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CRC for Cochlear Implant and Hearing Aid Innovation

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Communication is the key

LISTEN HEAR!

THE ECONOMIC IMPACT AND COST OF HEARING LOSS IN AUSTRALIA

ACCESS ECONOMICS

A report by Access Economics Pty Ltd

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GLOSSARY OF COMMON ABBREVIATIONS

ABS	Australian Bureau of Statistics
AUSLAN	Australian Sign Language
BTE	Bureau of Transport Economics
ACMA	Australian Communication and Media Authority
AIHW	Australian Institute for Health and Welfare
CI	Confidence Interval
CRC Hear	Cooperative Research Centre for Cochlear Implant and Hearing Aid Innovation
DALY	Disability adjusted life year
dB	Decibel
DCIS	Disease Costs and Impact Study
DRA	Deafness Resources Australia
DSP	Disability Support Pension
DWL	Dead weight loss
HOWCA	Heads of Workers Compensation Authorities
Hz	Hertz
ISO	International Standards Organisation
MRC	Medical Research Council (Britain)
NAL	National Acoustic Laboratory
NIHL	Noise induced hearing loss
NMIT	North Melbourne Institute of Technology
NOHSC	National Occupational Health and Safety Commission
OHL	Occupational hearing loss
OR	Odds Ratio
PBS	Pharmaceutical Benefits Scheme
QALY	Quality adjusted life year
RIDBC	Royal Deaf & Blind Children's Centre, North Rocks
RHL	Recreational hearing loss
SAHOS	South Australian Health Omnibus Study
SEEP	Special Education Expenditure Project
SDAC	Survey Disability, Ageing & Carers
TAFE	Technical & Further Education
TTY	Telephone typewriter
VSL	Value of a statistical life
YLD	Years of healthy life lost due to disability
YLL	Years of healthy life lost due to premature death

EXECUTIVE SUMMARY

Study context

To date there has been no definitive research on the full economic impact of hearing loss in Australia, despite the large proportion of people who have hearing loss and its substantial effects on the capacity to communicate, to work and function effectively in an increasingly communication-intense society, as well as its impacts on quality of life. Access Economics has thus been commissioned by CRC HEAR and the Victorian Deaf Society to quantify those impacts and estimate both the financial costs and the loss of wellbeing from hearing loss in Australia for the year 2005, using a prevalence-based costing approach, accepted international methodology for valuing healthy life and Australian epidemiological data. Such analysis is important to inform policy making and direct scarce health resources to preventive and therapeutic interventions that are most cost effective.

Prevalence of hearing loss

One in six Australians is affected by hearing loss. Prevalence rates for hearing loss are associated with increasing age, rising from less than 1% for people aged younger than 15 years to **three in every four people aged over 70** years. With an ageing population, hearing loss is projected to increase to **1 in every 4 Australians by 2050**.

The net consequence of hearing loss is a reduced capacity to communicate. The ability to listen and respond to speaking is reduced and for some, the ability to speak is lost or impaired. Reduced communication abilities impact on a person's life chances through the reduced opportunity to equitably participate in education, to gain competitive skills and employment and to participate in relationships. Adverse health effects are associated with hearing loss.

While interventions such as hearing aids and cochlear implants enhance a person's ability to communicate, the majority of people with hearing loss (85%) do not have such devices.

Costs

In 2005, the real financial cost of hearing loss was **$11.75 billion or 1.4% of GDP**.

- This figure represents an average cost of **$3,314 per person** per annum for each of the **3.55 million Australians who have hearing loss or $578 for every Australian.**
- Costs are conservatively based on prevalence of a hearing loss in the better ear.
- Costs conservatively do not include costs of otitis media, which can be substantial in some sub-populations, such as Aboriginal children.
- The financial cost does not take into account the net cost of the loss of wellbeing (disease burden) associated with hearing loss, which is a further **$11.3 billion.**

The largest financial cost component is **productivity loss, which accounts for well over half (57%) of all financial costs ($6.7 billion**).

- Nearly half the people with hearing loss are of working age (15-64 years), and there are an estimated 158,876 people not employed in 2005 due to hearing loss.

- The productivity cost arises due to lower employment rates for people with hearing loss over 45 years and subsequent losses in earnings.

The **cost of informal carers is second at 27% of the total ($3.2 billion**).

- Informal carers assist people with hearing loss to communicate in a variety of settings. The costs are calculated on a replacement valuation basis – ie, the amount that would have been required to pay someone to provide the communication assistance. This is calculated at $25.01 per hour for 126.6 million care hours per year, based on 422,765 people for 5.75 hours per week.

Since fewer people with hearing loss are working, as a group they have reduced incomes and, as such, pay less income taxation. With lower income, they also consume less, so the government forfeits both income and consumption tax revenues, worth $1.3 billion in 2005. Moreover, a further $1.3 billion is required by the Government to finance the welfare payments to people with hearing loss. Finally, the Government must find revenue to fund the health and other real services for people with hearing loss. The need to raise all this additional revenue has **deadweight losses** from administration of the government systems involved as well as from the distortionary impacts on the economy of making the taxation and spending transfers. These deadweight losses associated with hearing loss were estimated to **cost $1.0 billion in 2005 (9% of total financial costs)**.

Direct health system costs are expenditures incurred in the health system for the diagnosis, treatment and management of hearing loss. These costs are estimated at **$674 million** in 2005, **(including hearing aids and cochlear implants)** and account for less than 6% of total financial costs.

- The largest health expenditure item is devices spending on **hearing aids ($376.7 million encompassing public and private markets, of which $243 million represent the government's Office of Hearing Services Program)** and on **cochlear implants ($10 million)** per annum.
- Second, **$247.5 million** is allocated recurrent health system expenditure (just under $70 per person with hearing loss per annum, nationally).
  - The majority (53% or $130 million) of the allocated health expenditure is provided by allied health professionals, encompassing services such as audiology and speech pathology (ie, diagnostic and rehabilitation services).
  - Other large recurrent health expenditure items include outpatient costs (19% or $46 million), and medical specialists (12% or $33 million).
  - Health system research into hearing loss accounted for around 5% of health system expenditure.
  - 27% of health expenditure is on children aged less than 14 years, who comprise less than 1% of people with hearing loss, while noting that needs may be higher and impacts greater for children.
  - Males dominate health expenditure 61%:39% (male:female), reflecting the higher prevalence of hearing loss among males.
  - Less than 5% of the average per capita expenditure on the national health priorities is spent on hearing loss.
- Other health expenditure is **unallocated ($40.3 million)** on capital items, community health, public health programs and administration.

Education and support services and various non-health communication aids comprise the remaining **1.6% of real financial costs ($191 million in 2005)**.

Quality of life impacts

The financial costs are paralleled by the loss of wellbeing (or 'burden of disease') – the reduced quality of life, loss of leisure, suffering, physical pain and disability. The additional impact of the loss of human wellbeing is measured internationally in terms of DALYs Disability Adjusted Life Years (DALYs).

- 95,005 DALYs are estimated to be lost in 2005 due to hearing loss, worth **$11.3 billion in net terms** and some **3.8% of the total burden of disease** from all causes of disability and premature death.
- In terms of disability weighting (which measures the extent of the loss of a healthy life year, with 0 equal to no loss and 1 equal to total loss):
  - mild hearing loss is comparable to mild asthma;
  - moderate hearing loss is comparable to chronic pain resulting from a slipped disc;
  - severe hearing loss is comparable to having pneumonia on an ongoing basis.
- A conservative approach has been taken in the estimate of DALYs. The estimate is based on hearing loss in the better ear (a truer reflection of disability), does not include hearing loss in the Deaf Community (using the estimate of 10,000 people or less than 1% of people with hearing loss), takes into account the gains from wearing hearing aids and makes the most conservative assumptions regarding prevalence among young adults.

Projections and further work

Projections of hearing loss suggest that hearing loss in the worse ear is expected to more than double by 2050 (a 2.2-fold increase).

- **The prevalence of hearing loss overall is projected to increase from 17.4% (one in six) in 2005 to 26.7% (more than one in four) in 2050**.
- The prevalence of hearing loss is projected to increase from 21.0% (one in five) in 2005 to 31.5% of all males (nearly one in three, largely as a result of demographic ageing) in 2050.

A significant amount of hearing loss (37%) **is due to excessive noise exposure,** which is preventable.

Further research is warranted in the following areas:

- epidemiology of hearing loss
- prevention of hearing loss (cost-effective measures), in particular barriers to adoption of personal protection equipment;
- bio-molecular and genetic approaches to hearing loss;
- enhancing access to, and continued use of, hearing aids;
- health effects of hearing loss;
- cost-effective models of enhancing informal care;
- aboriginal hearing health; and
- enhancing productivity of people with hearing loss.

1. STUDY CONTEXT

1.1 THE NEED FOR THIS STUDY

Hearing is one of our primary senses. Together with vision and touch, hearing enables humans to interact with our environment at all levels. Of the three primary senses, hearing is the foundation sense used for communication between people. A loss of hearing acuity fundamentally limits the ability of the individual to communicate, and through this, limits their ability to interact with society. This has social and economic consequences both for the individual and for society.

The social consequences of a hearing loss have varied over human history. In Ancient Greece, hearing loss denied a person the right to participate in community life (Edwards, 1994). Similarly in Biblical times, deaf people were treated as social outcasts and survived primarily by begging. In Medieval times, Lane (1984) notes “the inability to speak or hear meant that the individual was not a person in law and therefore could not inherit the family fortune or participate in Church life.” However, hearing loss was not a total barrier to work in medieval times since the work undertaken was farm, village or craft-based (Hogan, 1996).

The advent of the industrial revolution and subsequent urbanisation resulted in an unravelling of traditional medieval social systems. Rapid urbanisation created a variety of social problems in the nineteenth century and concern for social order became paramount. As a result of these concerns, people with disabilities, including hearing loss, were often institutionalised and undertook labour in workhouses (Bentham, 1816, Kannar, 1964; Dean, 1992; Fusfeld, 1994; Hogan 1996). Several movements to educate deaf people to take their place in society emerged in the late nineteenth century. Students who graduated from these systems predominantly found employment in the trades (Winefield, 1987).

Ruben (2000) observes that at the beginning of the twentieth century, work was predominantly manual and easily undertaken by people with communication disorders like hearing loss. In the United States, only 20% of people were employed in white collar jobs where communication skills formed an essential part of the job requirement. However, as the twentieth century evolved the nature of work changed again. Ruben observes that by the end of the twentieth century “62% of (the) labor force made their livelihood using skills based on their communication abilities”.

Data produced by the Australian Bureau of Statistics shows a similar trend in Australia with a substantial growth in service industries jobs compared with, for example, the manufacturing sector.[1] The Bureau observes that 54% of people born 1927-1931 worked in the services industry compared with 74% of people born 1957-1961. Ruben (2000) studied the economic effect of communication disorders and the subsequent cost of lost or degraded employment opportunities in people who lacked the ability to hear or to talk without problems. He estimated the cost to the American economy to be between 2.5% and 3% of GDP. Ruben concluded his study with the observation that a person without communication skills was not only likely to be unemployed, but

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[1] **http://www.abs.gov.au/Ausstats/abs@.nsf/0/C39B360652A7A8BFCA256D39001BC355?Open** accessed 25/01/06.

unemployable in the modern era. With an increasing move to a service-based economy, people with hearing loss in Australia face similar challenges.

As well as limiting potential employment prospects, hearing loss places limitations on the individual's ability to interact with the community.

Although hearing loss affects 1 in 6 Australians, to date there has been no definitive research on its economic impact. Most studies have focused on prevalence issues, or delineating the social context of hearing loss to the individual and to some groups (for example workers suffering industry-based noise-induced hearing loss).

Given acceptance of the tenet that Australians must stay productive longer into their working lives, and the ever-escalating costs of health services for our ageing Australian population, any disorder or problem that places limitations on productivity and healthy ageing is of concern. As such, awareness of the economic costs of hearing loss is an important issue in public health, particularly in the context of comparing the costs of (preventive or therapeutic) interventions with those of not intervening.

Few attempts have been made to establish the consolidated costs of hearing loss in the wider community using sound economic techniques, and to the best of our knowledge, this has never been undertaken in Australia.

The aim of this study was therefore to estimate the economic impact and cost of hearing loss in Australia in 2005.

In commissioning this study, the Cooperative Research Centre for Cochlear Implant and Hearing Aid Innovation (CRC HEAR) and the Victorian Deaf Society (Vicdeaf) first posed the question "How much does deafness cost the Australian community?" There were a number of obstacles confronted in answering this question.

First, hearing healthcare services are fragmented between Commonwealth and State-based agencies, and between the public and private sectors. There is no coordinated overall hearing healthcare program across Australia, and as such, there are no detailed estimates of the overall costs of deafness that include all sources of expenditure. The education sector is also strongly involved in the remediation of hearing loss.

A more fundamental problem arises in that, although Australian Hearing Services (a Commonwealth statutory authority) has been established to provide hearing healthcare services to children, pensioners and ATSIC peoples, hearing health care is not considered to be a priority health care area. Hearing aids are not treated as essential medical appliances, reflected in the differential services provided under auxiliary cover by private health funds for hearing services and appliances.

