illnesses, injuries and accidents with increased physical activity. If more people were using active modes of transport, there could be more pedestrians or cyclists injured or killed if not 'sharing with care' on roads. Cost effectiveness analysis would be an appropriate method to measure whether the money spent on such policies is good investment that is, whether it achieves its intended outcomes.

4.3 Recommendations and further work

Physical inactivity is seen in the broader context of overall health, and it is just one risk factor. It is however becoming a discernible burden on the New Zealand health system and in terms of cost and its impact on the quality of life at an individual level. Epidemiological studies isolate the levels of risk for physical inactivity to each disease. When the effects are combined with economic values the extent of the problem becomes apparent. It is recommended that the relevant agencies across a variety of sectors - health, transport, education, local government, sport and recreation, economic development – acknowledge that an integrated approach to managing the physical inactivity pandemic in New Zealand is required. Policies should be integrated, and physical inactivity should be mainstreamed into the policy development process. The effects on the levels of physical inactivity in regions and across the population should be considered when devising policy.

Two studies have been undertaken to date that measure the costs of physical inactivity in New Zealand. Although not directly comparable (due to methodological differences), it seems there has been a massive increase in the cost of physical inactivity in the last twenty years. We recommend the ongoing monitoring of the costs of physical inactivity, given that it is now recognised as a pandemic (Kohl *et al.,* 2012). It is recommended to track changes in the costs and rates of physical inactivity over shorter periods. This would enable a better understanding of the effects of physical inactivity on communities, providing the evidence at a micro-level analysis for policy formulation.

This study highlighted areas where data was missing and more research is required. We recommend that a central agency such as Statistics New Zealand develop a value for a statistical life (VoSL) in New Zealand, which could be used generically in studies that value life, as used to measure indirect costs in our study. The only measure available in New Zealand was constructed specifically for the transport sector and the willingness to pay survey on which it is based was undertaken over 20 years ago, albeit with an update some years ago. Studies within health economics that measure the costs of treating depression were also identified as lacking in New Zealand. Our study made a cursory attempt in this regard, but more systematic research into the treatment of specific mental health diseases is required.

With regard to the relative risks of developing diseases, specific New Zealand studies were not identified in the literature. Should New Zealand epidemiological surveys become available, they could be used to update the figures used in this study. Until then, recourse has to be taken to using international studies, with the assumption that relative risks of physical inactivity are similar in other countries. Further research is required to assess whether there are specific attributes within the New Zealand population that affect relative risk.

Our study measured the costs of physical inactivity at a regional level. Given that the health costs were calculated on a patient basis from actual DHB data, it was considered that such a regional approach is robust and reliable. Obtaining regionalised data can limit valuations, but in this study it was not considered problematic, and a regional approach was considered technically accurate. However, given the relative size of New Zealand and the structure of health care (with some specialised care administered in select areas), patients often transfer to hospitals outside the DHB in which they live. The only significant regional difference identified in this study was the disproportionate higher indirect cost of physical inactivity in the regions not specifically identified in this study. Although not confirmed, we suggest that this was due to higher mortality rates associated with illnesses in these other regions, and may be due to access to emergency services, especially for stroke and CHD. Other than that regional disparity identified, the study could be replicated in the future (every two years) for the whole country, with the assumption that there is not so much regional disparity in terms of cost.

Full cost accounting is an emerging holistic technique to calculate the relative magnitude and scale of a social problem. We recommend it as a useful method in this regard, but caution against it being perceived as overcoming methodological issues associated with bounded rationality and establishing causation and effect amongst variables that other economic valuations similarly face.

5. Conclusion

Just under half of the New Zealand population met the recommended “30x5” physical activity guidelines, for maintaining good health and reducing risk of contracting certain diseases in 2007-08. The rates of inactivity were higher for the three regions of this study than the national average. Physical activity involves activity that increases the heart rate. Sport and exercise are examples of physical activity, but more moderate forms of activity may include walking and gardening, depending on the age and physical health of the individual.

If people were more active, and achieved to the recommended guidelines for physical activity, a proportion of disease could be avoided. Hence the cost of treating the diseases in society would be less. Physical inactivity is one of a number of factors that increase the risk of developing disease. Others include smoking, family history, age and so on.

The study estimated that in 2010 physical inactivity cost the Auckland region $_{2010}$\$402million, $_{2010}$\$106million for the Waikato region and $_{2010}$\$140million for the Wellington region. These costs were made up of direct, indirect and other costs. The direct costs were greater than indirect costs for Waikato and Wellington, whereas the indirect costs were greater for Auckland. The ‘other’ costs made up a smalll proportion of total costs attributed to physical inactivity in all the regions.

Table 5.1 Summary of Direct, Indrect and Other costs attributed to Physical Inactivity $_{2010}$\$ mil

	Direct costs	Indirect costs	‘Other’ costs*	Total costs	Estimated no of premature deaths
Auckland	178	213	10	**402**	73
Waikato	54	48	4	**106**	18
Wellington	74	62	5	**140**	21
New Zealand	614	661	30	**1,309**	246

Direct costs accorded to physical inactivity were \$178 million for Auckland, \$54 million for Waikato, \$74 million for Wellington and \$614 million for New Zealand. Direct costs are dominated by hospitalisation costs for most diseases associated with physical inactivity, with the exception of depression which is treated primarily in primary and secondary care. Stroke is the disease with the highest direct costs attributable to physical inactivity. This is despite lower numbers of people treated (in hospital) for stroke than hypertension, diabetes, chronic heart disease or colorectal cancer. The cost is determined by the type of hospital care, resources used while in hospital and length of stay in hospital. Depression had the lowest direct cost of physical inactivity, largely because not many people are hospitalised for depression.

Indirect costs accorded to physical inactivity were $213 million for Auckland, $48 million for Waikato, $62 million for Wellington and $661 million for New Zealand. It is not uncommon for the indirect costs of a disease to be greater than the direct costs, particularly if a person survives the disease but with some form of disability. The indirect costs were greater than the direct costs for Auckland and New Zealand, but less for Waikato and Wellington. It is difficult to measure intangible costs associated with pain and suffering. Caution is warranted in using these values of indirect costs, due to data limitations in our study, around the value of a statistical life. Attempts were made to find the most appropriate data, but in the end only proxy values were available.

Coronary heart disease had the highest indirect costs for all regions, largely due to the high mortality rates associated with this disease. This was followed by colorectal cancer in Wellington and Auckland, whereas, in Waikato stroke was second highest in terms of indirect costs. The high indirect costs of colorectal cancer can be explained by the relatively high premature mortality rates for the disease. Osteoporosis and hypertension had the lowest indirect costs in all regions, as people tend not to die directly from these illnesses, and therefore the indirect costs of premature death were small.

Other costs associated with physical inactivity were included in the study. These include promotional campaigns to get people more physically active, including programmes aimed to change travel and commuting to active modes. We considered including capital costs and infrastructure expenditure/ investment in resources for sport. But these were not included as they are expenditures on physical *activity* rather than *inactivity*. An attempt was however made to include the expenditure on changing sedentary behaviour to more active – getting the recommended weekly 30 minutes of moderate activity 5 times a week. These other associated costs are estimated at $10 million in Auckland, $4 million in Waikato, and $5 million in Wellington. The values for 'other' costs include region specific expenditure on tackling physical inactivity and information or promotional campaigns that partially dealt with physical inactivity. These included central and local government expenditure on active modes of transport.

There is a need to mainstream physical inactivity issues into policy decisions at all levels of government. As the evidence that physical activity has numerous physical, health, and emotional benefits has grown, the body of effective, evidence-based interventions also has grown. The health system deals with the effects of physical inactivity (diseases that could be avoided with more activity), and increasingly uses information campaigns and other tools to enhance people's activity levels and therefore reduce the health care costs.

Local government has a significant role to play in the provision of opportunity for residents to increase their physical activity levels, e.g. through urban design, transport planning, recreational facilities and places to exercise. Having access to places and opportunities for physical activity is critical. But people must also know that these facilities exist (promotional campaigns).

Open spaces, parks and improved pedestrian and cycling infrastructure promote physical activity. People walk more in neighbourhoods that are safe, walkable and aesthetically pleasing. Perceived unsafe areas and neighbourhoods are a significant barrier to physical activity. Incorporating such considerations into urban design would ensure that infrastructure and changes to the physical environmental of urban space could benefit the wider community and have an enduring health effect.

Communities can benefit significantly from integrated urban planning, ensuring due consideration to land use and transport policy. When people are able to live near and get to destinations such as work, shops, recreation and entertainment without using cars, opportunities for physical activity through active transport are increased. Availability of public transport is a key factor as use of public transport usually requires a walk or cycle to and from the transport node.

