Deloitte Access Economics

Social and economic costs of hearing loss in New Zealand

The National Foundation for the Deaf

2 December 2016

Deloitte.

Contents

Charts

Tables

Figures

Glossary

APD	auditory processing disorder
AWE	average weekly earnings
DAE	Deloitte Access Economics
DHB	District Health Board
DND	Deafness Notification Database
EU	European Union
the Foundation	The National Foundation for the Deaf
HAFS	Hearing Aid Funding Scheme
HASS	Hearing Aid Subsidy Scheme
HIMADA	Hearing Instrument Manufacturer and Distributors Association
HPQ	Health Performance Questionnaire
the Minister	the Minister of Health
MoH	Ministry of Health
NIHL	noise-induced hearing loss
NZ	New Zealand
PAF	population attributable fraction
WHO	World Health Organization

Acknowledgements

Deloitte Access Economics acknowledges with appreciation the comments and expert input from:

Project Steering Group Members
Professor Peter Thorne: Chairperson, Project Steering Group; President, The National Foundation for the Deaf
Dr. Louise Sinden-Carroll: Project Manager, Project Steering Group; Chief Executive, The National Foundation for the Deaf; General Secretary, International Federation of Hard of Hearing People
Phil Cammish,Deputy Board Chair, The National Foundation for the Deaf
Robert Hewison, Past President, Deaf Aotearoa New Zealand
Jemini Patel, Board Chair, The National Foundation for the Deaf
Lance Steven,Past Board Chair, The National Foundation for the Deaf

The National Foundation for the Deaf Research Reference Group
Co-chair:Associate Professor Grant Searchfield, Section of Audiology, , University of Auckland
Co-chair:Professor Suzanne Purdy, Head of Speech Science, School of Psychology, University of Auckland
Robyn Carter, Board Member, Deaf Aotearoa, New Zealand
Lachlan Keating, Chief Executive, Deaf Aotearoa New Zealand
Stuart Keene, President, Hearing Association New Zealand
David Kent: Deputy Chair, The National Foundation for the Deaf Council; Chair, Southern Hearing Charitable Trust
Dean Lawrie, CEO, Amplifon New Zealand; New Zealand Hearing Care Industry Association
Mike Sharp: CEO, Phonak New Zealand; New Zealand Hearing Care Industry Association
Paul Phillips: Managing Director, Starkey New Zealand,Hearing Instruments Manufacturers and Distributors Association
Karen Pullar:Secretary, the Oticon Foundation, New Zealand; President, New Zealand Audiological Society
Peter Stubbing, Past – President, New Zealand Audiological Society

Other Contributors
Chris Peters, Member, Captioning Working Group
Cynthia Brown-Mendes, General Manager, Auckland Hearing Association
Pauline Marshall, General Manager, Christchurch Hearing Association
John Harwood, President, Nelson Hearing Association
Sharon Webber
Dr Bill Keith PhD, Director, Sound Skills
Dr D.J. Exeter, Senior Lecturer,School of Population Health, University of Auckland
Dr Rebecca Kelly-Campbell, PhD, CCC-A, Senior Lecturer, Department of Communication Disorders, University of Canterbury
Sue Wood , Board Chair, New Zealand Hearing Care Industry Association

Executive Summary

Hearing is the ability to detect vibrations through the ear, and perceive and understand sound. It is a primary sense, one which enables communication, together with vision and touch. A hearing loss essentially limits one's ability to communicate, and through this, limits a person's ability to interact with their community, in the absence of appropriate supports. There are a number of causes of hearing loss, including congenital causes, environmental noise exposure-induced hearing loss, ageing, diseases and disorders, physical trauma, and the use of certain drugs and medicines. Hearing loss may be permanent or short term, and may commonly coexist with other conditions.

There are a variety of thresholds and measures that are used to define whether a person has hearing loss. This report relied on studies that have used audiometric testing and defined severity of hearing loss as mild, moderate or severe based on work undertaken for the Global Burden of Disease study.

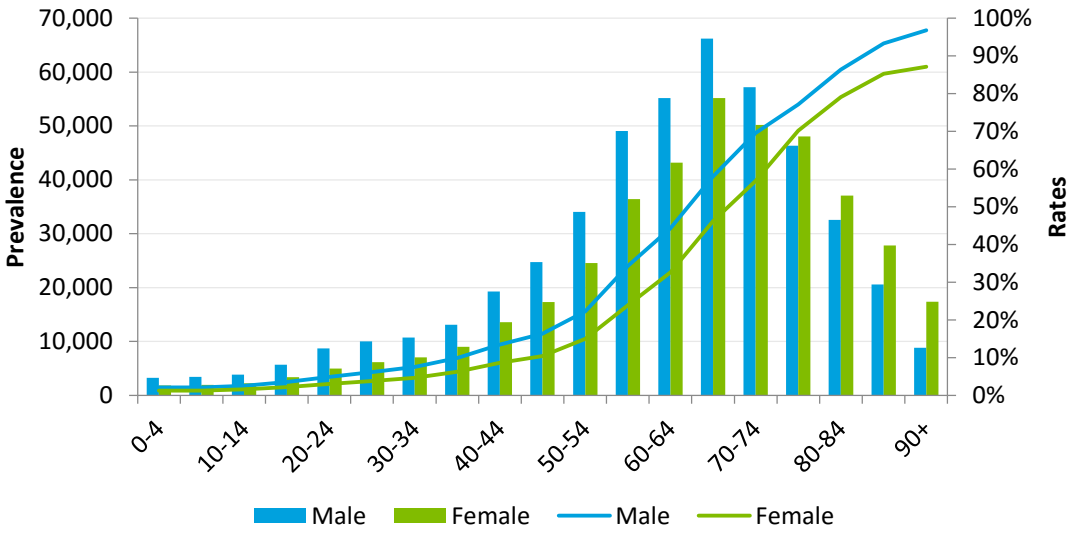
Prevalence of hearing loss

Hearing loss is relatively common in New Zealand. **The prevalence of hearing loss was estimated to be 880,350 people in New Zealand in 2016[1]. This represents 18.9% of all people**. Prevalence is higher among males (472,961 people) than females (407,388). Prevalence increases with age until almost all people have at least mild hearing loss in old age (90+ years old). Mild hearing loss is most prevalent until 80 years of age, after which moderate and severe prevalence account for most of the total within age groups. Prevalence by age and gender is shown in Chart i.

- total prevalence in adult males was estimated to be 20.6% overall – mild, moderate and severe were estimated to be 13.9%, 6.2% and 0.6%, respectively; and
- total prevalence in adult females was estimated to be 17.1% overall – mild, moderate and severe were estimated to be 11.9%, 5.0% and 0.3%, respectively

[1] Throughout this report, 2016 refers to the period July 2015 through June 2016.

Chart i: Prevalence number and rates by age and gender



Source: Deloitte Access Economics calculations based on Stevens et al (2011).

Costs associated with hearing loss

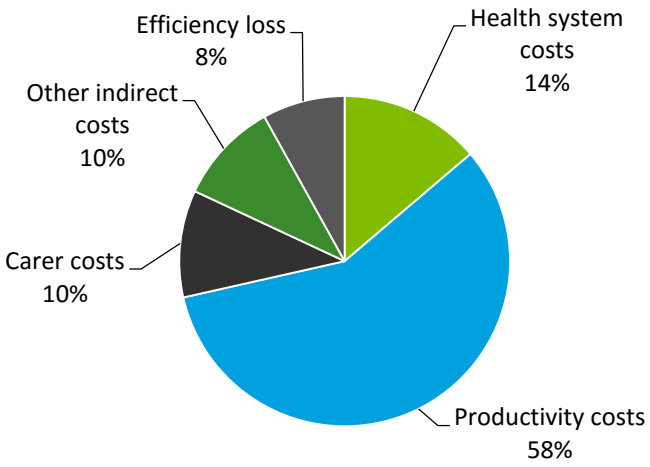
The costs of hearing loss comprise both economic costs, as well as loss of wellbeing costs.

> The total cost of hearing loss was estimated to be $4.9 billion in 2016. This was estimated to cost the New Zealand economy $957.3 million in 2016. The largest component of these costs was productivity costs, which represented 58% of total economic costs.

The components of economic costs are:

- health system costs of $131.8 million, or $150 per person with hearing loss. Health system costs are mainly comprised of other health professionals (59%), non-admitted hospital (14%) and out-of-hospital medical (13%);
- productivity losses of $552.4 million, or $627 per person with hearing loss;
- informal care costs of $100.5 million, or $114 per person with hearing loss;
- other financial costs of $95.5 million, or $108 per person with hearing loss; and
- efficiency losses of $77.2 million, or $88 per person with hearing loss.

Chart ii: Economic costs associated with hearing loss in New Zealand, 2016



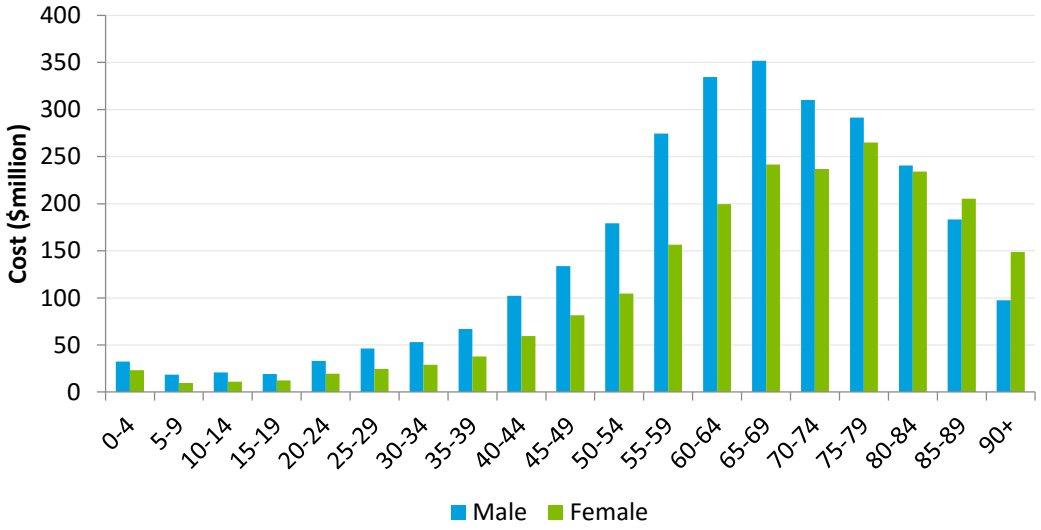
Source: Deloitte Access Economics.

In addition to economic costs, the loss of wellbeing was estimated to cost an additional 23,130 disability adjusted life years (DALYs).[2] The loss of wellbeing costs account for around 80% of the total costs associated with hearing loss in New Zealand in 2016. The net value of the lost wellbeing was estimated to be $3.9 billion.

Males bore the highest costs associated with hearing loss due to the larger productivity losses and underlying prevalence associated with these age groups (Chart iii). This reverses in older age where females over the age of 85 years bore more of the costs. Again, this largely reflects the underlying population characteristics.

[2] DALY terminology is globally adopted and understood, so is used in this report although acknowledging that some stakeholders would prefer different semantics.

Chart iii: Total costs associated with hearing loss in New Zealand, 2016



Source: Deloitte Access Economics.

Recommendations

This report has found that hearing loss is a significant issue facing the New Zealand population. As it currently stands, some of the 880,350 people with hearing loss in New Zealand as of 2016 can experience high barriers to the services, recognition and support they deserve. For example, available studies provide no indication of established hearing services being provided to prisoners. The limited data available from DHBs appears to indicate that Māori have less access to hearing treatment than other New Zealanders.

There is a need for better data to be reported on hearing loss by the Government in New Zealand. In particular, we could not locate any publicly available expenditure data on District Health Board (DHB) hearing loss services. This makes it very difficult to assess whether people with hearing loss are receiving the services they need.

The Government funds the provision of hearing aids at different amounts through various mechanisms e.g. ACC, Veterans Affairs, Childrens hearing aid fund, Ministry of Health Hearing Aid Funding Scheme and the universal Hearing Aid Subsidy Scheme. The amount of funding available for New Zealanders is inequitable based on agency funding and the age of the person. The level of funding does not meet the full costs of hearing aid provision.

Deloitte Access Economics

1 Introduction

Deloitte Access Economics was commissioned by the National Foundation for the Deaf (the Foundation) to undertake a comprehensive analysis on the social and economic cost of hearing loss in New Zealand.

This report has been structured in the following manner:

- **Chapter 1** provides an introduction to this report, including some background on the Foundation and the New Zealand public health system;
- **Chapter 2** provides some background on hearing loss, including a brief review of the causes of hearing loss, thresholds of hearing loss, comorbidities, and treatment and care pathways;
- **Chapter 3** presents prevalence estimates and mortality considerations for hearing loss, including a review of the available literature;
- **Chapter 4** outlines the costs of hearing loss to the New Zealand health system by type of cost;
- **Chapter 5** looks at the productivity costs and other financial costs associated with hearing loss, including a literature review of relevant studies;
- **Chapter 6** summarises other indirect costs of hearing loss such as aids and modifications, education and formal care;
- **Chapter 7** summarises costs of hearing loss associated with welfare payments, and the efficiency loss that arises from raising tax to fund government expenditure;
- **Chapter 8** estimates the total loss of wellbeing due to hearing loss
- **Chapter 9** summarises the total costs; and
- **Chapter 10** provides a discussion of the services available to the deaf and people with hearing loss in New Zealand, and identifies issues with access to these services.

1.1 The National Foundation for the Deaf

The National Foundation for the Deaf (the Foundation) is a national organisation that is dedicated to promoting the rights, interests and welfare of New Zealanders with hearing loss. Originally founded in 1978 under the Lions Club of New Zealand, the Foundation has since grown to become a consortium of ten consumer and hearing-health professional member organisations, including The Acoustical Society of NZ Inc, Deafness Research Foundation Inc, Hear for Families, Hearing Association New Zealand, Hearing Therapists Association of NZ, NZ Audiological Society Inc, NZ Federation for Deaf Children Inc, The NZ Society of Otolaryngology Head & Neck Surgery, Pindrop Foundation and the Southern Hearing Charitable Trust

As part of its scope, the Foundation raises awareness of hearing loss and hearing loss prevention for New Zealanders of all ages through education, sponsorship of screening programmes, and events, such as Hearing Week and the Silent Leadership Challenge. In addition, the Foundation also engages in national advocacy and support to improve public

funding for hearing loss and access to services. Some of the Foundation's current campaigns have focused on areas of service improvement such as legislation for 100% screen captioning of all broadcast and internet programmes, and the application of the Convention on the Rights of Persons with Disabilities to ensure human rights are applied on an equal basis to all people with all disabilities, including people with hearing loss.

The Foundation has commissioned this report in order to identify the full impact of hearing loss on New Zealand's community, health system and wider economy.

1.2 New Zealand health system

The New Zealand health system is characterised by a complex network of different organisations and individuals, each of which play a specific role in the administration, planning, funding, and delivery of different health and disability services. Like most developed countries, the New Zealand health system is a mixed public-private system but consists of a significant public infrastructure that is mainly supported by general taxation.

The Minister of Health (the Minister), in conjunction with the Ministry of Health (MoH) and its business units, is responsible for deciding public health policy, in addition to presiding over regulation, the funding and performance management of national services, and workforce planning in the New Zealand Health Workforce. The Minister is also tasked with overseeing New Zealand's 20 district health boards (DHBs).

DHBs are responsible for the majority of the planning, purchasing and providing of health services in New Zealand. In addition to carrying out these duties within their own districts, DHBs are also required to collaborate to ensure the inclusive and equitable distribution of services across regions. As such, DHBs play a significant role in the New Zealand health system as the primary source of funding for primary care, hospital services, public health services, aged care services, and services provided by other non-government providers. DHBs are required to deliver services in accordance with the Minister's expectations, regarding key planning priorities and performance targets and measures, as outlined in their accountability documents, while ministerial oversight is facilitated by requirements for reporting for monitoring. Approximately three-quarters or more of public funds managed by the MoH are allocated to DHBs to perform their responsibilities.

Public health providers, including primary health organisations, which provide essential primary health care through general practice, and public health units, which focus on more regional concerns and priorities, are responsible for delivering the majority of health care. However, recent years have seen a growing role for private providers, as well as NGOs, many of which provide valuable and innovative services at a community level and include specialised Māori and Pacific service providers (Ministry of Health, 2012b).

There are a number of services available to individuals with hearing loss in New Zealand including: screening and audiometric services; hearing aids and cochlear implants; access services such as hearing loops and captioning; and other specialist disability, hearing and employment services people who are deaf and hard of hearing.

Provision of these services is primarily through the public health system (New Zealand Ministry of Health), however hearing aids for adults are largely provided through private

clinics there has been an increasing presence of private firms providing hearing aids, community services and screening and audiometric services.

2 Hearing loss

Hearing is the ability to detect vibrations through the ear and to perceive and understand sound. It is a primary sense, which enables communication, together with vision and touch. A hearing loss essentially limits one's ability to communicate orally, and through this, limits a person's ability to interact with their community, in the absence of appropriate supports such as cochlear implants, hearing aids and sign language.

Hearing loss can be classified in the following ways (Niparko, 2012):

- **conductive hearing loss**, in which lesions in the external auditory canal, tympanic membrane, or middle ear, prevent sound from being conducted to the inner ear;
- **sensorineural hearing loss**, in which hearing loss is caused by lesions of either the inner ear or the auditory nerve; and
- **mixed loss**, which may be caused by severe head injury, chronic infection, genetic disorders, or when a transient conductive hearing loss occurs in conjunction with a sensorineural hearing loss.

2.1 Causes of hearing loss

The aetiology of hearing loss can vary significantly, depending on the affected individual. Hearing loss can be congenital (present at birth) or acquired; progressive or sudden; and temporary or permanent.

Causes of hearing loss can include the following (World Health Organization, 2015):

- **Congenital causes** – hearing loss may be caused by hereditary and non-hereditary genetic factors, prenatal exposure in utero to maternal disease or inappropriate drug use, or during childbirth, such as birth asphyxia, severe jaundice, and low birth weight resulting from premature birth.
- **Noise exposure / Noise-induced hearing loss (NIHL)** – single instances of extreme noise and prolonged exposure to noise can lead, respectively, to sudden or gradual sensorineural hearing loss, as a result of damage to the sensory cells. NIHL is commonly associated with occupational-related noise in industries such as agriculture, manufacturing and construction and may occur with noisy leisure pursuits.
- **Ageing** – age-related hearing loss, also known as presbycusis, can occur progressively with age and involves sensorineural hearing loss as a result of the degeneration of the cochlea and or auditory nerve..
- **Diseases and disorders –** hearing loss can result both directly and indirectly from a variety of different conditions, including autoimmune disorders, chronic ear infections, meningitis, measles, mumps and otitis media. The latter occurs as the result of infection or collection of fluid in the earand is particularly prevalent among children.
- **Use of particular drugs** – hearing loss may result from the use, or abuse, of particular drugs such as some antibiotic and antimalarial medicines.
- **Physical trauma** – hearing loss can occur as the result of physical trauma, caused by injuries either to the ear itself or to the brain.

- **Cerumen accumulation** – temporary hearing loss may be caused by the build-up of cerumen (earwax) or other foreign bodies in the ear canal, which prevents sound from being effectively conducted.

Due to insufficient country-specific data on hearing loss, it is not possible to identify the most common causes of impairment in New Zealand. However, the available literature suggests that noise-induced hearing loss (NIHL) may be highly prevalent in the country, with over 5,000 claims to ACC each year in the mid 2000's (Thorne et al, 2007), but between 2011 and 2015 this had fallen slightly to between 3,500 and 4,500 a year[3]. In 2015, the annual cost of new and ongoing claims was $46.6 million. While this figure represents a flow value, the stock value is far larger. The ACC estimated that, as at 30 June 2011, the net present value of existing hearing loss claims was $514 million – compared to $23.6 million paid out that year.[4]

In their study on the epidemiology of NIHL in New Zealand, Thorne et al (2013) reviewed the literature and data from the Accident Compensation Corporation (ACC) to explore the prevalence of, and trends regarding, NIHL in New Zealand. Thorne et al (2013) identified a significant increase in the number of new NIHL claims being annually made to the ACC, from a total of 2,823 in July 1995-June 1996 to 5,580 in July 2005-June 2006. This may be due to actual increases in NIHL prevalence, possibly in part due to demographic ageing, and/or to improved processes for making claims through the ACC.

2.2 Thresholds of hearing loss

There are a variety of thresholds that are used to define whether a person has hearing loss. The Stevens et al (2011) report[5] defines different hearing loss levels as mild, moderate, moderately severe, severe, profound and complete. Other studies might use other categorisations such as mild, moderate and severe. Table 2.1 compares the Stevens thresholds to both the WHO definitions (Mathers et al, 2000) and the definitions used in the European Union (EU) (Martini et al, 1996).

Table 2.1: Different thresholds of hearing loss

	NZ Deafness Notification Database	WHO	EU	Stevens et al (2011)
Mild	26-40 dBHL	26-40 dBHL	20-40 dBHL	20-34 dBHL
Moderate	41-65 dBHL	41-60 dBHL	40-70 dBHL	35-49 dBHL
Moderately severe				50-64 dBHL
Severe	66-95 dBHL	61-80 dBHL	70-95 dBHL	65-79 dBHL
Profound	>95 dbHL	81+ dBHL	95+ dBHL	80-94 dBHL

[3] http://www.acc.co.nz/about-acc/statistics/injury-statistics-tool/index.htm

[4] http://employment.govt.nz/initiatives/workplace/acc/hearing-loss/hearing-loss-stocktake-9.pdf

[5] Stevens et al (2011) is an audiometric study of 29 countries including Australia, the United States and the United Kingdom for the Global Burden of Disease study. New Zealand was not included, as there have been no audiometric studies.

Complete	95+ dBHL

Source: Mathers et al (2000), European Group on Genetics of Hearing Impairment (1996) and Digby (2015).

In this analysis, hearing loss by severity is defined as follows:

- mild is defined as 20-34 dB of hearing loss;
- moderate is defined as 35-64 dB of hearing loss; and
- severe is defined as 65 or more dB of hearing loss.

These thresholds are based on the Stevens et al (2011) definition, and were used to align with the definitions used in the NZ Burden of Disease study[6] – which provides the health states for mild, moderate and severe hearing loss.

This report does not comment on whether the contributing studies include all types of hearing loss including conductive, transient loss. This will have minimal effect on adult data but is important for child data, especially in New Zealand where conductive hearing loss associated with middle-ear disease is common in Maori and Pacific children.

2.3 Other hearing health conditions

Individuals with hearing loss may encounter a range of comorbidities, depending on their circumstances. For people whose hearing loss originated from a disease or disorder, comorbidities can include those catalysing conditions, such as meningitis or autoimmune ear disease. Meanwhile, other comorbidities may also arise either as the result of, or in conjunction with, hearing loss.

Tinnitus is a condition which is characterised by a noise in the ear, akin to a buzzing, roaring, whistling, or hissing, that may also accompany hearing loss. Individuals who suffer from sensorineural hearing loss as a result of causes such as physical trauma, noise exposure, ageing or certain infections, may also experience subjective tinnitus as a consequence (Tucci, 2013). Another form of tinnitus, known as objective tinnitus, can also occur but is far less common and usually involves noise from vascular flow, which is characterised by a pulsating sound.

While the effects of tinnitus can be relatively innocuous, tinnitus can be quite distressing if continuous and persisting and, if not adequately managed, can lead to depression and poor mental health. Tinnitus is usually relieved through treatment of the underlying disorder or treatment of the hearing loss. However, other possible means of treatment include relieving factors, such as stress or depression, that can exacerbate the condition, or via devices, such as a tinnitus masker or a background sound generator, that can obscure the sound of the tinnitus. Hearing aids have been recommended to reduce the annoyance of tinnitus and other difficulties associated with it (Shekhawat et al 2013, 2007; British Tinnitus Association, 2011).

Maes et al (2013) estimated the costs of tinnitus in The Netherlands as being around €6.8 billion. If health system, productivity and other costs, as well as prevalences and severity splits were similar in New Zealand, then after allowing for exchange rate differences and

[6] The New Zealand Burden of Disease study uses the Global Burden of Disease 2010, which has exactly the same categories as Stevens et al (2011).

inflation, the annual costs of tinnitus could be around $3.5 billion in New Zealand. If the health system, productivity and other costs of tinnitus in The Netherlands (Maes et al, 2013) held for New Zealand, and the prevalence and severity distributions were also the same, then tinnitus costs could be around $7.5 billion

Decreased Sound Tolerance (DST) including hyperacusis is an additional auditory disability that results in annoyance, discomfort or pain to sound, it affects about 2% of the population. This condition has a high impact on normal participation in life, as everyday sounds are intolerable. Persons experiencing this withdraw from activities or are forced to wear hearing protection on a regular basis. It is managed in a similar manner to tinnitus (Jastreboff & Jastreboff, 2015).

Another hearing problem is auditory processing disorder (APD), which covers a range of problematic auditory behaviours relating to changes in the way the central auditory nervous system processes complex sound such as speech in noise. While an affected individual's ear may be perfectly functional, dysfunctions in the central nervous system may affect their ability to understand auditory informatio – severe APD e.g. due to cortical deafness, which prevents understanding , is a rare form of APD.. As such, APD can affect auditory behaviours including sound localisation and lateralisation, auditory discrimination, auditory pattern recognition, temporal aspects of audition, and auditory performance decrements with competing acoustic signals and degraded acoustic signals (Esplin and Wright, 2014).

Due to the complexity and heterogeneity of the disorder, APD can be difficult to diagnose correctly, requiring specialised testing and audiological expertise. The effects of APD may manifest in different ways in affected individuals, however listening complaints are very consistent across adults and children with the condition. People with APD primarily have difficulty understanding complex auditory stimuli in challenging listening environments, such as following multistage instructions in a noisy classroom. Similarly, various aetiologies have been identified with APD in the literature, but none have been fully defined. Causality can be difficult to determine unless there is a known neurological condition that affects the auditory pathways, such as an acquired brain injury or disease (Esplin and Wright, 2014). Given the disorder's association with cognitive and behavioural function, comorbidities of APD can also include dyslexia, language disorder, attention deficient hyperactivity disorder, and autism spectrum disorder. The use of hearing aids for children with APD has seen limited discussion throughout the literature. The literature indicates that children with APD may benefit from the use of hearing aids and personal FM systems, which are more recently referred to as remote microphone hearing aids (Keith & Purdy, 2014; Kuhanek et al., 2016). However, although remote microphone hearing aids provide a signal to noise ratio advantage over conventional hearing aids, Esplin and Wright (2014 note that no studies have properly compared the use of hearing aids and remote microphone hearing aids to generate the best signal to noise ratio in children with APD. Currently, the Ministry of Education provides limited funding for children and young people aged 6 up to 21 years old for remote microphone hearing aids that assist with APD (Esplin and Wright, 2014).

The cost of APD could not be in scope for this report as no cost of disease studies were identified.

2.4 Treatment and care pathways

Based on the cause of the hearing loss, there exist some specific treatments that can be administered to an individual with hearing loss if their impairment is curable (Niparko, 2012). In the case of an ear canal obstruction, blockages by matter such as excess cerumen, benign growths or tumours can be addressed through removal of the foreign object(s).