In addition, although there is general acceptance that preventive measures – such as good education, ear protection and information about how to preserve hearing and how to avoid noise-induced hearing loss when working in noisy environments – should be readily available and provided as the norm in industry, the approaches to dealing with hearing conservation vary between States/Territories, and there is no consolidated Australia-wide awareness or public health program. This contrasts with skin cancer or other health conditions where there is a large role for prevention activities.

In considering economic costs, the loss of effectiveness and productivity in the workforce as a result of hearing loss and its associated communication problems are a key consideration. Additional health-related problems associated with hearing loss, such as tinnitus and/or balance disorders, may also compromise the individual's productivity and contribution to society.

For children, hearing loss poses additional difficulties, in that the sense of hearing is critical not only to development of auditory skills (such as localising sounds and comprehending the meaning of an acoustic message), but also to the development of spoken language, and most importantly to the development of speech and language. Hearing loss impacts directly on literacy and learning, education, and employment options for children.

To address these many issues, Access Economics was commissioned to provide a comprehensive economic analysis of the costs and economic impact of hearing loss in Australia. The commission required Access Economics to conduct an independent disease cost burden analysis of hearing loss in Australia. This study would estimate two key figures: the financial cost associated with hearing loss and the Australian economy and the cost of the loss of wellbeing to individuals as a result of hearing loss.

1.2 STRUCTURE OF THIS STUDY

The structure of the study was agreed to between Access Economics and the project stakeholders. A prevalence approach was adopted for the study, given the available epidemiological data and literature.

Prevalence rates in 2005 in Australia were estimated in the better and worse ear by:

- age groups;
- gender; and
- severity of hearing loss.

The prevalence of hearing loss was projected to 2050 based on ABS population projections.

Costs associated with hearing loss were examined comprising:

- direct health costs;
- other financial costs incurred due to hearing loss, including:
  - productivity losses;
  - education and support services;
  - communication aids and devices;
  - carers; and
  - the deadweight losses associated with government transfer payments; and
- loss of wellbeing (burden of disease), measured in terms of DALYs (an internationally accepted non-financial measure) as well as being converted to a dollar metric using willingness to pay methodology and applying the concept of the value of a statistical life (VSL), based on wage-risk studies.

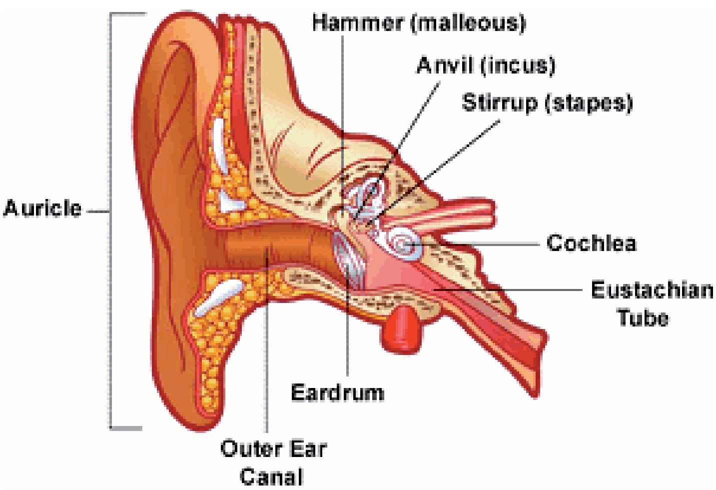
Sources of data for indirect costs were identified in collaboration with a broad range of service providers and government departments.

2. BACKGROUND

2.1 THE HEARING SENSE

The human body has five senses "which serve as receivers of stimulation from outside the body...the ear is the end-organ for hearing" (Myklebust, 1971:11). Sound waves travelling through the air are gathered in the outer part of the ear (called the *pinna*), travel through the auditory canal and pass through the ear drum (*tympanic membrane*) to what is commonly known as the middle ear. Sound waves set up vibrations of the tympanic membrane which separates the outer and middle ear. These vibrations are transformed via three small bones commonly known as the hammer (*malleus*), anvil (*incus*) and stirrup (*stapes*) (also known as the *ossicular chain*) so as to permit vibration of the fluid which fills the inner ear (the *cochlea*). The fluid filled cochlea resembles a snail shell. Inside it are thousands of tiny hair cells called *cilia*. These hair cells have been compared to new lawn which has just grown from seed. As grass moves to and fro in the wind, the cilia move to and fro in response to movements in the inner ear fluid which has been vibrated by incoming sound. Movement of the cilia discharges an electrical activity in the neurons that form the eighth cranial nerve, which connects the receptor surface of the cochlea with the central nervous system. Through developmental learning processes, differing forms and sequences of sound ultimately become associated with different events, objects and meanings. A person's ability to understand this variety of events, objects and meanings produced by sound is usually called hearing (Schubert, 1980). The key reason that people seek help for hearing loss is to be able to hear speech more clearly (Dillon, 2001).

FIGURE 2-1: THE HEARING MECHANISM AND SITES OF HEARING LOSS



Source: http://kidshealth.org/kid/body/ear_noSW.html

2.2 SEVERITY OF HEARING LOSS

Hearing can be described by the range of sounds one can hear (for example the lowest to the highest piano note) and how softly one can hear such sounds. The range of sounds is measured in *hertz* or number of sound waves per second. The intensity or strength of a sound is given in terms of a scale of *decibels* which usually ranges from 0 to 140 decibels where 0 decibels represents the quietest level of hearing accessible to the average healthy human ear[2] and 140 decibels, where physical damage immediately occurs (Table 2-1). Decibels are measured using a logarithmic scale. On an ordinary or linear scale, an increase say from a score of 50 to a score of 100 would equal a doubling of intensity. However, on a decibel scale, an increase of 6dB equates to a doubling of intensity.

TABLE 2-1: DECIBELS PRODUCED BY COMMON SOUND SOURCES

Decibel	Sound source
0	Silence – threshold of hearing
10	Rustling paper
20	Whispering
30	Ticking watch 1m from ear
40	Quiet room
50	Quiet conversation
60	Normal conversation
70	Loud conversation
80	Heavy traffic
90	Engineering workshop
100	Boilermakers shop
110	Road drill
120	Jet engine
130	Threshold of pain
140	Shotgun blast

Source: Serra, Bailey and Jackson,1986:102.

Noble (1978:174) points out that the concept of normal hearing is useful for ascertaining the extent of injury to hearing from factors such as workplace noise. Levels of hearing loss are commonly referred to as mild, moderate, severe or profound, depending on how intense a sound has to be before one can hear it. In this analysis, measured hearing loss by severity is defined (as per Australian Hearing, 2005) for children aged less than 15 years as:

- Mild 0-30 dB;
- Moderate 31-60 dB;
- Severe 61-90 dB;
- Profound 91 dB plus;

and, for people aged 15 years or more (as per Wilson, 1997) as:

- Mild ≥ 25 dB and <45dB;
- Moderate ≥ 45 dB and <65dB; and
- Severe ≥ 65 dB.

Measurement of hearing loss: Hearing can be tested using either subjective or objective testing methods. Subjective testing includes standard audiometric testing, usually conducted by an audiologist or hearing aid audiometrist, or an ear, nose and throat specialist. In adults, this test consists of presentation of a series of tones (known as pure tones) or other speech or environmental sounds through a pair of headphones

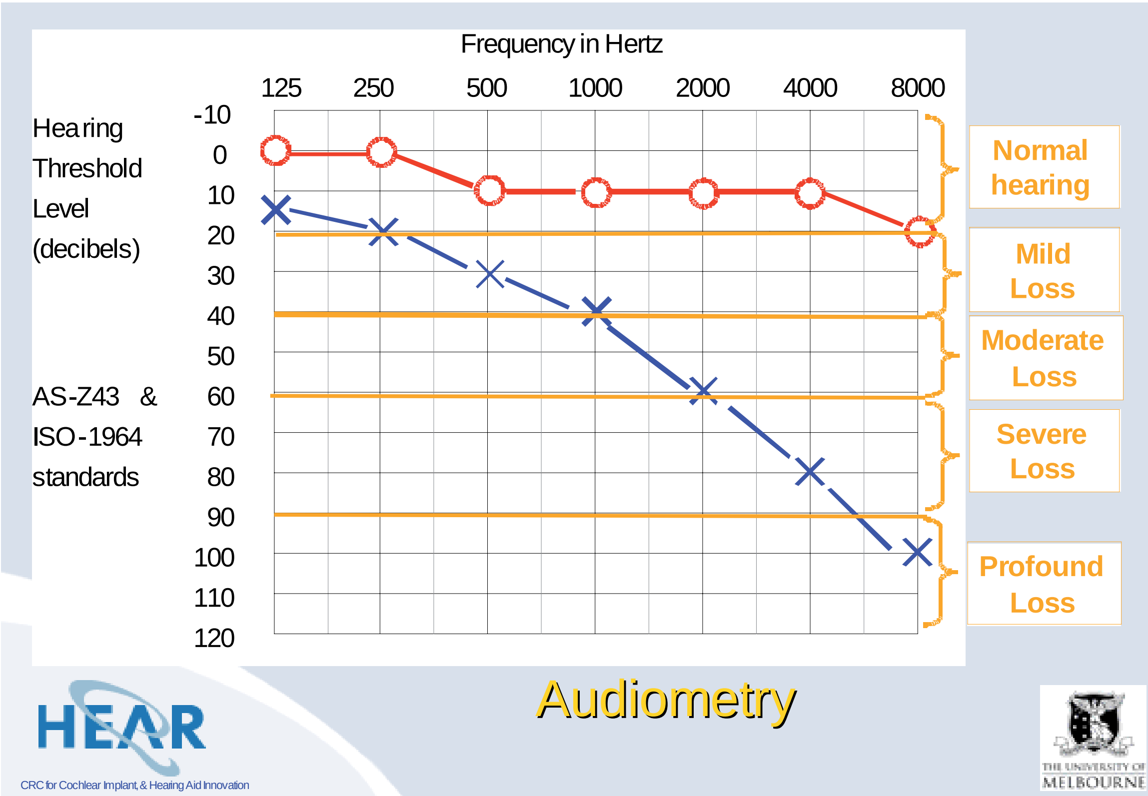
[2] The decibel standard was based on "the average threshold level of listeners at the Bell Telephone Laboratory" at a given time (Noble, 1978:176ff).

worn by the individual being tested. Each ear is tested separately. The presentation level of the sound (in decibels) is varied, and the individual reports the lowest level of sound that they can hear at a number of individual frequencies (usually encompassing the range from 250-8,000 Hertz). In young children, audiometric testing is conducted using a variety of sounds and estimating threshold from the behavioural responses observed. Objective testing does not require a subjective response from the individual. Rather, objective tests measure a physiological response from the individual. For example the hearing of newborn children can be measured using the auditory brain stem response technique or other electrophysiological measures of the neural response to an acoustic stimulus. These objective techniques can also be used in adults to measure thresholds or to help identify the site of lesion of a hearing loss.

Figure 2-2 depicts the audiogram with degrees of disability (mild, moderate, severe and profound) represented (these differ slightly in the diagram from the definitions of mild, moderate and severe used elsewhere in this report).

Just as noise levels doubled in intensity for each increase of 6dB, a person's hearing acuity is halved for each 6 dB deficit in hearing threshold.

FIGURE 2-2: HEARING LOSS AS SHOWN ON AN AUDIOGRAM

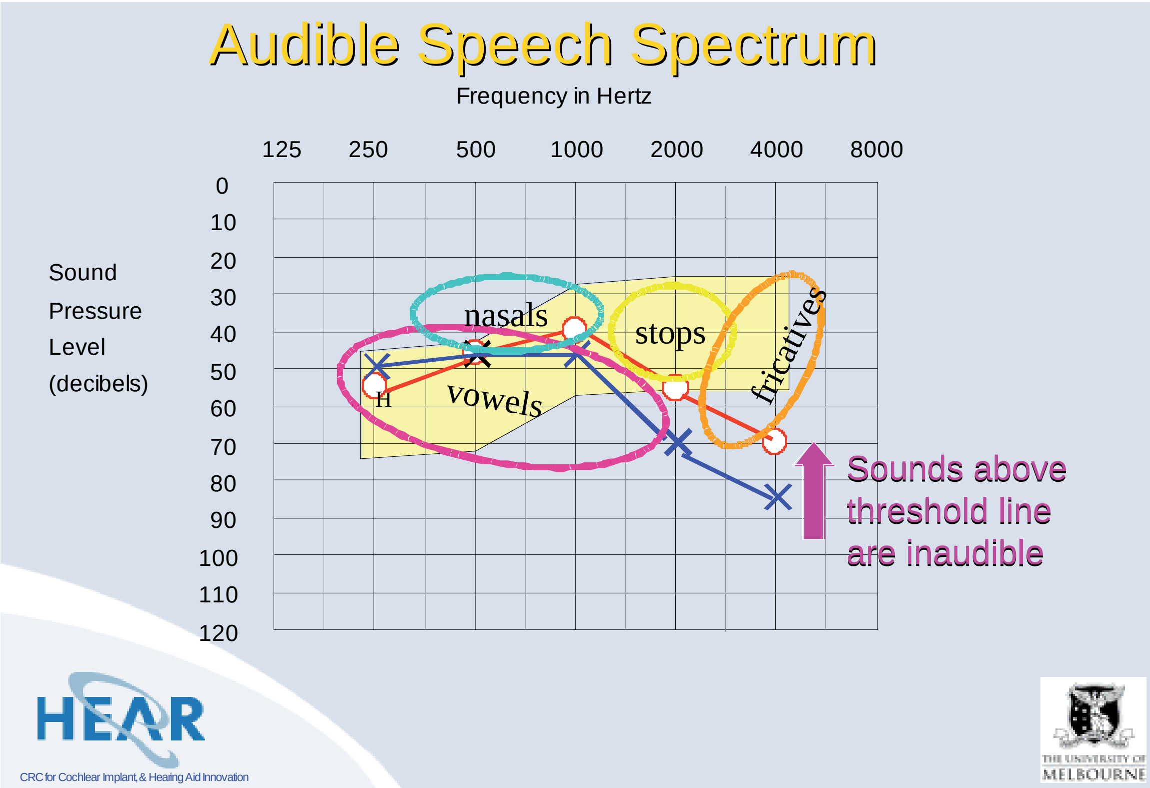


Source: CRC Hear – the red X line represents the hearing test for the left ear and red O line for the right ear. Note: severity categories differ slightly in the diagram from the definitions of mild, moderate and severe used elsewhere in this report.