Providing opportunities for travel other than by private car, such as cycling and walking, creates options for physical activity for a large portion of the population. Improving cycling infrastructure encourages the uptake of cycling.

Disincentives such as limited car access and parking or increased parking costs also have the potential to encourage and facilitate the use of alternative modes of transportation. Such measures also have the potential to improve air quality, green space, aesthetics, commerce, social cohesion and community spirit; and decrease stress.

In most parts of New Zealand, transport to and from school is a significant part of total vehicle kilometres driven. Programs that promote active transport to school have the potential to increase physical activity and improve health among a large number of youth on a regular basis (e.g. 'Walking School Bus'). This enables physical activity to be routinised from an early age.

This report was commissioned by local government agencies, and local government has a significant influence over physical activity, as it can affect how individuals incorporate physical activity into their daily life. Increasing the levels of physical activity is not within the remit of local government exclusively. Central government agencies also have influence over physical inactivity. Tackling the physical inactivity pandemic, and making cost savings in terms of treating diseases that are associated with it requires a concerted effort and integration of policy across government agencies and sectors. The behavior of individuals needs to change also, as individuals cannot be coerced into increasing their levels of activity. Ensuring that individuals make informed decisions about their levels of physical activity requires policy intervention, as there is a costly information failure with respect to the health issue of physical inactivity.

The study was undertaken within a FCA framework. The point of departure with the methodology was a cost of the illnesses associated with physical inactivity. Cost of illness studies monetise the costs of a particular health problem or disease. They are broken down into direct costs and indirect costs. FCA is an emerging method that conceptualises an extensive set of associated costs. Its merit lies in the attempt to integrate a range of causal effects. In this report the use of a FCA enables a qualitative and semi-quantitative understanding of how physical inactivity affects different parts of society and the economy. It incorporates not only direct and indirect, but also other costs. Where possible, measurement of these effects was undertaken. If measurement was not possible, there is still value in understanding how physical inactivity impacts on the society.

The study used a range of pre-existing published data. While this enabled estimates for the different cost categories, reliance on secondary data sources led to a significant process of data verification and triangulation. Where possible, the scope of all data sets and research reports used is given and any assumptions associated with the data detailed in the appendices. There were some data gaps identified; specifically, there are no estimates for the burden of depression in New Zealand, either the direct costs of treatment or the indirect costs from depression sufferers. Also, there is little data on the value of a statistical life in New Zealand. A figure is used by the New Zealand Transport Agency (NZTA), and this measures a willingness to pay to avoid death or injury in transport (on the road). This is an area of economic valuation that is largely contestable – the measurement of intangible effects and valuing life.

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Appendix 1: Measuring Physical Activity

Metabolic Equivalents (MET) are commonly used to express the intensity of physical activities. This is the ratio of a person's working metabolic rate relative to their resting metabolic rate. Technically, one MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1kcal/kg/hour. It is estimated that compared with sitting quietly, a person's caloric consumption is three to six times higher when being moderately active (3-6 METs) and more than six times higher when being vigorously active (>6 METs) (WHO website, 2012). The intensity of different forms of physical activity varies between people, according to their age and gender. Clinical studies have explored the effects of vigorous or high intensity interval training as a time-efficient alternative to traditional cardiorespiratory exercise training (Metcalfe, *et al.*, 2012; Trilk *et al.*, 2010), and concluded that short bursts of vigorous exercise (i.e. 'all-out' cycling sprints for between 10 to 20 seconds, after a warm up period, followed by a cool down period was the training protocol used in the experiment) improved metabolic health and aerobic capacity. The intensity of physical activity depends on an individual's previous exercise experience and their relative level of fitness. These considerations are incorporated into studies that measure physical activity across populations (SPARC, 2004), although for clinical studies there is increasingly a focus on accuracy of scales, facilitated by the use of heart rate monitors to measure intensity of exercise across all activities (Firth, 2012). This avoids biases associated with self-reporting of physical activity, and has been used in targeted studies, rather than in larger population surveys. For the New Zealand physical activity study, the survey relied on self-reporting of activity, measuring the frequency, intensity, duration, type and context of the activity (McLean and Tobias, 2004). There is much debate about dose-response effects on different diseases (Vina *et al.* 2012; Dunn, *et al.*, 2001), and this is explored in health research through epidemiological surveys.

Appendix 2: Review of Previous Burden of Illness Studies

Burden of illness studies have approximately a 20 year history, initially developed in the 1990s to measure obesity.[44] MoH (2009) identified and summarized 30 New Zealand specific economic impact reports and studies that addressed health and societal costs of long-term health conditions, since 1985. Although all these studies had different objectives and methodologies, it identified similarities in approach and was able to identify gaps in the literature. Costs are generally broken down into direct and indirect costs. Some of these studies calculated direct costs only, whereas others estimated the indirect costs, which typically contributed between *one-third and two-thirds* of the total cost.

Russell *et al.* (1992) calculated that physical inactivity cost New Zealand $179m in 1991 – equivalent to $_{2010}\$270$m. This latter study estimated that only 28 percent of New Zealanders engaged in physical activity at the level recommended to develop and maintain cardio-respiratory fitness. They found that age and gender had the greatest influence on physical activity patterns. Participation in high intensity activity and most sports declined markedly with age, whereas participation in medium-low intensity activity did not change with age. Males participated more frequently than females in most sports, and it was found that NZ Māori (both male and female) have higher percentages in high activity groups. Direct comparison of Russell's *et al.* (1992) results to more recent work undertaken in this area are difficult, given a lack of clarity on how physical activity was defined.

A New Zealand study on the health care costs of obesity was completed by Swinburn *et al.* (1997) using a burden of illness approach. The cost was calculated at $_{1991}\$135$m, which represented 2.5 percent of the total health expenditure for that year. There was overlap in the diseases associated with obesity and physical inactivity, although gallstones were included in the obesity study, while osteoporosis and depression were not included. Studies on obesity are important as they link physical activity with nutrition, again stressing that physical inactivity is just one component of healthy living.[45]

The GPI Atlantic studies on physical inactivity in Canadian regions (Walker and Colman, 2004), were undertaken as part of their 'Genuine Progress Indicator' reporting. Greater Wellington Regional Council suggested this approach as a preferred method for undertaking this current piece of work. The GPI Atlantic approach was, in turn, based on the Katzmarzyk's (2000) method of measuring physical inactivity. This is based on a cost of illness method. Katzmarzyk and Janssen (2004) used a 'prevalence-based approach' to measuring physical inactivity and obesity, based on Wolf and Colditz's (1998) prevalence-based approach to measure obesity in the United States. Costs to the individual were analysed, in terms of excess physician visits, work-lost days, restricted activity, and bed-days attributable to obesity using cross-sectional data from the 1988 and 1994 National Health Interview Survey (NHIS). Direct (personal health care, hospital care, physician services, allied health services, and

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[44] See Colditz, (1992) and Segal, Carter and Zimmet, (1994) for the initial studies in the US and Australia respectively, and Swinburn, Ashton, Gillespie *et al*, (1997) for a comparable New Zealand study.

[45] David Cameron-Smith of the Liggins Institute and Nicholas Gant, Dept of Sport and Exercise Science, University of Auckland explore the modulation of energy supplies to the brain and the role of physical activity in this process. Their public lecture and the 2012 Vice Chancellor's Lecture Series on Exercise is Medicine is available from the UoA website: www.science.auckland.ac.nz/uoa/home/news/template/news_item.jsp?cid=514888

medications) and indirect costs (lost output as a result of a reduction or cessation of productivity due to morbidity or mortality) from published reports and inflated to 1995 dollars using the medical component of the consumer price index (CPI) for direct cost and the all-items CPI for indirect cost.

A recent New Zealand study by NZTA (2008) estimated/calculated a cost per kilometer travelled by active modes of transport. This study used cost of illness as part of their methodology. Although this NZTA study did not focus on estimating the costs of physical inactivity, their methodological approach was of direct relevance, and use, to our study. It measured potential health care cost savings, if people used active modes of transport (e.g. - but not limited to – walking, running, cycling). It contained the most recent relevant figures for the relative risks of contracting diseases due to physical inactivity. Our definition of physical activity is broader than a transport only focus, as all type of physical activity is included, which can be age appropriate (e.g. gardening may be a physical activity for an aged person). Our definition of activity is based on SportNZ's (formerly SPARC) measures, which in turn are aligned with the World Health Organization physical activity guidelines. Physical activity can include sport, active transport mode and age appropriate activity (which is of importance for elderly people). More recently, Cadilhac *et al*. (2011) applied this method to measure the economic benefits of reducing physical inactivity in Australia.