Similarly, where hearing loss may be caused by fluid build-up in the middle ear, fluid can be drained through a surgical incision, known as a myringotomy, and prevented with the insertion of a tympanostomy tube, to keep the middle ear aerated.

Meanwhile, hearing loss resulting from autoimmune disorders or conditions such as otitis media can be treated through the use of appropriate medications, such as corticosteroids or antibiotics.

Where the cause of the hearing loss cannot be cured, care pathways may involve compensating for the hearing loss through the use of the following aids and modifications, and assistive mechanisms:

- **Hearing aids** – hearing aids can help individuals with hearing loss by amplifying sound and facilitating improved communication. Hearing aids can differ in model, and are prescribed depending on the severity of one's hearing loss, such as ear-level aids (for individuals with moderate to severe hearing loss), in the-ear aids or open-fit behind the ear aids (for individuals with mild to moderate hearing loss), or completely in the canal aids for those who wish to choose a more cosmetically inconspicuous option. As hearing aids have become more sophisticated and smaller, the styles of hearing aid that suit different severities and configurations of hearing loss and address cosmetic concerns have changed. In order to ensure that amplification is as natural and responsive as possible, hearing aids should be customised to a person's particular pattern of hearing loss (e.g. selective amplification of relevant frequencies).
- **Cochlear implants** – a cochlear implant is an electronic medical device that helps to provide sound signals to the brain by converting sound to electrical signals that directly stimulate the auditory nerve via multiple electrodes. Unlike hearing aids, which work by magnifying sound to overcome impaired function of the cochlear hair cells, cochlear implants operate by simulating the auditory nerve in the inner ear directly. Cochlear implants are best suited to individuals with profound levels of hearing loss who do not benefit from conventional hearing aids and who have an intact auditory nerve.
- **Brain stem implants** - individuals who have had both acoustic nerves damaged by tumours, disease or trauma may benefit from the use of a brain stem implant, which uses sound-detecting and sound-processing devices to convert sound to electrical signals that are delivered to auditory centres in the brainstem via implanted electrodes.
- **Assistive Approaches** – individuals with hearing loss and APD can also use a variety of assistive mechanisms to help cope with their hearing loss and disordered sound processing. Special sound systems can help transmit infrared or FM to radio signals to help people hear where there may be excess of conflicting noise, while visual signals or supports, such as lights or subtitles, can assist in place of solely auditory ones. People with hearing loss can also use lip-reading or speech-reading to help discriminate between sounds and may also use sign language to communicate.

3 Prevalence

This chapter outlines the prevalence estimates and mortality considerations for hearing loss in New Zealand. As hearing loss is a relatively common condition, a number of sources exist to estimate and triangulate the prevalence due to hearing loss in high income countries; however, very few sources were found to be specific to New Zealand.

Key finding:

- The prevalence of hearing loss was estimated to be 880,350 people in New Zealand in 2016, or 18.9% of all people. Prevalence is higher among males than females. Prevalence increases with age until almost all people have at least mild hearing loss in old age (90+ years old)

3.1 Data sources

Hearing loss is a common condition around the world, with hearing loss increasing with age. Despite this, there were a limited amount of sources that discuss the prevalence of hearing loss specifically in New Zealand. The primary source of data for New Zealand contains a measure of self-reported hearing loss, which was found in the 2013 Disability Survey (Statistics NZ, 2014).

Self-reported hearing loss is subjective and can poorly estimate total prevalence of hearing loss. For example, Wilson et al (1999) showed that the false positive rate in self-reported studies of hearing loss was 46% and the false negative rate was 17%. This indicates that self-reported hearing loss estimates such as the results from the Disability Survey are poor indicators of prevalence. Consequently, a literature search was conducted to find objective measures of hearing loss that would be relevant to New Zealand. The primary source of prevalence data was reported in Stevens et al (2011), as part of the Global Burden of Disease project.

Stevens et al (2011) used results from a number of global audiology hearing loss studies to build a Bayesian hierarchical model that estimated the prevalence of hearing loss in different geographical regions depending on local characteristics. To estimate the prevalence in high income countries, Stevens et al (2011) used more than 18 audiology studies which were conducted in Australia, Finland, Norway, Sweden, the United Kingdom and the United States and covered all ages.

The Stevens et al (2011) study was considered to be more representative of prevalence in New Zealand for two reasons. Firstly, the countries used in the Stevens et al (2011) study have similar characteristics to New Zealand, implying the prevalence of hearing loss in these countries is similar to the prevalence in New Zealand. The countries contained in the high income sample are all western, high income countries which have similar economic and health characteristics to New Zealand. Therefore, the same underlying factors that cause hearing loss in those countries are also prevalent in New Zealand and the countries would have comparable hearing loss prevalence. Secondly, the Stevens et al (2011) study uses audiological data and not self-reported data, which as discussed earlier, is a poor

estimate of prevalence. While this does not specifically include Māori and Pacific people, all of the other high income countries in Stevens et al (2011) also have substantial ethnic minorities. The main finding of the study was that national income has a strong inverse correlation with hearing loss prevalence. There were also correlations with age and gender, but not race.

The audiological data reported by Stevens et al (2011) was considered to be more representative of prevalence in New Zealand, as self-reported data fell outside the audiological 90% confidence intervals for all age groups. A comparison of the rates reported by Stevens et al (2011) and the Disability Survey is presented in section 3.2.3. Table 3.1 presents the prevalence rates reported by Stevens et al (2011), adjusted to match the severity defined in section 2.2.

Table 3.1: Proportion of population in high income countries with hearing loss by age, gender and severity

Age/gender	Mild	Moderate	Severe	Overall
Male				
5-19 years	2.3	0.4	0.0	2.7
20-34 years	5.1	1.0	0.1	6.1
35-44 years	9.6	2.0	0.1	11.7
45-54 years	15.6	3.5	0.2	19.3
55-64 years	29.5	8.9	0.6	38.9
65-74 years	41.2	20.2	1.5	62.9
75+ years	36.6	42.2	5.2	84.0
Female				
5-19 years	1.4	0.3	0.0	1.7
20-34 years	3.2	0.6	0.0	3.8
35-44 years	6.2	1.2	0.1	7.5
45-54 years	10.4	2.2	0.1	12.7
55-64 years	22.0	5.6	0.4	28.0
65-74 years	36.3	13.5	0.9	50.7
75+ years	39.6	34.4	3.6	77.6

Source: Deloitte Access Economics calculations based on Stevens et al (2011).

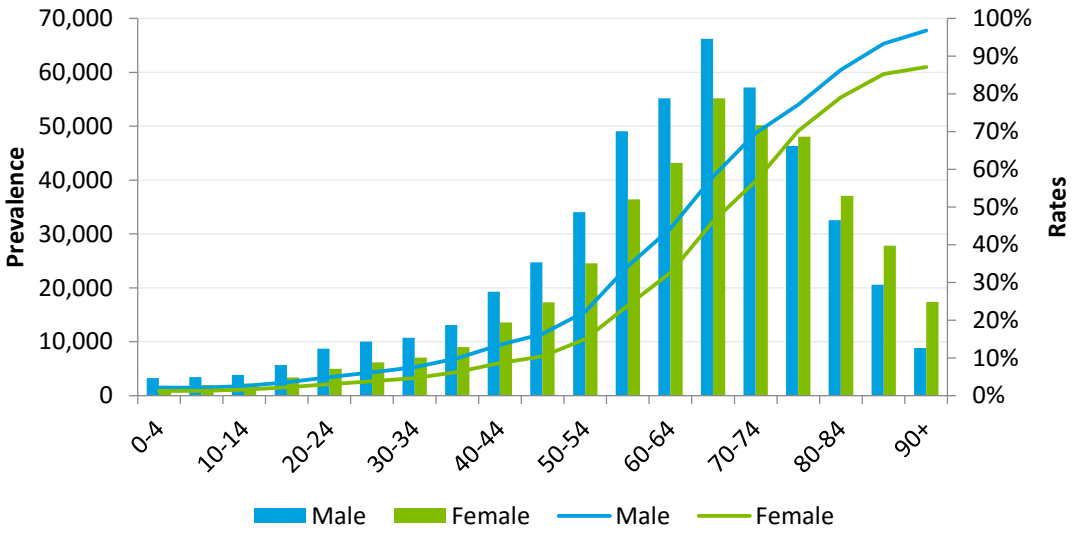
As the oldest age group reported by Stevens et al (2011) was 75+, applying this rate to the NZ population would likely underestimate the prevalence in this age cohort due to the ageing NZ population.[7] To adjust for this, the data from Stevens et al (2011) were used to estimate the prevalence by five year age and gender groups. The five year age and gender groups were modelled using a fourth order polynomial trend applied to the Stevens et al (2011) ten year age and gender groups up to the 80-84 age group. This process was repeated across the severity splits to estimate the total prevalence by mild, moderate and severe groupings. The weighted prevalence for each age and gender was then adjusted so that it matched the overall age group prevalence rate reported by Stevens et al (2011).

[7] As the New Zealand population is ageing over time, more people will be in older age groups and be more likely to have hearing loss. Applying the same rate to those over 75 years of age would underestimate the true prevalence in this cohort due to this ageing effect.

3.2 Prevalence in adults

There were estimated to be 880,350 people who have some form of hearing loss in New Zealand in 2016. The overall prevalence and number of people who have hearing loss in New Zealand is shown in Chart 3.1. Hearing loss is more prevalent in males in all age groups, although there are more females with hearing loss over 75 years old, reflecting the underlying population characteristics.

Chart 3.1: Prevalence number and rates by age and gender

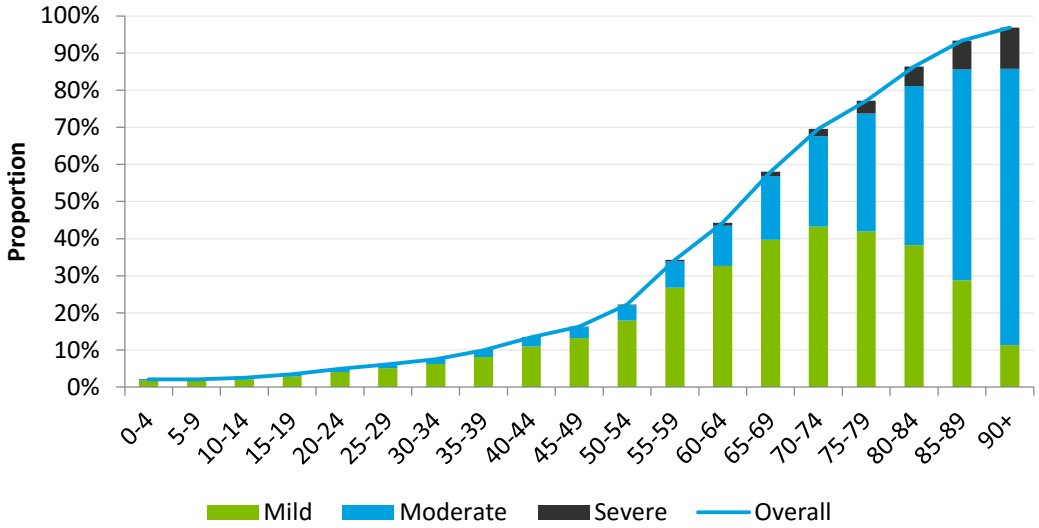


Source: Deloitte Access Economics calculations based on Stevens et al (2011).

The overall prevalence of hearing loss by severity for males is shown in Figure 3.1. For males:

- total prevalence was estimated to be 20.6% overall – mild, moderate and severe were estimated to be 13.9%, 6.2% and 0.6%, respectively; and
- mild hearing loss is more prevalent in the lower age brackets, and decreases in older age brackets as severity worsens over time.

Figure 3.1: Overall prevalence of hearing loss by severity, male

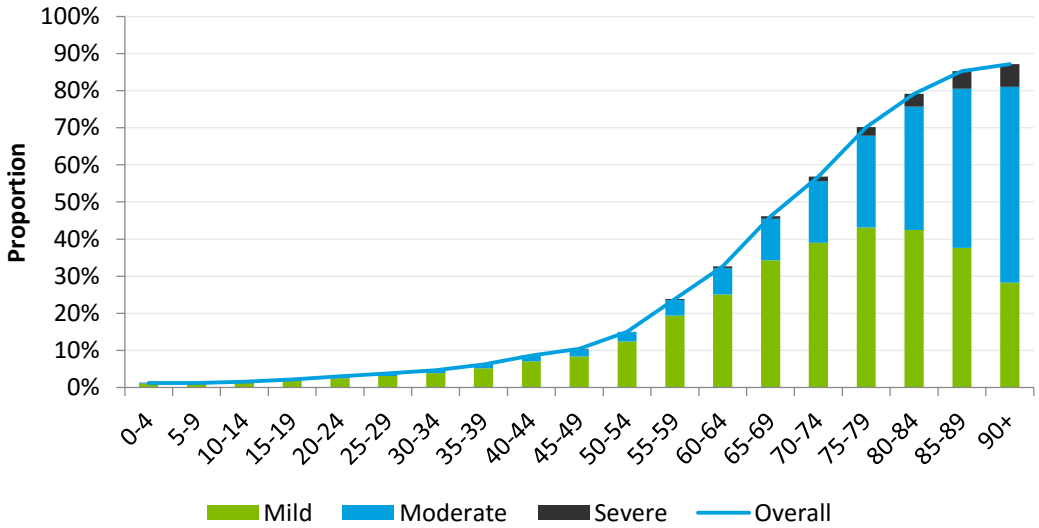


Source: Deloitte Access Economics calculations based on Stevens et al (2011).

The overall prevalence of hearing loss for females is shown in Figure 3.2 by severity. For females:

- total prevalence was estimated to be 17.1% overall – mild, moderate and severe were estimated to be 11.9%, 5.0% and 0.3%, respectively; and
- as with hearing loss in males, mild hearing loss is more prevalent in younger age brackets, which decreases over time as severity worsens.

Figure 3.2: Overall prevalence of hearing loss by severity, female



Source: Deloitte Access Economics calculations based on Stevens et al (2011).

Table 3.2 summarises the number of cases by severity, age and gender. There were estimated to be 472,961 males who have some form of hearing loss and 407,388 females who have some form of hearing loss.

Table 3.2: Number of cases of hearing loss by severity

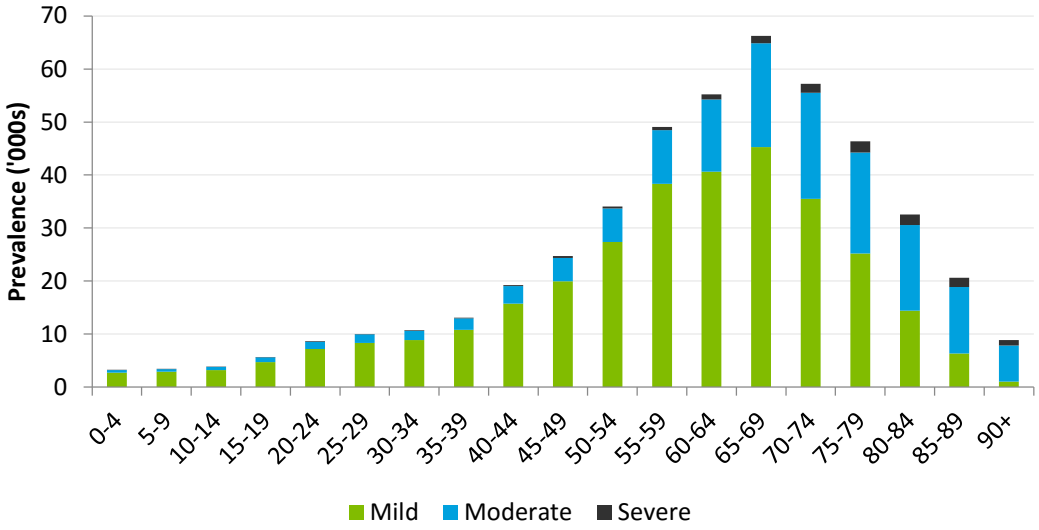
Age/gender	Mild	Moderate	Severe	Overall
Male				
0-9	5,628	1,000	59	6,686
10-19	7,956	1,523	91	9,570
20-29	15,532	3,031	181	18,744
30-39	19,709	3,909	235	23,853
40-49	35,689	7,761	537	43,986
50-59	65,757	16,460	904	83,121
60-69	85,911	33,184	2,339	121,435
70-79	60,689	39,111	3,731	103,531
80-89	20,773	28,708	3,694	53,174
90+	1,034	6,815	1,012	8,861
Male total	318,677	141,502	12,782	472,961
Female				
0-9	3,203	573	34	3,810
10-19	4,693	883	52	5,629
20-29	9,265	1,764	105	11,134
30-39	13,341	2,564	153	16,058
40-49	25,138	5,398	377	30,912
50-59	49,885	10,562	546	60,993
60-69	74,099	22,756	1,508	98,362
70-79	64,043	31,510	2,676	98,229
80-89	32,163	29,592	3,143	64,898
90+	5,638	10,504	1,223	17,364
Female total	281,467	116,105	9,817	407,388
Persons total	**600,144**	**257,607**	**22,599**	**880,350**

Source: Deloitte Access Economics calculations based on Stevens et al (2011).

Figure 3.3 and Figure 3.4 show the prevalence by severity for male and female, respectively. Mild hearing loss is the most common form of hearing loss until around 80 years of age. Moderate hearing loss is the most common form of hearing loss over the age of 80.

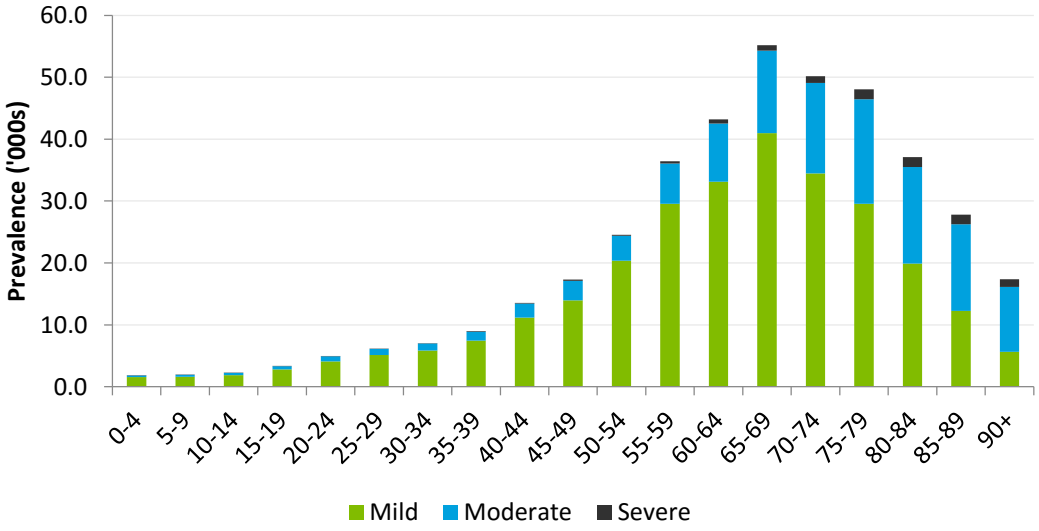
While prevalence rates within each given age-gender cohort are modelled as being identical for New Zealand and the Stevens et al (2011) high-income region, there are differences in the distribution of those cohorts between the two populations. This results in small differences in total prevalence estimates for the total population. For example, Stevens et al estimated that prevalence of moderate or worse hearing loss in males over 15 at 8.0%, while the estimate for New Zealand is slightly higher at 8.4%. Conversely, the Stevens et al estimate for females over 15 is 7.3%, but for New Zealand is slightly lower at 6.5%.

Figure 3.3: Prevalent cases by severity, male



Source: Deloitte Access Economics calculations based on Stevens et al (2011).

Figure 3.4: Prevalent cases by severity, female



Source: Deloitte Access Economics calculations based on Stevens et al (2011).

3.2.2 Differences in prevalence

As discussed in Section 3.1, there are limited data available on hearing loss in New Zealand. This makes it difficult to discern differences in the prevalence of hearing loss across other demographic factors beyond age and gender, such as ethnicity and occupation. Digby (2015) notes, that in children under the age of 18, "A number of sources suggest possible differences in prevalence of hearing loss between Māori and New Zealand Europeans, although no difference has ever been confirmed".

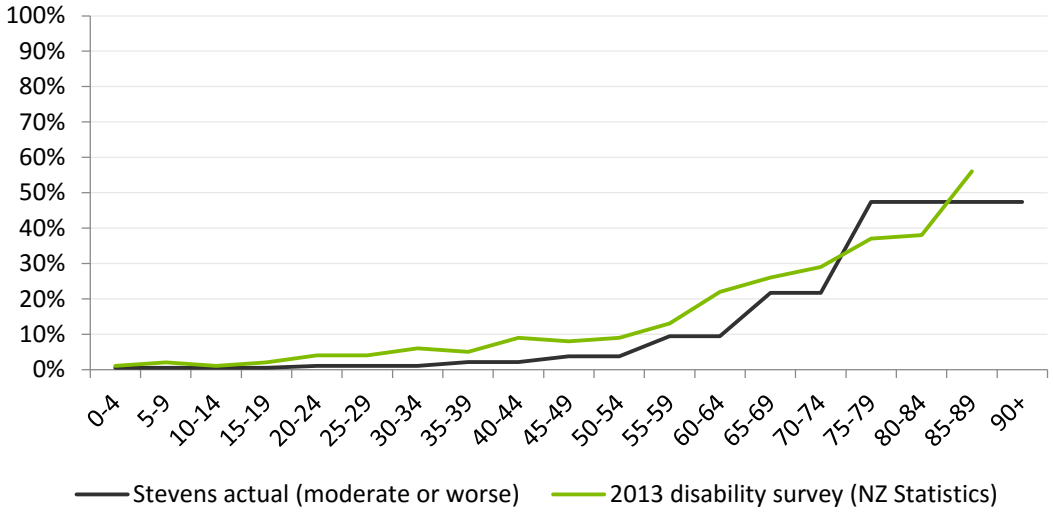
In a study on the differences in rates of hearing loss between the young Māori population of New Zealand and their non-Māori counterparts, Digby (2015) analysed data from the New Zealand Deafness Notification Database (DND), covering the periods of 1982-2005 and 2009-2014. The results found that, averaged across speech frequencies, young Māori were more likely to be diagnosed with permanent hearing loss greater than 26 dB of hearing loss, but had lower prevalence of severe or profound hearing loss. Conversely, young Māori were significantly more likely to have bilateral losses than non-Māori New Zealanders. However, it is important to note the presence of a number of other confounding factors. As the DND relies on voluntary notifications from audiologists throughout the country, it is likely that Māori may be underrepresented in data. Similarly, given the higher proportion of mild hearing loss among the Māori, Māori may be underrepresented in the DND as mild hearing loss has lower rates of diagnosis. Digby et al (2014) note that The B4 School Check data suggest the possibility of higher rates of hearing loss (of all types) among Māori. Digby et al (2014) also note that disability surveys suggest higher rates of hearing loss among Māori, but also that "although the surveys provide some information about hearing loss in the New Zealand population, there are a number of limitations with this data as the surveys are quite general, not age specific and categorise hearing disability in different ways".

3.2.3 Comparison with the Disability Survey

The self-reported results from the Disability Survey and the results from Stevens et al (2011) were compared to determine the appropriateness of each source for prevalence estimates. To determine hearing loss the Disability Survey used the question "has difficulty hearing a conversation even when using assistive hearing device". For comparison purposes, the Stevens et al (2011) study suggests the moderate threshold aligns with the question "has difficulty hearing and taking part in a conversation".

Figure 3.5 shows hearing loss prevalence for moderate or worse hearing loss in males. Mild hearing loss is not included in this figure as the results from the Disability Survey are indicative of moderate or severe hearing loss and not mild. The Disability Survey has consistently higher prevalence in younger age groups compared to Stevens et al (2011), although the two sources are relatively consistent for older age groups.

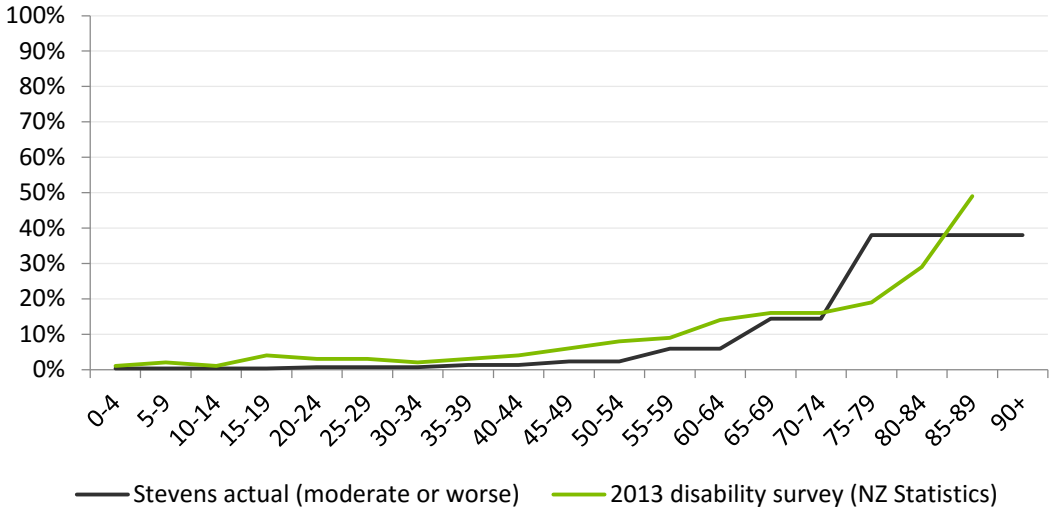
Figure 3.5: Hearing loss prevalence for moderate or worse hearing loss, male



Source: Statistics NZ (2014), and Stevens et al (2011).

Figure 3.6 shows hearing loss prevalence for moderate of worse hearing loss in females. The prevalence rates for females show a very similar pattern to males, with prevalence being overstated in younger age groups.

Figure 3.6: Hearing loss prevalence for moderate or worse hearing loss, female



Source: Statistics NZ (2014), and Stevens et al (2011).

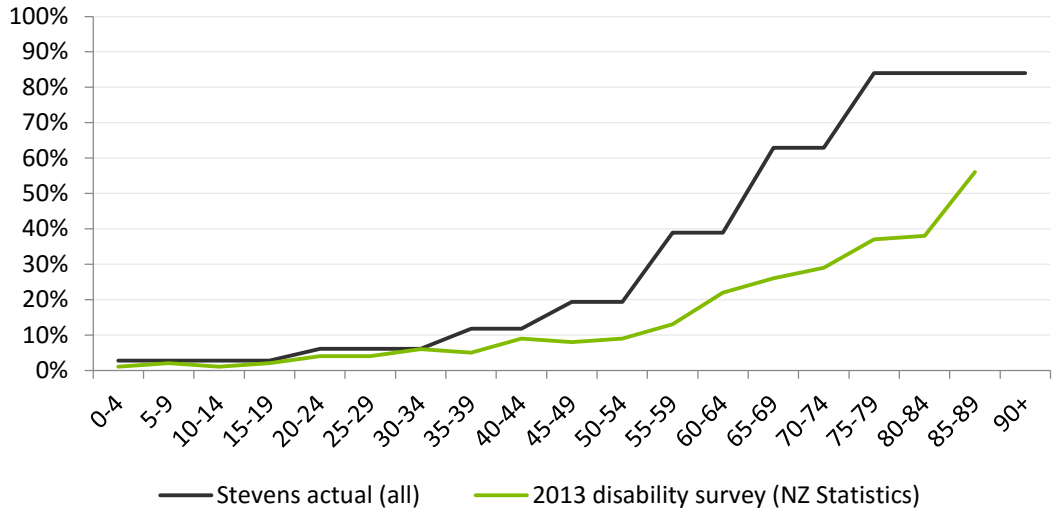
Both of these charts show that the Disability Survey approximately reports on moderate or worse prevalence that is reported by Stevens et al (2011).