Figure 2-3 depicts the audiogram and shows where key sounds fall by frequency and intensity. Overlaid on this audiogram is the result of a hearing test (pale red line for left ear and dark red line for right ear). In the left ear the audiogram depicts a hearing loss that is moderate by degree in the lower frequencies moving to profound in the higher frequencies. The hearing in the right ear is within the normal range. The level of hearing loss reported is commonly taken as an average of the three frequencies (500

Hz, 1,000Hz and 2,000 Hz). The audiogram in this example would be reported as normal in the right ear and moderate in the left ear. Taking measures of the better ear, this person would not be counted as having a hearing disability.

FIGURE 2-3: THE AUDIOGRAM SHOWING KEY SPEECH SOUNDS

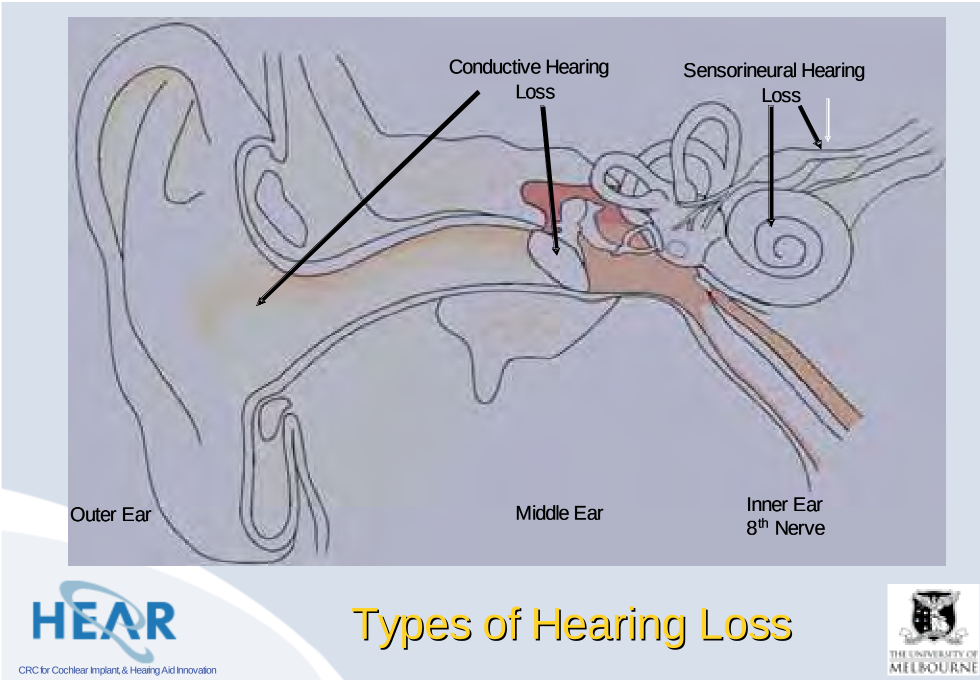


Source: CRC Hear.

2.3 CAUSES OF HEARING LOSS

Figure 2-4 depicts the hearing system; highlighting places within the ear where hearing loss occurs (see below).

FIGURE 2-4: THE HEARING SYSTEM



2.3.1 CONDUCTIVE AND SENSORINEURAL HEARING LOSS

The inability to hear generally stems from one of two causes.

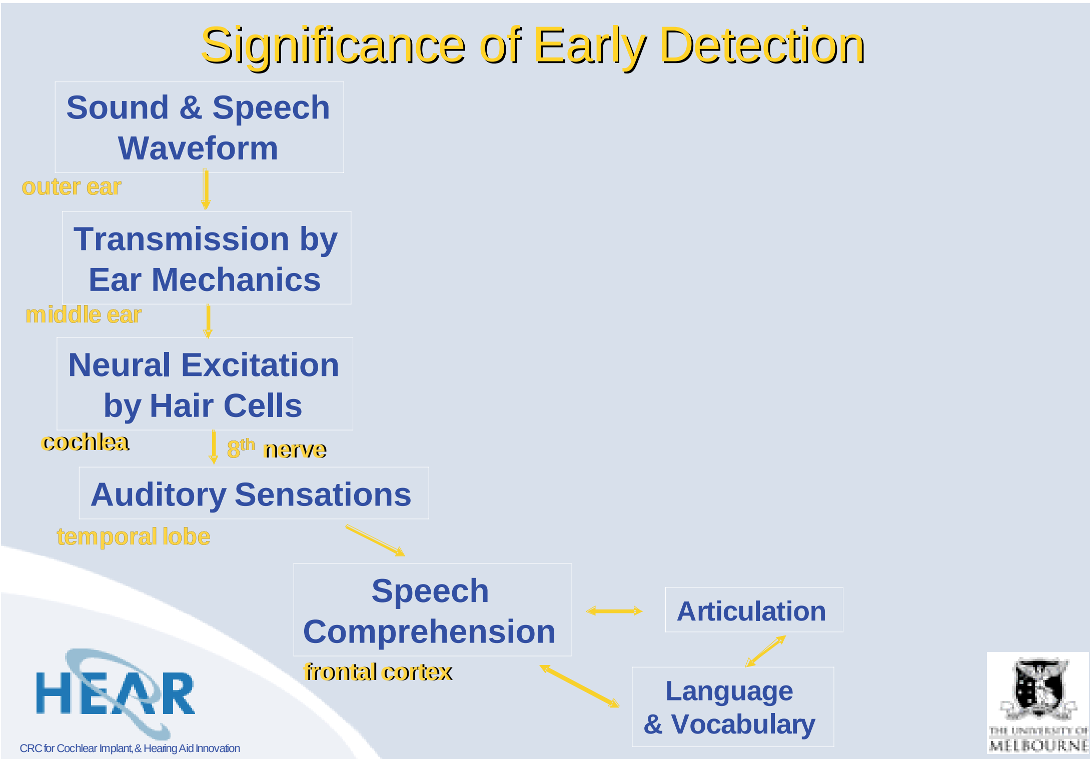
- **Conductive hearing loss** occurs when problems in the middle ear prevent it from conducting sound to the inner ear. A conductive loss can be transient or permanent. The most common cause of hearing loss in children is Eustachian tube dysfunction, which may affect up to 30% of children during the winter months. This problem, which all people may experience in terms of hearing loss associated with a severe head cold, may lead on to more serious problems such as fluid in the middle ear or the more serious *otitis media*, in which a bacterial or viral agent infects the middle ear or the ear drum. Otitis media may result in perforations of the ear drum as well. The level of hearing loss associated with this condition is approximately 40dB. More chronic types of otitis media can result in permanent scarring of the ear drum. Such scarring reduces the ability of the ear drum to respond to sound and hence the sound is not conducted well through the ossicular chain to the inner ear. Other forms of conductive loss can result from damage to the ossicular chain, which in some cases can ossify (harden into bone).
- **Sensorineural hearing loss**, the second type of deafness, results from damage within or malformation of the cochlea itself, where the hairs cells are either damaged or destroyed. Injury to the hair cells can result from excessive noise exposures, chemical damage such as smoking (Nomura et al, 2004),

environmental agents (Rybak, 1992) or medications (Buszman, 2003), and long term wear and tear from the ageing process, which is referred to as *presbycusis*. Hearing loss can also result from damage to the auditory or eighth nerve that runs from the cochlear to the brain – hence the term *sensorineural*. Sensorineural hearing loss is permanent by nature.

A smaller number of people can have a **mixed hearing loss**, where part of the hearing loss results from a conductive loss and part from sensorineural loss.

The first and primary impact of hearing loss is on the perception of usable information by the individual. Any disruption to this cascade of sounds, as they move from the environment through the various parts of the ear to the auditory nerve and on to the brain, poses a threat to the individual being able to hear and in turn to learn to recognise these sounds as speech and usable language. Hearing loss can impact on speech in adults who suffer a sudden and complete sensorineural hearing loss, but also particularly in children, as the motor pathways that control speech have a critical period for development that is thought to be within the first 5-7 years of life. Hearing loss in children also impacts on the acquisition of language and vocabulary, which may have a lifelong impact on educational and employment opportunities. Figure 2-5 summarises the relationship between speech and language.

FIGURE 2-5: THE LINK BETWEEN SOUND AND SPEECH



Source: CRC Hear

2.3.2 HEARING LOSS IN CHILDREN AND ADULTS

The impact of hearing loss in a person's life depends on the intersection of three key factors – the time a person acquires their hearing loss, the severity of the hearing loss, and the communication demands facing the person at their particular point of the life span. Hearing loss has a very specific impact on children, for example, who, while representing a very small proportion of the population of people with hearing loss, require significant support in developing language and accessing education and employment.

Hearing loss in children is commonly congenital (the child is born with it) and sensorineural in nature. The cause can be genetic or arise though maternal infections or birth problems. A number of sensorineural losses also arise in children from infections such as meningitis occurring in early life. Conductive losses are also quite common, resulting from Eustachian tube dysfunctions and otitis media discussed in the previous section. Hearing loss, even of a mild nature, can have serious educational implications for children.

Hearing loss in adults is predominantly sensorineural in nature commonly caused by the ageing process and excessive noise exposures resulting from occupational or recreational noise. As the Beaver Dam study reported, hearing loss is associated with increasing age (Cruickshanks et al, 1998). Thus, as the Australian population ages, there will be increasing numbers of people with hearing loss. Some of the causal factors associated with hearing loss, such as ototoxic substances (i.e. chemicals that damage or destroy the hair cells), are not as yet well understood, limiting prevention efforts in this area. However, some conditions, such as **noise induced hearing loss** (NIHL), are preventable (see next Section 2.3.3).

Hearing loss in the Aboriginal community is very common. A systematic review of evidence commissioned by the Office of Aboriginal and Torres Strait Islander Health (OATSIH) reported that ear disease (particularly otitis media) and subsequent hearing loss were significant problems among Aboriginal communities.[3] Data quality problems and differing prevalence rates across regions limit the extent to which the problem can be credibly reported. The prevalence of otitis media in children was reported to vary between 10% and 54%. By United Nations criteria, a prevalence exceeding 4% is considered to be a significant public health problem. Subsequent perforated ear drums were reported to be between 9% and 35% and as high as 95% in some studies. Otitis media was occurring in newborn children with two thirds of babies having one ear drum affected by six months of age. Rates of hearing loss were reported between 10%-41%. Hearing loss in comparative western populations was reported at between 5% and 7%.

Within the burden of disease model, otitis media is treated as a respiratory condition. Costs associated with this ear disease in itself are therefore correctly excluded from this study. However, where hearing loss results, associated costs are included. For example, Australian Hearing and Office of Hearing Services data reported later in this study includes services for Aboriginal people with hearing loss. The spread of costs by ethnicity may be more important in certain areas. In the Northern Territory, for example, it is estimated that 60% of people with hearing loss are Aboriginal (Central Australian Aboriginal Congress, 2005). However, assessment of costs by ethnicity was outside the scope of this brief.

Time of onset: A person can acquire a degree of deafness at any age. The timing of onset has a direct bearing on the type of language skills a person may develop, the education s/he may receive and the type of employment opportunities available which s/he may access. As such, time of onset (coupled with degree of deafness) serves as

[3] http://www.health.gov.au/internet/wcms/publishing.nsf/content/health-oatsih-pubs-omp.htm/$FILE/oc1.pdf

a critical marker with regards to service requirements and, potentially, lifetime costs. There are two critical onset markers – pre and post lingual deafness.

- The early identification of the onset of hearing loss at birth and/or prior to the development of spoken language (**pre-lingual deafness**) serves as a critical flag for the child's future. Decisions are subsequently made with regard to the mode of communication to develop (sign language and/or speech), technologies to use (hearing aids, cochlear implants, and/or telephone typewriters (TTYs)), support services required (eg speech therapy, sign language interpreters) and the types of educational settings s/he may in turn access (such as early intervention programs, schools for the deaf, deaf support classes or mainstream classrooms). Costs and opportunities are associated with the decisions made as are life opportunities for affected individuals. The impact of hearing loss on educational outcomes is evident in research, which indicates that young deaf people leave school with significantly lower educational outcomes than their hearing peers (Yoshinaga-Itano et al, 1998).
- **Post-lingual onset of deafness** means that the person has acquired hearing loss after they have developed a language system. Following the onset of deafness, most people continue to use spoken language, supported by hearing devices and pursue a hearing culture, although a small number of people make the transition into the Deaf Community (see Section 2.4) and become sign language users.