In New Zealand, Pharmac frequently undertake studies in cost utility analysis on different diseases, with the practical purpose of deciding which drugs should be bought for treatment of New Zealanders (after passing through Medsafe, the regulating authority for medicines and medical devices). Pharmac and the MoH usually calculate the direct costs of treating illnesses, but do not explicitly monetise indirect costs, due to methodological inconsistencies and measurement difficulties (Pharmac, 2012). Rather, they measure cost in terms of outcome that would be attained, as measured through reduced mortality (lives saved) and quality of life (disability index). This approach is discussed further within the context of measuring indirect costs, while the following section details the main principles underpinning the economic burden of illness methods.

Cost of illness studies are comprehensive studies that value in dollar terms the costs of a particular health problem, which then enables the economic burden of the problem to be estimated. Burden-of-disease studies are similar to cost of illness studies, but they describe the magnitude of a health problem, typically measured in health outcomes such as mortality and morbidity (MoH, 2009). According to Drummond *et al*. (2005) cost of illness studies are not considered full economic evaluations because they do not assess actions to address the problem. They do highlight the importance of the health issues in a particular society.

Appendix 3: Review of Physical Inactivity Surveys in New Zealand

The New Zealand Health Survey 2006/07 measured basic data on adult physical activity, by asking participants how many days in the previous seven they had done brisk walking, moderate activity and vigorous activity, and how many hours and minutes they had done per day for each of those activities.[46] A similar survey was undertaken for 2002/03, and a comparison between two studies was possible, showing no significant difference in the prevalence of regular physical activity (MoH, 2008).

The Hillary Commission for Sport, Fitness and Leisure (resulting in the Sport Fitness and Leisure Act 1987) undertook the first New Zealand surveys on physical activity between 1997 and 2001.[47] A question in the 'Quality of Life' survey explores self-reported physical activity rates for residents in the cities involved from 2000.[48] The most recent comprehensive published data was obtained directly from the SportNZ (formerly SPARC) 'Active New Zealand' survey 2007/08, which gave rates of physical activity at both national and regional levels for the adult population. This latter survey is more rigorous in its approach and focused on activity levels, as compared to the Quality of Life survey which includes only one question on physical activity/inactivity.

Two national surveys have been undertaken to date by Sport New Zealand to assess sport, recreation and physical activity among New Zealand adults, aged 16 years and over. Data from the most recent survey (2007/08) was used to determine the prevalence of a risk factor due to physical inactivity. The survey was designed at a regional level, based on the geographical areas serviced by New Zealand's 17 Regional Sports Trusts. The survey consisted of questions that interrogated the levels of participation in sport, organised competition events, levels of sport and recreation volunteering and membership of clubs or centers of sport. It also included a seven day physical activity recall diary, to assess the frequency, intensity and duration of sport, recreation and physical activity. The recall diary included the time spent on the activity and relative intensity to determine the number of people who met NZ's physical activity guideline of participating in at least 30 minutes of moderate-intensity physical activity on five or more days per week (SPARC, 2004). This approach intended to extend the international best practice approach developed in the International Physical Activity Questionnaire and overcome potential biases that have been identified in the literature in the use of self-report surveys (such as over-reporting of levels of physical activity - considered a social desirability bias (SPARC, 2004)).[49]

Sport New Zealand's survey was undertaken for adults only. Other emerging New Zealand research focuses on patterns of physical activity in children and young people exclusively (Maddison *et al.*, 2010). Assessing whether behaviour within age cohorts has changed over time is important, as there is an

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46 The data for 2006/07 showed that 50.5% of New Zealanders met the "30x50" guidelines; 47.7% of Auckland residents; 52.4% of Waikato residents and 46% of Wellington region residents met the guidelines. The SPARC 2007/2008 data was used in this study as it was the most recent data available.

47 These are available from www.sportnz.org.nz

48 http://www.qualityoflifeproject.govt.nz

49 See www.ipaq.ki.se for more details on the International Physical Activity Questionnaire and the International Prevalence Study which involved 17 countries, including New Zealand.

assumption that children are becoming more sedentary (VicHealth, 2010) and that children carry their patterns of physical activity through to adulthood, which can have long-term health effects (Lunn, 2009; Nilsson, *et al.*, 2008). If this is the case, then the burden on the health system may be greater in future years. Further research explores the impacts of maternal physical activity in the ante-natal phase and its effects on later health outcomes of the baby, due to gene expression (Barouki, Gluckman, Grandjean *et al.*, 2012). These early life experiences do influence subsequent behaviour, but are beyond the scope of this current study to include. The current costs to the system are a result of physical inactivity in previous years, not necessarily due to the current patterns of behavior or those observed in the 2007/2008 study. Therefore an implicit assumption in our approach is that levels of physical activity in any one year are representative of a lifetime's activity, and that patterns of behavior are consistent across generations. This assumption is questioned in the literature (Lunn, 2009), but due to the paucity of time series data in New Zealand, the snapshot of activity levels in one year was used.

The Lee *et al.* (2012) study published in The Lancet showed rates of inactivity amongst people eventually developing CHD, diabetes, breast and colon cancer, including estimated data for New Zealand. As would be expected, these rates are higher than the levels of inactivity for the total adult population that includes those who do not develop illness.

Table 3.3. Estimated prevalence of physical inactivity among persons eventually developing illness

Estimated prevalence of physical inactivity (95% confidence interval), %		
	New Zealand	Median for Western Pacific (NZ's WHO region)
CHD	57.2% (42.3-77.5)	42.2%
Type II Diabetes	58.7% (39.5-87.2)	43.2%
Breast Cancer	52.9% (29.4-95.2)	40.7%
Colon Cancer	53.3% (32.9-86.3)	42.9%

Source: Lee et al. 2012.

Appendix 4: Details of the key findings from the 2007/08 Active NZ Survey for the three regions.

Box 3.1 2007/08 Active NZ Survey – Key Findings: Greater Auckland region[50]

- Walking and swimming were, in that order, the two most popular sport and recreation activities.
- Men were significantly more likely than women to:
    - have participated in an organised competition or event (Men: 41%; Women: 27%);
    - have been members of a club or centre (Men: 41%; Women: 31%);
    - have achieved the national physical activity guideline (Men: 52%; Women: 42%).
- Compared to the Greater Auckland regional population:
    - adults from Pacific and Asian ethnic groups were significantly less likely to participate while New Zealand European adults were significantly more likely to participate in three or more activities (Greater Auckland: 66%; Asian: 45%; Pacific: 54%; NZ European: 75%);
    - participation levels in an organised competition or event were significantly lower for adults from Asian and Other ethnic groups (Greater Auckland: 34%; Asian: 17%; Other: 17%);
    - adults from the Asian ethnic group were significantly less likely to have been volunteers (Greater Auckland: 22%; Asian: 11%).
- Adults in the youngest age group (16 to 24 years) were significantly more likely than adults in older age groups to:
    - have participated in an organised competition or event (16-24 years: 53%; Other ages: ≤33%);
    - have received instruction (16-24 years: 70%; Other ages: ≤39%); and
    - have been members of a club or centre (16-24 years: 50%; Other ages: ≤34%)
- Adults in the older age groups (50 years and over) were significantly less likely to participate in at least three sport or recreation activities (50-64 years: 57%; 65 years+: 40%; Other ages: ≥71%).
- Compared with New Zealand adults, adults in the Greater Auckland region had similar:
    - participation levels in sport and recreation activities;
    - participation levels in club and centres to engage in sport and recreation;
    - levels of sport and recreation volunteering; and
    - physical activity levels.

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50 SportsNZ (2009). Report available from http://www.activenzsurvey.org.nz/Results/2007-08-Active-NZ-Survey/Regional-Profiles/Greater-Auckland/Executive-Summary/

Box 3.2 2007/08 Active NZ Survey – Key Findings: Waikato region[51]

The sport, recreation and physical activity profile for the Waikato region was similar to the national profile. Adults in the Waikato region:

- participated in at least one sport or recreation activity per week (New Zealand: 79%; Waikato: 82%) and per year (New Zealand: 96%; Waikato: 96%);
- participated in at least one organised competition or event per year (New Zealand: 37%; Waikato: 38%);
- were members of clubs or centres in order to take part in sport and recreation activities (New Zealand: 35%; Waikato: 34%);
- received instruction from a coach, instructor, teacher or trainer to help improve their performance (New Zealand: 40%; Waikato: 39%);
- were volunteers for a sport or recreation activity (New Zealand: 25%; Waikato: 28%); and
- achieved the national physical activity guideline by undertaking 30 minutes or more of moderate intensity physical activity on at least five days out of seven (New Zealand: 48%; Waikato: 46%).