The proportion of people with hearing loss that use hearing aids is generally low. This is a plausible explanation for why these two questions may be close. For example, the Access Economics (2006) *Listen Hear!* report noted that only 15% of older people with acknowledged hearing loss actually use hearing aids in Australia. This is further exacerbated by people with a hearing problem taking a number of years to seek help, some

waiting until receiving a pension to qualify for government assistance with financing hearing aids.

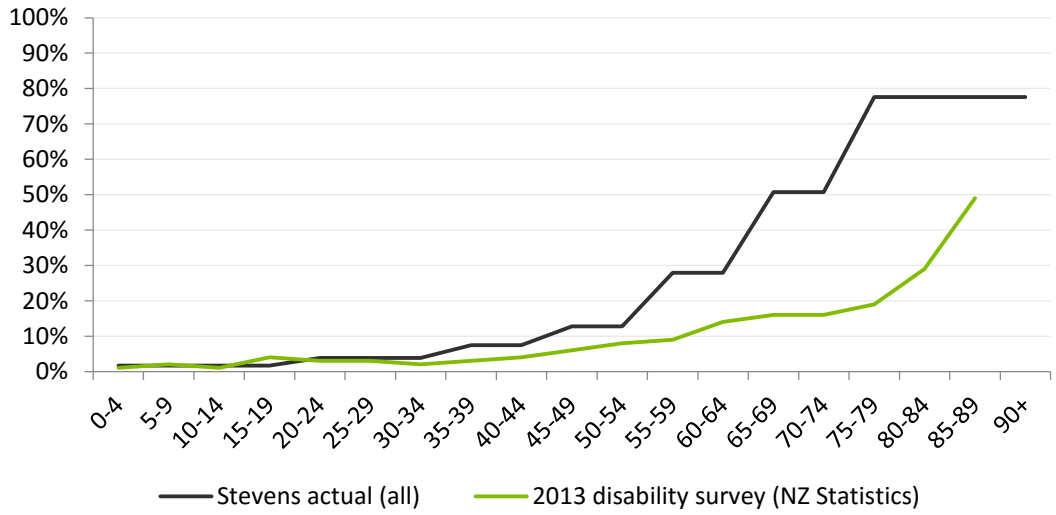
The prevalence rates from the Disability Survey were also compared with the overall rates reported by Stevens et al (2011). This is shown in Figure 3.7 for males and Figure 3.8 for females. The prevalence of hearing loss for males and females is consistently understated in the Disability Survey compared to the accepted moderate hearing loss threshold of around 35 dB of hearing loss. This provides further evidence that the rates in the Disability Survey reasonably approximate moderate or worse hearing loss.

Figure 3.7: Overall hearing loss prevalence (all severities), male



Source: Statistics NZ (2014), and Stevens et al (2011).

Figure 3.8: Overall hearing loss prevalence (all severities), female



Source: Statistics NZ (2014), and Stevens et al (2011).

3.3 Mortality

3.3.1 Associations between mortality and hearing loss

Hearing loss and associated hearing health conditions have been associated with an increase in mortality in a number of studies. This association has not been included in the costings for this report, but if (as appears) people do die because they have hearing loss, this issue merits further consideration.

In the past, adjusting for a number of confounding factors generally meant that hearing loss was no longer significantly associated with an increase in mortality. The confounding factors typically include age, gender, a range of comorbid conditions, and a range of indirect factors such as ability to walk, cognitive impairment and self-rated health. Previous work to cost the impact of hearing loss has typically excluded any mortality aspects and suggested no direct link between mortality and hearing loss – for example, see Access Economics (2006).

There are a number of suggested pathways that may link an increased risk of mortality with hearing loss. Genther et al (2015) cite studies that report an increased risk of falls and hospitalisations in people with hearing loss – for example, see Lopez et al (2011), which found that hearing loss was significantly associated with an increased risk of falls, and borderline significance for risk of being injured by a fall. The suggested mechanisms include confounding factors with shared conditions (e.g. microvascular conditions), increased brain processing requirements due to degraded auditory signals, and social isolation.[8] Genther et al (2015) highlight that these mechanisms are not mutually exclusive, meaning that they can coexist and contribute to reduced functioning in older adults with hearing loss. Finally, it is possible that other conditions which contribute to hearing loss may be the direct cause of death. For example, Sanders et al (2015) identifies a small number of deaths could arise from otitis media in Pacific Island countries due to resultant complications such as abscess, meningitis and thrombosis.

A literature search for studies was conducted to see if recent evidence suggests a direct association between hearing loss and mortality when controlling for confounding factors such as ageing, gender and other conditions. This is commonly measured using a hazard ratio, which assesses the relative difference in the probability of an event occurring (death) over time between two populations of interest– those with and without hearing loss. Most of the studies identified in the search were prospective observational studies, and generally contained a longitudinal sample or survey linked to national deaths data. A summary of the literature is presented in Appendix B.

The results identified in the literature and the respective population characteristics are shown in Table 3.3. Of the identified literature using audiometric testing, there was approximately a 10% increase in the risk of mortality across the studies, although this was only significant in some of the studies. As such, meta-analysis was undertaken on these results using a fixed effects model as the results were consistent with overlapping ranges. The results of the meta-analysis are reported in Table 3.3 and Figure 3.9.

[8] These cardiovascular disease risk factors (confounding factors) may lead to endogeneity in the sample.

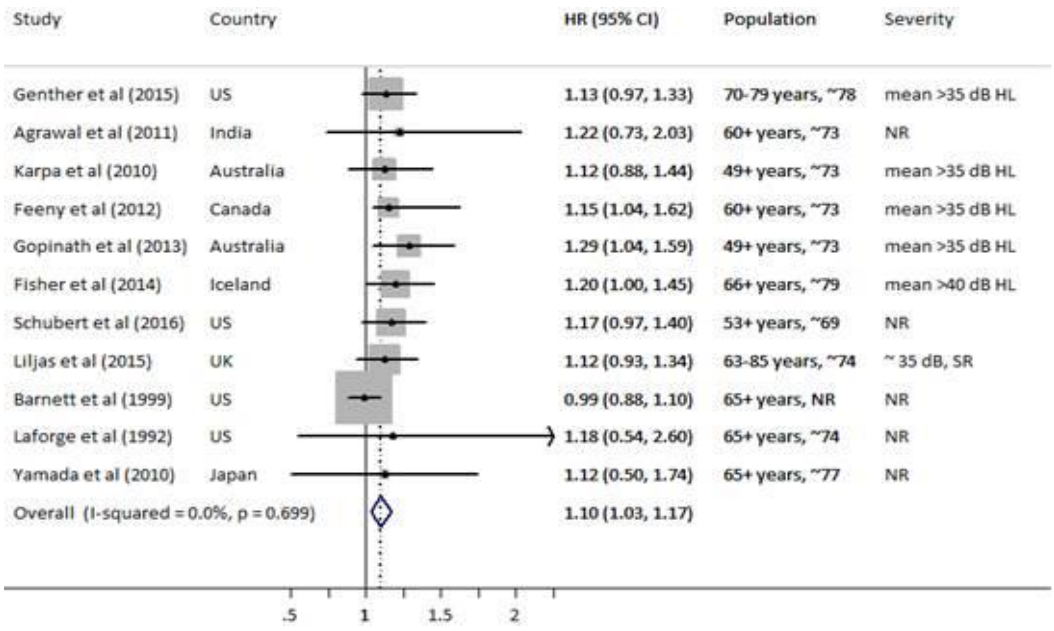
Overall, hearing loss appears to be significantly associated with a 10% increase in mortality for those that are over the age of 70 years and have moderate or worse hearing loss.

Table 3.3: : Meta-analysis of mortality outcomes

Study	Country	Population age	Mean severity	HR	95% CI
Genther et al (2015)	US	70-79 years, ~78	>35 dB HL	1.13	0.97-1.33
Agrawal et al (2011)	India	60+ years, ~73	NR	1.22	0.73-2.03
Karpa et al (2010)	Australia	49+ years, ~73	>35 dB HL	1.12	0.88-1.44
Feeny et al (2012)	Canada	60+ years, ~73	>35 dB HL	1.15	1.04-1.62
Gopinath et al (2013)	Australia	49+ years, ~73	>35 dB HL	1.29	1.04-1.59
Fisher et al (2014)	Iceland	66+ years, ~79	>40 dB HL	1.20	1.00-1.45
Schubert et al (2016)	US	53+ years, ~ 69	NR	1.17	0.97-1.40
Liljas et al (2015)	UK	63-85 years, ~74	~35 dB HL, SR	1.12	0.93-1.34
Barnett et al (1999)	US	65+ years, NR	NR	0.99	0.88-1.10
Laforge et al (1992)	US	65+ years, ~74	NR	1.18	0.54-2.60
Yamada et al (2010)	Japan	65+ years, ~77	NR	1.12	0.50-1.74
Pooled result	-	**70+ years**	**>35 dB**	**1.10**	**1.03-1.17**

Source: Deloitte Access Economics estimates.

Figure 3.9: Meta-analysis of mortality outcomes



Source: Deloitte Access Economics estimates.

Finally, the results presented above are considered to be plausible given the suggested pathways and mechanisms given in the literature. For example, Karpa et al (2010) used structural equation modelling to identify both direct and indirect pathways for hearing loss

to mortality, and found that both cognitive impairment and disability in walking were significantly associated with mortality for people with hearing loss. They observed that the hazard ratio for people with cognitive impairment was 1.45, while for disability in walking it was 1.63. Further, Karpa et al (2010) suggest that these associations may be due to "… increased fear of falling, infirmity caused by declining physical and social activities associated with hearing loss – reflecting a decreased ability to seek professional help for hearing loss – and impaired balance from accompanying decreased vestibular function" (p. 457). If this is the case, then the higher mortality risk is due to systemic issues that are modifiable. Further, an increase in cognitive impairment (which is associated with an increase in mortality) can be "… explained by sensory underload (lack of intellectual stimulation reducing cognitive ability, attentional demands of sensory measurement…, or some common cause (hearing loss and cognitive function are both measures of the physiological architecture of the brain)" (p. 457).

Although the indirect pathways of cognitive impairment and disability in walking are significantly associated with an increase in mortality, these results are not included in the above analysis. The primary reason for this is that structural equation modelling relies more heavily on statistical assumptions such as for direction of causality. That said, VanderWeele (2012) suggests that structural equation modelling can be useful for hypothesis testing and exploratory analysis.

> In summary, there is strong evidence emerging indicating causal pathways between hearing loss and increased mortality, which needs to be carefully monitored. However, in line with the traditional approach (e.g. Access Economics, 2006) this report does not estimate the impacts of hearing loss on mortality in New Zealand.

3.4 Noise induced hearing loss (NIHL)

It has been found that between 16% to 37% of hearing loss globally is attributable to occupational noise or NIHL (noise induced hearing loss) (Nelson et al, 2005; Kurmis and Apps, 2007). NIHL is a significant cause of hearing loss developed by adults later on in life. Nelson et al (2005) also demonstrate that the effects of exposure to occupational noise are significantly larger for males than females, mainly because of greater representation of males in noisy industries.

NIHL from the workplace is a potentially-avoidable morbidity that is significantly contributing to hearing loss across the world. Kurmis and Apps (2007) found, based on Access Economics (2006) that NIHL accounts for approximately 1.4% of GDP in Australia. For a condition that is potentially avoidable, this is a large burden for the health system to bear.

Specifically within New Zealand, Hannah, Page and McLaren (2016) find that 25% of the New Zealand workforce works within 'noisy' industries such as (but not limited to) manufacturing, construction and mining. Additionally, from 1998 to 2000 NIHL was described as the second most voluntarily reported occupational condition in New Zealand (Thorne, 2013). In fact, from 1994 to 2005 the ACC received 28,805 claims for NIHL which totalled to a cost of $218 million and rising. This equated to approximately 11 New Zealand

residents claiming ACC compensation for NIHL each day (Thorne et al., 2008). Thorne et al. (2011) estimated that in New Zealand between 13.5% and 17.5% of hearing loss burden is due to noise exposure.

4 Health system costs

This chapter estimates individual components of health system costs, to provide an estimate of the overall health system expenditure on hearing loss in New Zealand.

Health system costs comprise the costs of running hospitals, GP, specialist and other health professional services[9], the cost of any pharmaceuticals associated with rehabilitation after surgery – such as after a cochlear implant surgery – research and other direct costs such as health administration and infrastructure. Health system costs are primarily paid for by government, but there are also other payers including substantial out-of-pocket payments and other parties such as private health insurers.

Health system costs are estimated using a combination of a bottom-up approach and top-down approach.[10]

Key findings:

- The total health system costs due to hearing loss were estimated to be $131.8 million in 2016, or $149.68 per person with hearing loss.
- The largest component of health system expenditure was estimated to be other health professionals ($78.1 million), followed by non-admitted hospital expenditure ($18.7 million) and out-of-hospital medical services ($16.6 million).
- Governments bore the majority of health system costs (83.2%), while individuals bore 10.5%, and other parties (such as private health insurers and charities) bore the remaining 6.3%.

4.1 Hospital services

Hospital expenditure data in New Zealand includes general public and private hospital admissions, as well as outpatient clinics.

The determine the expenditure associated with hospital discharges for hearing loss, the total number of case-weighted discharges was multiplied by the average case-weighted discharge cost in publicly funded hospitals.[11] The average case-weighted discharge cost for ear procedures was derived from the caseload monitoring report published by the Ministry of Health (Ministry of Health 2015c). The cost of case-weighted discharges was taken from the New Zealand Casemix Framework, which indicated the average cost weight was $4,752

[9] "Other health professionals" includes all health professionals apart from specialists and GPs,

[10] Usually data is available from relevant government agencies, such as the Ministry of Health data that pertains to relevant health expenditure associated with hearing loss. A number of District Health Boards and the Ministry of Health were contacted to determine what expenditure was reported for hearing loss. Most DHBs and the Ministry were unable to assist with this request as data were not available for hearing loss.

[11] Case weighted discharges are a measure that accounts for the complexity of a hospital procedure. By adjusting for the complexity of the procedure, it is possible to assign a cost to each procedure using a standard costing methodology.

per procedure (Ministry of Health, 2016c). Overall, the case-weighted discharge value for ear, nose and throat procedures was 0.78 – meaning that 78% of the average cost weight ($4,752), or $3,684 is applied to all ear procedures to determine the overall expenditure.

The total number of discharges for hearing loss were taken as those for the ICD codes H90, H91 and H93. Both publicly and privately funded hospital discharges were obtained for 2012-13 from the Ministry of Health (Ministry of Health, 2015a; 2015b). The hospital discharge data were available by age and gender. Overall, there were reported to be 434 discharges related to hearing loss in 2012-13 – 159 were from private hospitals and 275 from public hospitals. This was adjusted by prevalence growth between 2013 and 2016 (8.2%)**. It was estimated that there would be 470 hospital discharges for hearing loss in 2016**. Applying the cost weight for ear procedures ($3,684), **the total admitted patient hospital expenditure for hearing loss was estimated to be $1.7 million in New Zealand in 2016.**

No publicly available data reported on the use of outpatient services by people with hearing loss in New Zealand.[12] However, data from the Organisation for Economic Cooperation and Development (OECD) show that Australia and New Zealand have very similar health systems and health outcomes[13]. Accordingly data from Access Economics (2006) were used to estimate the total outpatient expenditure by applying the outpatient cost per person with hearing loss by age and gender to the prevalence of hearing loss in New Zealand. The results from Access Economics (2006) were adjusted using purchasing power parity (PPP) between Australian dollars and New Zealand dollars within the year 2001, and these were then brought forward to 2016 using health inflation. It was estimated that outpatient costs were $21.30 per person with hearing loss. Multiplying the cost per person by the total prevalence, **it was estimated that outpatient costs were $18.7 million in New Zealand in 2016**.

> Total hospital expenditure for hearing loss was defined as the sum of both admitted and non-admitted patient expenditure. Total hospital expenditure for hearing loss was estimated to be $20.4 million in 2016.

4.2 Other health professionals

Expenditure on hearing loss associated with other health professionals includes hearing tests, fitting of hearing aids and other services provided by audiologists and audiometrists.

To estimate the cost associated with other health professionals, data pertaining to the use and cost of fitting tests and consultations for hearing aids were taken from McLean (2008) and Ministry of Health (2004). An allowance was also made to include the cost of maintenance services delivered by audiologists.

[12] Deloitte Access Economics wrote to all DHBs seeking data on non-hospital costs. Two replied. One gave two examples of costs (newborn screening and community referred screening). The other said some costs could be obtained, on a cost-recovery basis, over an unspecified time frame.

[13] See http://www.oecd.org/els/health-systems/health-data.htm

McLean estimated that the total size of the New Zealand hearing aid market was approximately 36,000 units in 2007, of which approximately 74% are binaural (two aids) and 26% are monaural (one aid). McLean (2008) reported that audiologists charge $400 and $600 for fitting services for monaural and binaural hearing aids on average, respectively[14]. Thus, the average cost of fitting was reported as being $548 in 2007. This value was inflated to $692 in 2016 using health inflation.

- By way of triangulation, information obtained from the Ministry of Health by the New Zealand Consumer society shows that the average difference between wholesale and retail prices for the 24,500 hearing aids purchased with Hearing Aid Subsidy Scheme (HASS) support in 2015 was $874.[15] Most of this gap is the cost of services, however some audiologists may also charge mark-up component on the price of the device.
- While fitting services account for a large component of the total costs of hearing aids, it appears to be money well spent. New Zealanders have very low rates of hearing aid disuse – the ACC (2015) reported that only 4% used their hearing aids for less than an hour a day. The Hearing Instrument Manufacturer and Distributors Association (HIMADA) advised during consultations[16] that this is because the fitting fee charged by New Zealand audiologists covers as many follow up appointments as it takes to get customers happy with their devices.

The total number of hearing aid units is derived later in this report (see section 6.1). HIMADA stated that there were 56,482 hearing aids sold in New Zealand in 2016. **Overall, it was estimated that the total fitting service costs for hearing aids in New Zealand would be $39.1 million in 2016**.

Additionally, consultations revealed that for each hearing aid sold in New Zealand, there are approximately **three additional hearing tests, or an estimated 169,446 people requiring hearing tests (=56,482 * 3)**.[17] McLean et al (2008) reported that the average cost of an initial consultation was $80 in 2007. This was inflated to 2016 using health inflation. **The total cost of hearing assessments was estimated to be $17.1 million in New Zealand in 2016**.

HIMADA also reported that most hearing aids are serviced on an annual basis – i.e. other than new sales. Audiologists and audiometrists are also responsible for providing maintenance services for hearing aids. Deaf Education Centres maintain children's hearing aids and provide batteries, free of charge.

No New Zealand specific maintenance costs were identified. However, in Australia, the Office of Hearing Services funds private contractors to conduct annual maintenance on hearing aids (including battery replacement) at $70.25 for monaural and $186.05 for

[14] Fitting services includes diagnostics, testing, subsequent reviews, and resolving issues as they arise.

[15] https://www.consumer.org.nz/articles/news-hearing-costs.

[16] See Appendix A for a list of consultations.

[17] The NZ Audiological Society stated that about half of the people who get a free hearing test are found to have 'aid-able' hearing then proceed to pay for hearing diagnosis, but only 1 in 3 of these then proceed to get a hearing aid.

binaural in 2016.[18] The average cost would be approximately $165.30 in New Zealand after adjusting for exchange rates and the binaural/monaural split (see section 6.1).

A hearing aid battery survey conducted by Audiology Online[19] showed that batteries were lasting anywhere from 3 to 10 days (size 10), 3 to 12 days (size 12), 6 to 14 days (size 13) and 9 to 20 days (size 675).

As in section 6.1, maintenance services for 2016 were estimated by taking the total size of the hearing aid pool older than one year, and they were assumed to be serviced annually. That is, roughly 132,188 hearing aids are serviced annually (=188,670 total hearing aids minus 56,482 new hearing aids).

The total cost of maintenance services provided by audiologists or audiometrists was estimated to be $21.9 million in New Zealand in 2016 (= 132,188 * $165).

Finally, audiologists would be responsible for delivering the audiological diagnostic and intervention services within the Universal Newborn Hearing Screening program. Hearing loss screening services are available at birth for all children in New Zealand. The National Screening Unit of the Ministry of Health is responsible for screening hearing in newborns at birth.

The National Screening Unit publishes monitoring reports with key indicators, including the number of children and percentage of children who are screened (Ministry of Health, 2016d). In 2014, 93.3% of all children born completed a hearing assessment. Costs are also associated with whether children were then referred to an audiologist for follow-up hearing assessment. Approximately 2.2% of all children born in 2014 were referred to an audiologist for additional assessment. **Applying these ratios to the total number of children born in 2016 (59,580), it was estimated that 55,578 children completed screening for hearing loss, and a further 819 were referred to an audiologist and completed a follow-up assessment**.

The costs of screening have been estimated by Young Futures (2014) for the Ministry of Health. Young Futures (2014) estimated that the cost of the screening program was approximately $59,575 per 1,000 children screened. This was inflated to 2016 using health inflation. **It was estimated that the total screening cost for children was $3.4 million in New Zealand in 2016**.

Expenditure for other health professionals associated with hearing loss was calculated as the sum of hearing assessments and fitting costs conducted by audiologists and audiometrists. Total expenditure for other health professionals was estimated to be $78.1 million in New Zealand in 2016.

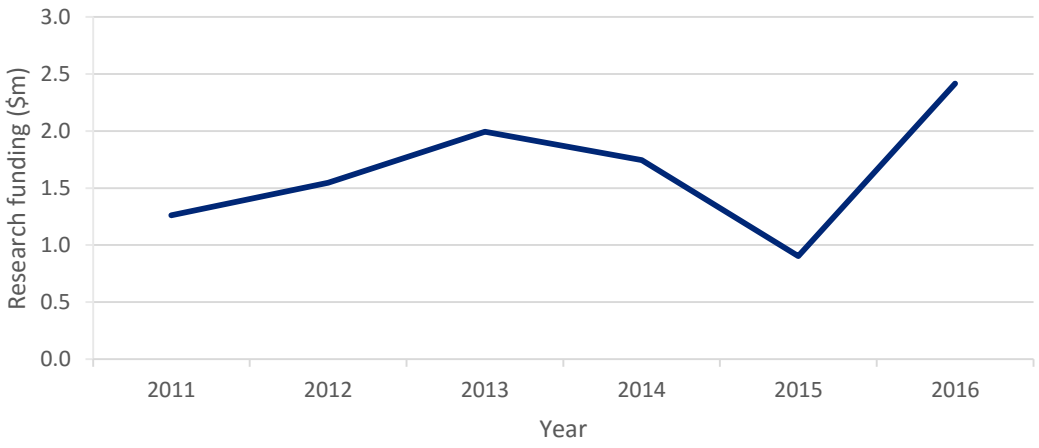
[18] http://hearingservices.gov.au/wps/wcm/connect/hso/edaa4626-079e-460b-9cc4-a423063085a9/Final+Schedule+of+Fees+2016-2017.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=edaa4626-079e-460b-9cc4-a423063085a9

[19] http://www.audiologyonline.com/articles/rayovac-hearing-aid-batteries-important-12293

4.3 Research

Research costs are based on the Health Research Council of New Zealand (HRC) and other sources of research funding over the last six years. Based on advice from the Foundation, HRC, other public research funding agencies, not-for-profits and commercial sources have funded a total of $9.9 million worth of grants towards hearing research since 2011. In 2016, research funding totalled $2.4 million. This has been used as the estimate for research in this costing analysis. Research funding pertaining to hearing are shown in Chart 4.1.

Chart 4.1: Grants for hearing research 2011-2016



Source: Personal Communication, The National Foundation for the Deaf.

4.4 GPs, specialised medical services, and other health system costs

There are limited data in New Zealand in relation to service usage for out-of-hospital medical services, pharmaceuticals, research and other health system costs for people with hearing loss. As such, the estimates for these aspects of the health system are based on the per person expenditure estimated in Access Economics (2006). These costs include specialists for hearing services.

Table 4.1 presents the per person expenditure in 2016 dollars for each additional health system aspect, along with the total estimated expenditure. These costs were modelled with age and gender breakdown, so the total reflects the prevalence in 2016.

- Pharmaceuticals in Access Economics (2006) were mainly non-prescription medications for children. These can include antibiotics for middle ear infections, and steroids to reduce inflammation.
- Medical imaging can be used to identify structural causes of hearing loss, such as shape of the inner ear, tumours and enlarged vestibular aqueduct syndrome. It can also be useful in to determine if hearing loss is caused by bacterial infection or auto-immune diseases.

- Other soft consumables such as swim plugs for children with grommets are hidden costs

Table 4.1: Other health system expenditure, 2016

Other health sector	Per person costs (2016$)	Total expenditure ($ million)
GPs	1.7	1.5
Pathology & imaging	0.2	0.2
Specialist	17.0	14.9
Pharmaceutical	6.6	5.8
Total other expenditure	**25.5**	**22.5**

Source: Deloitte Access Economics calculations.

Overall, Access Economics (2006) estimated that $25.50 per person was spent on out-of-hospital medical services, pharmaceuticals, research and other health system costs such as capital and administration for people with hearing loss.

Multiplying these values by the estimated total prevalence in New Zealand, **it was estimated that $22.5 million was spent on GP and specialised medical services for people with hearing loss in New Zealand in 2016**.

4.5 Cochlear implants

The NZ Government invests sustainable funding of $8.4 million each year to support up to 16 newborns, 30 children and 40 adults to receive cochlear implants.[20] The Northern Cochlear Implant programme reportedly serviced 19 private cochlear implants in 2015, with the Southern Cochlear Implant programme providing a total of 7 privately funded cochlear implants in this same year.[21] Adults from both programmes are required to fund their own spares and repairs, with the only item being cost-free being their processor upgrade which is done once every 7 years if funding is available, or the processor is deemed to be uneconomic to repair prior to 7 years.