2.3.3 Noise induced hearing loss (NIHL)

Wilson et al (1998:34) reports that a noise component was associated with 37% of the population of people with hearing loss. That is, for 37% of people with hearing loss, noise was responsible for at least part of their hearing loss. The most common sources of noise injury are workplace noise and recreational noise (personal stereos, domestic use of power tools, motor sports), although the attributable fractions for each have been debated.

2.3.3.1 Recreational hearing loss (RHL)

Sufficient exposure to recreational noise may result in recreational hearing loss (RHL). Music exposure has been an issue for four decades – from rock and roll in the 1960s and 1970s, to walkmans in the 1980s and 1990s and more recently the emergence of MP3 players. However, the significance attributed to recreational noise by advocates and the media may be disproportionate to the risk. This may result in part because personal stereo systems are such a ubiquitous part of modern life. Apple, for example, advises that there are 28 million iPods in use worldwide. Despite such widespread use, there is no epidemiological data that systematically examines RHL, although there are studies that show short term or minor hearing damage resulting from personal stereo systems and music exposure generally. However, there have been no long term studies that document exposure outcomes resulting in permanent measurable and significant hearing loss eg > 25 dB. Moreover, there is as yet no consensus on the contribution RHL makes to the overall prevalence of hearing loss (Mostafapour et al, 1998) and, indeed, in studies that have examined the contribution of recreational noise in the context of assessing people exposed to workplace noise, the contribution of other sources had been found to be so low as to be of minor consideration within calculations (see for example Neitzel et al, 2004). Finally, even where it was proposed that other conditions such as Ottis Media possibly made subjects more vulnerable to RHL, one study found this not to be the case (de Beer et al, 2003).

Recreational noise can cause hearing loss if the extent of exposure is loud enough and people are exposed over sufficient years (Williams, 2005b). While there is evidence that personal stereo system exposures are loud enough (Williams, 2005a) there is no evidence that exposures occur over a long enough period. A prospective study to this end is indicated. Rather recreational exposures appear to occur within a specific part of the life cycle (Serra et al, 2005) and not for the prolonged periods that would be required to sustain hearing loss (Williams 2005a). Studies linking substantial threshold shift (i.e. increases in hearing impairment) in the population with music are not there. What is known presently is that some people succumb to hearing loss more readily than others (Biassoni et al, 2005) – the phenomenon of *soft ears*. In the absence of sufficient epidemiological data and attributable risk factors, it has not been possible in this study to estimate the number of people who may sustain RHL in the future.

2.3.3.2 Occupational hearing loss (OHL)

Table 2-2 reports workers' compensation claims for **occupational hearing loss** (OHL) over the six years to 2003.

Table 2-2: Paid workers compensation claims for OHL, 1998-2003

Year	Hearing Compensation Claims
1998	6,156
1999	4,305
2000	4,213
2001	3,973
2002	3,811
2003	3,041

Source: National Data Set for Compensation Based Statistics, OASCC special data request.

Official rates for workers' compensation claims for OHL have been falling in recent years, in the absence of any significant prevention programs. A notable fall is between 1998 and 1999 as shown in the table above. The most likely explanation for this is the introduction of a minimum threshold (also called a 'low fence') for eligibility for compensation, introduced during the 1990s by various governments in response to rising workers compensation claims.[4] Prior to the introduction of a low fence, the average level of hearing loss from workplace noise was approximately 5%. This move culminated in a recommendation by the Heads of Workers Compensation Authorities (HOWCA, 1997:13) to recommend that in order to be eligible for compensation a worker must have a 10% hearing loss. While the height of the low fence differs between jurisdictions, low fences have been introduced in all jurisdictions, effectively reducing the number of people able to submit a claim for OHL.

While the Office of the Australian Safety and Compensation Council have developed a national standard for the control of OHL[5] and this standard has been widely adopted into state regulations[6], there is no nationally co-ordinated OHL prevention campaign.

[4] The concept of the low fence refers to least level of impairment allowable before a person becomes eligible for compensation.

[5] http://www.nohsc.gov.au/OHSLegalObligations/NationalStandards/NOISE.htm

[6] http://www.workplace.gov.au/workplace/Category/Publications/WorkplaceRelations/WorkplaceRelationsMinistersCouncil-ComparativePerformanceMonitoringReports.htm

The jurisdictions report monitoring noise exposures as part of the routine work ensuring occupational health and safety compliance and one-off, smaller scale projects are initiated in local settings. Periodically, there have also been campaigns targeting industry sectors, such as hearing loss prevention among farmers.

OHL is a slow onset condition and behaves in response to prevention efforts more like a chronic disease rather than an injury. In injury prevention, payback can be expected fairly soon after the program has been initiated. With OHL, it is reasonable that exposed workers over the age of 45 years will already have some degree of hearing loss. OHL prevention efforts target (1) reducing the severity of loss for those already affected and (2) preventing the onset of the condition in the next generation of workers.

2.3.3.3 ACOUSTIC SHOCK AND ACOUSTIC TRAUMA

Two sources of hearing loss of current interest include **acoustic shock** and **acoustic trauma.** Acoustic shock is associated with the use of head sets in call centres while acoustic trauma is associated with acute, intense noise exposures.

- **Acoustic shock** arising from head set use results from “a sudden and unexpected burst of noise transmitted through the call handler’s headset …the maximum output sound pressure level is limited to 118dB(A)” (Lawton, 2003:249). One Danish study reported that 22% of the workers in a call centre had experienced acoustic shock (Hinke and Brask, 1999). Acoustic shock may result in a temporary hearing loss (Milhinch, 2002). However, the extent to which it results in permanent damage to the auditory system is debated. Lawton (2003) observes that the noise emitted from headsets in the shock situation is not sufficient to cause permanent hearing loss. Furthermore, of the people studied, there were other explanations for any hearing loss they had sustained. Lawton does however observe that other debilitating effects are associated with acoustic shock including **tinnitus** (intermittent or prolonged spontaneous sounds in the ear) and psychological stress akin to post-traumatic stress disorder. Certainly emotional trauma is associated with the event as may be physical damage to parts of the inner ear, such as emergence of holes or fistulas occurring in parts of the hearing mechanism. What is particularly concerning but as yet not firmly established is the possible link between acoustic shock and the later development of **Meniere’s Disease** (Riotman et al, 1989; Di Biase and Arriaga, 1997; van der Laan, 2001; Segal et al, 2003). This disease impacts on the parts of the ear associated with balance. Episodes of the disease may be associated with the onset of hearing loss that is sensorineural in nature. However, there is no available epidemiological evidence that establishes a causal link or an association at the population level to allow estimates to be derived. The psychological sequelae resulting from acoustic shock warrants preventative efforts in its own right.
- **Acoustic trauma:** Acute noise exposures associated with explosions such as bombs, localised alarm systems or artillery fire are common and known to result in hearing problems. Indeed, much of the modern development in hearing services resulted from the need to care for veterans following World War II (Henoch, 1979). While artillery fire may result in temporary hearing loss, for the majority of the population, repeated and preventable exposures are usually required before permanent hearing loss is sustained (Mrena et al, 2004). However, current modelling scenarios for noise exposure and injury allow for the probability that, even within existing safe limits, 6% of people exposed may still sustain hearing damage (ISO, 1999). In such settings, the screening of people

with *soft ears*, may be indicated. Acoustic trauma is treated in this study within the population of people with noise-induced hearing loss.

2.4 CULTURAL PERSPECTIVES, DISABILITY AND HANDICAP

2.4.1 CULTURAL PERSPECTIVES

Two models are commonly used to socially situate people with hearing loss.

- The first is a **medical-disability model**. The vast majority of people with hearing loss acquire a mild to moderate hearing loss in adult life, with a small number of people acquiring deafness during childhood. People with acquired hearing loss commonly understand hearing loss as a sensory deficit within the body. For them, hearing loss can be appropriately described as a disability for which aids, devices and therapies are indicated. The most commonly reported consequence of hearing loss for this group is a loss of social participation such as being unable to follow conversations in noisy social settings. This group often finds hearing loss stigmatising and consequently they may less readily take up the services on offer or utilise commonly recommended communication strategies. For this group, hearing loss can be appropriately described within the context of a burden of disease model. Parents whose children are born deaf often identify with hearing culture and also view hearing loss within the medical-disability model.
- The second model is a **cultural-linguistic model**. By contrast, people who are born severely to profoundly deaf may grow up in or later join the Deaf Community. Within the Deaf Community deafness is understood as a cultural-linguistic experience. Deafness, rather than being a source of stigma is a source of pride and cultural identity. Members of the Australian Deaf Community communicate using Australian sign language known as *Auslan*. A common communication problem facing members of the Deaf Community is the inability of most Australians to converse with them in Auslan and the lack of availability of sign language interpreters. This group would define the social consequences of hearing loss in terms of reduced social participation in the broader community and encounters the impact of this in terms of socio-economic loss and reduced social interactions rather than perceiving it as a burdensome disease.

Irrespective of differing cultural constructions underpinning perceptions of deafness, people who experience deafness in some form encounter communication difficulties in specific social settings. Such difficulties can result in personal, health and social consequences. For some encounters, the Australian community has put in place remedies (eg schools for the Deaf, cochlear implant, sign language interpreters and hearing aid services) to redress the consequences of deafness.

This study examines the costs arising from such interventions and documents the net economic impact of people living with differing degrees of hearing loss in Australian society.

2.4.2 LIMITS TO SOCIAL PARTICIPATION

Hearing impairment does not necessarily equate to 'disability', 'burden' or 'handicap'. Noble (1991:60-63) points out that an assessment of the existence of a hearing loss in itself yields little information about the exact nature of the disability or social limitation experienced by the affected individual. A person's perception of the level of difficulty caused by their hearing loss (what used to be called their hearing handicap, but now is defined in terms of social participation) may vary from individual to individual. By example, a lecturer with mild hearing loss may experience severe hearing handicap simply trying to interact with students in a lecture theatre – hearing loss reduces their capacity to work and relate effectively. Stressors are associated with this experience. By contrast, a metal worker with advanced hearing loss living alone may experience little hearing handicap if he has few difficult communicative interactions.

Lutman et al (1987) observed that as the level of measured impairment increased, so too did the likelihood of communication difficulties. Cruickshanks et al (1998:881) report that the percentage of people reporting a hearing handicap increased with severity of loss – 5.5%, 19.7%, 47.5% and 71.4% for none, mild, moderate and severe losses respectively (p for trend < .001). As such, people may choose to restrict their social, recreational or professional activities because of their hearing loss.

The degree of handicap or participation restriction is usually assessed using a self report scale (Noble, 1991:60) states that:

> *"(W)ithout direct inquiry into the lives and circumstances of the people who manifest signs of impairment on these tests, little useful knowledge is gained about the disabilities (functional hearing incapacities in the everyday world) and none whatever about the handicaps (the disadvantages for everyday living) experienced as a consequence of the impairment".*

Hawthorne and Hogan (2002) have shown that measures of hearing social participation are strongly associated with health related quality of life. Dillon (2001:368) observes that hearing loss is associated with a cascade of negative events.

> *"Hearing impairment decreases a person's ability to communicate. Decreased communication with others can lead to a range of negative emotions such as depression, loneliness, anxiety, paranoia, exhaustion, insecurity, loss of group affiliation, loss of intimacy and anger."*

2.5 BETTER EAR, WORSE EAR

Hearing loss can differ from one ear to the other (asymmetrical hearing loss). As a result of this, prevalence rates can be reported for either the better or the worse ear in terms of the level of hearing loss. This presents a particular problem in hearing because almost a quarter of people with hearing loss have the impairment in only one ear (Wilson, 1997:96). Older right handed farmers, for example, often have hearing loss predominately in the left ear. This occurs as a result of looking over their right shoulder watching their work while driving older style tractors for extended hours, where the left ear is more directly exposed to the motor noise. A similar effect results from rifle shooting. As an individual takes aim down the barrel of a rifle, one ear is more exposed to the muzzle than the other (depending again on whether one is left or right handed). When the rifle is discharged, the ear nearer the muzzle has a higher noise exposure and in time greater hearing damage from repeated exposures.

Asymmetrical hearing loss results in problems such as difficulties with the spatial identification of sound (not being able to tell where a speaker's voice is coming from), and auditory discrimination problems (picking up foreground sounds from background sounds) resulting in practical problems like not being able to function in meetings or social settings especially when people are on their 'bad side'. Having better hearing in one ear than the other impacts on the ability to communicate and may lessen the overall effect of the impairment in the worse ear. Given this outcome, disability in epidemiological hearing studies has been defined on measures of the better ear (Davis, 1989; Wilson et al, 1988), the approach also adopted in this study.

Differences in hearing difficulties rather than hearing loss are not expressed by an audiogram, although the level of hearing handicap may be "more highly correlated with measures of impairment in the worse ear than in the better ear" (Lutman et al, 1987:45-58).

When reporting prevalence rates, better ear measures would provide conservative estimates while worse ear measures may more accurately reflect impairment. This is a little different from visual impairment, where there is very little impairment experienced if vision loss occurs in one eye only.