In the Waikato region:

- walking and gardening were, in that order, the two most popular sport and recreation activities;
- touch rugby was on the 10 most popular activities list for adults in the Waikato region, but not on the list for New Zealand adults;
- touch rugby and dance were on the 10 most popular activities list for men in the Waikato region, but not on the list for New Zealand men; and
- fishing and exercise (other) were on the 10 most popular activities list for women in the Waikato region, but not on the list for New Zealand women.

[51] SportsNZ (2009). Report available from http://www.activenzsurvey.org.nz/Results/2007-08-Active-NZ-Survey/Regional-Profiles/Waikato/Executive-Summary/ttp://www.activenzsurvey.org.nz/Results/2007-08-Active-NZ-Survey/Regional-Profiles/Greater-Auckland/Executive-Summary/

Box 3.3 2007/08 Active NZ Survey – Key Findings: Wellington region[52]

The sport, recreation and physical activity profile for the Wellington region was similar to the national profile. Compared with New Zealand adults, a similar percentage of adults in the Wellington region:

- participated in at least one sport or recreation activity per week (New Zealand: 79%; Wellington: 80%) and per year (New Zealand: 96%; Wellington: 96%);
- participated in at least one organised competition or event per year (New Zealand: 37%; Wellington: 40%);
- were members of clubs or centres in order to take part in sport and recreation activities (New Zealand: 35%; Wellington: 38%);
- received instruction from a coach, instructor, teacher or trainer to help improve their performance (New Zealand: 40%; Wellington: 38%);
- were volunteers for a sport or recreation activity (New Zealand: 25%; Wellington: 22%); and
- achieved the national physical activity guideline by undertaking 30 minutes or more of moderate intensity physical activity on at least five days out of seven (New Zealand: 48%; Wellington: 48%).

In the Wellington region:

- walking, gardening and swimming were, in that order, the three most popular sport and recreation activities;
- tramping and tennis were on the 10 most popular activities list for women in the Wellington region, but not on the list for New Zealand women; and
- men were significantly more likely than women in the Wellington region to have participated in an organised competition or event per year (Men: 50%; Women: 29%).

[52] SportsNZ (2009). Report available from http://www.activenzsurvey.org.nz/Results/2007-08-Active-NZ-Survey/Regional-Profiles/Waikato/Executive-Summary/ttp://www.activenzsurvey.org.nz/Results/2007-08-Active-NZ-Survey/Regional-Profiles/Greater-Auckland/Executive-Summary/

Appendix 5: Calculation of the Population Attributable Fraction

Calculation of the Population Attributable Fraction

	P (for inactive)	RR	RR-1	P(RR-1)	PAF
New Zealand					
Breast cancer	0.518	1.212	0.212	0.11	0.099
Colorectal cancer	0.518	1.667	0.667	0.346	0.257
Hypertension	0.518	1.3	0.3	0.155	0.134
Chronic heart disease	0.518	1.45	0.45	0.233	0.189
Stroke	0.518	1.6	0.6	0.311	0.237
Osteoporosis	0.518	1.59	0.59	0.306	0.234
Diabetes Type II	0.518	1.5	0.5	0.259	0.206
Depression	0.518	1.282	0.282	0.146	0.127
Auckland Region					
Breast cancer	0.523	1.212	0.212	0.111	0.1
Colorectal cancer	0.523	1.667	0.667	0.349	0.259
Hypertension	0.523	1.3	0.3	0.157	0.136
Chronic heart disease	0.523	1.45	0.45	0.235	0.191
Stroke	0.523	1.6	0.6	0.314	0.239
Osteoporosis	0.523	1.59	0.59	0.309	0.236
Diabetes Type II	0.523	1.5	0.5	0.262	0.207
Depression	0.523	1.282	0.282	0.148	0.129
Waikato Region					
Breast cancer	0.541	1.212	0.212	0.115	0.103
Colorectal cancer	0.541	1.667	0.667	0.361	0.265
Hypertension	0.541	1.3	0.3	0.162	0.14
Chronic heart disease	0.541	1.45	0.45	0.243	0.196
Stroke	0.541	1.6	0.6	0.325	0.245
Osteoporosis	0.541	1.59	0.59	0.319	0.242
Diabetes Type II	0.541	1.5	0.5	0.271	0.213
Depression	0.541	1.282	0.282	0.153	0.132
Wellington Region					
Breast cancer	0.524	1.212	0.212	0.111	0.1
Colorectal cancer	0.524	1.667	0.667	0.35	0.259
Hypertension	0.524	1.3	0.3	0.157	0.136
Chronic heart disease	0.524	1.45	0.45	0.236	0.191
Stroke	0.524	1.6	0.6	0.314	0.239
Osteoporosis	0.524	1.59	0.59	0.309	0.236
Diabetes Type II	0.524	1.5	0.5	0.262	0.208
Depression	0.524	1.282	0.282	0.148	0.129

Appendix 6: International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) used in this study to identify conditions treated in hospitals.

The six codes that make up **the ischaemic heart disease CVD** ICD classification grouping used in this analysis are:

I20 Angina pectoris

I21 acute myocardial infarction

I22 subsequent myocardial infarction

I23 certain current complications following acute myocardial infarction

I24 other acute ischaemic heart diseases

I25 chronic ischaemic heart disease.

The five codes that make up **hypertension** ICD classification grouping used in this analysis are:

I10 Essential hypertension

I11 Hypertensive heart disease

I12 Hypertensive renal disease

I13 Hypertensive heart disease and hypertensive renal disease

I674 Hypertensive encephalopathy

The five codes that make up **Stroke** from ICD classification grouping used in this analysis are:

I60 Subarachnoid haemorrhage

I61 Intracerebral haemorrhage

I62 Other nontraumatic intracranial haemorrhage

I63 Cerebral infarction

I64 Stroke, not specified as haemorrhage or infarction

The four codes that make up **Breast cancer** from the ICD classification grouping used in this analysis are:

C50 Malignant neoplasm of breast

D05 Carcinoma in situ of breast

D24 Benign neoplasm of breast

D486 Neoplasm of uncertain or unknown behaviour of breast

The seven codes that make up **Colorectal cancer** from the ICD classification grouping used in this analysis are:

C18 Malignant neoplasm of colon

C19 Malignant neoplasm of rectosigmoid junction

C20 Malignant neoplasm of rectum

C21 Malignant neoplasms of anus and anal canal

D01 Carcinoma in situ of other digestive organs

D12 Benign neoplasm of colon, rectum, anus and anal canal

D37 Neoplasm of uncertain or unknown behaviour (digestive organs)

The three codes that make up **Osteoporosis** from the ICD classification grouping used in this analysis are:

M80 Osteoporosis with pathological fracture

M81 Osteoporosis without pathological fracture

M82 Osteoporosis in diseases classified elsewhere

The codes that make up **Diabetes Type II** from the ICD classification grouping used in this analysis are:

E11 Non-insulin dependent diabetes mellitus

The codes that make up **Depression** from the ICD classification grouping used in this analysis are:

F32 Depressive episode

F33 Recurrent depressive disorder

F341 Dysthymia

Appendix 7: Chemical names of drugs used to treat illnesses

Chemical ID	***Chemical name***	***Chemical ID***	***Chemical name***	***Chemical ID***	***Chemical name***
Diabetes		**Hypertension**		**Osteoporosis**	
2277	Tolbutamide	1031	Trandolapril	1487	Etidronate disodium
2276	Tolazamide	3749	Quinapril	1037	Alendronate sodium
3739	Rosiglitazone	2772	Quinapril	3913	Zoledronic acid
3800	Pioglitazone	2060	Propranolol	3938	Raloxifene hydrochloride
1794	Metformin hydrochloride	2031	Prazosin hydrochloride	3939	Teriparatide
1570	Glucagon hydrochloride	2806	Perindopril	3868	Alendronate sodium
1569	Glipizide	1863	Nifedipine		
1568	Gliclazide	1818	Metoprolol tartrate	**Breast cancer**	
1567	Glibenclamide	1817	Metoprolol succinate	2218	Tamoxifen citrate
1134	Coag U Chek	1061	Losartan	3872	Exemestane
1068	Chlorpropamide	2795	Lisinopril with HCl	3818	Trastuzumab
1247	Acarbose	2797	Lisinopril	1181	Letrozole
1655	Insulin zinc suspension	2771	Isradipine	3886	Anastrozole-DP
1653	Insulin syringes	2398	Felodipine	1158	Anastrozole
6307	Insulin syringes	2708	Enalapril with HCl		
1110	Insulin pen needles	2711	Enalapril	**Colorectal cancer**	
1648	Insulin Neutral	2528	Diltiazem HCl	3808	Capecitabine
1648	Insulin neutral	1127	Cilazapril with HCl	3811	Irinotecan
3882	Insulin lispro	2770	Cilazapril	3832	Oxaliplatin
1192	Insulin lispro	2840	Captopril	1198	Calcium folinate
3783	Insulin aspart	2841	Captopril	1529	Fluorouracil sodium
6300	Insulin isophane	1254	Candesartan	1797	Methotrexate
1649	Insulin isophane	1095	Atenolol		
3908	Insulin glulisine	1094	Atenolol		
3857	Insulin glargine	2793	Amlodipine		
1572	Glucose oxidase	2794	Benazepril		
Depression		**CVD and Stroke**			
1876	Nortriptyline hydrochloride	2513	Simvastatin		
1824	Mianserin hydrochloride	1427	Dipyridamole		
1760	Maprotiline hydrochloride	3860	Clopidogrel		
1642	Imipramine hydrochloride	1949	Perhexiline maleate		
1379	Desipramine hydrochloride	2836	Isosorbide mononitrate		
3926	Escitalopram	2377	Isosorbide Dinitrate		
1193	Citalopram hydrobromide	1577	Glyceryl trinitrate		
1180	Venlafaxine	2780	Pravastatin		
2285	Tranylcypromine sulphate	1063	Fluvastatin		
1955	Phenelzine sulphate	1137	Atorvastatin		
1125	Nefazodone	2331	Warfarin sodium		
1437	Dothiepin hydrochloride	1087	Aspirin		
1030	Sertraline Hydrochloride				

Appendix 8: Data used for calculating the direct medical costs

Box 8.1 Calculating Direct Medical Costs of Colorectal and Breast cancer

The Ministry of Health (2011) undertook a comprehensive national study of the public price of cancer, including colorectal and breast, calculating the average price per patient over a six year treatment period. This period was chosen as it represents six cohorts of patients passing through separate stages of the cancer diagnosis and treatment. This methodological approach is akin to a FCA approach, where the extended costs of treating a disease are included. The type and value of resources used by cancer patients vary considerably through the course of treatment (*ibid*. pp. 16, 22). The MoH study used the New Zealand Cancer Registry, following the cost associated with treating the patient over the term of the cancer treatment. The MoH (2011) cost model for colorectal and breast cancer costs used:

- Public hospital discharge data (from MoH),
- Outpatient data from the National Non-Admitted Patient Collection Data Mart,
- Data from community hospice related palliative care,
- Proxy indicators for primary care consultations,
- National Travel Assistance subsidies,
- Community Laboratory Tests, and
- Community and hospital pharmacy dispensing.

After calculating the costs of each category of service provided, the relative proportions of costs over the treatment services were calculated. These ratios were used to estimate the outpatient and primary healthcare costs for colorectal and breast cancer in our current study, relative to the hospitalisation and drug costs obtained from the Inpatient Dataset from the MoH. Adjustments had to be made, as the actual drug and hospitalisation costs for the 2010 year did not correspond exactly to these ratios. Tables 2.4 and 2.5 show the costs. This study also included an estimate of private health care costs.

Table 8.1 Colorectum cancer: the cost of care (estimated price per case)

	One year to registration	Five years following registration	Total (over six years)	Distribution (averaged over six years)
Public price	**Mean cost**	**Mean cost**	**Mean cost**	**%**
National travel assistance	$8	$283	$292	1%
Public hospital discharge (excluding palliative care)	548	9030	9578	0.39
Public inpatient palliative care discharge	$47	$1,243	$1,290	5%
Outpatient attendance	$114	$5,545	$5,658	23%
Community and hospital pharmacy disp	$58	$3,218	$3,277	13%
Laboratory testing	$163	$641	$804	3%
Primary care consult	$257	$1,199	$1,456	6%
Subtotal	$1,196	$21,158	$22,355	90%
Community hospice (Ministry funded)	–	–	$2,469	10%
Total	–	–	**$24,824**	100%
Private hospital discharge	$36	$1,082	$1,119	–

Source: Ministry of Health, 2011, p.15

The average costs for treating colorectal cancer are driven predominantly by public hospital discharge (39%), outpatient attendance (23%), and community and hospital pharmacy dispensing (13%).

Table 8.2 Breast cancer: the cost of are (estimated price per case				
	One year to registration	**Five years following registration**	**Total (over six years)**	**Distribution (averaged over six years)**
Public price	**Mean cost**	**Mean cost**	**Mean cost**	
National travel assistance	**6**	**425**	**431**	**0.02**
Public hospital discharge (excluding palliative care)	$545	$9,076	$9,621	34%
Public inpatient palliative care discharge	4	527	531	0.02
Outpatient attendance	$56	$10,551	$10,607	38%
Community and hospital pharmacy dispensing	$5	$3,479	$3,484	12%
Laboratory testing	$98	$721	$818	3%
Primary care consult	$203	$1,362	$1,565	6%
Subtotal	$917	$26,140	$27,057	96%
Community hospice (Ministry funded)	–	–	$1,017	4%
Total	–	–	$28,074	100%
Private hospital discharge	20	1325	**$1,345**	–

Source Ministry of Health, 2011, p.21.

The average cost of treating breast cancer over six years is predominantly driven by outpatient attendance (38% of total average cost), public hospital discharge (34%) and community and hospital pharmacy dispensing (12%).

Box 8.2 Calculating Direct Medical Costs of Diabetes

PWC (2007) developed an ‘outcomes model’ for Type II diabetes.[53] The estimates for costs of treating diabetes and diabetes services were based on a 2001 study which looked at the treatment, care and services used by diabetes patients. The medical costs for treating diabetes cover a diverse range of health services from primary care consultations, outpatient services (including diabetes education and management; home visits and home help) to very high cost services for hospital treatment of complications associated with the disease.

The PWC (2007) ratios of inpatient hospital cost estimates to outpatient and primary care costs were applied to the hospitalisation and drug data from the Ministry of Health’s database. There is an assumption that the levels of service administered through GPs, PHOs and Outpatient services have remained the same since 2001. The ratios of the costs of inpatient (hospital), to costs of outpatient treatment, to costs of primary care was 49:6:45 (PWC, 2001). It was also assumed that the level of service for diabetes was the same throughout the country. No regional adjustments to the ratios were made. The PWC (2001) study included hospitalisation costs for undiagnosed diabetes, but these were not included in this study, given that it could lead to double counting if the hospitalisation was one of the other diseases related to physical inactivity, and included in our data set anyhow. As there were eight diseases in total under consideration in our study, co-morbidity of patients with undiagnosed diabetes would not matter, if the other diseases were ones associated with physical inactivity (see Smith *et al*., 2008).

Table 8.3 Diabetes - Model for Cost of Care as developed by PricewaterhouseCoopers

Number of people with Type 2 diabetes as a % of total diabetes population		85%
Number of people with undiagnosed Type 2 diabetes as a % of diagnosed		50%
% of people with Type 2 diabetes who develop serious complications per annum		3%
% of recorded diabetes hospital costs attributable to serious complications		90%
% of people with Type 2 diabetes who develop serious complications per annum		6.60%
		10%
Hospital Care	**$_{2006}\$000$**	
Average cost per patient of treating serious complications	25.6	
Average cost per patient of treating other complications	1.2	
Average cost per patient of specialist diabetes services	1.2	
Average cost per patient of hospitalisation due to undiagnosed diabetes	12.3	
Primary Care	**$_{2006}\$mil$**	
Estimated total primary care costs for diabetes	89	
Estimated total hospital costs for diagnosed diabetes	110	
Estimated total inpatient costs for diabetes	98	
Estimated total outpatient costs for diabetes	12	
Estimated total hospital costs for undiagnosed diabetes	135	

Source: PWC (2006)

[53] The diabetes outcomes model was developed for the 2001 report *Type 2 Diabetes: Managing for Better Health Outcomes*, published by Diabetes New Zealand and prepared by PricewaterhouseCoopers. The model’s approach to estimating diabetes health costs, assumptions and inputs are set out in detail in the 2001 Report, and were based on available literature and expert workshops.