4.6 Aged care

As there was no publicly available information on the number of people with hearing loss requiring aged care, a literature search was undertaken to identify any additional need for aged care in people with hearing loss. No studies were identified that discussed aged care in people with hearing loss, which suggests that people with hearing loss are not substantially more likely to require aged care. This is similar to the results from Access Economics (2006), which suggested that aged care was less than 1% of all health system costs for hearing loss. As such, no estimates for aged care costs are included in this report. It is worth noting that while no aged care costs are attributed to hearing loss, this naturally does not mean that people with hearing loss do not use aged care services. Rather, it is worth noting, this may reflect a gap in residential aged care services as they may have many

[20] https://www.beehive.govt.nz/release/cochlear-implants-programme-delivers-results

[21] Personal communication, 2016.

residents with hearing loss, without hearing aids and hence they could in theory be providing hearing support on top of usual support for daily living.

More research is needed to provide better data in relation to this cost item.

4.7 Summary of health system costs

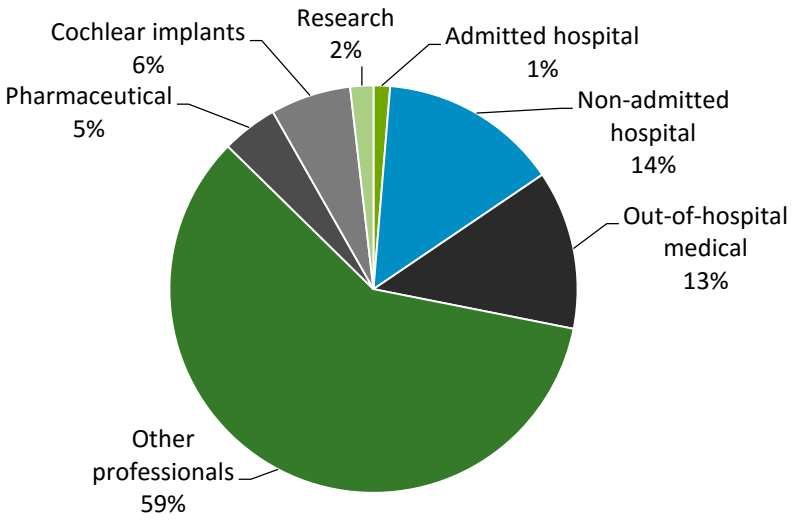
Total health system costs associated with hearing loss in New Zealand were estimated to be $131.8 million in 2016 (Table 4.2 and Chart 4.2). The largest component was associated with other health professionals ($78.1 million), followed by non-admitted hospital ($18.7 million). Cochlear implants represented around 6.4% of the total health system expenditure. It was not possible to allocate cochlear implants to the respective health sectors although this would be predominately shared by hospitals, other professionals and out-of-hospital-medical.

Table 4.2: Health system costs by sector, total and per person, 2016

Health expenditure sector	$ (million)	Per person ($)
Admitted hospital	1.7	1.96
Non-admitted hospital	18.7	21.25
Other professionals (audiologists and audiometrists)	78.1	88.66
Out-of-hospital medical (e.g. imaging, pathology, other medical specialists including GPs)	16.6	18.88
Pharmaceuticals	8.4	9.54
Cochlear implants and associated expenses	5.8	6.64
Research	2.4	2.74
Total health system expenditure	**131.8**	**149.68**

Note: Per person is total national cost divided by total persons with hearing loss
Source: Deloitte Access Economics calculations.

Chart 4.2: Health system expenditure by sector, 2016

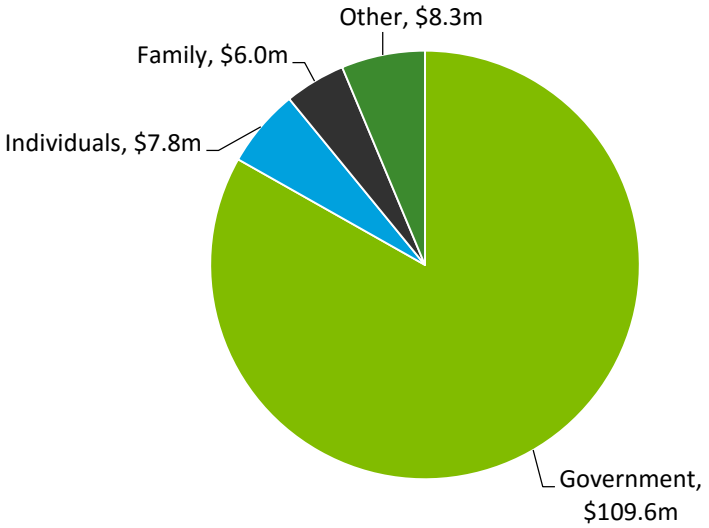


Source: Deloitte Access Economics' calculations.

Chart 4.3 presents estimates of the cost for different sectors of society based on data from the Ministry of Health (2012a). In 2016, hearing loss was estimated to cost:

- government $109.6 million;
- individuals and families $13.8 million; and
- other parties (such as private health insurers) $8.3 million.

Chart 4.3: Health system expenditure by who pays, 2016



Source: Deloitte Access Economics calculations using Ministry of Health (2012).

5 Productivity and other financial costs

This chapter describes the approach that was used to estimate productivity costs associated with hearing loss in New Zealand. Broadly, the costs included here cover lost productivity for people with hearing loss, and lost productivity for people who care for people with hearing loss.

Key findings:

- The productivity loss in individuals with hearing loss is $552.4 million in 2016, or $627 per person with hearing loss. Individuals ($298.9 million) and government ($215.4million) bear most of these costs. The productivity cost is largely due to losses as a result of reduced employment ($387.1 million).
- The productivity loss due to informal care was $100.5 million in 2016, or $114 per person with hearing loss. Individuals bear most of these costs ($61.3 million), with government bearing the rest ($39.2 million). Each informal carer is estimated to provide 5.2 hours of care per week to people with hearing loss.

5.1 Productivity costs

Hearing loss can have a significant impact on an individual's ability to work. This may include a reduced chance of employment; premature retirement; a greater number of sick days of leave than average due to caring for one's condition; and even a diminished capacity to be productive at work, due to impaired ability or psychological stresses. As such, hearing loss may incur a range of productivity costs not only to the individual but also to their employers and the economy in general.

This section provides an analysis of the productivity costs associated with hearing loss, in particular the costs associated with reduced employment, absenteeism, and impaired ability at work, known as presenteeism. We adopt a human capital approach to the estimation of productivity losses. This involves the calculation of the difference in employment between people with hearing loss and that of the general population, multiplied by average weekly earnings (AWE). Furthermore, any productivity losses from premature retirement are estimated in terms of the net present value of the future income streams lost. Similarly, costs incurred through absenteeism and/or presenteeism are derived by multiplying the average number of weeks, as converted from the number of days and hours respectively lost, by AWE.

5.1.1 Reduced employment

Hearing loss may have a considerable impact on an individual's chances of employment, resulting in reduced employment either through disadvantages in job-seeking or self-selection out of the labour force. This can lead to significant productivity losses, in the form

of wages lost from employment that would otherwise have been gained, in addition to other costs to the individual, such as diminished social engagement.

In their study on disability and work participation in New Zealand, Jensen et al (2005) used data from Statistics NZ's 2001 Disability Survey to estimate the impact of people's disabilities on their employment outcomes. An additional procedure was utilised to estimate the size of "counterfactuals" (i.e. what the employment outcomes would have been for disabled people if they had not had disabilities) in order to best gauge the magnitude of this impact. As part of this process, results were also controlled for the demographic variables that made the largest independent contribution towards explaining variation in the outcome variables. These variables were gender, marital status, having dependent children, age, ethnicity and qualifications.

Based on this analysis, Jensen et al (2005) found that while 63% of people with a hearing disability were employed either full-time or part-time, expected employment for this group would have been 73% in the absence of their hearing disability. **This reflects a significant decrease in the likelihood of employment, due to hearing loss, of 10%.** While more recent data from Statistics NZ are available from the 2013 Disability Survey, in the absence of similar adjustments made to the 2013 results, the findings from Jensen et al (2005) represent the most up-to-date and country-specific estimates currently available that are controlled for confounding factors.

A literature review was conducted to triangulate these findings. A summary of the results found in the literature scan is included in Table 5.1.

Table 5.1: Summary of results pertaining to the impact of hearing loss on employment

Reference	Country	Relationship
Mohr et al, 2000	United States (severe to profound hearing loss)	Labour force participation gap^ – 18% (18-44), 19% (45-64), 6% (65 and older)
O'Neill, 1999	United States	Employment gap* - 8%
Ruben, 2000	United States	Employment gap - 10.4% (difficulty hearing), 24.4% (unable to hear)
Rydberg et al, 2010	Sweden	Employment gap - 15%
SDAC, 2012	Australia	Employment gap - 17.3%

Note: ^ Labour force participation gap is calculated in the following manner: general labour force participation rate minus labour force participation rate of individuals with hearing loss.
* Employment gap is calculated in the following manner: general employment rate minus employment rate of individuals with hearing loss.

As demonstrated in the table above, the findings of Jensen et al (2005) are largely supported by the studies identified, all of which similarly found a disadvantage to people with hearing loss in the labour market. While the respective magnitudes of this effect differed for each study, the Jensen et al's (2005) estimate of a 10% employment gap falls well within the range of the results reported by the identified studies (6% to 24.4%).

In their study on the impact of severe to profound hearing loss on employment outcomes, Mohr et al (2000) identified differences between the labour force participation rates of people with severe to profound hearing loss and the general population for three specified

age brackets, with labour force participation gaps ranging from 6% for individuals aged 65 and older to 19% for individuals aged between 45 and 64.

In his analysis of data from the 1994 National Health Interview Survey of Disability, O'Neill (1999) compared quality of life outcomes between Americans with hearing loss and the general population. He identified 8% lower rates of labour force participation and employment for people with hearing loss, noting that approximately 67% of the working-age population with hearing loss was employed, in comparison to 75% of the population without.

In his study of the economic impact of communication disorders on the US economy, Ruben (2000) analysed 1997 data from the US Department of Labor and compared employment outcomes between individuals with hearing loss and the general working age population. In comparison to the general working age population who reported an employment rate of 74.8%, working age individuals who either had difficulty hearing or were unable to hear reported employment rates of 64.4% and 50.4% respectively, i.e. groups of 10.4% to 24.4% respectively.

In their study on the position of deaf people in the Swedish labour market, Rydberg et al (2010) analysed the employment outcomes of a sample of 2,144 congenitally deaf individuals with those of a comparable sample of 100,000 randomly chosen individuals. Rydberg et al (2010) found that while 63% of the study's deaf population were employed, this figure was 78% for the reference population, resulting in an employment gap of 15%.

Estimates derived from data taken from Australia's 2012 Survey on Disability, Ageing and Carers (ABS, 2013) reported a similarly large employment gap of 17.3% between people with hearing loss and the general population.

> As demonstrated by the literature, hearing loss can have a negative impact on an individual's likelihood of employment. As derived in Jensen et al (2005), the estimated **employment gap of 10%** has been used as the foundation of our analysis of the productivity costs of reduced employment due to hearing loss.

The employment gap estimated in Jensen et al (2005) was for a sample of people with hearing loss that imposes disability as measured in the 2001 Household Disability Survey. As such, the employment gap is expected to only occur for those with moderate or worse hearing loss. It is estimated that there were 9,302 people not employed due to their hearing loss in New Zealand in 2016, of whom almost 75% are male.

Applying this to the New Zealand general employment rates and average weekly earnings by age and gender (Statistics NZ, 2015; Statistics NZ, 2015c), **the total economic cost associated with reduced employment was estimated to be $387.1 million – or $440 per person with hearing loss**.

5.1.2 Absenteeism

Absenteeism is defined in the literature as the average number of days per year that an employee takes off work as a result of their hearing loss. This can incur a significant

productivity cost to employers if absenteeism rates for employees with hearing loss are higher than those for their employees without hearing loss.

A literature scan was conducted to find relevant data regarding the relationship between hearing loss and absenteeism. As noted in a systematic literature review by Friberg et al (2012), there exist limited studies on the impact of hearing loss on absenteeism. While there are a variety of studies on the impacts of different conditions associated with hearing loss, such as otitis media and Ménière's disease, far fewer were identified on the impacts of hearing loss in particular. This may be attributed to the inconspicuous nature of the symptoms associated with hearing loss, which do not require sick leave to manage in the typical fashion that other more acute or episodic conditions do. This is reflected in hearing loss often being known as an 'invisible disability'.

However, in their study of supports required by employees with chronic diseases in the workplace, Detaille et al (2003) identified that employees with hearing loss were particularly affected by the psychological toll of their condition. This was reflected in an identified need for more emotional forms of support, such as workplace support and acceptance and awareness of their limitations, in addition to material supports, such as reimbursement for hearing aids. Similarly, in their study of data from the Dutch national Longitudinal Study on Hearing, which included self-reported data on psychological work characteristics, Nachtegaal et al (2009) found a significant association between hearing status and the need for recovery after work. For every dB SNR (signal to noise ratio) worsening hearing status, they identified an increase of 9% in the need for recovery after work. This effect was attributed to the psychological stresses associated with working with hearing loss, such as the extra effort and concentration required to communicate with normally-hearing colleagues, essentially imparting a 'double workload' on hearing-impaired employees.

A number of studies, which identified the specific impact of hearing loss on absenteeism, were found as part of the literature scan. Their results, which largely support the findings described above, are summarised in Table 5.2.

Table 5.2: Summary of results pertaining to the impact of hearing loss on absenteeism

Reference	Country	Average difference in sick days*
Joore et al, 2003	The Netherlands	0 days
Kramer et al, 2006	The Netherlands	20.3 days
Nachtegaal et al, 2012	The Netherlands	3.5 days

Note: * Difference in sick days is calculated in the following manner: average number of sick days taken by individuals with hearing loss minus average number of sick days taken by individuals without hearing loss over the course of a year.

In Joore et al (2003), a study was undertaken among 80 moderately hearing-impaired first-time hearing aid applicants over the course of 25 weeks in the Netherlands, focusing on the impact of hearing aid fittings on societal and quality of life outcomes. Analysis of the two groups was not controlled for any confounding factors. Analysis of the ten employed individuals in this sample found no difference between absence from work before and after hearing aid fitting. However, a sample size of ten is extremely small.

A study by Kramer et al (2006) of hearing loss in the Netherlands surveyed the work-related outcomes of 150 hearing-impaired employees and 60 normally-hearing employees. While the data were not controlled for any confounding factors, both groups were found to be highly comparable in terms of age, gender and educational level. They identified a significant difference between the average number of days of sick-leave taken in a year by hearing able individuals (6.0 days) and those with hearing loss (26.3 days). Participants were required to codify their sick leave either as due to "mental distress" (e.g. burnout, stress, fatigue) or to "other reasons" (e.g. an operation, a cold, other illness). While approximately 50% of both populations reported sick leave due to "other reasons", a significantly larger proportion of employees with hearing loss (26%) attributed their sick leave to "mental distress" than that of their hearing able colleagues (7%). As such, the relative difference in average sick days taken between both populations reflects the number of sick days taken due to stress-related factors associated with hearing loss, in line with the findings in the literature. Given the significant magnitude of this result and the possible attribution of this effect to a variety of other, omitted factors, the result from Kramer et al (2006) was excluded from our estimates.

In another study situated in the Netherlands, Nachtegaal et al (2012) surveyed 1,295 adults and reported far smaller differences between the amounts of sick leave taken by those with hearing loss and their hearing able colleagues. All analysis was adjusted for relevant confounders, including age, gender, educational level, and the presence of other chronic conditions. Of those who were in the "Good" National Hearing test category, employees reported an average of 3.1 days of sick leave in the past four months. Conversely, those in the "Insufficient" and "Poor" categories reported only slightly higher averages of 4.4 and 4.1, respectively, resulting in an average number of sick days for employees with hearing loss of 4.3 days, a difference of one to two days (rounded) over four months or three to five days over a year. The annual estimate overall was 3.5 days absent due to hearing loss.

In order to identify an estimate for the impact of hearing loss on absenteeism, the results of the study by Nachtegaal et al (2012) were used as it was the largest and most representative and well-constructed study. .

> Based on adjusted findings from the literature, it was estimated that **an individual with hearing loss takes an average of 3.5 days of sick leave per year** due to that loss.

Applying the number of sick days to those who are employed, it was estimated that there were approximately 4,070 additional sick days in 2016 due to hearing loss. Approximately 72% of these were taken by males, which reflected their higher employment rates.

Applying this to the New Zealand general population employment rates and average weekly earnings by age and gender (Statistics NZ, 2015; Statistics NZ, 2015c), **the total economic cost associated with absenteeism was estimated to be $66.7 million – or $76 per person with hearing loss**.

5.1.3 Presenteeism

Presenteeism refers to the average number of hours per day that an employee loses to reduced performance or impaired function as the result of their condition. As

presenteeism is not as readily apparent as absenteeism, its prevalence and effects may not be as easily discerned. However, presenteeism can have the potential to incur significant costs to employers by reducing the quality of work produced by employees or the efficiency with which it is performed. Relative to absenteeism, presenteeism may occur more frequently and have a larger effect (Van den Heuvel et al, 2010).

A literature scan was conducted to find relevant data on the impact of hearing loss on presenteeism. Due to the relative infancy of this area of study in academia, limited data on presenteeism were available. Two studies were found regarding the relationship between hearing loss and presenteeism. In Van den Heuvel et al (2010), logistic regression analysis was used to identify the association between problems with hearing and low performance at work. Analysis produced an odds ratio of 1.17, suggesting that hearing loss was positively associated with presenteeism. Presenteeism was assessed using three questions (i.e. "I achieve all objectives of the job", "job-related tasks come easily to me", and "I perform well in my job"), with answers ranked on a 5-point scale and a sum score calculated as a result. Given the relative subjectivity of these answers and an inability to translate these scores into a measure of time, a decision was made to exclude van den Heuvel et al's (2010) results from our presenteeism estimate.

In Nachtegaal et al (2012), self-reported productivity was collected from the study's survey sample, using the World Health Organisation Health Performance Questionnaire (HPQ). Differential work productivity, which measured each employee's perception of their own performance against their perception of the performance of the average employee, was found to be higher for employees in the "Good" National Hearing test category, at an average of 0.32, than for employees in the "Insufficient" and "Poor" categories, who reported averages of 0.18 and 0.04 respectively. Relative productivity was calculated for each of the categories and a weighted average produced for the "Insufficient" and "Poor" categories. In comparison to the "Good" score of 1.04, the average score for relative productivity for "Insufficient" and "Poor" was found to be 1.02.

> Based on calculations made to data from Nachtegaal et al (2012), it was estimated that hearing loss leads to a small increase in presenteeism, resulting on average in a **3% (=1.02/1.04-1) decrease in productivity** relative to that of a employee without hearing loss.

Applying the relative reduction in productivity to those who are employed, it was estimated that approximately 2,366 productive days would be lost in 2016 due to hearing loss.

Applying this to the New Zealand general population employment rates and average weekly earnings by age and gender (Statistics NZ, 2015; Statistics NZ, 2015c), **the total economic cost associated with presenteeism was estimated to be $98.4 million – or $112 per person with hearing loss**.

5.1.4 Other productivity costs

Other productivity costs include premature mortality and administrative costs such as search, hiring and training costs associated with replacing hiring a new worker earlier than planned. No mortality was attributed to occur due to hearing loss, and consequently, there are no costs associated with premature mortality.

5.1.5 Summary of productivity costs

Productivity costs are summarised in Table 5.3. The total productivity costs in people with hearing loss are estimated to be $552.4 million annually. This is equivalent to $627 per person with hearing loss.

The vast majority of productivity costs are associated with reduced employment opportunities for people with hearing loss ($387.1 million), and reduced productivity while at work ($98.5 million). This does not include the substantial carer costs associated with informal care (discussed further in section 5.2 – although this is also a productivity loss).

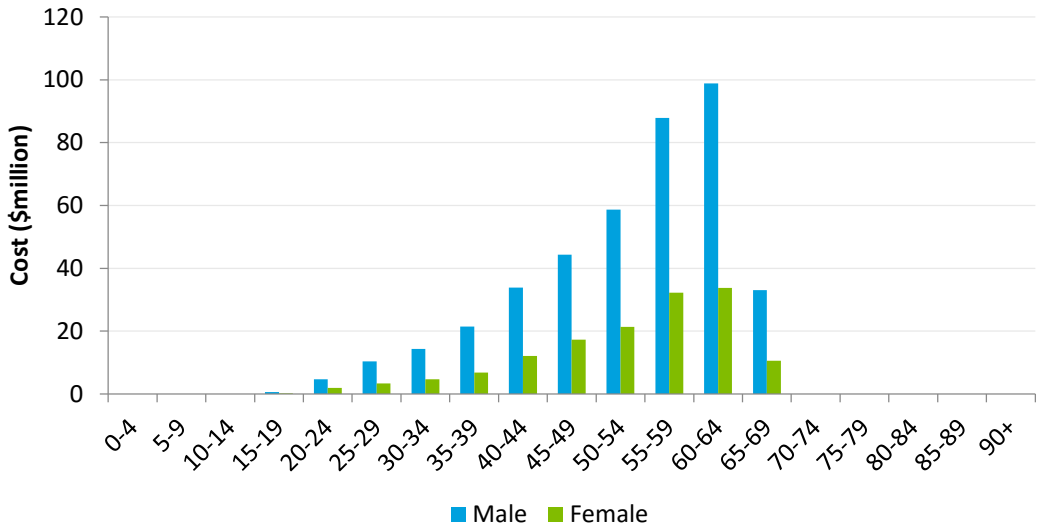
Table 5.3: Summary of productivity costs for people with hearing loss

Source of productivity loss	2016 $m	Per person ($)
Reduced employment	387.1	440
Temporary absenteeism from work (including management time)	66.8	76
Presenteeism (reduced productivity at work)	98.5	112
Total	**552.4**	**627**

Source: Deloitte Access Economics' calculations.

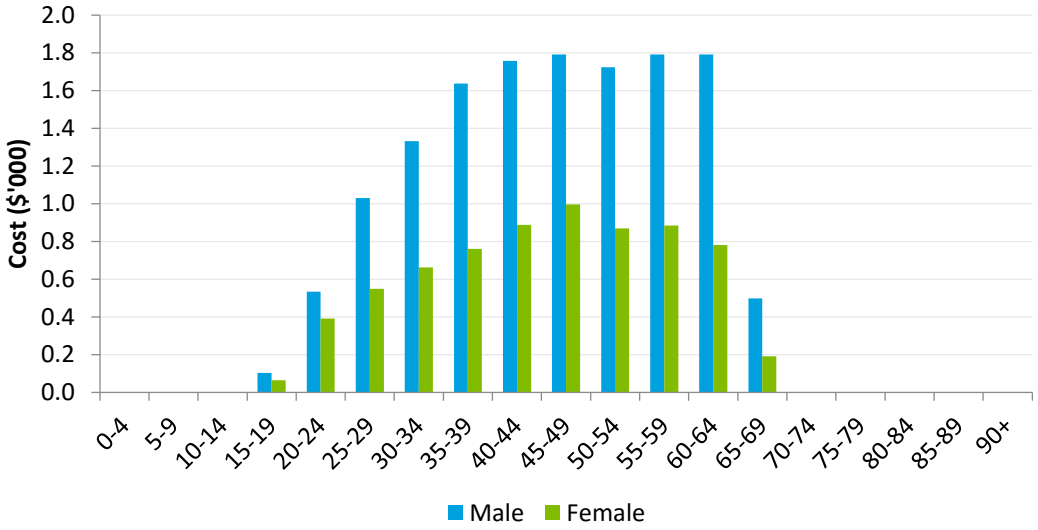
As shown in Chart 5.1 and Chart 5.2, the overall costs and the average productivity cost per person with hearing loss differs vastly by age and gender. Males have higher associated productivity costs, which reflects their higher earnings.

Chart 5.1: Productivity costs by age and gender, 2016 $ million



Source: Deloitte Access Economics calculations.

Chart 5.2: Productivity cost per person by age and gender, 2016 $



Source: Deloitte Access Economics calculations.

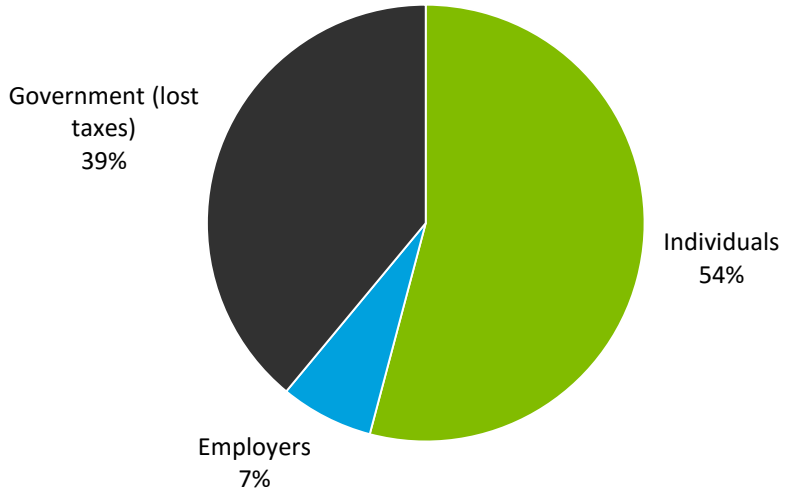
The average productivity cost per person primarily related to reduced employment. This means that costs are higher in later age groups as the lost earnings for these groups are higher.

The productivity costs are shared between workers, employers and government (through a reduction in taxable income). Post-tax, the shares of productivity losses are:

- Workers: the productivity cost of hearing loss borne by workers was $298.9 million in 2016 – this largely consists of lost earnings as a result of reduced employment, although there are small costs associated with unpaid days off work.
- Employers: the productivity cost of hearing loss borne by employers was $38.0 million in 2016 – this largely consists of reduced productivity while at work (presenteeism) and additional paid days off work (absenteeism).
- Government: the productivity cost of hearing loss borne by government was $215.4 million, which again is largely the result of reduced employment for people with hearing loss – resulting in lower taxation revenue.

The share of total productivity costs borne by each payer are shown in Chart 5.3. Employees bore the largest share of costs (54%), followed by government (39%) and employers (7%).

Chart 5.3: Productivity costs for people with hearing loss by who bears the cost, 2016



Source: Deloitte Access Economics' calculations.

5.2 Informal care costs

This section describes the approach that was used to estimate the costs of informal care for people with hearing loss in New Zealand. Carers are people who provide care to others in need of assistance or support, such as assistance with everyday activities of daily living. An informal carer provides this service free of charge and does so outside the formal care sector. An informal carer will typically be a family member or friend of the person receiving care, and usually lives in the same household as the recipient of care. As such, many people receive informal care from more than one person. The person who provides the majority of informal care is known as the primary carer.

While informal carers are not paid for providing this care, informal care is not free in an economic sense. Time spent caring involves forfeiting time that could have been spent on paid work or undertaking leisure activities. As such, informal care can be valued as the opportunity cost associated with the loss of economic resources (labour) and the loss in leisure time valued by the carer. To estimate the dollar value of informal care, the opportunity cost method measures the formal sector productivity losses associated with caring, as time devoted to caring responsibilities is time which cannot be spent in the paid workforce.[22]

To determine the amount of, and costs associated with, informal care given by carers of people with hearing loss, a literature search was undertaken to determine how many people with hearing loss receive care, the number of hours each carer provides on average, and who generally provides this care (i.e. a spouse or other family member). Who provides this care is important to ascertain, in order to correctly value the carer's opportunity cost of

[22] It is also possible to use the replacement cost method (which measures the cost of 'buying' an equivalent amount of care from the formal sector if the informal care was not supplied), and the self-valuation method (which measures how much carers themselves feel they should be paid for undertaking their responsibilities. However, these options were not explored further in this report.

time, which is calculated based AWE for age and gender groups (Statistics NZ, 2015) and the chance of being employed (Statistics NZ, 2015).