In this study, the approach has thus been to report hearing loss prevalence for both the better and worse ear, but conservatively to use hearing loss prevalence in the better ear to attribute costs and disease burden. In addition, to distinguish the two, *prevalence of hearing loss* is used to refer to impairment in the worse ear, while *prevalence of hearing disability* is used to refer to impairment in the better ear.

This aligns with the Australian Institute of Health and Welfare (AIHW) approach, to avoid overstating the burden of disease on the community and adopt a minimum cost burden position.

2.5.1 HEARING LOSS AND COMORBIDITIES

Hearing loss has been described as an under-estimated health problem (Wilson et al, 1992). Adult hearing loss is associated with an increased risk for a variety of health conditions including:

- diabetes (Wilson et al, 1992; Mitchell, 2002);
- stroke (Mitchell, 2002);
- elevated blood pressure (Wilson et al, 1992);
- heart attack, particularly those rating their hearing as poor (Hogan et al., 2001);
- psychiatric disorder, particularly those rating their hearing as poor (Hogan et al., 2001);
- affective mood disorders (Ihara, 1993; Mulrow et al, 1990);
- poorer social relations (Mulrow et al, 1990);
- higher sickness impact profiles (physical and psycho-social (Bess et al, 1989);
- reduced health related quality of life, particularly those with more severe hearing loss (Wilson, 1997).

Wilson (1997:104-108) investigated two health conditions (diabetes and tinnitus) and two risk factors (overweight and risky drinking) in relation to people with hearing loss. However, only the relationship with diabetes was found to be statistically significant at all levels of hearing loss. The Blue Mountains Hearing Study (Mitchell, 2002) also reported that older people with hearing loss (>25 dB) were more likely to report diabetes (OR 1.5 CI 95% 1.1-2.1), as well as a history of stroke (OR 1.7 CI 95% 1.1-2.6) and currently smoking (OR 1.4 CI 95% 0.9 – 2.1).

Mortality: While hearing loss has been associated with a number of conditions that are life threatening (eg diabetes) and with social isolation that may also lead to premature mortality, no direct causality has been found between hearing loss and increased mortality or injury rates. One study by Appollonio et al (1996) did report an elevated mortality rate in men aged 70-75 years with unmanaged hearing loss. However, as Harvey Dillon observes (pers.com, 2005) there may be a number of possible explanations for this outcome:

- a cascade of benefits results from effective hearing interventions, so people not receiving assistance may fare worse;
- differences in attitudes and behaviours associated with health service utilisation including willingness to seek treatment for medical conditions resulting in differing health outcomes; and
- health professionals or patients trading off the need to treat hearing loss in the context of managing seemingly more serious conditions, focus on the other conditions.

Each of these questions warrants further investigation.

Children: The research shows that it is quite common for children to have a disability in addition to hearing loss. This factor, referred to as dual diagnosis, is a particular issue for children with hearing loss as it has profound implications for their educational placement and subsequent life chances. Fortnum et al (2002:176) report that 27.4% of children with hearing loss have at least one other disability. From a sample of 17,169 children with hearing loss, there were reports of 4,709 children having an additional disability, with 7,581 disabilities (or an average of 1.6 disabilities other than hearing loss per disabled child) reported. The most common additional disabilities were learning difficulties (11.1%) and visual impairment (5.7%) followed by a series of conditions with a prevalence of 2%-3% (developmental delays, cerebral palsy, speech and language, musculoskeletal, psychosocial and neuromotor). Additional educational and community services costs are incurred when children with hearing loss have more than one disability.

2.5.2 HEALTH UTILISATION AND DISABILITY

Wilson (1997:104-108) investigated whether people with hearing loss were higher users of health and care services (Table 2-3). However, apart from the greater use of medications and, for people with severe hearing loss only, elevated utilisation of GP services, health system service utilisation was not significantly greater for people with hearing loss. However the need for help was significantly greater for all levels of hearing severity.

TABLE 2-3: UTILISATION OF HEALTH AND CARE SERVICES BY ADULTS WITH HEARING LOSS

Service	Degree of loss	OR	CI 95%
GPs	Mild	1.33	0.87-2.03
	Moderate	1.24	0.75-2.03
	Severe	**3.23**	**1.38-7.89**
Use of medications	Mild	**2.30**	**1.63-3.25**
	Moderate	**3.19**	**2.08-4.91**
	Severe	**3.88**	**2.23-6.79**
Hospital admissions	Mild	1.2	0.81-1.79
	Moderate	1.84	0.84-1.79
	Severe	1.16	0.64-2.09
Attend casualty	Mild	0.86	0.57-1.29
	Moderate	1.07	0.66-1.71
	Severe	1.7	0.99-2.92
Requires help for difficulty	Mild	**4.75**	**2.82-8.02**
	Moderate	**14.91**	**8.69-25.67**
	Severe	**15.9**	**8.46-30.02**
Domestic help required	Mild	**2.6**	**1.11-6.10**
	Moderate	**2.86**	**1.1-7.35**
	Severe	**7.81**	**3.24-18.88**

Source: Wilson (1997).

On average, people with hearing loss delay seeking help for their disability for six years from when they realise they are experiencing difficulties. There are two key factors that motivate a person to seek help for their hearing loss. First, their hearing problems become so unmanageable that they can no longer deny they have a hearing problem, and second, family members, tired of communication difficulties, bring pressure to bear on them to do something about their hearing problem. (Kochkin, 1999). The adverse impacts of hearing loss on inter-personal relationships have been established as have health effects associated with hearing loss. Employment impacts are discussed in Section 5.1.1. Early intervention in hearing loss may serve to avert these difficulties or minimise their impact.

3. PREVALENCE OF HEARING LOSS AND HEARING DISABILITY

3.1 DATA SOURCES

In Australia, solid data exist on the measured loss of hearing in children and adults. For decades, the government-funded service, *Australian Hearing*, has been recognised as a world leading service for children with hearing loss. For this study, their data on measured hearing loss by severity for children aged up to 15 years has been used. These data also have a high level of consistency with prevalence rates reported in international studies. Prevalence rates for congenital (pre-lingual) and child acquired hearing loss were therefore readily derived and applied to population data, with historical series drawn from the Australian Bureau of Statistics estimates and future population projections drawn from Access Economics projections, which in turn are based on ABS Series B data.

David Wilson and his then team at the Behavioural Epidemiology Unit within the South Australian Health Commission conducted a measured study of hearing loss in adults in the mid to late 1990s (Wilson, 1997; Wilson et al,1998). This study was based on the methodology of the renowned British Hearing Study (Davis, 1989). The South Australian study yielded prevalence data that were quite consistent with international studies. Wilson (1997:93) observes:

> *"(T)he overall estimates for the South Australia population are largely in agreement with those of the MRC National Study of Hearing and at each level of severity the confidence intervals overlap".*

Estimates of educational, employment and socio-economic outcomes were subsequently derived from the South Australian data (Hogan et al, 1999).

The Wilson study was a representative population sample which consisted of a "multi-staged, clustered, self-weighting, systematic area sample of persons aged 15 years or older who live(d) in metropolitan Adelaide and major country centres... (H)otels, motels, hospitals, nursing homes and other institutions are excluded" (Wilson,1997:63). Random samples of people who did and did not report hearing loss subsequently underwent audiological assessment to provide measured prevalence data. The base sample size was N=9,027 with a participation rate of 75.2%. The sample had double the number of respondents (n=926) required to meet power requirements at the 95% level for detecting differences in hearing loss and almost three times the size required for data on quality of life.

Data from the Beaver Dam study (Cruickshanks et al, 1998) are not directly comparable with the Australian data since the study focused on older people, but also because of slightly different age groupings. Nonetheless, some similarities were evident, particularly among males. For measures of the worse ear, the South Australian study reported for men aged 60-69 years a prevalence of 63.8% compared with the Beaver Dam study of 61.8%. Similarly for males aged 70-79 years, the South Australian study reported a prevalence of 87.7% compared with the Beaver Dam study of 83.0%. The similarities were not so apparent in females, with the South Australian study reporting for females aged 60-69 years a prevalence of 53.8% compared with the Beaver Dam study of 28.1%. Similarly for females aged 70-79 years, the South

Australian study reported a prevalence of 63.8% compared with the Beaver Dam study of 54.6%.

Alternate data choices were available but were limited in their usefulness for this project. First, the Blue Mountains Hearing Study (Mitchell, 2002) is a respected local data source and its outcomes are comparable to the South Australia Study. However, its focus was limited to older adults. In addition, very detailed data on the study could not be accessed in the required timeframe. The second alternate data source was the Survey of Disability, Ageing and Carers (SDAC; ABS, 2003a,b). However, in comparison with the data sets selected, SDAC is particularly limited.

- First, SDAC defines hearing loss as "loss of hearing where communication is restricted or an aid to assist with, or substitute for, hearing is used" (ABS, 2003b:12). This definition of hearing loss used may only capture people with more severe levels of hearing loss.
- Second, the levels of reported disability in SDAC (ABS, 2003a) relate to perceived communication difficulties and/or the need for assistance rather than measured hearing loss or disability. The *profound* classification was defined in terms of people being unable to perform the core activity i.e. to communicate. The *severe* classification was defined as having difficulty understanding family or friends or that the person communicated more easily in sign language. The *moderate* classification suggested that the person needed no assistance with communication. These measures do not concord well with categories used to measure hearing loss or hearing handicap and in fact distort the common clinical understanding of hearing loss. A person can readily have difficulties understanding a conversation and only have a mild or moderate hearing loss.
- Third, the methodology is based on reports from the opinion of the first responsible adult contacted within the household, that a person in that household has a hearing loss. Wilson et al (1999) showed that the false positive rate in self reports of hearing loss was 46% and the false negative rate was 17%. Self reported hearing loss then is a poor indicator of prevalence. Further, with regard to reporting the hearing loss of others in the household, it is feasible that the person reporting other peoples' experience of hearing loss may also mis-report their hearing status both by nature and severity. The SDAC data report the prevalence of childhood hearing loss for children aged less than 15 years as approximately 19,000, almost double that reported below based on internationally consistent measured studies. For adults, the reverse occurs – SDAC reports an estimated 901,000 adults aged 15 years or more with hearing loss (ABS, 2003c), compared with estimates based on measured studies of 3.5 million people (Wilson, 1997). This suggests that SDACS under estimates the population by a factor of 1:3.

In sum, SDAC may under-report the prevalence and over-report the severity of hearing loss, mistaking communication difficulties and hearing handicap with hearing impairment. In studies concerned with the cost and burden of disease, it is important that the data can be segmented by severity of impairment, as the cost of interventions differs considerably. A hearing aid intervention for an adult with mild loss, for example, may cost as little as $808[7] (Commonwealth Department of Health, 2004) whereas a cochlear implant program can cost up to $45,000 in the first year (Carter and Hailey,

[7] Email from Office of Hearing Services 23/11/05 cites a cost of $793.03 per client, adjust for 6 months health inflation.

1999). Consequently, the data sets selected to estimate prevalence for this study enable the segmentation of the population based on proven measured rates of severity.

General population forecasts used in this study are from the Access Economics Demographic Model (AE-DEM) of the Australian population. AE-DEM uses a combination of fertility, mortality and migration rates forecasts to project the future Australian population. Base fertility and mortality profiles for each age and gender (for mortality) are sourced from Productivity Commission (2005), and adjusted over time to match the projection for the total value. Migration rates are forecast in line with the assumptions in the ABS (forthcoming), with adjustments for changes to Australia's migration program (that is, an additional 20,000 migrants each year). There are also some initial adjustments to reflect the latest actual migration (international and interstate) results.

The following sections estimate prevalence in children and adults, as well as providing overall estimates of the prevalence of hearing loss in Australia in 2005, projected to mid-century.

3.2 PREVALENCE IN CHILDREN

Table 3-1 reports the prevalence rates of measured hearing loss in children from a range of studies in Australia and overseas.

TABLE 3-1: STUDIES OF HEARING LOSS PREVALENCE RATES IN CHILDREN

Study[1]	Country	Scope	Rate of hearing loss new births/1,000	Rate of hearing loss in children /1,000[2]
Upfold and Ipsey: 1982:323	Australia	Longitudinal	N/A	2.6
Australian Hearing 2005:4,9	Australia	Longitudinal	1.2	2.5[3]
Yoshinaga-Itano et al. 2000	USA	New births	2.5	2.5
Mehl and Thomson:2002	USA	New births	1.54	N/A
Fortnum et al. 2001:4; 2002:171	United Kingdom	Longitudinal	0.91	2.1[4]

[1] See Johnston:2004:363 for a review of these papers. [2] Includes congenital and acquired losses.
[3] Calculated on data for children aged less than 15 years. [4] Adjusted for under-ascertainment.

The two Australian studies (Australian Hearing, 2005; Upfold and Ipsey, 1982) report clients seen by the country's national service for children with hearing loss. The service is thought to cover 99% of the sector and the data cover children who use any form of hearing device. The data would not include children with such a mild loss that they did not need a device. The original Australian Hearing data report rates for children aged to 17 years. The grouped rates reported here were re-calculated from the Australian Hearing data for children aged less than 15 years. These data suggest a prevalence of pre-lingual (0-4 years) hearing loss of 1.2/1,000 live births and of child acquired loss (4-14 years) as 3.2/1,000 live births.