Box 8.3 Calculating Direct Medical Costs of Osteoporosis

A comprehensive assessment of the costs of treating osteoporosis, in hospital, accident and emergency, primary and community care was undertaken by Brown, *et al.* (2007). They stressed that hospital records alone do not capture the extent of treatment relating to osteoporosis. Two main reasons are cited, the first that osteoporotic fractures are not always diagnosed formally (given the cost and time to undertake an osteoporosis diagnosis) and secondly that fractures themselves are under-reported as not all fractures are treated in hospitals. Certain fractures, such as hip fractures, nearly always result in hospitalisation, whereas other fractures are treated in primary care or in Accident and Emergency. To adjust for the potential under-reporting, they assumed that most hip fractures in people aged over 49 years were osteoporotic. Next they used ratios from previous studies on osteoporosis fractures to estimate the occurrence of vertebral, rib, arm and other fractures.[54] The Brown *et al*. (2007) report fully accounted for both medical and non-medical costs of treating osteoporosis, including outpatient, community and residential support that may be required after a fracture. These included nursing services, GP visits, occupational therapy, physiotherapy, orthopaedic clinics, home help and residential care. This is in line with an 'incidence based approach' for estimating costs, which captures the lifetime costs of a condition. The total cost of treating and management of osteoporotic fractures was estimated at $_{2007}$\$331million (shown in Table 2.7). This figure was used in this study, inflated to 2010 prices using the StatsNZ CPI for health, $_{2010}$\$363million.[55]

Table 8.4: Total Cost of Osteoporosis in New Zealand

		Cost (\$m)	Total Cost (\$m)
Fractures	Hip	90.7	
	Vertebra	14.3	
	Other site	80.6	212.7
After Fracture	Hip	14.5	
	Vertebra	54.8	
	Other site	15.4	84.8
Treatment and management	Pharmaceuticals	20.5	
	GP	5.2	
	Over the Counter	7.6	33.5
Total ($_{2007}$\$m)			331

Source: Brown et al (2007)

As the Brown *et al.* (2007) study was for the whole country, the figures were regionalised using population estimates. The Brown *et al.* study emphasised the unreliability of hospital discharge data for a correct estimate of

[54] It is estimated that only 5% of osteoporotic fractures are hip fractures, with vertebral (33%), rib (25%) and forearm (14%).

[55] Brown *et al.* (2007) also included an estimate for costs of 'other osteoporotic' conditions, such as musculoskeletal problems, back problems and curvature of the spine. These other costs constituted over 70% of the total estimated annual burden of osteoporosis (\$1.16 billion in 2007). These costs were not included in this current study, due to uncertainty over costs, but it is likely that the total cost of osteoporosis used in this study is an underestimate.

the magnitude of osteoporosis costs. The figures for osteoporosis hospitalisations were adjusted from the figure obtained from MoH's inpatient National Minimum Dataset due to the findings in Brown *et al*. (2007) that treating osteoporosis in hospitals is under-reported mainly due to undiagnosed cases, and the number of people with osteoporosis who are treated in accident and emergency after a fall.

Appendix 9: Research and Disease Screening Costs

The Health Research Council of New Zealand (HRC) is the largest funder of health research in New Zealand and funds research with a predominantly clinical focus. Data was obtained on the funds distributed by the HRC in the 2010 calendar year, for research contracts relevant to the eight diseases/illnesses of interest in this study. As many research projects extend beyond a calendar year, the proportion of the total research budget that was spent in 2010 was counted.

Although research is conducted in various hospitals, universities and research units throughout the country, the research expenditure was apportioned to the regions on a population proportion basis. There are knowledge spill-overs in terms of dissemination and use of medical research findings (including international spill over – the NZ medical system benefitting from research undertaken overseas). Not surprisingly, a considerable amount of research into the eight diseases have a specific New Zealand context, in terms of understanding prevalence and risk factors in specific communities (e.g. Māori and Pacific people in the case of diabetes; or cultural contexts in the delivery and design of treatment).

Other avenues of research that are not included but could be are research funding from the Foundation for Research, Science and Technology, internal university grants, Lotteries and charitable trusts. In addition several Government agencies, DHBs and NGOs may tender or commission specific pieces of work.

Disease Screening Costs

Data was gathered on screening costs for the different diseases in 2010 covering breast cancer and diabetes. A pilot bowel cancer screening programme is currently underway in Waitemata DHB (Auckland region), but this did not begin until 2011, but such projects would/should be included in future analyses. Data on screening was attributed to the regions on a pro capita basis.

Appendix 10: Addressing Information Gaps on Direct Costs

Stroke

The most recent cost estimate for treating stroke patients in New Zealand was from Scott (1994). These estimates may understate the direct costs of rehabilitating stroke patients in particular, as it has been recognised that the combination of an increase in survival rates along with constant incidence rates for stroke means a substantial rise in the costs of continuing care and community support for stroke survivors (Barber, 2002). There were similar issues with the study on coronary heart disease. Nevertheless, the ratios from the Scott (1994) study were used.

Hypertension

No NZ cost of illness studies could be sourced for the treatment of chronic heart disease, hypertension and depression. For hypertension, this was not considered problematic or a glaring omission from the analysis, because hypertension is normally treated with medication and data was available from the MoH's pharmaceutical dataset. However hypertension is problematic when it presents with other illnesses or complications (as seen from the co-morbidity figures in Table 2.2). Rather than give a zero figure for outpatient, GP and primary health care for hypertension, a nominal/arbitrary value of 5 percent of total known direct costs was assigned. This was a conservative estimate, and may under report actual costs of primary and secondary care. Due to lack of data, this was considered the most appropriate method.

Coronary Heart Disease (CHD)

Scott (1993) undertook a cost estimate for treating CHD. A more recent comprehensive study was not found in the literature on the costs of outpatient service and estimates for GP and primary care costs relating to CHD in New Zealand, and this is an area which requires further attention. Chan *et al.* (2010) undertook a study on the health care costs related to cardiovascular disease (CVD) and diabetes for Counties Manukau DHB, but this study focused on the public sector costs, rather than a cost estimate for society. It did include laboratory costs for people with CVD. Cardiovascular disease encompasses chronic heart disease (e.g. angina, heart attack, heart failure, high cholesterol) and stroke.

An assessment would require establishing the extent of CHD screening that occurs in primary care (e.g. regular health checks "Wellness checks", exercise tolerance tests) and in outpatient care (e.g. coronary angiograph, electrocardiogram, echocardiography etc.), along with the number and cost of blood tests undertaken for CHD. Scott and Scott (1993) estimated that direct costs of coronary heart disease in New Zealand amounted to $_{1992}$\$179 million in 1992.[56] This was considerably lower than the combined known

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[56] This would equate with $_{2010}$\$265 million in 2010.

actual costs of hospitalisation, drug and research costs for CHD (see section 3.2.1). Further research is required to establish the cause of this increase in cost – either through an increase in the numbers presenting with CHD or a dramatic increase in the cost of treatment. Rather than giving a zero value to outpatient, GP and Primary Health Care costs for CHD, an arbitrary 10 percent on known existing direct costs was allocated. This figure can be updated with better data, when available.

Depression

The costs of treating depression in New Zealand are difficult to measure, given the diversity of treatment options, the variety of treatment agencies and the co-morbidity of depression, especially with chronic diseases. It is widely accepted that primary healthcare providers deliver treatment for the vast majority of patients with mood disorders and mental health concerns (Russell and Kazantzis, 2008; MaGPIe, 2003; Hornblow, *et al.* 1990). Caution is warranted in relying on hospital discharge data that includes depressive disorders. The occurrence of depression with a mental or physical co-morbidity is well documented, particularly in the case of chronic or terminal illnesses (Lindsay, 2007).

Emerging research in New Zealand estimates that between 85 and 90 percent of depression is treated in primary care (Health Research Council, 2012 personal communication). No comprehensive burden of illness studies looking at the cost of depression (alone) in New Zealand were identified in the literature. Wang, Simon and Kessler (2003) undertook such a study in the US, estimating that the greatest burden of cost for depression is via its indirect costs rather than direct medical treatment (only 22 percent of cost). The economic burden of depression is great, including economic losses at an individual level such as reduced employment prospects and job instability (Vaithianathan and Pram, 2010), often measured through disability adjusted life years (Dunn, Trivedi and O'Neal, 2001) and loss of productivity to the economy overall.

Guidelines for the best practice in the treatment of depression in adults in primary care have been published in New Zealand (BPAC, 2009). Treatment is largely undertaken in the primary care sector, using a range of therapies including:

- Exercise (Green Prescriptions)
- Self-management (problem solving, identifying support networks, and increasingly electronic based resources),
- Psychological therapies and counseling (talk therapies such as cognitive behavior therapy, problem solving therapy and interpersonal therapy), and
- Medication (antidepressants).