5.2.1 Recipients of care

The most recent study to identify how many people with hearing loss receive informal care was published following the 2006 Disability Survey in New Zealand, titled *"Disability and informal care in New Zealand in 2006"*. This survey showed that of people who had hearing loss that imposed the main disability, **approximately 5% of those aged 0-64 years old and 19% of 65 years old or older received informal care**. These rates are applied to the estimated prevalence of moderate and severe prevalence in New Zealand in 2016.[23]

No studies specifically identified the relationship between carers and care recipients. In the case of children, it is assumed that informal care is provided by the parent or guardian of the child. For adults, it was assumed that any additional care is provided by the spouse or partner, while for children, it was assumed that any additional care is provided by a parent or guardian. This means that the age distribution of carers is similar to the age distribution of people with hearing loss.

It was estimated that there are 41,575 people with moderate or worse hearing loss received informal care in New Zealand in 2016.

5.2.2 Hours of informal care provided

No recent literature was identified specifically for New Zealand that identified the hours of informal care provided to people with hearing loss. The best available data was from the Survey of Disability, Ageing and Carers in Australia, conducted in 2012 (ABS, 2013). The two countries are likely to be similar with respect to care hours e.g. similar levels of community services and cultural aspects that relate to care. Although there are also differences, for example Māori in NZ comprise a far larger share of the population compared with aboriginals in Australia.

Confidentialised unit record files were obtained for the Survey of Disability, Ageing and Carers, in order to estimate the additional care hours for hearing loss compared with no main condition for those receiving care from a primary carer. For people with hearing loss as a main condition, primary carers provided 22.0 hours of care each week, while for those with no main condition, primary carers provided 16.8 hours of additional care each week. This represents an additional 5.2 hours of care each week for those with hearing loss.

5.2.3 Cost of informal care

To estimate the carer costs, estimates of the number of people requiring care were multiplied by the annual hours of care provided (5.2 hours on average per week x 52.1 weeks), and the opportunity cost of carers' time. The total hours of care per year per person (271 hours) was multiplied by the total number of people receiving care – which was estimated to be 41,575 people with moderate or severe hearing loss. **This represents**

[23] It is noted that the more recent 2013 Disability Survey also collected information on informal care, although at the time of writing this report, Statistics NZ was unable to respond to our request for more up to date data.

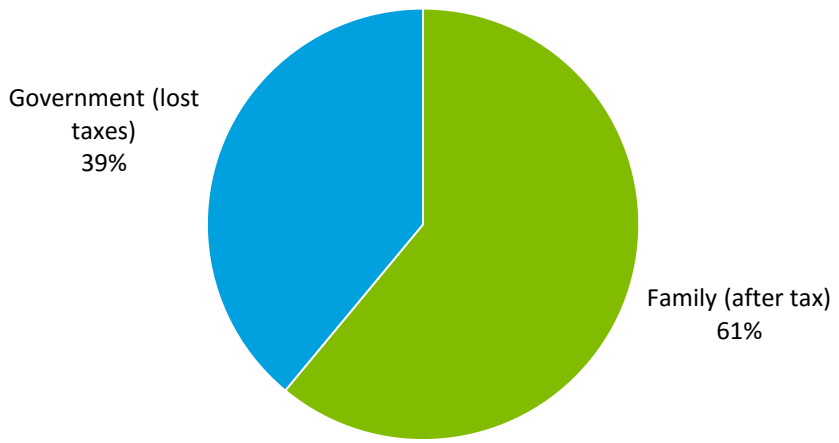
approximately 11.3 million hours of care to people with hearing loss in New Zealand during 2016.

Multiplying these hours by AWE (by age and gender) for the carers leads to an estimate of the cost of **informal care provided to people with hearing loss of around $100.5 million in New Zealand in 2016**. This represents $8.91 per hour of informal care based on an opportunity cost approach. Of the total cost:

- carers (post-tax) bore around $61.3 million (61%) in the form of lost income; and
- government bore around $39.2 million (39%) in the form of lost taxes.

The distribution of informal care costs by the respective payer is shown in Chart 5.4.

Chart 5.4: Informal care costs by who bears the cost, 2016



Source: Deloitte Access Economics calculations.

6 Other financial costs

In addition to productivity and carer costs, there can be other burdensome costs, such as the costs of special aids and modifications, costs of formal care, costs of respite for informal carers, travel and accommodation costs to access health services, the cost of other government programs, and funeral costs. There are also costs to society which result from distortionary measures in the market such as taxation – these costs are referred to as efficiency losses.

Key findings:

- Total other financial costs incurred due to hearing loss are estimated to be $95.5 million in 2016, or $108.50 per person with hearing loss.
- The largest component of other financial costs is expenditure on aids, equipment and modifications to the home for people with hearing loss. These were estimated to be $79.3 million in 2016, or $90.05 per person with hearing loss.
- People with hearing loss receive only a small amount of formal care, with data showing that people with hearing loss receive approximately 0.3 hours of formal care each week, on average. The costs associated with this are estimated to be $4.0 million in 2016, or $4.50 per person with hearing loss.

6.1 Aids and modifications

For people with hearing loss, aids and modifications can be become essential for everyday communication – allowing people with hearing loss to remain independent and included in society. Aids and modifications such as hearing aids, hearing loops and FM (frequency modulation) or remote microphone systems allow people with hearing loss to hear in a wide variety of situations where they would otherwise not be able to.

There are two ways to estimate the number of hearing aids in use, and thus annual replacement and maintenance costs. The first is using consumer data, the second is industry supply data. However the two sources do not concur.

On the consumer side, the 2001 Disability Survey (Ministry of Health, 2004) estimated that 28% of adults with (uncorrected) hearing disability used hearing aids. The usage rates were then applied to the total moderate or worse prevalence in 2016 (280,205). Overall, 80,831 people were estimated to be using hearing aids (= 280,205*0.28). Following McLean (2008) 74% of users are estimated to have two hearing aids. This yields an estimate of 140,646 hearing aids in use in New Zealand in 2016.

- Using the same source and methodology for other types of devices, 3,297 were using a hearing loop, FM or infrared system, 2,637 used a computer to communicate, and 19,614 were estimated to have made home modifications.

On the supplier side, HIMADA estimates that in 2016, sales of hearing aids were 56,482 units[24]. While undoubtedly accurate for that year, it is difficult to reconcile these figures with population estimates.

- The Government will only provide financial support for new hearing aids every six years (Ministry of Health, 2016a). Thus, if everyone was dependent on public finance, HIMADA figures imply there would be 338,892 hearing aids in use in New Zealand in 2016 (=56,482 * 6). That figure is more than double the amount of hearing aids estimated from consumer data.
- Assuming 74% are binaural, this implies 194,766 users of hearing aids (=338,892 /1.74). Compared to the estimated population with mild or worse hearing loss of 280,205 people, this implies a penetration rate of 70%. However, such a rate is implausible, given that in the UK where hearing aids are provided for free to anyone who needs them, the penetration rate in 2016 was 42% (European Hearing Instrument Manufacturers Association, 2015).
- Data from various NZ Disability Surveys implies an annual growth rate of around 5% in the number of people who could benefit from hearing aids. This suggests a growth in potential users of around 30% between 2008 and 2016. However, the increase in sales between those reported by McLean for 2008 and HIMADA for 2016 is around 60%.

The consumer and supplier based estimates can be brought closer together using a range of plausible estimates.

- The prevalence of binaural hearing aids may be conservative. Data from 3,668 consumers across seven developed countries in Hougaard (2012) from 2009, 2010 and 2011 showed the average prevalence of binaural usage was increasing by 4.5% annually. The median binaural prevalence in 2011 was 74%.[25] As New Zealand had attained this level many years ago, it is reasonable to assume that binaural use is similar to Norway or Germany at 76%.
- It is also likely that penetration rates have increased in New Zealand since 2001. In the UK, penetration rates have been increasing around 1.9% a year since 2009, and in 2015 fully 43% of those who could benefit from hearing aids have them (European Hearing Instrument Manufacturers Association, 2015). Assuming similar growth rates since 2001, penetration rates in New Zealand would be 38.3% in 2016[26].
- On the supply side, Donahue et al (2010) report that the average lifespan of a hearing aid is four to six years, depending on type. There will be some people who need MoH support and will have to wait the full six years. But there will also be those who can afford to replace their in-ear aids at the end of their four year life. (HIMADA indicated at consultations that 17% of new hearing aids are paid for by household contents insurance, it is reasonable to assume that the average age of lost hearing aids would be around three years.) Accordingly, an average of five years is used in this report.

[24] Personal correspondence, 13 October 2016

[25] Countries were Norway, Switzerland, Germany, France, UK, Italy and Japan. In Germany and Norway, 76% of users had two hearing aids. Prevalence of binaural hearing loss among HA owners in Switzerland was 77%.

[26] The average for the European countries in Hougaard (2012) was 36.1% in 2011.

Taken together, these parameters would imply there are 107,199 New Zealanders who use hearing aids, with a combined total of 186,526 hearing aids in use.[27] These figures are used in the report to estimate annual costs such maintenance, repairs and tests.

Direct sales costs, including fitting, are as per HIMADA. However, there is reason to believe that 2015 sales may incorporate a substantial spike component, rather being representative of average yearly sales. (Thus caution should be used in relying on this figure for any future updates of costs from this report.)

In the years leading up to 2014, the ACC had both been tightening access conditions and reducing payments for noise injuries. ACC expenditure claims data for a diagnosis of hearing loss increased by approximately $23.5 million between 2013-14 and 2014-15[28] (ACC, 2016). NFD raised this issue with the Health Minister, which resulted in changes whereby the ACC introduced more generous financial support and eligibility changes to make hearing aids more accessible to those with injury-related hearing loss.[29] ACC claims have no effective 'statute of limitations' – that is people can claim now for industrial noise induced hearing loss that was caused many years earlier. Accordingly, it is likely that this policy change would have led to an initial spike in claims during 2015 from a backlog of historic noise injuries that would have previously been ineligible for compensation at all, or not for sufficient compensation to purchase hearing aids.

The average cost of hearing aids was based on MoH data for 24,500 hearing aids subsidised under HASS. The average cost was $1,359 per aid.[30]

Table 6.1 reports data the estimated usage of each type of aid and modification, as well as the associated cost. Overall, **aids and modifications for people with hearing loss were estimated to cost $53.8 million** in New Zealand in 2016 – comprising $51.3 million for hearing aids and $2.5 million for communication devices and alarms, not including hearing aids and cochlear implants. The total cost of aids and modifications was equivalent to $61.11 per person with hearing loss.

[27] That is 280,205 people with mild or worse hearing loss, 38.3% of whom use hearing aids (107,199). If 76% of users are binaural, that yields 188,670 hearing aids in use (=107,199 * 1.76).

[28] http://www.acc.co.nz/about-acc/statistics/injury-statistics-tool/index.htm

[29] http://www.aucklandhearing.co.nz/hearing-aids/hearing-aid-funding-acc/

[30] As obtained by New Zealand Consumer, https://www.consumer.org.nz/articles/news-hearing-costs.

Table 6.1: Aids and modifications for people with hearing loss

Type of aid	People using aids in 2016	Price of aid in 2016 ($)	Life of aid (years)	Total cost of aids in 2016 ($m)
Hearing aid*	107,199	1,359	5.0	76.8
Hearing loop, FM or infrared system	3,297	290	10.0	0.1
Computer to communicate	2,637	1,398	6.6	0.6
Home modifications	19,614	170	7.2	0.5
Other	6,329	554	2.5	1.4
Total cost ($)				**79.3**

Source: Deloitte Access Economics calculations Based on Mohr et al (2000), NZ Inland Revenue (2015) and Disability Resource Centre (2010).
* Sales of hearing aids sources directly from HIMADA.

The aids and modification costs reported here are likely to be conservative as they do not include items such as the infrastructure required for hearing loops or FM systems to work. Data are not available on the number of buildings in New Zealand fitted with induction loops, but the cost is not likely to be large. An Australian supplier estimated that the cost of an induction loop for an average church would be around the same as for a pair of hearing aids for one of its parishioners.[31]

6.2 Telecommunications

The New Zealand Telephone Relay Service provides individuals with hearing loss with the ability to use a special phone to dial an operator such that an operator can type the response of individuals to the person with hearing loss so they can read it as text on their telephone.

The cost of providing the telephone relay service was **$2.7 million in 2016**.[32] It is anticipated that individuals will use the relay service less as mobile phone texting and captioned telephony become more popular.[33]

6.3 Formal care

Formal care can include help with childcare, housekeeping, gardening, shopping and private nursing that is not covered by private health insurance or the government. The services are generally provided by nursing aides or other paid carers. These costs are generally out-of-pocket expenses borne by individuals and their families, although some government assistance is provided through programs such as home assistance programs.

[31] http://www.hearingloopsmelbourne.com.au/wp-content/uploads/2014/04/Induction-Loops.pdf

[32] http://www.treasury.govt.nz/budget/2016/data/b16-expenditure-data.xls .

[33] Captioned telephony works by displaying what is being said on a screen without the need for an operator.

Middleton et al (2003) detail that specialist ear nurses can assist with a range of ear-related treatments and diagnoses for hearing loss. Many are mobile ear nurses that are known to visit remote communities, including Māori communities, to assist with ear conditions. Compared to visiting an ENT, the ear nurse is viewed as a more accessible and affordable method of obtaining assistance with ear conditions.

A literature search was conducted to establish whether any additional formal care was provided to people with hearing loss and if so, the amount of additional formal care in terms of hours.

Tay et al (2007) assessed the home help and community nursing needs in a sample of older Australians being assessed for aged care in Australia and found no significant association between moderate to severe hearing loss and the use of community support services after controlling for other factors. This finding is consistent with earlier work from the Blue Mountains Eye Study (Wang et al, 1999). Contrasting with this, Wilson (1997) found that people with hearing loss of all types had a significant association with "requires help for difficulty" and "domestic help required". It is assumed that this primarily relates to informal care services, estimated in section 5.2.

A study in the United States suggested an increase in nursing care requirements. Chen et al (2015) assessed the association of hearing loss with declines in physical functioning and the risk of disability in older adults in the United States. In community-dwelling adults aged 70-79 years old, hearing loss was independently associated with poorer physical functioning over a ten year follow-up period and was associated with an increased risk of disability and need for nursing care in those with moderate or greater hearing loss. Nursing care was defined as overnight admission to a nursing home, or requirement for home nursing care. Chen et al (2015) suggest that nursing care needs for people with hearing loss likely requires more long term research and monitoring of shared pathology, cognitive load and social isolation and the causality between disability and nursing requirements. This study was not included in the analysis as it related only to nursing care in the US, and the alternative study described below represented a more comprehensive source from a country with more similar community care service and funding arrangements.

Schneider et al (2010) provided one of the most complete pictures of hearing loss and the use of community services (formal care). In a sample from the Blue Mountains Eye Study in Australia, community support services were being used by 1% of people without hearing loss. Schneider undertook multivariate analysis, and adjusting for a range of confounding factors, found that people with hearing loss were significantly more likely to be using community supports – the adjusted odds ratio was 2.12, with a 95% confidence interval of 1.15 to 3.90. Applying the odds ratio to the rate of use for those without hearing loss, it was estimated that 1.1% of those with hearing loss required additional community support services to what would otherwise be required (= 1% * 2.12 – 1%).

This Blue Mountains Eye Study sample has been shown to have a mean age over 70 years with a relatively small standard deviation, and mean severity over 35 dB HL (see section 3.3). As in section 3.3, the use of community support services is applied to those over the age of 70 and with moderate or worse hearing loss.

By taking the results from the Blue Mountains Eye Study**, it was estimated that 1,811 people with moderate or worse hearing loss over the age of 70 years received formal care services in New Zealand in 2016**.

In 2015, the New Zealand Productivity Commission estimated that $217 million was spent on home-based support for older people. Approximately 10 million hours of care were supplied to around 75,000 people (New Zealand Productivity Commission, 2015). This is equivalent to approximately 2.6 hours per person per week.

Applying the estimate of average formal care hours to the number of people requiring formal care services, **it was estimated that 241,035 hours of formal care were provided to people with hearing loss**.[34]

The average cost of formal care was estimated using the average wage for a carer, which was $16.10 per hour in 2013 (Infometrics, 2014). This wage was updated for inflation and was approximately $16.50 per hour in 2016 dollars.

> Applying the carer hourly wage to the hours of formal care, it was estimated that $4.0 million was spent on formal care services for older people with moderate or worse hearing loss in New Zealand in 2016.

There are a range of services provided to those with hearing loss that were unable to be quantified in this study. This includes some early intervention services such as special education programs and childhood services and interpreter supports.

6.4 Education services

The New Zealand government directs funding of $2.84 million annually to support New Zealand Sign Language in children. This has two components[35]:

- First Signs, which involves facilitators working with families of newly identified deaf children aged 0-5 to help them learn sign language, and
- Sign language support for schools, including sign language tutors.

Early intervention services

In 2016, it was estimated that there are 5,087 children aged from 0-4 that have hearing loss. To ensure that these children are given the best start in life, there are a number of audiological and educational services available in New Zealand including:

- Newborn hearing screening programs – which has been included in health system costs in Chapter 4;

Primary and secondary education services

Though requested, we were unable to source relevant data from the Deaf Education Units.

[34] Hours of formal care = 1,811 * 10,000,000/75,000. Numbers are different due to rounding.

[35] Based on Beehive (2014) and 2016-17 Budget documents (http://www.treasury.govt.nz/budget/2016/data/b16-expenditure-data.xls)

Special education classes and programs are available for children in New Zealand schools. The New Zealand Household Disability Survey (2001) estimated that approximately 15% of children with hearing loss utilise these services. Individual Education Programs (IEP's) are also in place to which students receive a management program for how their condition will be managed at school- approximately 16% of children with hearing loss participate in the IEP program. Currently there are 125 students in deaf education centres, and an excess of 750 in regular schools (Human Rights Commission, 2013). The Ongoing Resourcing Scheme is the primary source of funding for children with special needs in schools.

The New Zealand Ministry of Health assists school children by providing assistive listening devices and NZSL resources. Students in year 7 and year 8 may also participate in a "Thumbs up" program that supports introductory NZSL courses (Human Rights Commission, 2013).

Other services include the option to obtain free assistance from a Advisors on Deaf Children (AoDC's) and Resource Teachers of the Deaf (RTD's) who can discuss support options for families and their children. For those children that identify as Māori, there is the option to meet with a Māori special education officer before meeting with an advisor (Ministry of Health, 2016). No cost data was identified with these programs, and costs were therefore not included.[36]

New Zealand has also recently moved to using large flexible learning spaces in its schools. It is not clear what the Government is spending in this regard and further research is required to establish the cost and impact of this learning environment on students with hearing loss

In addition, the Government has introduced *The Vulnerable Children's Act 2014* from which the Ministry for Vulnerable Children is expected to evolve by April 2017. Some Government funding, currently allocated to the Ministry of Education Special Education Service, is being devolved across to this new Ministry. Further research is required to establish the financial impact of this service development and its effect on the learning and social environments of children with hearing loss.

Post school education services

Students with hearing loss are attending university. Within New Zealand there were approximately 1,050 deaf and hard of hearing students enrolled in publicly funded tertiary education in 2005 (Powell, 2011).[37] Additionally, Powell (2011) noted that the Tertiary Education Commission reported that 75% of deaf and hard of hearing students study full time, with the remaining 25% studying part-time.

NZSL support is not readily available for students participating in tertiary education. The Human Rights Commission (2013) cites that deaf students must share funding support with students from all other categories of disability or impairment. This means that only a small

[36] At the time of writing this report, we have written to the deaf education centres to seek information about resources provided and the associated funding; however, no information has been provided to date, while one school responded seeking further clarification surrounding the request.

[37] To be included, students had to be registered with the tertiary provider's disability support services. Therefore, this value may be conservative.

percentage of funding will be allocated to deaf students. Also, some Universities provide notetakers who are paid as teaching assistants.

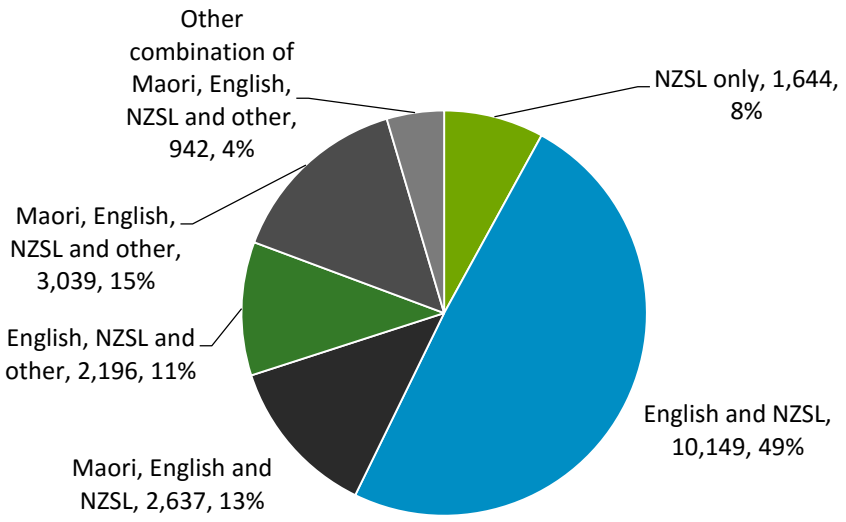
6.5 Interpreter/translator services

There are limited official data outlining the use of interpreter or translator services in NZ. Consequently, it was necessary to estimate the number of people who would use these services, the total time services were used by each person, and the cost of services. The following sections outline the methodology and estimate of the cost of interpreter or translator services.

6.5.1 New Zealand Sign Language (NZSL) use

In 2013, the New Zealand Census reported that 20,607 New Zealanders could use NZSL (Statistics NZ, 2015e). This included deaf individuals, their families, friends and interpreters. Of all deaf or hard of hearing individuals, 7,700 have been reported to use NZSL on a regular basis (Human Rights Commission, 2013). Use of NZSL and its combination with other languages are detailed in Chart 6.1. Overall, 0.04% of the sample census population use NZSL only, with 0.1% speaking a combination of English, Māori and NZSL.

Chart 6.1: NZSL usage in New Zealand, 2013



Source: Statistics NZ (2015e).

iSign (a service of Deaf Aotearoa) is the major supplier of interpreter services in New Zealand. Services are provided by more than 80 qualified NZSL interpreters contracted by iSign. Over 2015-16, demand exceeded supply for iSign services, with a total 10,766 job requests (19,266 hours) being submitted. Only 10,060 of these job requests (16,599 hours) were able to be provided. These services were provided to a total of 1,001 deaf customers. It was noted that the service gap was due to a lack of funding to cover the costs of these services.[38] Within schools, this service gap was found to be the result of interpreters not

[38] Internal communications, iSign

being covered by the Ongoing Resourcing Scheme in New Zealand (Human Rights Commission, 2013).

6.5.2 Costs and hours of interpreter support

Outside of schools, the New Zealand government directly funds $1.3 million annually towards supply of telecommunications relay services textphones and other equipment for user access to relay service platforms (including video) and the cost for administering rental of relay user equipment[39]. This also includes New Zealand Sign Language interpreters.

Other survey based research in New Zealand has found that additional services are required for those with severe hearing loss. These additional services are in the form of translator services (Disability Resource Centre, 2010). Disability Resource Centre (2010) costed additional service requirements for a range of services, finding that support related costs are primarily for communication purposes, including the use of interpreters. Disability Resource Centre (2010) estimated that 4 hours of interpreter support each week, 1 hour of note taker services each month and 2 hours of additional interpreter time each year to assist with participation in events and activities. Further, people with severe hearing loss required 2 hours of interpreter support each week for grocery shopping and 1 hour each month for personal shopping. Finally, support was also assumed for medical visits and support sessions – work related or otherwise – allowing for an additional 1 session of each per month (this is assumed to be half an hour in length).

Overall, Disability Resource Centre (2010) estimated that people with severe hearing loss would require approximately 6.6 additional hours of interpreter support each week, or around 345 additional hours each year to assist with shopping and participating in events, activities or medical visits.

Table 6.2: Interpreter support for people with severe hearing loss

Support aspect	Care provider	Hours	Time period
Participation in events/activities	Interpreter support and note taker	222.4	1 year
Grocery shopping	Interpreter support	104.2	1 year
Personal shopping	Interpreter support	12	1 year
Medical visits	Interpreter support	6	1 year
Total		**344.6**	**1 year**

Source: Adapted from Disability Resource Centre (2010).

However, Access Economics (2008), when studying utilisation of sign language in Australia, found that Auslan users were only able to obtain 50 hours of interpreter services annually. It was assumed that the supply constraints would be similar in New Zealand.

[39] http://www.treasury.govt.nz/budget/2015/estimates/v2/058.htm

The Disability Resource Centre (2010) reported that the cost of interpreter services was $60 in 2010 values. After allowing for inflation, this was multiplied by the 50 hours of support from Access Economics (2008) and by the 1,644 people who report that they only use NZSL as a language (section 6.5.1). The total cost of interpreter support was estimated to be $5.5 million.

6.6 Hearing associations

There are 27 hearing associations in locations across New Zealand. These are mostly run by volunteers, and receive no government funding. Some associations in the major cities are relatively large and employ audiologists and or audiometrists Others in remote areas can be as small as two volunteers who keep a stock of spare batteries for those who run out. Box 6.1 below illustrates the types of services provided.

Box 6.1 The Nelson Hearing Association

The Association is a non-profit organisation that receives no Government funding and relies on grants, donations, membership, product sales and room rental for funding. To the end of July 2016 the Association had a total of 6,623 contacts with the public on all hearing related topics. All the services and programmes are coordinated in the central office in Nelson city which is staffed by three part time staff. Hearing Nelson is run by a board who are all volunteers. The Association runs several programmes in the community:

- Fieldworkers go into rest homes in the Nelson/Tasman region looking after residents hearing aids in the rest home/hospital wings. They see on average 120 residents each month.
- Outreach clinics in five areas of Nelson/Tasman to service the hearing aids of those who cannot get into the city.
- A trust that funds a New Zealand Sign Language programme, in 2016, there are 6 schools and 2 kindergartens taking part in the programme.
- An Education Coordinator works with all sectors of the community; from educating babies and young children on safe listening levels to high school students and all those in between. She visits service groups to talk to them about hearing protection, hearing loss and any hearing related issue they may have[40].

6.7 Summary of other indirect costs

Overall, **other financial costs for people with hearing loss were estimated to be $95.5 million in 2016, or $108.50 per person with hearing loss**. It is not surprising that the main cost component was aids, equipment and modifications to the home. That said, there may be considerably more expenditure providing assistance to people with hearing loss by government programs such as for education support programs and other interpreter support.