The American studies (Yoshinaga-Itano et al, 2000 and Mehl and Thomson, 2002) are limited in that they only report data on neonates and as such do not include children with later onset hearing loss. The United Kingdom study (Fortnum et al, 2001) reports a prevalence rate of 2.05/1,000 once adjusted for under-ascertainment. However, the study does not include children with mild hearing loss. Australian Hearing reports 36% of children with hearing loss in the mild hearing loss range of 0-30dB.

Table 3-2 reports studies of hearing loss among children by degree of loss.

TABLE 3-2: DEGREE OF HEARING LOSS IN CHILDREN (% OF TOTAL)

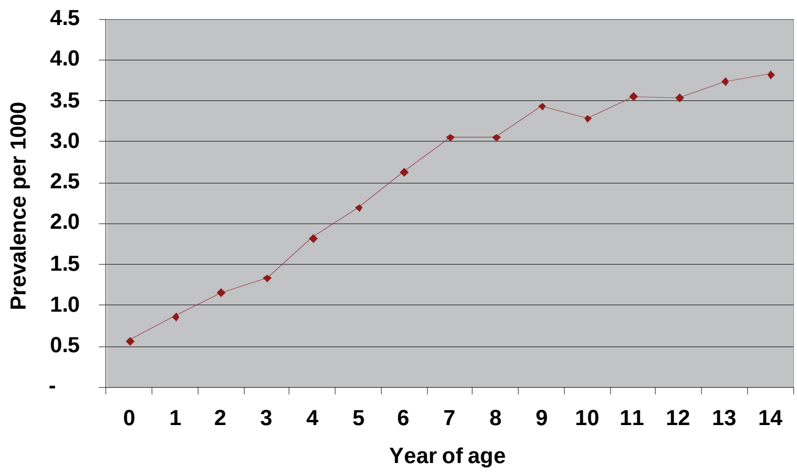
	Mild	Moderate	Mild-Moderate	Severe	Profound
Upfold and Ipsey:1982			59	24	18
Australian Hearing:2005	36	38		13	12
Stredler Brown:2003	30	30		30	10
Fortnum et al. 2001			59	20	21

Note: numbers may not sum to 100% due to rounding.

Some studies report mild and moderate hearing loss together. The reported rate in the mild-to-moderate cohort is approximately 60% of hearing loss cases. The United Kingdom study (Fortnum et al, 2001) and the earlier Australian study (Upfold and Ipsey, 1982) report moderate hearing loss as 59% of the cohort. The American study (Stredler Brown, 2003) reports mild hearing loss as 30% and moderate as a further 30% of the total. The Australian Hearing data report a lower rate of severe and profound loss (25%:75% rather than 40%:60%). The rate for mild losses is very high in this Australian cohort. However, all children reported in this group have received a device of some sort, even if this is an FM system. The data also include assessments of Aboriginal children where otitis media is a significant problem as well as children with unilateral hearing loss.

Figure 3-1 shows the increasing prevalence of hearing loss in Australian children by age. Gender based data were not available. Similarly the data were not segmented by worse or better ear but were supplied on the basis that the child had been fitted with a hearing device or aid.

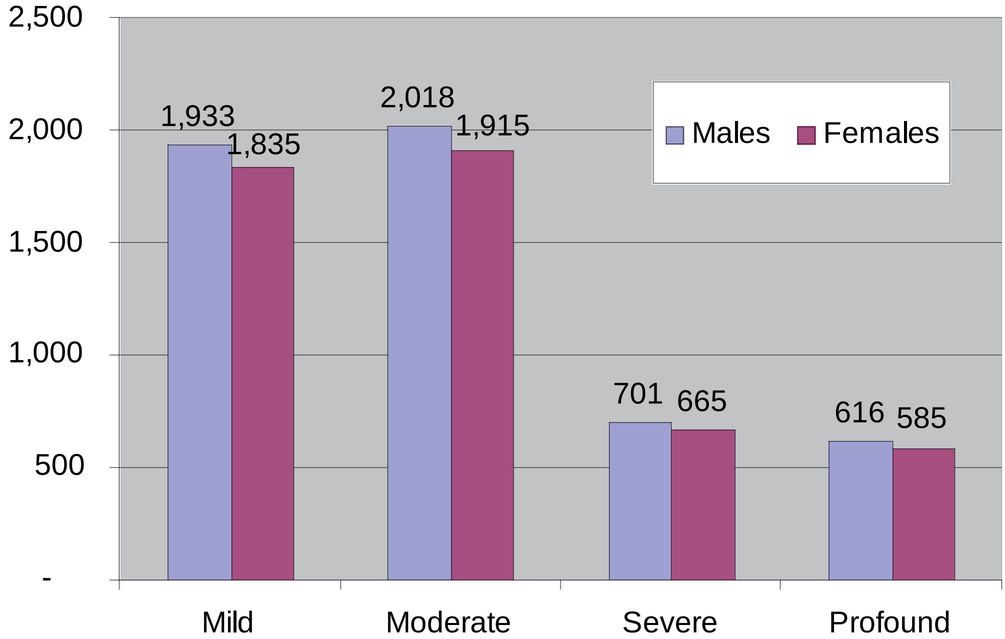
FIGURE 3-1: PREVALENCE RATES, HEARING LOSS, CHILDREN ≤ 14



Source: Based on Australian Hearing (2005) data.

The prevalence rates by year of age as reported by Australian Hearing were applied to population data to generate an **overall prevalence of 10,268 children in 2005** aged less than 15 years, 2.5/1,000 in this age group, which is broadly consistent with the studies in Table 3-1. The Australian Hearing (2005) data were also considered to be the most reliable to estimate the severity proportions in the Australian child population currently (proportionately allocating unknowns across each sub-group) as 36.7% mild, 38.3% moderate, 13.3% severe, and 11.7% profound. Figure 3-2 depicts the prevalence of hearing loss in children aged less than 15 years in 2005, while the detailed numbers are provided in the tables in Section 3.4

FIGURE 3-2: PREVALENCE, HEARING LOSS, BY SEVERITY & GENDER, CHILDREN ≤ 14, 2005



Source: Based on Australian Hearing (2005) data.

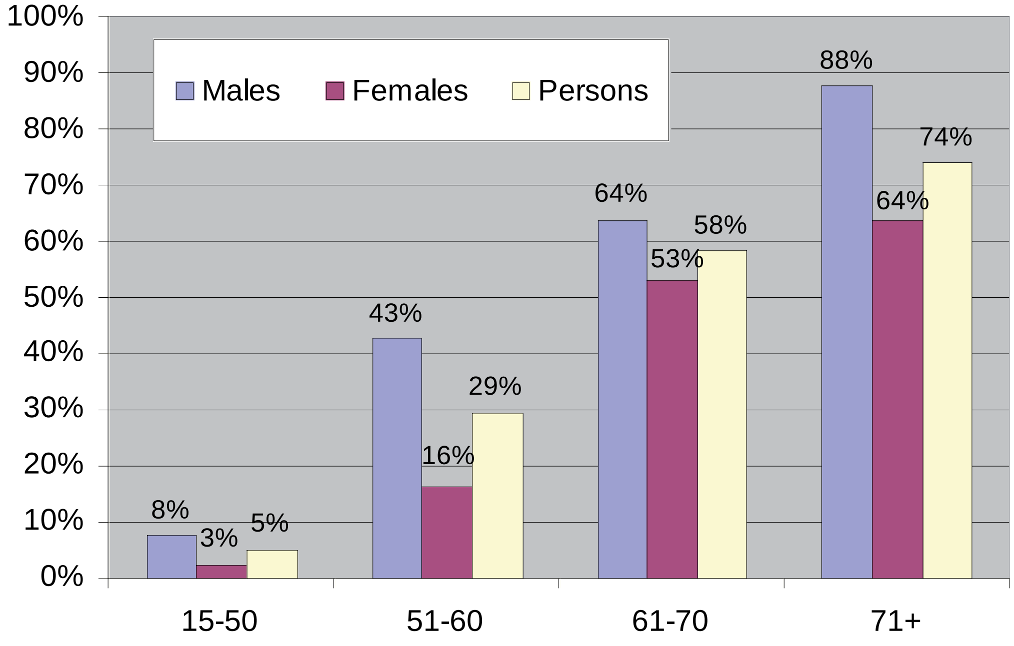
3.3 PREVALENCE IN ADULTS

3.3.1 PREVALENCE OF ADULT HEARING LOSS IN THE WORSE EAR

Figure 3-3 presents prevalence rates in the worse ear for adult (over 15 years) hearing loss by age group.

- Overall prevalence rates are 26.3% for males 15 years and over, 17.1% for females 15 years and over and 21.6% for the adult population.
  - This equates to more than one in every four men and more than one in every five Australian adults who have hearing loss.

FIGURE 3-3: PREVALENCE RATES, HEARING LOSS, ADULTS (WORSE EAR)



Source: Based on Wilson (1997) data.

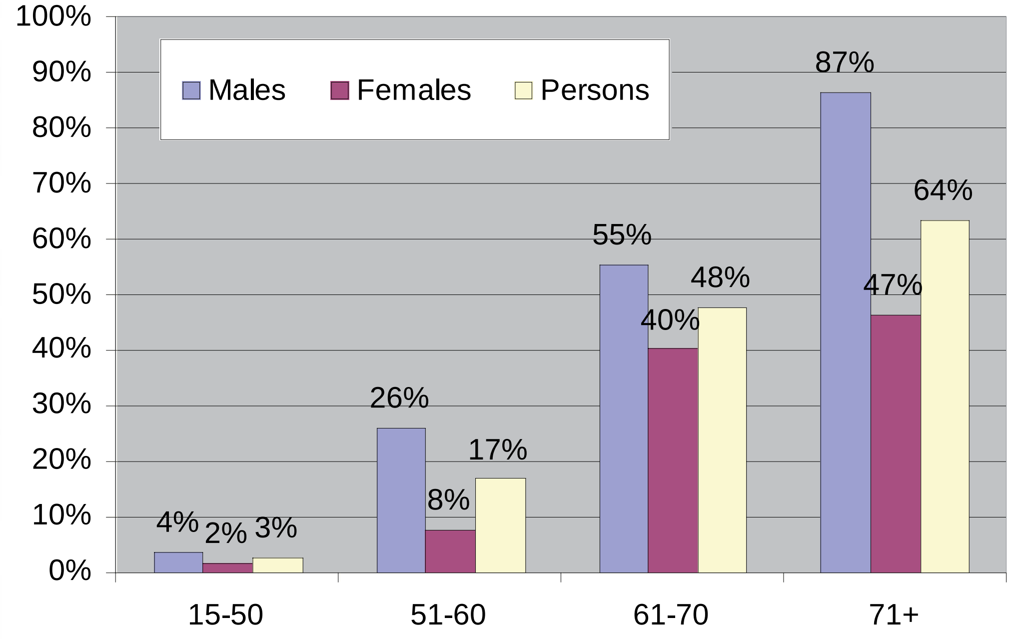
When applying these rates to the Australian population, there are an estimated 3,534,963 adults (people 15 years and over) in Australia with hearing loss.

- 60% of Australian adults with hearing loss are male, with the gender differences attributed to differing levels of workplace noise exposure.
- Approximately half are in the working age population (aged 15-64 years).
- 37% of adults with hearing loss are aged over 70 and, within this age group, 74% have hearing loss.
- Two thirds of people aged over 60, and 88% of men over 70, have hearing loss in the worse ear.
- 66% had a mild loss, 23% had a moderate loss and 11% had a severe or profound hearing loss.
  - This is somewhat similar to the Beaver Dam Study where the proportions of hearing loss were reported as 58.1% mild, 30.6% moderate and 11.3% marked (Cruickshanks et al, 1998).
- Wilson et al (1998) report that hearing loss in the population is predominantly sensori-neural in nature with a prevalence of 20.2% compared with prevalence rates for conductive (0.4%) and mixed hearing loss (1.6%).
- Wilson also reports that hearing loss is also predominantly bilateral in nature with a prevalence of 20.3% versus 6.3% for unilateral losses at the 21dB threshold level in the worse ear.
- Detailed data tables are provided in Section 3.4.

3.3.2 PREVALENCE OF ADULT HEARING DISABILITY IN THE BETTER EAR

Prevalence rates of adult hearing loss for the better ear, referred to by Wilson as hearing disability, are illustrated in Figure 3-4.

FIGURE 3-4: PREVALENCE RATES, HEARING LOSS, ADULTS (BETTER EAR)



Source: Based on Wilson (1997) data.