The most reliable dataset that was obtained for this study measuring the costs of treating depression is for drug costs - actual drugs prescribed per DHB area. Depression or mood disorder occurs on a scale from mild to severe and the treatment is tailored to the individual's circumstances. An attempt was made to develop a generic cost model, using available data. We used the NZ Mental Health Survey (Oakley Browne *et al.,* 2006), Lindsay's (2007) detailed analysis of mental health levels of service and care in Counties Manukau DHB, Dowell *et al.'s* (2009) evaluation of the primary mental health initiatives and costs of treatment published by Pharmac (2012) to develop the cost model. The cost calculations/model for depression is shown below along with the assumptions associated with these estimates. Our data estimates are not formally validated and this is a research area that has been identified as requiring further analysis. We feel that our figures are conservative and underestimate the costs of treating depression, as they do not take into account the proportion of MoH funding for Primary Mental Health Specific Services (a proportion of which is spent on depression, in conjunction with other mental health illnesses) or any allocation by the DHBs toward depression. Given that our estimates for indirect costs of treating depression are based on these direct costs, the indirect costs may also be underestimated.

Box 9.1 Estimating the costs of treating depression in primary and secondary care

As no burden of illness study for treating depression was available within the New Zealand literature, and given the importance of treating depression in the primary and secondary health care sectors, the following cost model was constructed with the following assumptions:

- Prevalence rates in the New Zealand Mental Health survey were representative of rates in the DHBs of this study.[57]
- Age-standardisation of mental health conditions were made, using the age structure of StatsNZ population data and prevalence rates by age cohort in the NZ Mental Health Survey. These rates were important, as it can be seen that the rate of adults suffering from depression decreases as they get older. Also the bias of higher rates of depression amongst teenagers and under 25 year olds has been removed, given that our study focuses on the adult population aged over 25.
- It is assumed that the rates of people suffering depression that seek help is the same as in the NZ Mental Health Survey. This rate is 97%, although the lag between the onset of depression and seeking help can be lengthy. This lag does not affect this model.
- An estimate of two GP visits per patient is assumed, based on MoH's (2009) evaluation of the Primary Mental Health Initiatives Summary report, and Lindsay (2007) who states that there is partial remission occurring in 20-30% of people.
- In terms of secondary care, MoH targets are that 3% of the adult population receive secondary mental health care (for all mental health conditions). Sixty-nine percent of mental health users had depression (perhaps not in isolation, due to co-morbidity). To apportion the proportion of that secondary care that was for depression, MoH (2009) estimated that 26% of all mental health service users got counseling, while 13% undertook cognitive behavior therapy. Assuming that these rates apply to depression (due to lack of any other evidence of the rates for depression), it is assumed that 18% of depression patients get counseling and 9% get cognitive behavior therapy.
- The cost of counseling was estimated at \$99 per session, and cost of psychiatrist \$155 per session (based on Pharmac, (2012) rates, adjusted to $_{2010}$\$.
- McDowell (2007) estimated that on average for patients who accessed secondary services, they attended 4 Counselling sessions and attended 3.62 cognitive behavior therapy sessions.

Table 9.1 Estimates for the cost of treating depression in primary and secondary care in Auckland, Waikato and Wellington regions. (Figures are in $_{2010}$\$)

57 Lindsay (2007) tested the NZ Mental Health Survey (Oakley Browne *et al.*, 2006) data with Counties Manukau prevalence rates, and found that they were representative, with some minor differences. Much work has been undertaken on prevalence rates in certain ethnic groups.

	Age	Auckland Region	Waikato Region	Wellington Region	Notes:
Population 2010	25-44	437,936	103,100	139,842	*Population figures*
	45-64	341,313	101,600	117,615	*using StatsNZ census*
	65+	151,882	55,252	59,063	*data and estimates*
Estimated suffering depression	25-44	27,590	6,495	8,810	*rate 6.3% Known from*
	45-64	17,748	5,283	6,116	*rate 5.2% NZ Mental*
	65+	2,582	939	1,004	*rate 1.7% Health Survey*
Estimated total adults >25 suffering depression		47,920	12,718	15,930	
Estimated seeking help		46,483	12,336	15,452	*97% sufferers seek help*
	GP and PHO visits	92,965	24,673	30,904	(NZ Mental Health Survey)
	Cost of GP visit @ $65	6,042,743	1,603,717	2,008,785	
Secondary Mental Health Services					
	No. of patients in Counselling	8,371.06	2,221.64	2,782.79	*(McDowell et al 2009)*
	@$99 per visit	3,354,733	890,331	1,115,212	
Talking therapies	No. in cognitive behaviour therapy	4,105.35	1,089.54	1,364.74	*(McDowell et al 2009)*
	@$155 per visit	2,304,550	611,617	766,100	
Total	**Primary and Secondary care**	**11,702,026**	**3,105,666**	**3,890,097**	

Note the figures above were calculated on a per-patient basis. They do not include the allocation of funding and overheads spent by the DHBs. The Ministry of Health provide capitation funding for mental health to DHBs and Service providers ($23.765 million for the services in 2011/2012), however it is not on a per capita basis. The funding formula targets vulnerable/high-needs communities, specifically Māori, Pacific and low income communities. This funding is for all mental health treatment, with depression being just one component. As such, there is no centralised database containing the number of patients treated for depression. The issue of confounding is also prevalent with depression – people with chronic or terminal illnesses often suffer depression, and depression may be associated with other mental health illnesses.

Figure 9.1. Structure of mental health funding in New Zealand

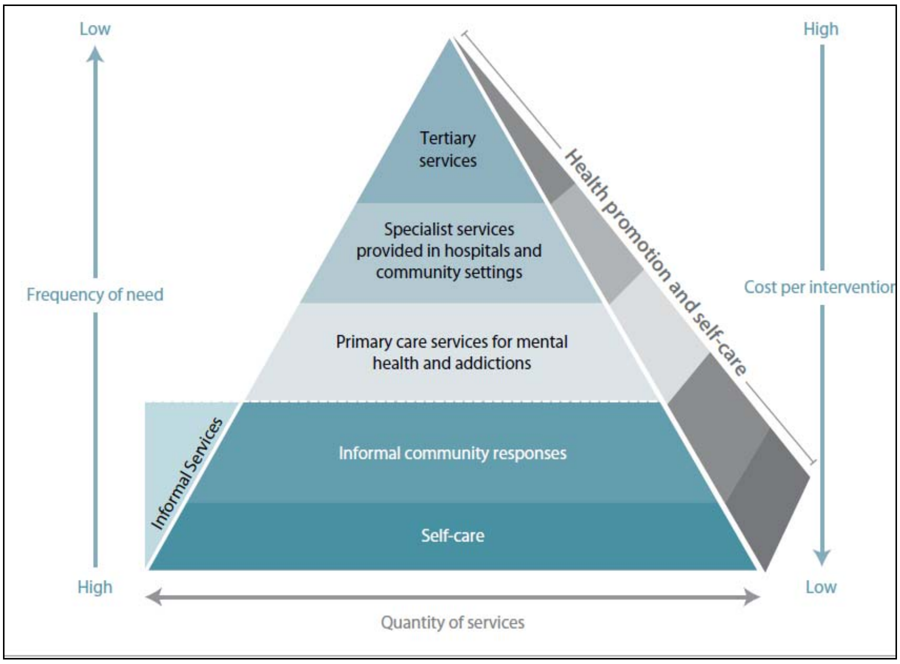
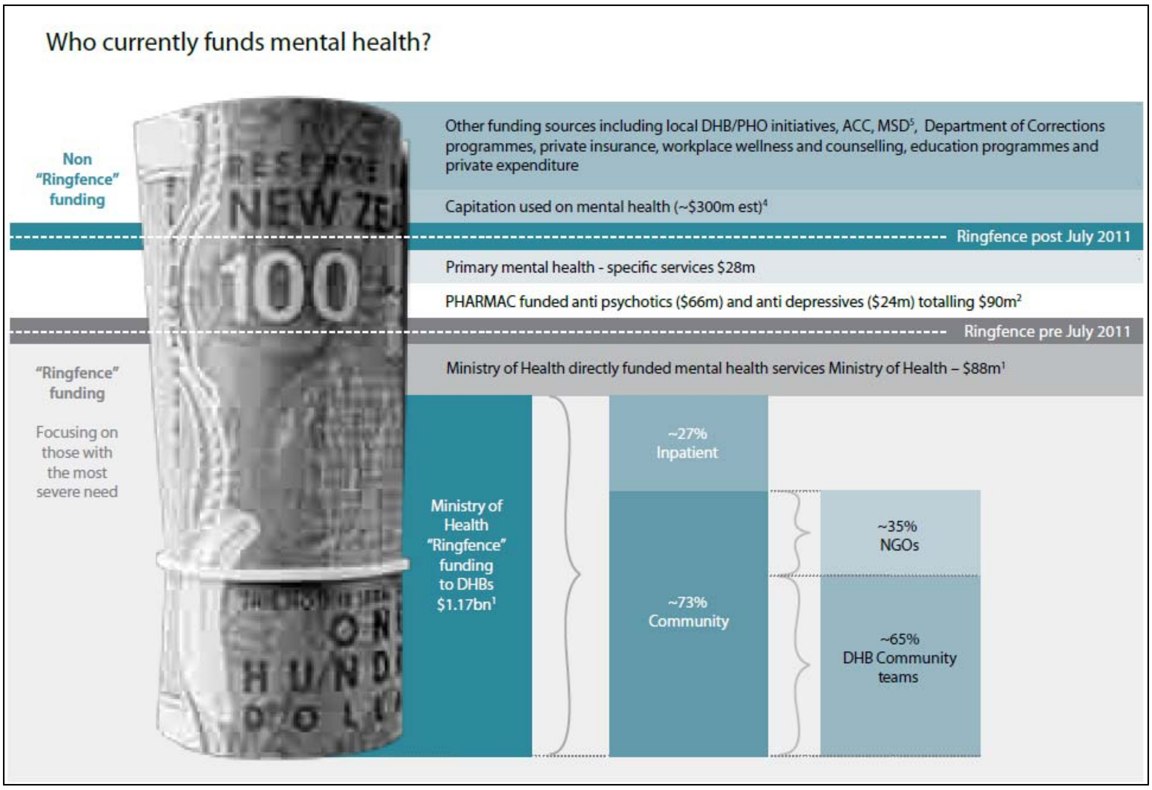