[40] Source, personal correspondence, 6 October 2016

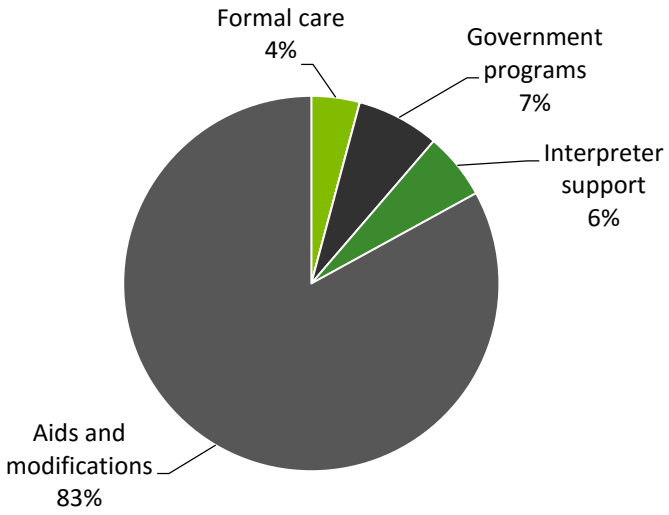
The estimated expenditure associated with other financial costs is outlined in Table 6.3. Chart 6.2 presents the other financial costs associated with hearing loss graphically.

Table 6.3: Other financial costs of hearing loss, 2016

Financial cost	Annual cost ($m)	Per person ($)
Aids, equipment and modifications	79.3	90.05
Formal care	4.0	4.52
Interpreter support	5.5	6.21
Government programs	6.8	7.72
Total	**95.5**	**108.50**

Source: Deloitte Access Economics' calculations.

Chart 6.2: Other financial costs of hearing loss, 2016



Source: Deloitte Access Economics calculations.

7 Transfers

Transfer payments represent a shift of resources from one economic entity to another, such as raising taxes from the entire population to provide welfare payments to people with hearing loss. The act of taxation and redistribution creates distortions and inefficiencies in the economy, so transfers also involve real net costs to the economy, referred to as efficiency losses.

Transfer costs are important when adopting a whole-of-government approach to policy formulation and budgeting. Transfer costs also allow us to examine the distribution of the costs of hearing loss across different parts of society.

Key findings:

- Around $14.9 million, or $17 per person with hearing loss, will be paid via welfare payments to people with hearing loss and their carers in 2016.
- Government lost $254.6 million in tax revenue as a result of hearing loss' negative impact on employee productivity, and the amount of hours of informal care that will be provided to people with hearing loss. This is equal to $289 per person with hearing loss.
- The efficiency losses associated with health system costs borne by government, lost taxes, welfare payments and other costs borne by government are estimated to be $77.2 million in 2016, or $88 per person with hearing loss.

7.1 Income support for people with hearing loss

The main source of income support for people aged less than 65 years comes from the Support Living Payment (SLP) and Jobseeker Support (JS) in New Zealand.

SLP and JS are income support payments for people who are unable to work due to their condition or another reason. JS assists people to find work and provides them with a weekly payment until this occurs, while SLP is assistance for people who have, or are caring for someone with a health condition, injury or disability (Ministry of Social Development, 2016).

A special data request was submitted to the Ministry of Social Development (MSD) to obtain information on the number of people who received either the SLP or JS as a result of their hearing loss. This data only captures the number of working age clients on a main benefit with hearing loss as a primary incapacity where they have a medical referral for hearing loss and this is their main condition. The data was provided as at 31 December 2016, reflecting the mid-point average across the 2015-16 financial year.

Across all people with hearing loss aged 15-64 years, there were 669 and 223 people with hearing loss as a primary incapacity receiving SLP and JS, respectively. More females than males were receiving support, and slightly more than half of all recipients were aged between 50 to 64 years old.

To determine the total payments made to people with hearing loss, the number of people receiving support was multiplied by the average yearly payments per person. Average yearly payments per person were calculated as total expenditure for SLP and JS, respectively, divided by the total number of people receiving each payment. The data were collected from the Ministry of Social Development (2015; 2016).

Taking the average number of people receiving payments in any one quarter, there were approximately 72,381 people receiving SLP during 2014-15, and 121,447 receiving JS during 2014-15. Total expenditure was $1.51 billion and $1.68 billion for SLP and JS, respectively. The average annual payments were therefore calculated as $20,925 per SLP recipient and $13,865 per JS recipient. These payments were adjusted using CPI.

Applying the average annual payment to the number of people with hearing loss receiving payments, it was estimated that approximately $14.0 million were paid in SLP payments to people with hearing loss in 2016, and a further $3.1 million were paid in JS payments.

It is likely that some of these people would have received DSP payments even in the absence of hearing loss (e.g. due to comorbidities), which must be netted out to estimate the additional welfare payments due to hearing loss. Jensen et al (2005) estimated that in the absence of hearing loss, 13% would be receiving any type of welfare payment based on data from the 2001 Disability Survey.

> By netting out general reliance on welfare payments, it was estimated that $14.9 million in additional SLP and JS payments were paid to people of working age with hearing loss in 2016. This is an estimated $17 per person with hearing loss, or $16,714 per recipient of SLP or JS with hearing loss, on average.

7.2 Taxation revenue forgone

People with hearing loss and their carers in paid employment, who have left the workforce temporarily due to caring responsibilities, or permanently due to premature retirement, will contribute less tax revenue to the government. As presented in the relevant sections throughout this report:

- people with hearing loss missed out on $490.1 million in wage income due to reduced productivity, unpaid absenteeism and reduced employment;
- carers lost $100.5 million in wage income due to caring for a person with hearing loss; and
- employers lost $62.3 million in productivity on account of paid absenteeism resulting from hearing loss.

Consistent with Deloitte Access Economics' standard methodology, in terms of allocating these losses to either personal income or company income, only the employer losses were included as lost company revenue, with the remainder allocated as lost personal income in one form or another. In 2016, the average personal income tax rate was 24% (NZ Treasury, 2016), and the average indirect tax rate was modelled as 15% using the current Goods and Services Tax (Inland Revenue, 2016).

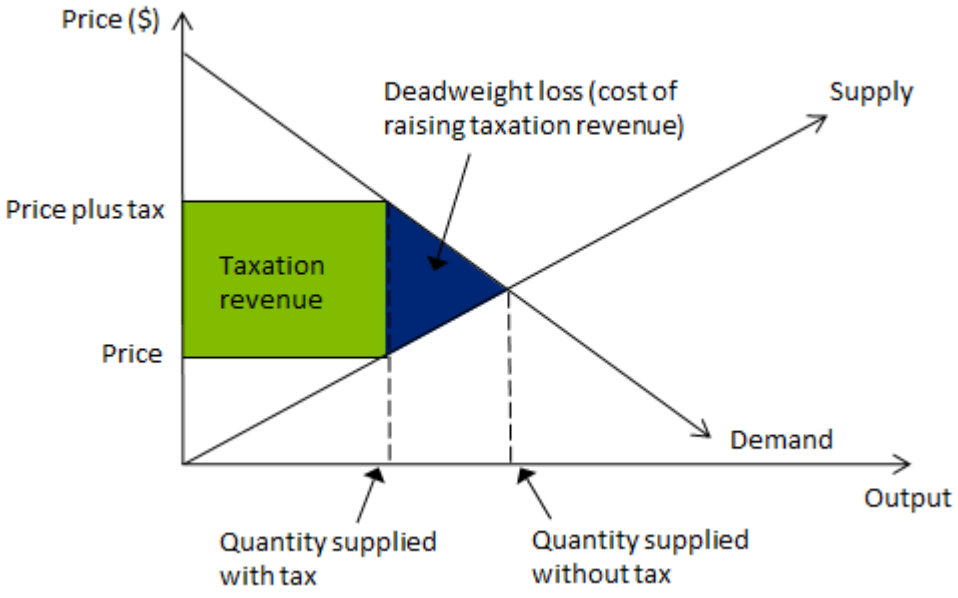
By applying the total lost wage income or business output to the marginal income tax and indirect tax rate, **the total loss of tax revenue was estimated to be $254.6 million in 2016**. This represents taxation revenue that must be collected from other parts of the economy (e.g. those that remain in the workforce) given a "no change in expenditure" assumption. That is, small tax changes are unlikely to change the level of demand for expenditure.

7.3 Efficiency loss of taxation payments and administration

Transfer payments (government payments and taxes) are not a net cost to society, as they represent a shift of consumption power from one group of individuals to another in society. If the act of taxation did not create distortions and inefficiencies in the economy, then transfers could be made without a net cost to society. However, these distortions do impose an efficiency loss on the economy.

An efficiency loss is the loss of consumer and producer surplus, as a result of the imposition of a distortion to the equilibrium (society preferred) level of output and prices (Figure 7.1). Taxes alter the price and quantity of goods sold compared to what they would be if the market were not distorted, and thus lead to some diminution in the value of trade between buyers and sellers that would otherwise be enjoyed. The principal mechanism by which efficiency losses occur is the price induced reduction in output, removing potential trades that would benefit both buyers and sellers. In a practical sense, this distortion reveals itself as a loss of efficiency in the economy, which means that raising $100 of revenue requires consumers and producers to give up more than $100 of value.

Figure 7.1: Deadweight loss of taxation



Source: Deloitte Access Economics.

The rate of efficiency loss used in this report is 20 cents per $1 of tax revenue raised (NZ Treasury, 2015). The efficiency loss rate is applied to:

- lost tax revenue from forgone earnings of people with hearing loss, their carers and employers (which must be raised from another source);
- welfare payments made to people with hearing loss and their carers; and
- government services provided (for example, the public health system, grants and programs), since in a budget neutral setting, government expenditures require taxation to be raised and thus also have associated distortionary impacts.

7.4 Summary of transfer costs

Using the rate of efficiency losses (20%), the expected total efficiency loss associated with hearing loss was estimated to be $76.9 million in 2016, or $87.31 per person with hearing loss. This is summarised in Table 7.1.

Table 7.1: Components of efficiency loss, 2016

Component of efficiency loss	2016 ($million)
Health system costs borne by government	109.6
Lost taxes	254.6
Welfare payments	14.9
Other costs borne by government*	6.8
Total transfers	386.0
Rate of efficiency loss	20%
Resulting efficiency loss	**77.2**

Source: Deloitte Access Economics calculations.
Note: * these include the cost of government programs including telecommunication services.

8 Loss of wellbeing

This chapter adopts the 'loss of wellbeing' methodology in order to quantify the impact of hearing loss on wellbeing. This methodology is used to calculate non-financial costs and instead assesses reduced health and premature mortality in terms of **disability adjusted life years (DALYs).**

Key findings:

- The economic value of lost wellbeing due to hearing loss was estimated to be $3.9 billion in 2016.
- Overall, people with hearing loss experienced 23,130 DALYs, or 0.026 DALYs per person, in 2016.

8.1 Valuing life and health

Life and health can be measured in terms of DALYs, where 0 represents a year of perfect health and 1 represents death. The DALY approach has been adopted and applied in Australia by the AIHW. Mathers et al (1999) separately identify the premature mortality (years of life lost due to premature death - YLL) and morbidity (years of healthy life lost due to disability - YLD) associated with disability due to a condition:

DALYs = YLLs + YLDs

In any year, the disability weight of a health condition reflects a relative health state. For example, the disability weight for a broken wrist is 0.18, which represents losing 18% of a year of healthy life because of the inflicted injury.

The burden of disease as measured in DALYs can be converted into a dollar figure using an estimate of the **value of a statistical life** (VSL). The VSL is an estimate of the value society places on an anonymous life. To overcome issues in relation to placing a dollar value on a human life, a non-financial approach to valuing human life is used.

As DALYs are enumerated in years of life rather than in whole lives it is necessary to calculate the **value of a statistical life year (VSLY)** based on the VSL. This is done using the formula:[41]

[41] The formula is derived from the definition:
VSL = ΣVSLYi/(1+r)^i where i=0,1,2….n
where VSLY is assumed to be constant (i.e. no variation with age).

$$VSLY = VSL / \Sigma_{i=0,\ldots,n-1}(1+r)^n$$

Where: n = years of remaining life, and
r = discount rate

NZ Ministry of Transport (2016) estimated that the VSL was $4.06 million in 2015, which was estimated to be $4.19 million in 2016 when accounting for the average growth in AWE. The average person living in NZ has 45 years of expected life remaining (Statistics NZ, 2015a), so the VLSY was estimated to be **$170,085 in 2016 dollars**.

8.2 Estimating the loss of wellbeing from hearing loss

To estimate the loss of wellbeing from hearing loss, it is necessary to determine an appropriate health weight given the severity of hearing loss. In New Zealand, the current health weights for varying severity of hearing loss come from the Ministry of Health's *New Zealand Burden of Diseases, Injuries and Risk Factors Study* (Ministry of Health, 2012). YLDs are estimated using the health states for mild, moderate and severe hearing loss multiplied by the number of people with each level of hearing loss as estimated in Chapter 3.

Table 8.1 shows the total DALYs by severity, age and gender. DALYs comprise only YLDs as there is no mortality due to hearing loss in New Zealand. Males have higher loss of wellbeing compared to females, which is mostly the result of higher prevalence in males. As people age, the loss of wellbeing increases in line with prevalence – hearing loss and severity of hearing loss both progress with ageing. **Overall, people with hearing loss experienced 23,130 DALYs, or 0.026 DALYs per person with hearing loss** (Table 8.1).

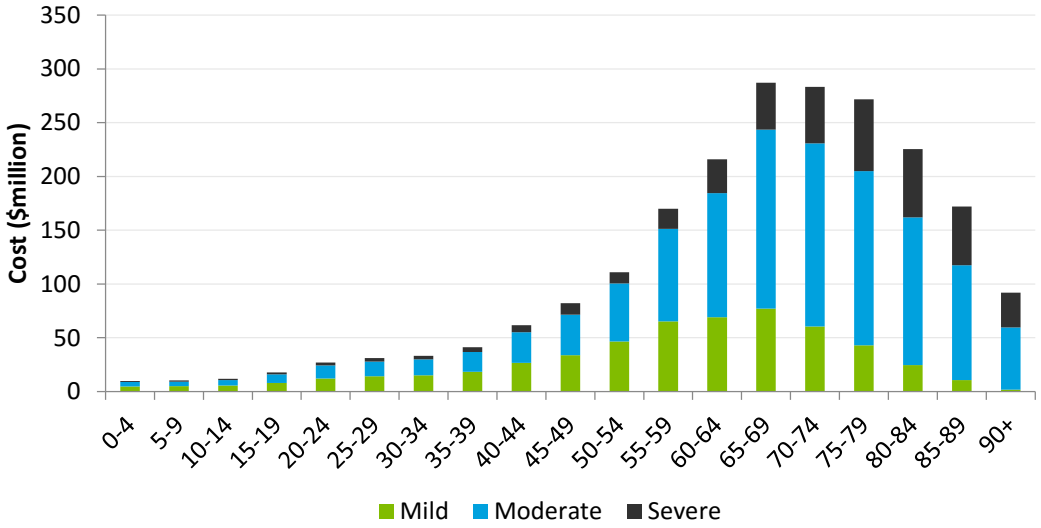
Table 8.1: DALYs due to hearing loss in New Zealand in 2016, by severity, age and gender

Age/gender	Mild	Moderate	Severe	Overall	DALYs ($)
Male					
0-9	56	50	11	117	20.0
10-19	80	76	17	173	29.4
20-29	155	152	34	341	58.0
30-39	197	195	44	437	74.3
40-49	357	388	101	846	143.9
50-59	658	823	170	1,651	280.7
60-69	859	1,659	440	2,958	503.1
70-79	607	1,956	701	3,264	555.1
80-89	208	1,435	694	2,338	397.6
90+	10	341	190	541	92.1
Male total	3,187	7,075	2,403	12,665	2,154.1
Female					
0-9	32	29	6	67	11.4
10-19	47	44	10	101	17.2
20-29	93	88	20	201	34.1
30-39	133	128	29	290	49.4
40-49	251	270	71	592	100.7
50-59	499	528	103	1,130	192.1
60-69	741	1,138	283	2,162	367.8
70-79	640	1,575	503	2,719	462.5
80-89	322	1,480	591	2,392	406.9
90+	56	525	230	811	138.0
Female total	2,815	5,805	1,846	10,465	1,780.0
Persons	**6,001**	**12,880**	**4,249**	**23,130**	**3,934.1**

Source: Deloitte Access Economics calculations.

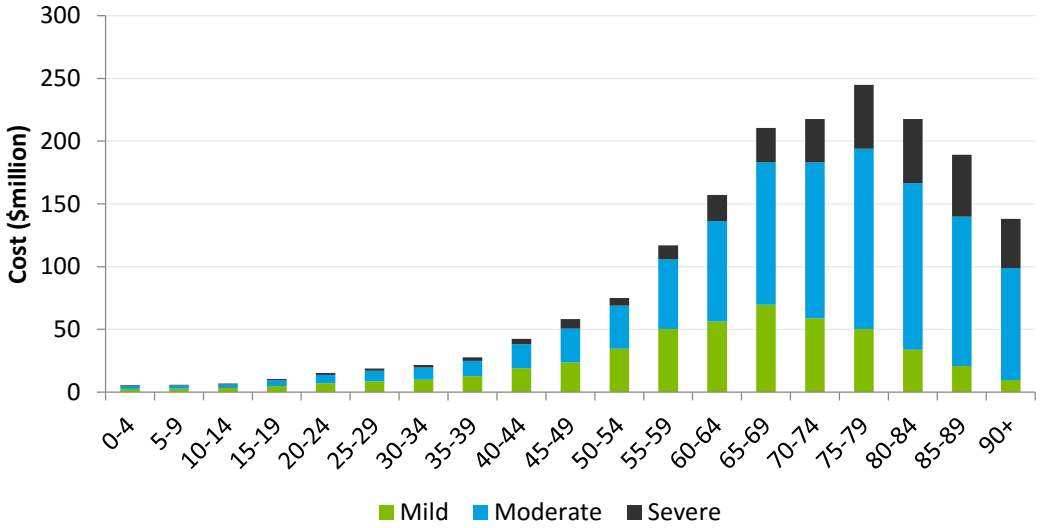
The loss of wellbeing by severity is shown in Chart 8.1 and Chart 8.2 for males and females, respectively. Loss of wellbeing increases with age for both males and females, reflecting both increasing prevalence and severity with age. The loss of wellbeing starts to decline in older age groups due to a smaller underlying population.

Chart 8.1: Loss of wellbeing by age and severity, male, $ million



Source: Deloitte Access Economics calculations.

Chart 8.2: Loss of wellbeing by age and severity, female, $ million



Source: Deloitte Access Economics calculations.

Overall, the economic value of lost wellbeing due to hearing loss was estimated to be $3.9 billion in 2016.

9 Issues accessing hearing aids and services in New Zealand

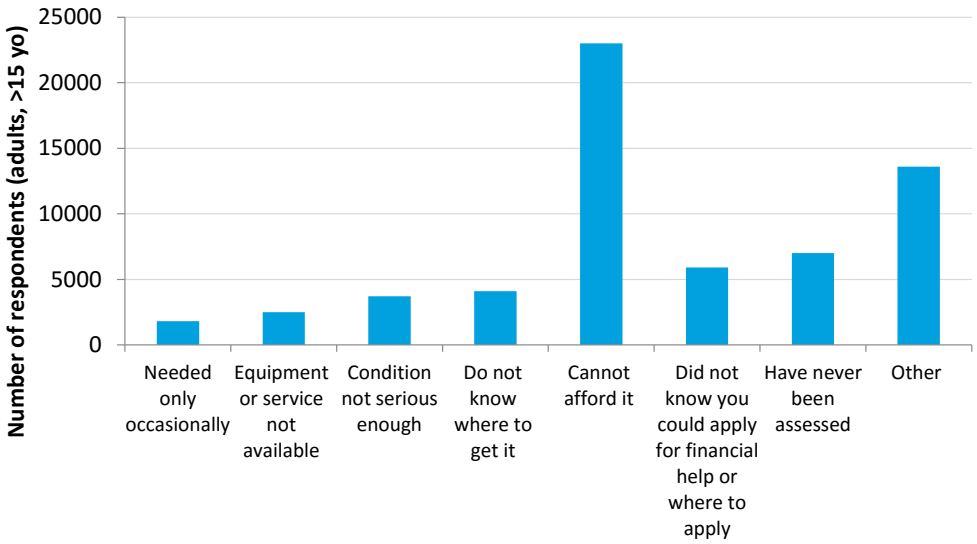
Key findings:

- The most common reason why people are unable to access services is that they cannot afford it
- There is an inefficient market with respect to hearing aid and cochlear implant services in New Zealand with many cost restrictions including large co-payments governing who can and cannot access services
- Aside from cost, other barriers to accessing services include: geography, proximity to services, psychological impacts, complicated funding methods, inadequately resourced support and advice programmes, lack of recognition and awareness, and fragmented services.

9.1 Number of people unable to access services

Approximately 80,831 people in New Zealand were using hearing aids in 2016. From the 2001 New Zealand Disability Survey, 45,100 (21%) adults with an uncorrected hearing disability living in households aged 15 years and over identified as having an unmet need with respect to equipment and services for people who are deaf or hard of hearing. Of this, 17,500 respondents were unable to obtain a hearing aid with a t-switch type of hearing aid that provides access to sound via an electromagnetic telecoil or 'loop' that can be used to improve hearing in difficult listening situations such as movie theatre or bank and (17,000), a volume control telephone (5,000) or other services (6,200). Chart 8.1 highlights the reasons why adults with an uncorrected hearing loss have been unable to access the services they need. An overwhelming proportion of respondents (23,000) reported that they cannot afford the service or device required. There has been no research done to update this data since 2001.

Chart 9.1: Reasons why respondents are unable to access the services they need



Source: Statistics New Zealand (2001)

One specific group with a high prevalence of hearing loss and poor access to services is prisoners. Hearing loss is the most prevalent self-reported sensory disability in the prison population, with one in three prisoners in New Zealand reporting some degree of hearing loss (Carroll, 2015). At present health questionnaires given to prisoners on admission do not include hearing loss, and recent audiometric testing of 100 self-referred prisoners at the Mount Eden Correction Centre found over 50 who were in need of ENT specialist or audiologist intervention.

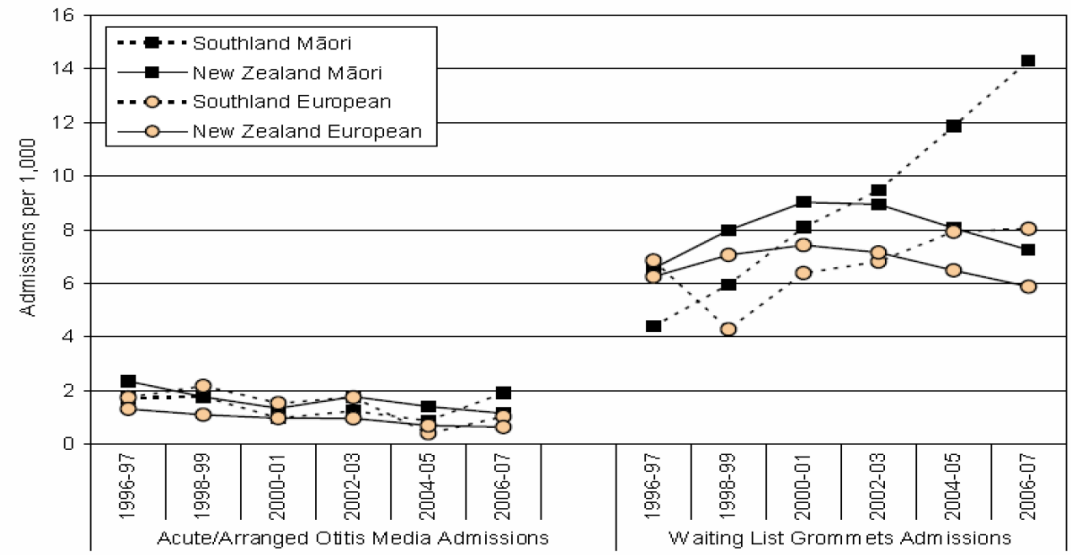
Geographic location also plays a significant role in determining an individual's access to services. Digby (2016) suggests that the range of services, FTE ratios and charging schedules of the separate DHBs in New Zealand vary significantly across locations. Charging schedules refer to whether a DHB charges for fitting fees or other part charges or not. This lack of consistency means that there is inequality of services provided throughout New Zealand, impeding access to services for some.

From the limited data available from DHBs, Māori may have more difficulty accessing services than other New Zealanders. Over the period 1997 to 2007, there was persistently a greater proportion of Māori children waiting for otitis media treatment than children of other ethnicities. Given the limited data available, this is an area that needs further research.

The average wait for cochlear implants for adults is four years (Guitar et al, 2013). This study found those on waiting lists for cochlear implants are more likely to suffer from illnesses which are potentially mediated by stress than are people who have already received implants. The authors concluded that reduction of the waiting list time for cochlear implantation could contribute to the reduction of stress-associated medical

conditions in those who have lost their hearing and thereby reduce the burden on the health system.

Chart 9.2: Waiting lists and admissions for otitis media treatment in children under 15



Source: Southern District Health Board

Enabling access to these services is of utmost importance. Other than the direct benefits of an increased ability to participate in the community, a number of other benefits can be observed from the use of hearing aids. Anovum (2012) report a number of social cost-savings from hearing aid use, including: higher personal income, positive job impacts, and significantly lower risks of being depressed and/or forgetful. Kervasdoué and Hartmann (2016) likewise note that hearing aid use reduces the negative consequences of hearing loss on healthcare expenditure, health state and patient quality of life.

Additionally, individuals included in this study reported that the use of hearing aids increases job promotion opportunities, job selection opportunities and salary increases. In support of this, 25% of respondents who had hearing loss that did not own a hearing aid reported receiving a worse salary than their peers (Anovum, 2012).

9.2 Cost pressures

Chart 8.1 identified that the main reason why New Zealand adults are unable to access services is because they are unable to afford them. Wallace (2014) identified an inefficient market with respect to hearing aid services in New Zealand. He found that the majority of publically funded audiology clinics are restricting access to adult hearing aid services. Furthermore, access has also been restricted via the introduction of a co-payment regime. Currently, 33% of public adult hearing aid clinics require patients receiving hearing aid funding to pay a large co-payment fee, with a mean value of $1,532.25 including GST (Wallace, 2014).

In light of growing co-payment fees, Wallace (2014) identifies an increasing need to address the negative externalities arising from a growing number of people being unable to afford hearing aid services. Negative externalities may pertain to lost productivity for those with

long term hearing disabilities and ultimately lost tax revenue for the New Zealand government.

Arguably, individuals requiring a cochlear implant(s) are the most significantly affected by cost pressures. Without funding, patients face growing costs to implant and maintain their cochlear implants. However, if it were possible to reduce these pressures then individuals would be equipped with the necessary technology to have greater social participation and lower levels of depression. Cohen et al (2004) argues that individuals who are given access to cochlear implants demonstrate higher levels of improvement to their quality of life as compared to individuals receiving hearing aid interventions.