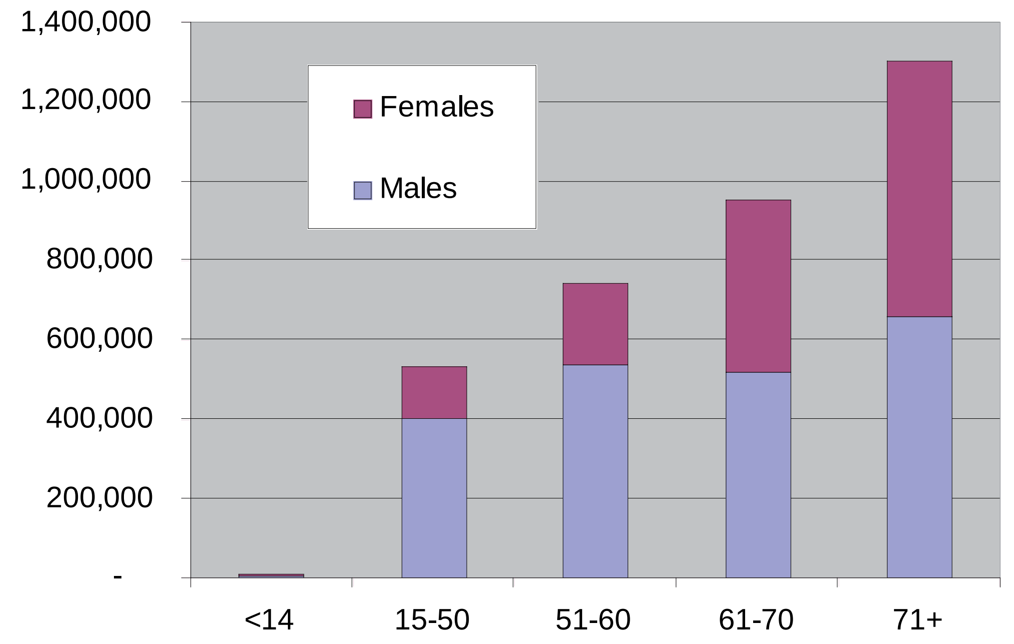
- Naturally overall rates of disability from hearing loss are lower than those reported for impairment – 16.0% of adults aged 15 and over have hearing loss in the better ear compared to 21.6% who have hearing loss in the worse ear.
- Consistently hearing disability is more common in males across all age groups.
- Hearing loss becomes quite apparent in the community aged over 60 years.
- Using measures of the better ear, 12.9% of the population has treatable hearing loss (≥ 25 db) and approximately 2.1% experience considerable disability with losses of ≥ 45 db or worse (Wilson, 1997: 92).
- Detailed data tables are provided in Section 3.4.

3.4 SUMMARY OF PREVALENCE IN 2005

3.4.1 PREVALENCE OF HEARING LOSS

In 2005, there were an estimated 3.55 million Australians with hearing loss (worse ear). Figure 3-5 highlights the increasing prevalence rates with age.

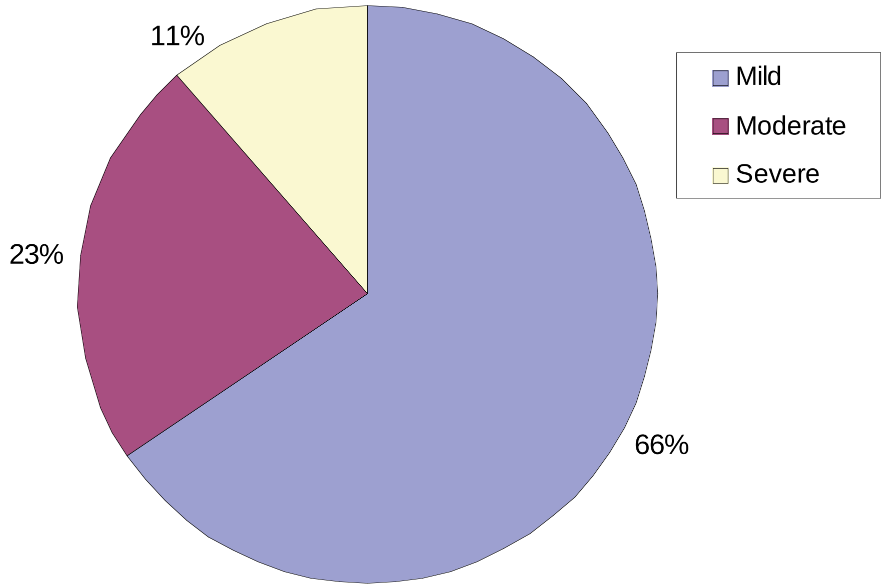
FIGURE 3-5: PEOPLE WITH HEARING LOSS IN AUSTRALIA, 2005



Source: Based on Australian Hearing (2005) and Wilson (1997) data.

- Of these 10,268 were children aged up to 14 years (0.29% of the total) and 3,534,963 were adults 15 and over.
  - 49.5% were of working age (15–64 years)
  - 64% of people with hearing loss were aged over 60 years with 37% aged 70 years or more
- Overall 59.9% (2,125,162) were males and 40.1% (1,420,069) were females with hearing loss predominantly affecting males to 60 years with the female rate catching up in the older years.
- Figure 3-6 shows that hearing loss is predominantly mild in nature, although one third (34%) of people with hearing loss experience a loss that is moderate or worse.
- Using measures of the better ear, there were 2,626,364 people with hearing loss causing disability, with 62% of these being male.

FIGURE 3-6: HEARING LOSS BY SEVERITY



Source: Wilson (1997) and Australian Hearing (2005)

Detailed data are provided in Table 3-3 through to Table 3-6.

TABLE 3-3: PREVALENCE (%), HEARING LOSS BY SEVERITY, GENDER AND AGE (WORSE EAR)

	Mild	Moderate	Severe	Total
Males				
0-14	0.09%	0.10%	0.06%	0.26%
15-50	4.6%	2.1%	1.0%	7.7%
51-60	25.4%	11.8%	5.5%	42.7%
61-70	38.0%	17.7%	8.1%	63.8%
71+	52.3%	24.3%	11.1%	87.7%
Total Males	**12.5%**	**5.8%**	**2.7%**	**21.0%**
Females				
0-14	0.09%	0.10%	0.06%	0.26%
15-50	1.9%	0.4%	0.2%	2.5%
51-60	12.1%	2.7%	1.5%	16.3%
61-70	39.5%	8.7%	4.9%	53.1%
71+	47.5%	10.4%	5.9%	63.8%
Total Female	**10.3%**	**2.3%**	**1.3%**	**13.9%**
Persons				
0-14	0.09%	0.10%	0.06%	0.26%
15-50	3.2%	1.3%	0.6%	5.1%
51-60	18.8%	7.2%	3.5%	29.5%
61-70	38.8%	13.1%	6.5%	58.4%
71+	49.5%	16.3%	8.1%	74.0%
Total Persons	**11.4%**	**4.0%**	**2.0%**	**17.4%**

Source: Based on Wilson (1997) and Australian Hearing (2005). Numbers may not sum due to rounding.

TABLE 3-4: PREVALENCE, HEARING LOSS BY SEVERITY, GENDER AND AGE (WORSE EAR)

	Mild	Moderate	Severe	Total
Males				
0-14	1,933	2,018	1,317	5,268
15-50	240,845	111,877	51,277	403,999
51-60	319,649	148,482	68,839	536,970
61-70	310,046	144,022	66,010	520,078
71+	392,774	182,450	83,623	658,847
Total Males	**1,265,249**	**588,848**	**271,065**	**2,125,162**
Females				
0-14	1,835	1,915	1,250	5,000
15-50	96,885	21,216	12,022	130,123
51-60	152,585	33,413	18,934	204,932
61-70	324,256	71,005	40,236	435,498
71+	479,885	105,084	59,548	644,517
Total Female	**1,055,446**	**232,633**	**131,990**	**1,420,069**
Persons				
0-14	3,768	3,933	2,567	10,268
15-50	337,730	133,092	63,299	534,121
51-60	472,234	181,895	87,773	741,902
61-70	634,303	215,027	106,246	955,575
71+	872,659	287,534	143,171	1,303,364
Total Persons	**2,320,695**	**821,481**	**403,055**	**3,545,231**

Source: Based on Wilson (1997) and Australian Hearing (2005). Numbers may not sum due to rounding.

Table 3-5: Prevalence (%), hearing disability by severity, gender and age (better ear)

	Mild	Moderate	Severe	Total
Males				
0-14	0.09%	0.10%	0.06%	0.26%
15-50	3.0%	0.6%	0.1%	3.7%
51-60	21.1%	4.4%	0.6%	26.1%
61-70	44.8%	9.3%	1.4%	55.4%
71+	74.4%	8.7%	3.4%	86.5%
Total Males	**13.3%**	**2.3%**	**0.5%**	**16.1%**
Females				
0-14	0.09%	0.10%	0.06%	0.26%
15-50	1.5%	0.2%	0.1%	1.8%
51-60	6.7%	0.8%	0.3%	7.8%
61-70	34.7%	4.1%	1.6%	40.3%
71+	40.0%	4.7%	1.8%	46.5%
Total Female	**8.4%**	**1.0%**	**0.4%**	**9.7%**
Persons				
0-14	0.09%	0.10%	0.06%	0.25%
15-50	2.3%	0.4%	0.1%	2.8%
51-60	13.9%	2.6%	0.5%	17.0%
61-70	39.7%	6.7%	1.5%	47.8%
71+	54.7%	6.4%	2.5%	63.6%
Total Persons	**10.8%**	**1.6%**	**0.4%**	**12.9%**

Source: Based on Wilson (1997) and Australian Hearing (2005). Numbers may not sum due to rounding.

Table 3-6: Prevalence, hearing disability by severity, gender and age (better ear)

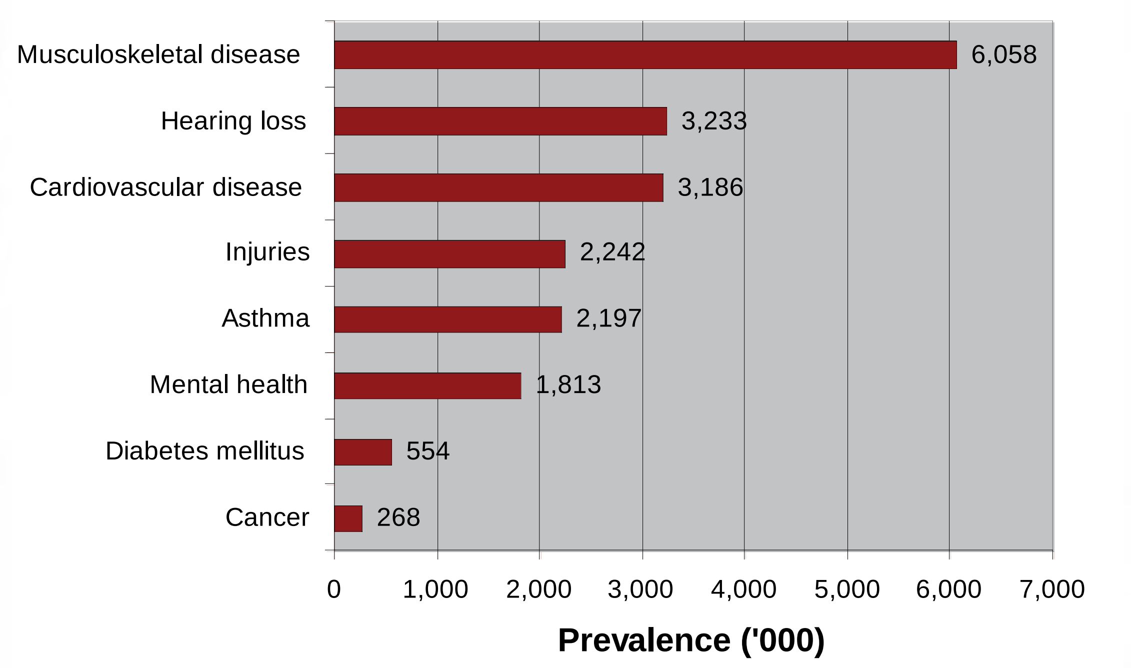
	Mild	Moderate	Severe	Total
Males				
0-14	1,933	2,018	1,317	5,268
15-50	156,834	32,514	4,782	194,129
51-60	265,396	55,021	8,091	328,508
61-70	364,842	75,638	11,123	451,604
71+	559,158	65,487	25,187	649,832
Total Males	**1,348,163**	**230,678**	**50,500**	**1,629,341**
Females				
0-14	1,835	1,915	1,250	5,000
15-50	80,615	9,441	3,631	93,688
51-60	84,382	9,883	3,801	98,066
61-70	284,400	33,308	12,811	330,519
71+	404,203	47,339	18,207	469,750
Total Female	**855,436**	**101,886**	**39,701**	**997,023**
Persons				
0-14	3,768	3,933	2,567	10,268
15-50	237,449	41,956	8,413	287,818
51-60	349,778	64,904	11,892	426,574
61-70	649,242	108,946	23,934	782,122
71+	963,361	112,826	43,395	1,119,582
Total Persons	**2,203,599**	**332,564**	**90,201**	**2,626,364**

Source: Based on Wilson (1997) and Australian Hearing (2005). Numbers may not sum due to rounding.

3.4.2 Comparison with national health priorities

Figure 3-7 provides a comparison of the prevalence of hearing loss (worse ear) with the national health priority areas, showing it to be more prevalent than all national health priorities except musculoskeletal conditions.

Figure 3-7: Prevalence, hearing loss and national health priorities, 2001



Source: AIHW (2004:389). Note: Hearing loss in worse ear for 2001.

3.5 Estimates of the Deaf Community

The concept of the Australian Deaf Community refers to people who are either born (severely to profoundly) deaf to Deaf families who use Auslan (Australian Sign Language) or people born with hearing loss into families where the parents hear, but who learn sign language. As Johnston (2004:358) observes: "(I)t is only children with an early and profound hearing loss, who are likely to be lifelong sign language users". Johnston also observes that there have been a number of studies that have attempted to estimate the size of the Australian Deaf Community, or on the basis of which estimates have been attempted. Estimates derived from enrolments in Deaf Schools and community data collection methods vary between 6,500 individuals and 15,000 individuals. As this study focuses on costs associated with hearing loss using confirmed costs where available, the indeterminate size of the Deaf Community was not a specific barrier to this study. However, an estimate is required for the burden of disease analysis (Chapter 6), where the estimate used was 10,000 people, the mid-point number from a variety of studies seeking to estimate the size of this Community (Johnston, 2004).