Figure 9.2. Funding Mental Health in New Zealand



Source: MoH

Appendix 11: Review of methods to calculate indirect costs of illness

The cost of a disability (broadly defined as long term effects of a disease) to a person is highly variable. Disability in itself ranges in severity, duration and effects. Disability to an income earner may cause significant disruption and reorganisation within a household. Overall, disability may just have a 'displacement' effect - the inability to complete tasks normally undertaken in the home (gardening, housework or self-care) may be undertaken through formal employment of others. This could be considered positive in terms of employment creation for helpers/carers. The response of the disabled person to the disability will depend on the severity of the effect and the resiliency of the person themselves and the quality of their support networks. It is not possible to put monetary values on suffering and pain, as these are intangible. O'Dea and Wren (2010) describe them as non-figurative and difficult to measure.

It has been found that indirect costs can constitute a significant proportion of the total cost of burden of illness studies – for most diseases it is at least double the direct health costs, and for diseases with high survival rates the impact on quality of life for the remaining years can be significant.[58] The indirect economic costs of depression disorders to individuals and society can be enormous (compared to direct costs), given that it increases sick days, and can inhibit access to the workforce. For a full cost accounting exercise, understanding these indirect costs is important.

Box 10.1 Arguments for Inclusion of Indirect Costs Counter-Arguments in burden of illness studies
• Sickness or treatment that results in inability for the patient or caregiver to work incurs a cost to individuals and employers in terms of replacement of sick workers, training the replacement, and lower levels of productivity.
The actual production loss for society from sickness is likely to be much smaller than the estimated value of potential production lost. For short-term absences a person's work may be covered by others or made up by the sick person on his/her return to work. For long-term absences, an individual's work can be covered by someone drawn from the unemployed. Therefore, while absence from work may cost the individual or employer, it may not cost society very much. This counter argument assumes that there is suitable capacity in the labour market to replace the lost worker.
• There are ethical concerns with including the cost of lost productivity in analyses, as these costs tend to bias against those who are not in the labour force - particularly children, homemakers, retired people, the unemployed, and those unable to work.
Incorporating differential earning levels will also result in valuing one group of individuals more than another, which is politically and ethically contrary to society's values. It would also result in

58 Access Economics (2008) estimated that it ranged between 50-70 percent of total costs of injuries (insert figures from other NZ studies, using indirect measures of costs).

healthcare interventions being more likely to be directed towards well-paid working people.

- There are costs associated with premature mortality in terms of loss of potential income; and savings in terms of future health care spending that would likely have occurred if the patient survived.

  Similar ethical issues as with the inclusion of lost productivity costs, that is, biases against those not working.

- Intangible costs, such as pain and suffering experienced as a side-effect of a treatment, may be significant.

  Intangible costs are particularly difficult to measure and value. There are also ethical concerns with placing a monetary value on patient pain, suffering and discomfort. The impact of treatment on pain and suffering is often taken into account when estimating **Quality of life** (see below). To include a monetary cost can result in double-counting in the Pharmac (2012) approach.

Source: Pharmac (2012)

Approaches taken in different NZ studies:

Value of a Statistical Life (VoSL)

In New Zealand, the Value of a Statistical Life (VoSL) was calculated for road safety in 1991 and updated in 2003 (Guria, 1993; Guria *et al*., 2003) for use by the NZ Transport Authority. It originally used a willingness to pay survey to avoid injury and death from a transport/road accident. This is the only study to date that has used a willingness to pay approach for the VoSL in New Zealand. Its use and transferability to non-transport related issues has been discussed in the NZ literature. Caution is warranted with its use outside the transport sector, as the current VoSL value is a 20 year old estimate, updated on the assumption that people's willingness to pay is only related to their real wage rate. In reality society's preference for safety and health improvement might have changed substantially over this period. 'Public policy and investment decisions commonly apply the VoSL derived for transport risk to situations with different types of risk, or else apply a value of statistical life year and other derivative measures, which could be resulting in the misallocation of large amounts of taxpayers' money' (Guria, 2010).

Sanderson *et al.* (2007) compared the VoSL used for a road fatality to that of a home fire related fatality for the New Zealand Fire Service. They found that people would be less willing to pay to prevent a fire related fatality, and suggest that there is greater personal responsibility involved in acting in a fire-wise and safe manner in the home, whereas there is not so much (personal) control over preventing fatality on the road due to the actions of others. Accordingly they adjusted the VoSL to 0.66 percent of the Official New Zealand Transport Sector VoSL. By this logic, it is conceivable that the VoSL for physical inactivity would be lower, given that there is an element of personal choice to exercise/do the recommended rates of physical activity.

There are methodological weaknesses with measuring indirect and intangible costs. Some of these weaknesses have pragmatically been overcome within health economics through the use of 'cost utility analysis' to avoid placing monetary value on health outcomes. In New Zealand, Pharmac frequently undertake studies in cost utility analysis on different diseases, with the practical purpose of deciding which drugs should be bought for treatment of New Zealanders (after passing through MedSafe, the regulating authority for medicines and medical devices). Pharmac and the Ministry of Health do not explicitly monetise indirect costs of illness, due to methodological inconsistencies and difficulty, some of which are identified above (Pharmac, 2012). They do use the disability-adjusted life year (DALY) measure. This is in line with the approach taken in health economics, to avoid placing a monetary value on health outcomes (Hirth, Chernew, Miller *et al*., 2000; Pinto-Prades, Loomes and Brey, 2009).

Disability Adjusted Life Year (DALY)

The DALY was developed by the WHO, World Bank and Harvard University (Murray and Lopez, 1997; WHO, 2004). A DALY is an indicator that assesses the global burden of disease. These are calculated by adjusting age-specific life expectancy for loss of life and functioning due to disability. In a DALY, premature mortality (years of life lost) and morbidity (years lost with disability) components are separated. The disability weight resulting from a disease measures the loss of functioning. Another related (precursor) to the DALY is the quality adjusted life year (QALY).[59] The QALY explicitly assigns different weights to life years lived, at different ages. Both QALY and DALY emerge from the same conceptual framework. A DALY measures health loss, whereas a QALY measures health gain. QALYs and DALYs are appealing for use, in order to avoid the fraught process of monetising indirect and intangible effects. However, a full cost accounting methodology requires a measurement for these indirect and intangible effects of inactivity.

[59] A QALY is an economic measure, which combines the effects of changes in the length and quality of life that result from treatment. Quality-adjusted life-years help compare gains in the quality of life with gains in the quantity (length) of life. Quality of life weightings (or utilities) are typically measured on a scale of 0 to 1, where 0 is equivalent to death and 1 to perfect health. These weights can then be summed over life expectancy in order to calculate the total number of QALYs. When used in cost-utility analysis, the difference in QALYs and overall costs gained between two treatments informs the relative cost-effectiveness of an intervention.

Authors:
Auckland Council
Waikato Regional Council
Wellington Regional Strategy Committee

Prepared by:
Market Economics Limited

For more information, contact:

Auckland Council, 09 301 0101, www.aucklandcouncil.govt.nz

Waikato Regional Council, 07 859 0999, waikatoregion.govt.nz

Wellington Regional Strategy Office, 04 830 4300, gpiwellingtonregion.govt.nz

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