Heslop (2015) reported that the Southern Cochlear Implant Programme (SCIP) is continually faced with a shortage of funding for the number of referrals they are receiving. In 2015/15 it was noted that the SCIP received 122 adult referrals but only enough funding to provide 20 implants. Whilst there is currently no significant waiting period for children, adults (post-assessment) can expect to wait between 15 and 19 months to receive a cochlear implant.

Allan (2015) found there was no statistically significant difference in income between hearing aid users and non-users in New Zealand, whereas in countries where the health system did not subsidise hearing aids, hearing aid possession is positively correlated with income. He speculated that current New Zealand government subsidy of $511.11 per ear may account for the lack of income difference between hearing aid users and non-users in New Zealand. However, this could also be because people in the workforce who need hearing aids can put off doing so until they retire and become eligible for subsidies.

According to the Ministry of Health (2016a), nearly all home contents insurance policies cover hearing aids. They do so through either the complementary provision or additional coverage of a personal articles policy, which includes items such as jewellery, art, glasses and hearing aids. Loss and damage to these items are covered by this policy.

9.3 Other issues affecting access to services

Masters (2016) observes that the rate of hearing aid use has never been researched in New Zealand. Although the usage rate has not been fully investigated, a survey conducted by the ACC (2015) notes that from a sample of 947 respondents, only 4% reported using their hearing aid for less than one hour per day. Conversely, 74% reported using their hearing aids for more than four hours per day. Despite this, Masters (2016) found that two-thirds of New Zealanders who own hearing aids reported negative side effects or other obstacles that dissuaded use, including:

- background noise;
- feedback;
- annoyance/irritation;
- fit;
- rain;
- interference with /head gear;
- scared they will get lost;
- not satisfied with sound;

- lack of need;
- and ongoing costs.

Other factors limiting individuals from accessing services are listed below:

- **Technology aids but does not cure hearing loss :** Zhang et al (2012) identified in their study that 64% of respondents who use hearing aids still have difficulty hearing. This may have a negative impact on an individual's ability to participate in the workforce, particularly if they do not have access to funding for cochlear implants.
- **Ethnic background and location:** Chandra and Searchfield (2015) reported that there are increased barriers to healthcare services for Māori and Pacific adults. This has resulted in a lower usage of hearing aids among this group. Access to services may also be limited for those living in rural locations who are unable to reach such services.
- **Psychological impact:** Hearing aids have been found to have a negative impact on psychological quality of life (Zhang et al, 2012).
- **The nature of funding for hearing aids and cochlear implants:** Individuals with hearing loss who only meet some of the eligibility criteria or are transitioning from school to work are often being left out of funding opportunities. For those who cannot afford hearing-related services without funding, this makes their access to services extremely limited.
- **The 'opt in' nature of services:** Childhood early intervention programs and other programs for children with hearing loss are currently structured such that parents must opt their children into programs, meaning that many parents are unaware that some of these programs even exist. This leads to large delays in the provision of support services to children (Econtext, 2011).
- **Marginalisation:** The Deaf and Hard of Hearing populations are not fully included in community activities e.g. live closed captioning was not available for the broadcast of Rugby World Cup games. The Foundation granted $200,000 in 2016 to ensure live broadcast captioning was available to enable access to the SKY TV Prime channel Rio Olympic coverage. There is a long wait period associated with booking interpreters; the provision of hearing rehabilitation equipment is considered to be fragmented, complicated and unnecessary and children are 'falling through the cracks' of services (Fitzgerald & Associates, 2010).
- As a whole, the deaf population struggles to access health care services, often resulting in poor health outcomes including: higher risk of mental illness and hospitalisations. (Wairarapa, Hutt Valley and Capital & Coast District Health Boards, 2016).

9.4 Future directions for access to services

With respect to the rising cost of obtaining hearing aids and cochlear implants, the ability for eligible persons to access hearing aids will become more important in order to minimise productivity losses and maximise tax revenues. Wallace (2014) cites that private providers will play an increasingly important role in improving the overall level of accessibility in the face of an oligopolistic market structure alongside insufficient funding from the Ministry of Health.

The increased influence and role of the internet in society also provides new opportunities for more people to both access *and* afford hearing aids and related services. As it already stands, the internet removes the verbal barriers to communication caused by hearing loss. Individuals with hearing loss can therefore communicate more freely than ever before using their phone or computer. Naturally, this scope can be extended to include an increased ability of individuals with hearing loss to manage their condition online. Chandra and Searchfield (2015) cite that 53% of adults aged 65-74 would be interested in doing a hearing test online, with 60% interested in adjusting their hearing aids online.

9.5 Funding options

The Ministry of Health provides a number of schemes to assist an individual's access to the services they require, including:

- **Hearing aid funding scheme:** funding that covers the cost of their hearing aid(s) if the individual has had a significant hearing loss from childhood, or have had hearing loss and a severe visual impairment or other form of disability that limits their ability to communicate safely and effectively, or have a community service card. The cost of the assessment or fitting of the hearing aid is not included. Adults are eligible for funding once every six years, while children are eligible for funding no more than three times every six years (Ministry of Health, 2016a).
- **Hearing aid subsidy**: Individuals who are not successful in obtaining other funding may be eligible for a hearing aid funding subsidy of $511 (including GST) per hearing aid. Adults are eligible for the subsidy once every three years (Ministry of Health, 2016b).
- **Hearing aid repairs:** Hearing aids provided by the Ministry of Health under the hearing aid funding scheme can be repaired at the expense of the ministry however people who receive funding from the hearing aid subsidy scheme must meet the cost of the repairs on their own.
- **Cochlear implant funding:** Funding for cochlear implants is provided on the basis that the individual: (a) has severe to profound hearing loss in both ears, (b) been unsuccessful in using standard hearing aids, (c) is likely to benefit from a cochlear implant, (d) is eligible for publicly funded health and disability services, (e) has permanent residency in New Zealand, and (f) been unable to obtain a cochlear implant through ACC. Funding is all-encompassing and includes: assessment, device, surgery, audiology, maintenance, support, rehabilitation and replacement fees. Up to two implants can be funded for children however only one implant is funded for adults as it is perceived that a single implant can provide enough benefits for an individual to communicate with others (Ministry of Health, 2016e). In other words, the MoH funds all expenses associated with obtaining a cochlear implant, the level of funding is not means tested like hearing aids are.
    - Cochlear implants are provided via the Northern Cochlear Implant Programme (NCIP) and the Southern Cochlear Implant Programme (SCIP). Choice of hospital is determined by the provider.

Alternative funding options for hearing aids and cochlear implants include[42]:

- ***Accessable*** their 19th birthday if deemed clinically suitable are able to access one or two cochlear implants. Students, up to the age of 21 who are enrolled in full time education may be eligible for hearing aid funding[43]. Funding is provided for new and replacement hearing aids, including repairs and the provision of batteries. *Accessable* includes *Environmental Support Services* which provides funding for adults aged 16 and over that present with complex needs or meet the eligibility criteria which includes holding a community services card
- **ACC (Accident Compensation Corporation):** If an individual suffers hearing loss as the result of occupational noise exposure or trauma that has damaged their hearing, they may be eligible for ACC funding. Funding is provided based on approval from an audiologist, GP or ENT surgeon. Cochlear implants may be funded if cause is medical accident or trauma.
- **Veterans Affairs:** Individuals who have suffered hearing loss whilst serving in the armed forces are eligible for hearing aid funding. To be eligible, individuals must be recognised as having a degree of hearing loss and be receiving the War Pension.
- **Work and income New Zealand:** People who already receive welfare benefits from Work and Income NZ are eligible to apply for a $1000 loan to assist with purchasing hearing aids that is deducted gradually from future benefit payments. There is also the *disability allowance* and *child disability allowance* that provides extra welfare benefits for individuals with a severe hearing disability.
- **New Zealand Audiological Society Hearing Aid Bank:** If unsuccessful in obtaining any of the above funding options, the New Zealand Audiological Society Hearing Aid Bank provides donated hearing aids or a limited amount of funding to assist individuals in getting a hearing aid.

[42] Information on alternative funding options is sourced from the New Zealand Audiological Society (2011). *Accessable* is a NZ company.

[43] https://www.audiology.org.nz/hearing-aid-funding.aspx. Accessed 27 October 2016.

10 Conclusions

10.1 Summary of costs

This chapter summarises the total costs of hearing loss.

Key findings:

- The total cost of hearing loss in New Zealand is $4.9 billion in 2016, comprising $957.3 million in financial costs and $3.9 billion in the loss of wellbeing. This equates to approximately $5,556 per person in both financial and wellbeing costs.

10.2 Total costs of hearing loss

The components of economic costs are:

- health system costs of $131.8 million, or $150 per person with hearing loss. Health system costs are mainly comprised of other health professionals (59%), non-admitted hospital (14%) and out-of-hospital medical (13%);
- productivity losses of $552.4 million, or $627 per person with hearing loss;
- informal care costs of $100.5 million, or $114 per person with hearing loss;
- other financial costs of $95.5 million, or $108 per person with hearing loss; and
- efficiency losses of $77.2 million, or $88 per person with hearing loss.

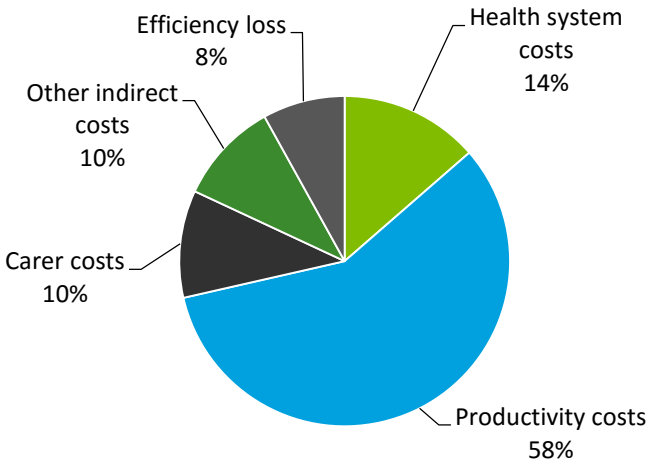
Table 10.1: Total costs of hearing loss, 2016

Component	Value ($m)	Per person ($)
Health system costs	129.8	147
Productivity costs	552.4	627
Carer costs	100.5	114
Other financial costs	95.5	108
Efficiency losses	77.2	88
Total economic costs	*957.3*	*1,087*
Total loss of wellbeing costs	*3,934.1*	*4,469*
Total costs	**4,891.5**	**5,556**

Source: Deloitte Access Economics calculations.
Note: numbers may not add due to rounding.

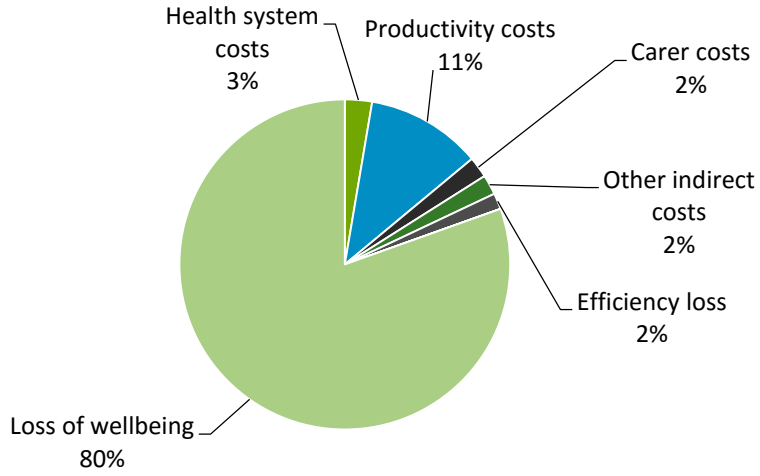
Chart 10.1 illustrates the economic costs associated with hearing loss in New Zealand for 2016. Overall, the majority of costs were associated with productivity costs (58%), followed by health system costs (14%) and carer costs and other indirect costs (10% each). Total costs reflect economic and wellbeing costs, as depicted in Chart 10.2. As a whole, loss of wellbeing accounted for 80% of total costs of hearing loss in 2016. Table 10.2 provides a breakdown of total costs by age and gender.

Chart 10.1: Economic costs associated with hearing loss in NZ, 2016



Source: Deloitte Access Economics calculations.

Chart 10.2: Total costs associated with hearing loss in NZ, 2016



Source: Deloitte Access Economics calculations.

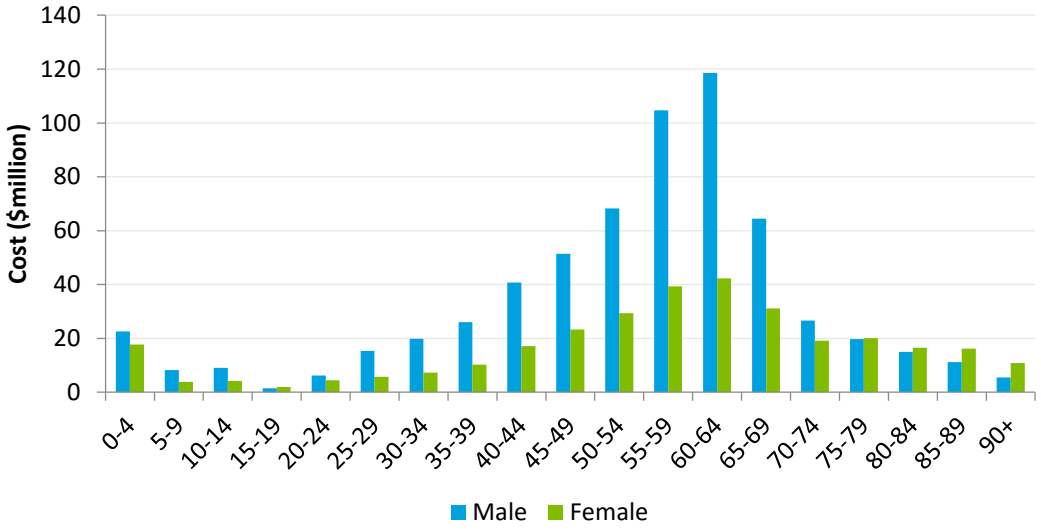
Table 10.2 depicts total economic costs and total costs by age and gender. It is evident that males, particularly in the 40-69 age group, experience significantly higher economic costs in the form of lost productivity and participation in the workforce. The general trend is that men bear higher costs of hearing loss, particularly after the age of 40. Interestingly, this trend reverses and women are found to bear higher costs of hearing loss beyond the age of 85, which largely reflects the greater underlying population in this age group. These trends are illustrated in Chart 10.3 and Chart 10.4.

Table 10.2: Total costs associated with hearing loss by age and gender, $ million

Age/ gender	Economic cost ($m)	Loss of wellbeing ($m)	Total cost ($m)
Male			
0-9	31.2	20.0	51.1
10-19	10.6	29.4	40.0
20-29	21.6	58.0	79.5
30-39	46.0	74.3	120.2
40-49	92.1	143.9	236.0
50-59	173.0	280.7	453.7
60-69	183.2	503.1	686.4
70-79	46.5	555.1	601.6
80-89	26.3	397.6	423.9
90+	5.5	92.1	97.6
Male	636.0	2,154.1	2,790.1
Female			
0-9	21.9	11.4	33.3
10-19	6.2	17.2	23.4
20-29	10.1	34.1	44.2
30-39	17.6	49.4	67.0
40-49	40.5	100.7	141.3
50-59	68.7	192.1	260.8
60-69	73.4	367.8	441.2
70-79	39.4	462.5	501.8
80-89	32.8	406.9	439.6
90+	10.8	138.0	148.9
Female	321.4	1,780.0	2,101.4
Persons	**957.3**	**3,934.1**	**4,891.5**

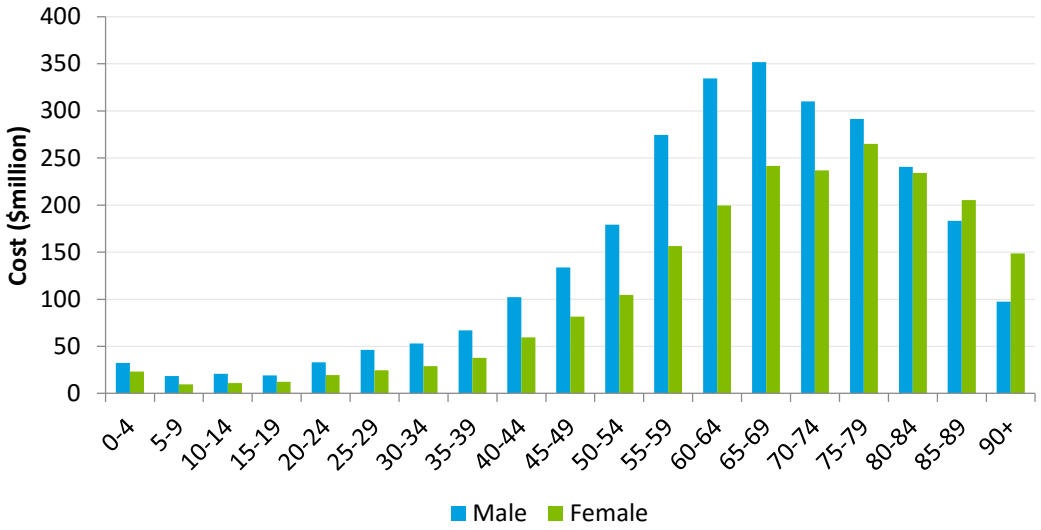
Source: Deloitte Access Economics calculations.
Note: numbers may not add due to rounding.

Chart 10.3: Total economic costs associated with hearing loss by age and gender, 2016



Source: Deloitte Access Economics calculations.

Chart 10.4: Total cost associated with hearing loss by age and gender, 2016



Source: Deloitte Access Economics calculations.

Recommendations:

This report has found that hearing loss is a significant issue facing the New Zealand population. As it currently stands, some of the 880,350 people with hearing loss in New Zealand as of 2016 can experience substantial barriers to accessing services, recognition and support they deserve. For example, available studies provide no indication of established hearing services being provided to prisoners, and the limited data available from DHBs appears to indicate that Māori have less access to hearing treatment than other New Zealanders.

There is a need for better data to be reported on hearing loss by the Government in New Zealand across all areas of service provision including Corrections and the Ministry of Health.

Appendix A: Consultations

Consultations where held with consumer, professional, industry and academic representatives on 21 and 22 July at the NFD offices in Auckland.

Table A.1: Consultations

Representative	Organisation
David Kent	Chair, Southern Hearing Charitable Trust
Dean Lawrie	New Zealand Hearing Care Industry Association
Assoc Prof Grant Searchfield	Clinical Director, University of Auckland Hearing and Tinnitus Clinic
Dr Louise Carroll	Chief Executive Officer, The National Foundation for the Deaf
Mike Sharp	New Zealand Hearing Care Industry Association
Peter Stubbing	New Zealand Audiological Society
Prof Peter Thorne	Deputy Director, Centre for Brain Research, University of Auckland
Robyn Carter	Board member, Deaf Aotearoa New Zealand
Scott Mitchell	Director, Deloitte Access Economics
Stuart Keene	President, Hearing Association
Prof Suzanne Purdy	Head of Speech Science, University of Auckland

Appendix B: Hearing loss and mortality

A literature search for studies was conducted to see if recent evidence suggests a direct association between hearing loss and mortality when controlling for confounding factors such as ageing, gender and other conditions. This is commonly measured using a hazard ratio, which assesses the relative difference in the probability of an event occurring (death) over time between two populations of interest– those with and without hearing loss. Most of the studies identified in the search were prospective observational studies, and generally contained a longitudinal sample or survey linked to national deaths data. A summary of the literature is presented below.

Genther et al (2015) assessed the association between hearing loss and mortality in community dwelling older adults in the United States. There were 1,146 participants with hearing loss, of whom 492 died during the study period – representing 42.9% of the sample with hearing loss. For those with normal hearing, 31.4% died during the study period. Hearing was assessed using audiometric testing and the threshold was defined as greater than 25 dB HL. Genther et al (2015) found that hearing was associated with a 13% increase in mortality risk compared with those with normal hearing in their fully adjusted model. The model adjusted for age, gender, race, education, study site, cardiovascular risk factors[44], hearing aid use, and cognitive impairment. Interestingly, Genther et al (2015) observed a nonlinear relationship, with the risk of mortality increasing with severity, and with the increase in mortality only occurring from around >35 dB HL. The sample characteristics were representative of those over the age of 70 with moderate or worse hearing loss.

Agrawal et al (2011) assessed the association between hearing loss and mortality in a random sample of 1,422 elderly persons (aged 60 years and over) living in rural villages in India. Hearing loss was assessed using audiometric testing. After adjusting for age gender, literacy and a range of comorbid conditions, orthopaedic impairment, and scores for dressing, feeding and self-rated health, Agrawal et al (2011) did not find a significant association between increased mortality and hearing loss in their sample. However, hearing loss was associated with an increased risk of mortality for those aged 70 years or older when subgroup analysis was conducted. For the overall sample, the hazard ratio was 1.22 with a confidence interval of 0.73 to 2.03. No measure of mean severity was reported for this study. Although it controls well for confounding factors, there are significant differences in the setting of rural India compared to New Zealand.

Karpa et al (2010) assessed the association between hearing loss and mortality risk in 2,956 older persons (aged 49 years and over) in the Blue Mountains Hearing Study in Australia. After adjusting for age, history of acute myocardial infarction, stroke, angina, hypertension, current smoking status, body mass index, cancer, diabetes, walking disability, high serum urate, alcohol consumption, cognitive impairment, depression and self-rated health, the

[44] The study did not control for family size or presence of a carer compared to living alone. Moreover, as with Genther et al (2015), cardiovascular disease risk factors (confounding factors) may lead to endogeneity in the sample.

hazard ratio was 1.12, although this was not significant – the confidence interval was 0.88 to 1.44. The sample characteristics were representative of those over the age of 70 with moderate or worse hearing loss, as assessed with audiometric testing.

Gopinath et al (2013) also assessed the association between hearing loss and mortality risk in a sample of 2,812 older persons (aged 55 years and over) in the Blue Mountains, but the sample was drawn from the Blue Mountains Eye Study. The sample characteristics were very similar to those in the Hearing Study reported in Karpa et al (2010), although the results were presented as those without visual impairment when vision was corrected with appropriate prescriptions. Overall, Gopinath et al (2013) found that hearing loss was significantly associated with a 29% increase in the risk of mortality – the confidence interval was 1.04 to 1.59. The analysis by Gopinath et al (2013) adjusted for age, gender, body mass index, systolic blood pressure, current smoking status, self-rated health, walking disability, presence of hypertension and/or diabetes, history of cancer, angina, stroke, acute myocardial infarction and cognitive impairment.

Feeny et al (2012), in a Canadian longitudinal study of 12,375 women and men over the age of 18 years, found that hearing loss was significantly associated with an increased risk of mortality. When considering the sample over 60 years old, the hazard ratio for mortality was 0.14 with a confidence interval of 0.04 to 0.48. This was expressed in logarithm terms, where the hazard ratio of less than 0 indicates a reduction in mortality and above 0 indicates an increased risk of mortality. Adjusting this by taking the exponential values for consistency with the other identified studies, the hazard ratio was 1.15 with a confidence interval of 1.04 to 1.62. The sample was mostly representative of those over the age of 70 years and a severity of moderate or worse. Feeny et al (2012) adjusted for a range of factors, including age, gender, marital status, education, income, chronic health conditions, smoking, physical activity, body mass index, alcohol use and subjective measures of stress, coherence and social support.

Fisher et al (2014) used a longitudinal cohort study of 4,926 participants aged 66 years and above in Iceland to identify any associations between hearing loss and mortality. Hearing loss was assessed using audiometric testing and participants were only classified as having hearing loss if the impairment was moderate or greater. After adjusting for a range of confounding factors, including self-reported status, cognitive status, hearing aid use and established mortality risk factors including body mass index, hypertension, diabetes, history of falls, cholesterol, and cardiovascular disease history, Fisher et al (2014) found that hearing loss was borderline associated with a 20% increased risk of mortality – the confidence interval was 1.00 to 1.45. The sample was again representative of those aged over 70 years and severity was moderate or worse.

Even though these studies mostly control for other chronic conditions, there could still be endogeneity issues if conditions such as CVD, hypertension or diabetes which increase mortality also increase hearing loss. For example, Yamasoba et al (2013) report that diabetes, cerebrovascular disease and CVD are statistically associated with increased hearing loss. On the other hand, Oh et al (2014) in a study of over 37,000 individuals, found no statistically significant association with hearing loss and hypertension.

Yamada et al (2010) discusses outcomes of dependence in activities of daily living (ADL) and death with hearing difficulty. A total of 1364 participants aged over 65 years (average 77 years of age) self-reported their hearing difficulty based on a range of: “no difficulty”, “a

little difficulty", and "a lot of difficulty". Potential major confounding factors were adjusted for in the study's multivariate regression model, including Yamada et al (2010) estimated a hazard ratio of 1.12 with a confidence ratio of 0.50 – 1.74. Overall, a strong association between adverse health outcomes and advanced hearing difficulty was observed however the result was not statistically significant for individuals with moderate hearing difficulty.

A longitudinal analysis evaluating the risk of dying was performed by Laforge et al (1992). Overall, 1408 participants aged over 65 years (average age 74 years) self-reported their level of hearing based on the following categories: excellent, good, fair, poor and blind/deaf. The relationship between hearing loss and one-year mortality and functional decline was evaluated to generate a hazard ratio of 1.18 with a confidence interval of 0.54 – 2.60. Using bivariate and multiple logistic regression modelling, hearing loss was found to have a statistically significant risk factor for functional decline, which is a possible risk factor for death (Karpa et al, 2010).

Furthermore, a study performed by Liljas (2015) used logistic regression to assess the association of hearing loss with mortality. A group of 1074 community-dwelling men aged 63 to 85 (average age 74) were followed up for all-cause mortality after 10 years as a part of the British Regional Heart Study. From this, 27% of men reported having a hearing loss with severity being self-reported on a scale of: "can hear with no aid", "can hear using an aid", "cannot hear with no aid" and "cannot hear and used aid". The regression model was adjusted for confounding factors. Men who could not hear and did not use a hearing aid were found to have a higher risk of all-cause mortality compared to their hearing counterparts. The hazard ratio for mortality was 1.12 with a confidence interval of 0.93 – 1.34. However, after adjusting for comorbidities, social class, and lifestyle factors the result was attenuated. It is possible that residual confounding factors existed in the form of unmeasured cognitive functioning.

The relationship between mortality and hearing loss was also discussed in Schubert et al (2016). Overall, a sample of 2418 individuals aged 53 to 97 (average age 69) undertook audiometric testing to test for hearing loss. This study evaluated hearing, visual and olfactory impairments together as this is perceived to provide an enhanced understanding of mortality, particularly as these conditions are likely to co-occur. Other confounding factors including atherosclerosis and inflammation were included in the study. A hazard ratio of 1.17 with a confidence interval of 0.97 – 1.40 was estimated for hearing loss. It was found that hearing loss is not linked to any increased risk of mortality, although this was approaching significance. Schubert et al (2016) did not report sufficient data to estimate severity.

Barnett and Franks (1999) utilised national health interview survey data from 1990-1991 in the United States to conduct a multivariate analysis that examined the association between age at onset of deafness, and mortality. A total of 1565 participants aged over 65 years self-reported their level of hearing loss based on a scale of "good" (1) to "deaf" (4). The analysis was adjusted for sociodemographic factors and stratified by age. The hazard ratio for mortality was found to be 0.99 with a confidence interval of 0.88–1.10. Overall, it was found that adults presenting with postlingual deafness were more likely to die than their hearing counterparts over the given timeframe

References

Access Economics 2006, *Listen Hear! The economic impact and cost of hearing loss in Australia,* prepared for The Cooperative Research Centre for Cochlear Implant and Hearing Aid Innovation and Victorian Deaf Society.

Accident Compensation Corporation 2015*, Audiology report.*

Agrawal N, Kalaivani M, Gupta S, Misra P, Anand K and Pandav C 2011, 'Association of blindness and hearing impairment with mortality in a cohort of elderly persons in a rural area, *Indian J Community Med*, 36:208-12.

Allan L 2015, *Factors associated with hearing aid disuse in New Zealand* – Aotearoa, Master of Audiology thesis, University of Canterbury

Anovum (2012) Summary: EuroTrak UK 2012

Australian Bureau of Statistics 2013, *Survey on Disability, Ageing and Carers*.

Barnett S and Franks P 1999, 'Deafness and Mortality: analyses of Linked Data from the National Health Interview Survey and National Death Index', *Public Health Reports*, 114(4): 330-336.

Beehive 2014, *$11m in funding for sign language*, https://www.beehive.govt.nz/release/11m-funding-sign-language, accessed 26 May 2016.

British Tinnitus Association 2011, *Can hearing aids help people with tinnitus?*, http://www.tinnitus.org.uk/canhearingaidshelppeoplewithtinnitus, accessed 10 August 2016.

Brown, C 2012, *Conditions: Cochlear Implants*, http://www.ear.co.nz/index.php/conditions/cochlear-implants, accessed 29th April 2016.

Carroll, L.M., 2015. 'Participatory Education Research for Capacity Building to enhance capabilities and quality of life of prisoners with hearing loss in New Zealand prisons: implications for social justice'. *Participatory Educational Research*.

Chandra N, and Searchfield G 2015, 'Perceptions toward Internet-Based Delivery of Hearing Aids among Older Hearing-Impaired Adults'*, Journal of the American Academy of Audiology.*

Chen D, Betz J, Taffe K, Ayonaton H, Kritchevsky S, Martin K, Harris T, Purchase-Helzner E, Satterfield S, Xue Q and Pratt S 2015, 'Association of hearing impairment with declines in physical functioning and the risk of disability in older adults', *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 70(5): 654-661.

Citizens Advice Bureau 2016, *Funerals & registration of death*, http://www.cab.org.nz/vat/fp/d/pages/funeralsregistrationofdeath.aspx#3 , accessed May 2016.

Cohen S, Robert L, Dietrich M and Haynes D 2004, 'Quality of life in hearing impaired adults: the role of cochlear implants and hearing aids', *Otolaryngology- Head and Neck Surgery,* October 2004, pp413-421.

DeafQuip 2016, 'Amplified Telephones and Accessories', http://deafquip.co.nz/Amplified-Telephones.html, accessed 23 May 2016.

Del Bo L and Ambrosetti U 2007, 'Hearing aids for the treatment of tinnitus', *Progress in brain research,* 166: 341-345.

Detaille SI, Haafkens JA and van Dijk FJH 2003, 'What employees with rheumatoid arthritis, diabetes mellitus and hearing loss need to cope at work', *Scandinavian Journal of Work, Environment & Health,* 29(2): 134-142.

Digby J 2016, 'NZAS Audiology Benchmarking: NZ's Audiology Workforce', New Zealand Audiological Society.

Digby J 2015, 'Deafness Notification Report (2014): Notified cases of hearing loss (not remediable by grommets) among New Zealanders under the age of 19.

Disability Resource Centre 2010, 'The cost of disability', Final report.

Donahue, A, Dubno, J and Beck L, 2010 'Accessible and affordable hearing health care for adults with mild to moderate hearing loss'. *Ear and hearing*, 31(1), p.2.

Econtext (2011), "Early intervention programs to assist children with hearing loss develop spoken language", http://www.ncip.org.nz/pdf/early-intervention-programs.pdf, accessed 23 May

Esplin J and Wright C 2014, *Auditory Processing Disorder: New Zealand Review,* Sapere Research Group

European Hearing Instrument Manufacturers Association 2015, *Results: EuroTrak UK 2015*, http://www.ehima.com/wp-content/uploads/2016/02/EuroTrak_2015_UK.pdf

Exeter D, Wu B, Lee A and Searchfield G 2015, 'The projected burden of hearing loss in New Zealand (2011-2061) and the implications for the hearing health workforce', *New Zealand Medical Association*, 128 (1419)

Feeny D, Huguet N, McFarland B, Kaplan M, Orpana H and Eckstrom E 2012, 'Hearing, mobility, and pain predict mortality: a longitudinal population-based study', *Journal of Clinical Epidemiology*, 56: 764-777.

Fisher D, Li C, Chui M, Themann C, Petersen H, Jonasson F, Jonasson P, Sverrisdottir J, Garcia M, Harris T, Launer L, Eiriksdottir G, Gundason V, Hoffman H and Cotch, M 2014, 'Impairments in hearing and vision impact on mortality in older people: the AGES-Reykjavik Study, *Age and Ageing*, 43: 69-76.

Fitzgerald & Associates (2010), "Deaf way: a new service delivery model", http://deaf.org.nz/images/misc/Deaf-Way-Report-Final.pdf, accessed 23 May 2015.

Friberg E, Gustafsson K and Alexanderson K 2012, 'Hearing difficulties, ear-related diagnoses and sickness absence or disability pension – a systematic literature review', *BMC Public Health,* 2012 12:772.

Genther D, Betz J, Pratt S, Kritchevsky S, Martin K, Harris T, Helzner E et al 2015, 'Association of hearing impairment and mortality in older adults', *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 70 no.1, 85-90.

Gopinath B, Schneider J, McMahon C, Burlutsky G, Leeder S and Mitchell P 2013, 'Dual Sensory Impairment in Older Adults Increases the Risk of Mortality: A Population-Based Study', *PloS one,* 8(3): 1-6.

Greville A 2005, *Hearing impaired and deaf people in New Zealand: an update on population numbers and characteristics,* Greville Consulting

Guitar K, Giles E, Raymond B and Welch D, 2013. 'Health effects of cochlear implants'. *The New Zealand Medical Journal (Online)*, 126(1375).

Hannah L, Page W and McLaren S 2016, 'A review of Occupational Noise in New Zealand', *New Zealand Acoustics*, 29(1): 4-26.

Hearing Association New Zealand 2014, *Hearing aid funding options*, http://www.hearing.org.nz/info_funding.php, accessed 29th April 2016.

Hearing Association New Zealand 2009, *Hear here! Hearing loss at a glance*, available at: http://www.hearing.org.nz/infocards/7%20FUNDING.pdf, accessed 29th April 2016.

Hearing Association New Zealand 2009a, *Cochlear implants*, http://www.hearing.org.nz/infocards/6%20Cochlear.pdf, accessed 29th April 2016.

Heslop 2015, Southern Cochlear Implant Programme 2014-15 General Manager's Report, http://scip.co.nz/wp-content/uploads/2015/12/SCIP-General-Managers-Report-2014-15.pdf, accessed 23 May 2016.

Hougaard S 2012, *What can we learn from 3668 users in 7 countries?* Paper presented to the 2012 Advances in Audiology Conference, Las Vegas

Human Rights Commission New Zealand 2013, *A New Era in the Right to Sign: Report of the New Zealand Sign Language Inquiry*

Infometrics 2014, *The economic value and impacts of informal care in New Zealand: For Carers NZ and the NZ Carers Alliance*.

Inland Revenue 2016, 'GST (Goods and services tax)', http://www.ird.govt.nz/gst/gst-index.html, accessed 24 May 2016.

Inland Revenue 2015, *General depreciation rates: February 2015.*

Jastreboff, P.J. and Jastreboff, M.M., 2015. 'Decreased sound tolerance: hyperacusis, misophonia, diplacousis, and polyacousis'. *Handbook of clinical neurology*, 129, pp.375-387.

Jensen J, Sathiyandra S, Rochford M, Jones D, Krishnan V and McLeod K 2005, *Disability and work participation in New Zealand: Outcomes relating to paid employment and benefit receipt*, Ministry of Social Development, Wellington.

Joore MA, Brunenberg DEM, Chenault MN and Anteunis LJC 2003, 'Societal effects of hearing aid fitting among the moderately hearing impaired', *International Journal of Audiology,* 42: 152-160.

Karpa M, Gopinath B, Beath K, Rochtchina R, Cumming R, Wang J and Mitchell P 2010, 'Assocations between hearing impairment and mortality risk in older persons: the Blue Mountains Hearing Study'*, Annals of epidemiology*, 20, no.6: 452-459.

Kervasdoué and Hartmann 2016, *Economic Impact of Hearing Loss in France and Developed Countries: A survey of academic literature 2005-2015.*

Keith W, & Purdy S, (2014). 'Assistive and therapeutic effects of amplification for auditory processing disorder'. *Seminars in Hearing*, 35, 27-38

Kochkin S 2002, Factors impacting consumer choice of dispenser and hearing aid brand; use of ALDs and computers. *Hear Rev* 9(12): 14-23.

Kramer SE, Kapteyn TS and Houtgast T 2006, 'Occupational performance: comparing normally-hearing and hearing-impaired employees using the Amsterdam Checklist for Hearing and Work', *International Journal of Audiology,* 45: 503-512.

Kurmis A and Apps S 2007, 'Occupationally-acquired noise-induced hearing loss: a senseless workplace hazard', *International journal of occupational medicine and environmental health*, 20(2): 127-136.

Laforge R, Spector W and Sternberg J 1992, 'The Relationship of Vision and Hearing Impairment to One-Year Mortality and Functional Decline', *Journal of Aging and Health*, 4(1): 126-148.

Liljas A, Wannamethee S, Whincup P, Papacosta O, Walters K, Ilffe S, Lennon L, Carvalho L and Ramsay S 2016, 'Hearing impairment and incident disability and all-cause mortality in older British community-dwelling men', *Age and Ageing*, 0:1-6.

Lopez D, McCaul K, Hankey G, Norman P, Almeida O, Dobson A, Byles J, Yeap B and Flicker L 2011, 'Falls, injuries from falls, health related quality of life and mortality in older adults with vision and hearing impairment – is there a gender difference?', *Maturitas*, 69.4: 359-364.

Maes I, Cima R, Vlaeyen J, Anteunis L and Joore M, 2013 'Tinnitus: a cost study' *Ear and hearing*, 34(4), pp.508-514.

Masters, R 2016, *Rate and reason for hearing aid non-use in Aotearoa / New Zealand*, Master of Audiology thesis, University of Canterbury

Mathers C, Stevenson C, Carter R and Penm R 1998, *Disease costing methodology used in the Disease Costs and Impact Study 1993-94,* Cat No. HWE 7. AIHW, Canberra

McLean A, Caudwell L and Greville A 2008, 'Development and Implementation of a National Funding and Service System for Hearing Aids', Stage one report prepared for Disability Services, Health and Disability National Services.

Middleton, B., Couillault, M. and Lloyd, C. Ear nurse specialists: New Zealand's unique answer for the treatment of otitis media with eddusion, "Glue Ear", *International Congress Series,* 1254: 501-506.

Ministry of Business, Innovation and Employment 2011, *Consultation on replacement Telecommunications Relay Service, Telecommunications Service Obligation Deed*, http://www.mbie.govt.nz/info-services/sectors-industries/technology-communications/communications/documents-image-library/consultation-on-replacement-telecoms-relay-service-tso-deed.pdf, accessed 29th July 2016.

Ministry of Health (New Zealand) 2016, *Education for Children with hearing loss*, http://www.health.govt.nz/your-health/services-and-support/disability-services/types-disability-support/hearing-and-vision-services/hearing-services/education-children-hearing-loss, accessed 29th April 2016.

Ministry of Health (New Zealand) 2016a, *Guide to getting hearing aids: hearing aid funding scheme*, http://www.health.govt.nz/publication/guide-getting-hearing-aids-hearing-aid-funding-scheme, accessed 29th April 2016.

Ministry of Health (New Zealand) 2016b, *Guide to getting hearing aids: hearing aid subsidy scheme*, http://www.health.govt.nz/publication/guide-getting-hearing-aids-hearing-aid-subsidy-scheme, accessed 29th April 2016.

Ministry of Health (New Zealand) 2016c, *New Zealand Casemix Framework for Publicly Funded Hospitals*, Ministry of Health, Wellington.

Ministry of Health (New Zealand) 2016d, *Universal Newborn Hearing Screening and Early Intervention Programme (UNHSEIP), Monitoring report, January – December 2014*, Ministry of Health, Wellington.

Ministry of Health (New Zealand) 2016e, *Cochlear implants*, http://www.health.govt.nz/your-health/services-and-support/disability-services/types-disability-support/hearing-and-vision-services/hearing-services/cochlear-implants, accessed 20th May 2016.

Ministry of Health 2015a, Publicly funded hospital discharges – 1 July 2012 to 30 June 2013, http://www.health.govt.nz/nz-health-statistics/health-statistics-and-data-sets/publicly-funded-hospital-discharges-series, accessed April 2016.

Ministry of Health 2015b, Privately funded hospital discharges – 1 July 2012 to 30 June 2013, http://www.health.govt.nz/nz-health-statistics/health-statistics-and-data-sets/privately-funded-hospital-discharges-series, accessed April 2016.

Ministry of Health 2015c, *2014/15 DHB Hospital Caseload Monitoring Report*, http://www.health.govt.nz/nz-health-statistics/health-statistics-and-data-sets/district-health-board-data-and-stats/caseload-monitoring-reports, accessed April 2016.

Ministry of Health (New Zealand) 2013, *Health Loss in New Zealand: A report from the New Zealand Burden of Diseases, Injuries and Risk Factors Study, 2006–2016*. Wellington

Ministry of Health (New Zealand) 2012a, *Ways and Means: A report on methodology from the New Zealand Burden of Diseases, Injuries and Risk Factors Study, 2006-2016,* Ministry of Health, Wellington.

Ministry of Health (New Zealand) 2012b, *The New Zealand Health and Disability System: Organisations and Responsibilities: Briefing to the Minister of Health,* Ministry of Health, Wellington.

Ministry of Health (New Zealand) 2012c, *Health expenditure trends in New Zealand 2000-2010*, Ministry of Health, Wellington.

Ministry of Health (New Zealand) 2012d, *New Zealand Burden of Diseases, Injuries and Risk Factors Study*, Wellington.

Ministry of Health (New Zealand) 2004, Living with Disability in New Zealand, Wellington, ISBN 0-478-28305-9

Ministry of Social Development (New Zealand) 2016, *Annual Report 2014/2015.*

Ministry of Transport (New Zealand) 2016, *Social cost of road crashes and injuries 2015 update,* Wellington.

Mohr PE, Feldman JJ and Dunbar JL 2000, 'The societal costs of severe to profound hearing loss in the United States', *International Journal of Technology Assessment in Health Care,* 16(4): 1120-1135.

Murray C, Lopez A, Mathers C, Stein C 2001, *The Global Burden of Disease 2000 Project: aims, methods & data sources,* Discussion Policy Paper No. 36, World Health Organization, Geneva.

Murray C, Lopez A 1996, *The Global Burden of Disease: a comprehensive assessment of mortality & disability from disease, injuries & risk factors in 1990 & projected to 2020,* Harvard School of Public Health, Boston.

Nachtegaal J, Festen JM and Kramer SE 2012, 'Hearing ability in working life and its relationship with sick leave and self-reported work productivity', *Ear Hear,* 33 (1): 94-103.

Nachtegaal J, Kuik DJ, Anema JR, Goverts ST, Festen JM and Kramer Se 2009, 'Hearing status, need for recovery after work, and psychosocial work characteristics: Results from an internet-based national survey on hearing', *International Journal of Audiology,* 48: 684-691.

Nelson D, Nelson R, Barrientos M and Fingerhut M 2005, 'The global burden of occupational noise-induced hearing loss', *American journal of industrial medicine*, 48(6): 446-458.

New Zealand Audiological Society (2015) Response to Questions posed to NZAS by Karoline Tuckey, https://www.audiology.org.nz/Userfiles/file/formedia/Audiological%20Care%20in%20New%20Zealand.pdf, accessed 1 August 2016.

New Zealand Audiological Society 2011, *Funding for Hearing Aids*, https://www.audiology.org.nz/hearing-aid-funding.aspx, accessed 29th April 2016.

New Zealand Ministry of Special Education 2010, *Scoping support for New Zealand Sign Langugae users accessing the curriculum*, https://www.educationcounts.govt.nz/__data/assets/pdf_file/0004/87088/ScopingSupportNZSL-UsersPart-II-13122010-nw.pdf, accessed 29th April 2016.

New Zealand Productivity Commission 2015, *Appendix E: Home-based support for older people*.

New Zealand Treasury 2016, 'Current Discount Rates' http://www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/currentdiscountrates, accessed May 2016.

New Zealand Treasury 2016a, 'Expenditure – Budget 2016 Data from the Estimates of Appropriations 2016/17', Wellington.

New Zealand Treasury 2016b, 'Special Needs Support (M26)', Wellington.

New Zealand Treasury 2015, 'Guide to social cost benefit analysis', Wellington.

Niparko JK 2012, *Evaluation of hearing loss,* http://www.merckmanuals.com/professional/ear,-nose,-and-throat-disorders/hearing-loss/evaluation-of-hearing-loss, accessed 14 April 2016

Oh, I.H., Lee, J.H., Park, D.C., Kim, M., Chung, J.H., Kim, S.H. and Yeo, S.G., 2014. Hearing loss as a function of aging and diabetes mellitus: a cross sectional study. *PloS one*, *9*(12), p.e116161.O'Neill G 1999, 'Hearing loss – a growing problem that affects quality of life', *National Academy on an Aging Society,* Number 2.

Powell D 2011, Floating in the Mainstream: New Zealand Deaf Students' Learning and Social Participation Experiences in Tertiary Education, http://www.oticon.org.nz/pdf/Deaf_students_experiences_of_tertiary_education.pdf, accessed 10 May 2016.

Productivity Commission 2003, 'Evaluation of the Pharmaceutical Industry Investment Program', *Research Report*, AusInfo, Canberra.

Punch, R., Creed, P. and Hyde, M. 2005, 'Predicting Career Development in Hard-of-Hearing Adolescents in Australia', *Journal of Deaf Studies and Deaf Education*, 10(2), pp. 146-159.

Reynolds S, Miller Kuhaneck H, & Pfeiffer B 2016, 'Systematic review of the effectiveness of frequency modulation devices in improving academic outcomes in children with auditory processing difficulties'. *American Journal of Occupational Therapy*, 70, 7001220030.

Ruben RJ 2000, 'Redefining the survival of the fittest: communication disorders in the 21st century', *Laryngoscope,* 110(2): 241-5.

Rydberg E, Gellerstedt LC and Danermark B 2010, 'The position of the deaf in the Swedish labor market', *American Annals of the Deaf,* 155(1): 68-77.

Sanders M, Houghton N, Dewes O, McCool J and Thorne P 2015, Estimated prevalence of hearing loss and provision of hearing services in Pacific Island nations, *Journal of Primary Health Care,* (7) 1

Schelling 1968, 'The life you save may be your own', in SB Chase (eds) *Problems in public expenditure and analysis*, Brookings Institution, Washington DC.

Schneider J, Gopinath B, Karpa M, McMahon C, Rochtchina E, Leeder S and Mitchell P 2010, 'Hearing loss impacts on the use of community and informal supports', *Age and Ageing*, 39: 458-464.

Schubert C, Fisher M, Pinto A, Klein B, Klein R, Tweed T and Cruickshanks K 2016, 'Sensory Impairments and Risk of Mortality in Older Adults', *Journals of Gerontology: Medical Sciences*, 0:1-6.

Shekhawat, G.S. Searchfield, Stinear, C.M. 2013. 'Role of Hearing Aids in tinnitus intervention: a scoping review'. *Journal of the American Academy of Audiology* 24, 747-62.

Soundskills 2011, *Treatment*, http://www.soundskills.co.nz/Auditory%20Processing%20Disorder/Treatment_copy.html, accessed 3 August 2016.

Statistics New Zealand 2014, *Disability Survey: 2013*.

Statistics New Zealand 2014a, *National population projections 2014 (base) – 2068*, http://www.stats.govt.nz/infoshare/, accessed 25 February 2016

Statistics New Zealand 2015, *Income for all people by labour force status, sex, and age groups*, http://nzdotstat.stats.govt.nz/wbos/index.aspx, accessed 25 February 2016.

Statistics New Zealand 2015a, *New Zealand Period Life Tables: 2012-14*.

Statistics New Zealand 2015b, *Estimated resident population by age and sex (1991+) (Annual-Jun)*, http://www.stats.govt.nz/infoshare/, accessed 25 February 2016.

Statistics New Zealand 2015c, *Key labour force measures by qualification, age and sex*, http://nzdotstat.stats.govt.nz/wbos/index.aspx, accessed 25 February 2016.

Statistics New Zealand 2015d, *Deaths by age and sex (Annual-Jun)*, http://www.stats.govt.nz/infoshare/, accessed 25 February 2016.

Statistics New Zealand 2015e, *2013 Census*, http://www.stats.govt.nz/Census/2013-census/data-tables.aspx, accessed August 2016.

Statistics New Zealand 2001, *Household Disability Survey.*

Stevens G, Flaxman S, Brunskill E, Mascarenhas M, Mathers C and Finucane M 2011, 'Global and regional hearing impairment prevalence: an analysis of 42 studies in 29 countries', *European Journal of Public Health*¸ 23 (1): 146-152

Tay T, Wang J, Lindley R, Chia E, Landau P, Ingham N, Kifley A and Mitchell P 2007, 'Sensory Impairment, Use of Community Support Services, and Quality of Life in Aged Care Clients', *Journal of Aging and Health*, 19(2): 229-241.

Thorne, P., Ameratunga, S., Stewart, J., Reid, N., Williams, W., Purdy, S., et al. (2008). Epidemiology of noise-induced hearing loss in New Zealand. Journal of the New Zealand Medical Association, 121(1280), 33-44.

Thorne PR, John G, Grynevych A, Stewart J, Ameratunga S and Welch D, Modelling the Incidence and Prevalence of Noise-induced Hearing Loss in New Zealand. Proceedings of the Institute of Acoustics.(ed B Griefhan) 33(3):39-45.

Tucci DL 2013, *Tinnitus,* http://www.merckmanuals.com/professional/ear,-nose,-and-throat-disorders/approach-to-the-patient-with-ear-problems/tinnitus, accessed 15 April 2016.

U.S Department of Health and Human Services 2010, *Hearing Aids,* National Institutes of Health accessed in April 2016 retrieved from < https://report.nih.gov/nihfactsheets/Pdfs/HearingAids(NIDCD).pdf>

Van den Heuvel SG, Geuskens GA, Hooftman WE, Koppes LLJ and van den Bossche SNJ 2010, 'Productivity loss at work; health-related and work-related factors', *Journal of Occupational Rehabilitation,* 20:331-339.

VanderWeele T 2012, 'Invited Commentary: Structural Equation Models and Epidemiologic Analysis', *American Journal of Epidemiology*, kws213.

Wairarapa, Hutt Valley and Capital & Coast District Health Boards, 'Wairarapa, Hutt Valley and Capital & Coast District Health Boards Community & Public Health Boards Community & Public Health and Disability Support Advisory Committees, http://www.huttvalleydhb.org.nz/content/5edc07e0-492d-4e63-aea4-7a83d0bce1d7.cmr, accessed 23 May.

Wang J, Mitchell P, Smith W, Cumming R and Attebo K 1999, 'Impact of visual impairment on use of community support services by elderly persons: the Blue Mountains Eye Study. *Investigative ophthalmology & visual science,* 40(1):12-19.

Wallace 2014, 'How allocation of funding influences fully funded adult hearing aid schemes: from a new Zealand perspective', *unpublished Master's thesis*.

Wilson D, Walsh P, Sanchez L, Davis A, Taylor A, Tucker G and Meagher I 1999, 'The epidemiology of hearing impairment in an Australian adult population', *International Journal of Epidemiology*, 28(2), 247-252.

Wilson D 1997, 'Hearing in South Australia: Disability, impairment and quality-of-life', *PhD Thesis, University of Adelaide.*

World Health Organization, *Deafness and hearing loss,* http://www.who.int/mediacentre/factsheets/fs300/en/*,* accessed 14 April 2016.

World Health Organization 2005, *New Zealand estimates of unit costs for patient services for New Zealand*, http://www.who.int/choice/country/nzl/cost/en/, accessed 29th April 2016.

Yamada M, Nishiwaki Y, Michikawa T and Takebayashi T 2011, 'Impact of hearing difficulty on dependence in activities of daily living (ADL) and mortality: A 3-year cohort study of community-dwelling Japanese older adults', *Archives of Gerontology and Geriatrics*, 52: 245-249.

Yamasoba, T., Lin, F.R., Someya, S., Kashio, A., Sakamoto, T. and Kondo, K., 2013. Current concepts in age-related hearing loss: epidemiology and mechanistic pathways. *Hearing research*, *303*, pp.30-38.

Young Futures 2014, *Review of newborn hearing screening regimes and associated screening devices*, Report for the National Screening Unit, Ministry of Health, New Zealand.

Zhang S, Moyes S, McLean C, Searchfield G, Welch G, Jacobs R, Kerse N 2012, 'Self-reported hearing, vision and quality of life: older people in New Zealand', *Australian Journal on Aging*.

Limitation of our work

General use restriction

This report is prepared solely for the use of The National Foundation for the Deaf. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose of estimating the social and economic impacts of hearing loss in New Zealand. You should not refer to or use our name or the advice for any other purpose.

Contact us

Deloitte Access Economics
ACN: 149 633 116

8 Brindabella Cct
Brindabella Business Park
Canberra Airport, ACT 2609
GPO Box 823
Canberra, ACT, 2601

Tel: +61 2 6263 7000

www.deloitteaccesseconomics.com.au

Deloitte Access Economics is Australia's pre-eminent economics advisory practice and a member of Deloitte's global economics group. For more information, please visit our website www.deloitteaccesseconomics.com.au

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com.au\about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms.

Deloitte provides audit, tax, consulting, and financial advisory services to public and private clients spanning multiple industries. With a globally connected network of member firms in more than 150 countries, Deloitte brings world-class capabilities and deep local expertise to help clients succeed wherever they operate. Deloitte's approximately 200,000 professionals are committed to becoming the standard of excellence.

About Deloitte Australia

In Australia, the member firm is the Australian partnership of Deloitte Touche Tohmatsu. As one of Australia's leading professional services firms. Deloitte Touche Tohmatsu and its affiliates provide audit, tax, consulting, and financial advisory services through approximately 6,000 people across the country. Focused on the creation of value and growth, and known as an employer of choice for innovative human resources programs, we are dedicated to helping our clients and our people excel. For more information, please visit our web site at.
http://www.deloitte.com/dtt/home