3.6 PREVALENCE PROJECTIONS

3.6.1 PROJECTIONS FOR CHILDREN

Table 3-7 projects hearing loss in children by severity. These projections are a function of population growth and so, unlike the adult population, these numbers remain fairly static over time. **The number of children with hearing loss is projected to increase from 10,268 in 2005 to 11,031 by mid-century, an increase of only 7.4% over the period**.

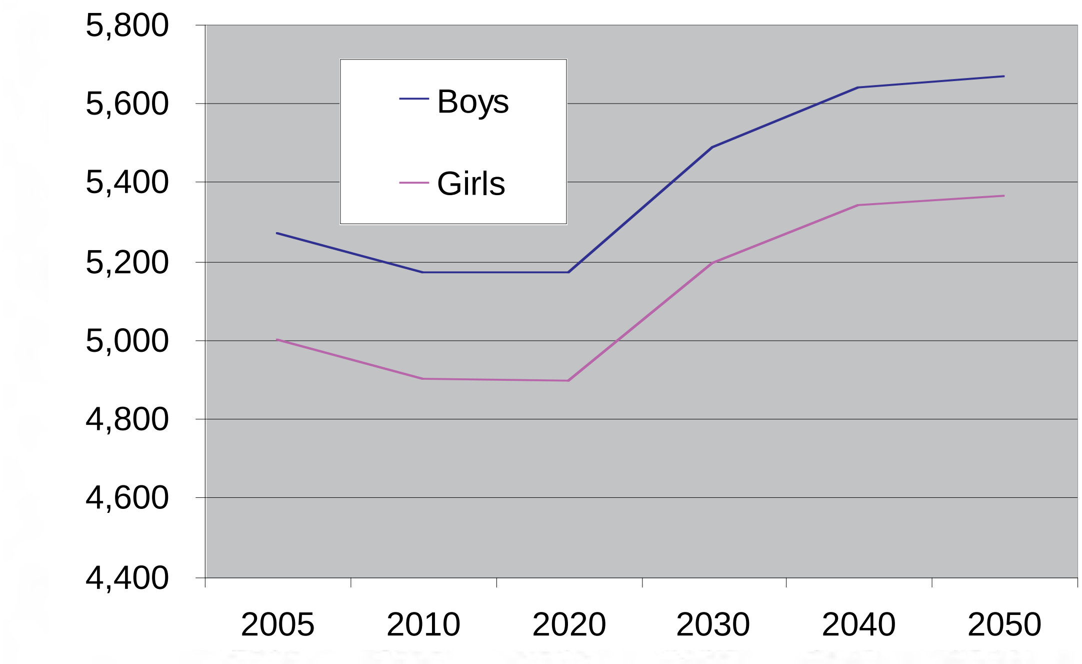
TABLE 3-7: PROJECTED PREVALENCE TO 2050, HEARING LOSS BY SEVERITY, CHILDREN ≤ 14

Severity	2005	2010	2020	2030	2040	2050
Mild	3,768	3,696	3,695	3,920	4,031	4,048
Moderate	3,933	3,857	3,856	4,091	4,207	4,225
Severe	2,567	2,518	2,517	2,670	2,746	2,758
Total	**10,268**	**10,071**	**10,069**	**10,681**	**10,983**	**11,031**

Source: Based on Australian Hearing (2005) data.

As can be seen in Figure 3-8 below, hearing loss is expected to remain more common in boys in the coming years, although the differences between genders is small in real terms.

FIGURE 3-8: PROJECTED PREVALENCE OF CHILD HEARING LOSS BY GENDER



Source: Australian Hearing (2005) data by ABS population projections.

3.6.2 PROJECTIONS FOR ADULTS

Table 3-8 reports the projected prevalence of hearing loss (worse ear) in the adult population, on the basis of demographic ageing only (ie not taking into account possible changes in age-gender prevalence rates in the future, which may increase or decrease depending on noise and other exposures, technology and policy changes).

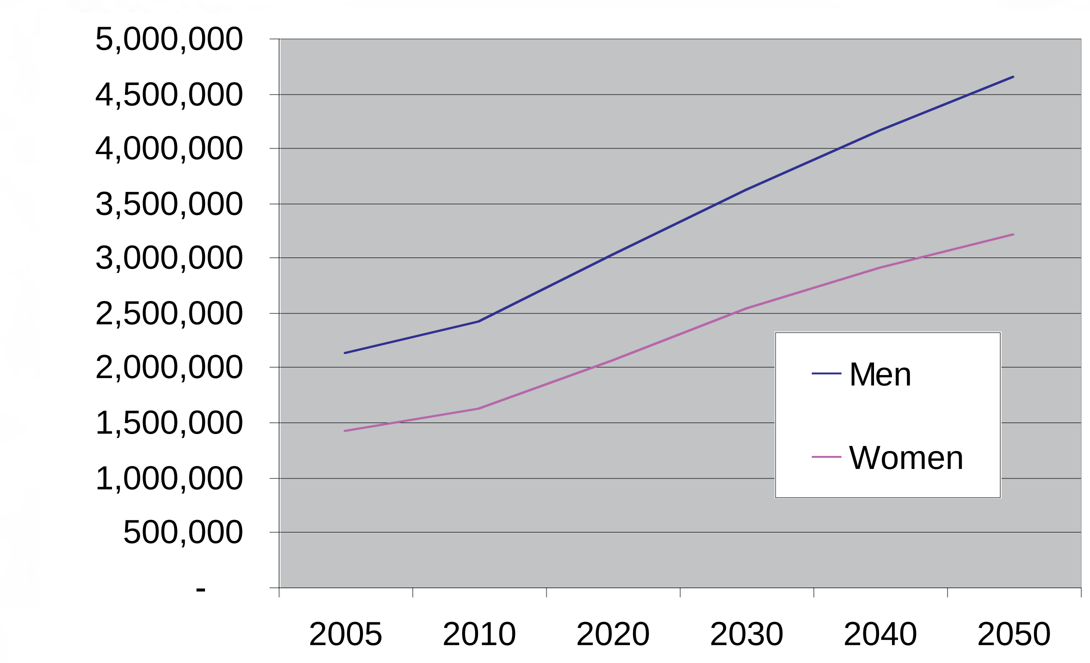
TABLE 3-8: PROJECTED PREVALENCE TO 2050, HEARING LOSS BY SEVERITY, ADULTS>15 (WORSE EAR)

	2005	2010	2020	2030	2040	2050
Mild	2,316,927	2,627,261	3,327,928	4,023,875	4,624,210	5,150,190
Moderate	817,548	926,463	1,169,715	1,408,768	1,618,500	1,805,611
Severe	400,488	453,870	573,398	691,128	794,042	885,422
Total	**3,534,963**	**4,007,594**	**5,071,040**	**6,123,771**	**7,036,752**	**7,841,223**

Source: Based on Australian Hearing (2005) data.

- In the absence of a substantive prevention program, the severity of prevalent hearing loss is not expected to change much (mild hearing loss remains at 66%, moderate at 23% and severe at 11% of the total).
- Figure 3-9 depicts the growth in hearing loss by gender.
  - The prevalence of hearing loss increases from 21.0% to 31.5% of all males.
  - The prevalence of hearing loss increases from 13.9% to 21.9% of all females and the female share of total hearing loss increases fractionally from 40% to 41%.
- The prevalence of hearing loss in the worse ear is expected to more than double by 2050 (a 2.2-fold increase).
- The prevalence of hearing loss in the better ear – hearing disability – is expected to increase more than 80% by 2030 and nearly 2.4-fold by 2050.

FIGURE 3-9: PROJECTED GROWTH IN HEARING LOSS BY GENDER (WORSE EAR)



3.6.3 TOTAL PROJECTIONS

Table 3-9 reports the projected prevalence of hearing loss (worse ear) in the total population. Table 3-10 reports the projected prevalence of hearing loss (better ear) in the total population.

TABLE 3-9: PROJECTED PREVALENCE TO 2050, HEARING LOSS BY AGE AND GENDER (WORSE EAR)

	2005	2010	2020	2030	2040	2050
0-14	5,268	5,169	5,172	5,485	5,641	5,666
15-50	403,999	421,342	445,681	467,100	482,545	490,521
51-60	536,970	576,870	640,697	658,937	732,307	796,023
61-70	520,078	647,254	818,532	918,172	952,498	1,066,189
71+	658,847	754,295	1,108,569	1,561,295	1,972,989	2,279,112
Total Males	**2,125,162**	**2,404,931**	**3,018,651**	**3,610,989**	**4,145,979**	**4,637,510**
% of males	21.0%	22.5%	25.4%	27.8%	29.8%	31.5%
% of total prev	59.9%	59.9%	59.4%	58.9%	58.8%	59.1%
0-14	5,000	4,902	4,897	5,196	5,342	5,365
15-50	130,123	134,824	141,047	146,729	151,263	153,500
51-60	204,932	223,920	247,008	250,145	271,674	294,065
61-70	435,498	540,658	708,334	785,254	798,717	870,653
71+	644,517	708,430	961,171	1,336,139	1,674,760	1,891,162
Total Females	**1,420,069**	**1,612,734**	**2,062,458**	**2,523,463**	**2,901,756**	**3,214,744**
% of females	13.9%	14.9%	17.3%	19.4%	20.8%	21.9%
% of total prev	40.1%	40.1%	40.6%	41.1%	41.2%	40.9%
0-14	10,268	10,071	10,069	10,681	10,983	11,031
15-50	534,121	556,167	586,728	613,829	633,807	644,021
51-60	741,902	800,790	887,705	909,082	1,003,982	1,090,087
61-70	955,575	1,187,912	1,526,866	1,703,426	1,751,215	1,936,841
71+	1,303,364	1,462,726	2,069,740	2,897,434	3,647,748	4,170,273
Total Persons	**3,545,231**	**4,017,664**	**5,081,109**	**6,134,452**	**7,047,735**	**7,852,253**
% of persons	17.4%	18.7%	21.4%	23.6%	25.3%	26.7%

Source: Based on Wilson (1997) and Australian Hearing (2005).

Table 3-10: Projected prevalence to 2050, hearing loss by age and gender (better ear)

	2005	2010	2020	2030	2040	2050
0-14	5,268	5,169	5,172	5,485	5,641	5,666
15-50	194,129	202,463	214,159	224,451	231,872	235,705
51-60	328,508	352,918	391,966	403,125	448,012	486,992
61-70	451,604	562,036	710,763	797,284	827,090	925,813
71+	649,832	743,974	1,093,401	1,539,932	1,945,992	2,247,927
Total Males	**1,629,341**	**1,866,560**	**2,415,460**	**2,970,277**	**3,458,608**	**3,902,102**
% of males	16.1%	17.4%	20.3%	22.9%	24.8%	26.5%
% of total prev	62.0%	62.2%	62.3%	62.3%	62.5%	63.0%
0-14	5,000	4,902	4,897	5,196	5,342	5,365
15-50	93,688	97,073	101,554	105,645	108,909	110,520
51-60	98,066	107,152	118,200	119,701	130,004	140,718
61-70	330,519	410,330	537,587	595,965	606,183	660,778
71+	469,750	516,332	700,540	973,831	1,220,632	1,378,354
Total Females	**997,023**	**1,135,789**	**1,462,778**	**1,800,339**	**2,071,070**	**2,295,735**
% of females	9.7%	10.5%	12.3%	13.8%	14.9%	15.7%
% of total prev	38.0%	37.8%	37.7%	37.7%	37.5%	37.0%
0-14	10,268	10,071	10,069	10,681	10,983	11,031
15-50	287,818	299,537	315,712	330,096	340,781	346,225
51-60	426,574	460,070	510,167	522,826	578,016	627,710
61-70	782,122	972,366	1,248,350	1,393,249	1,433,273	1,586,590
71+	1,119,582	1,260,307	1,793,941	2,513,763	3,166,624	3,626,281
Total Persons	**2,626,364**	**3,002,349**	**3,878,239**	**4,770,616**	**5,529,678**	**6,197,837**
% of persons	12.9%	14.0%	16.3%	18.3%	19.9%	21.1%

Source: Based on Wilson (1997) and Australian Hearing (2005).

4. HEALTH SYSTEM COSTS

4.1 METHODOLOGY

Estimates for direct health system costs are derived in Australia by the Australian Institute for Health and Welfare (AIHW) from an extensive process developed in collaboration with the National Centre for Health Program Evaluation for the Disease Costs and Impact Study (DCIS). The approach measures health services utilisation and expenditure (private and public) for specific diseases and disease groups in Australia. The DCIS methodology has been gradually refined over the 1990s to now estimate a range of direct health costs from hospital morbidity data, case mix data, Bettering the Evaluation and Care of Health (BEACH) data, the National Health Survey and other sources. AIHW (2005) provides a summary of the main results of estimates of health expenditure by disease and injury for the year 2000-01. The advantage of top-down methodology is that cost estimates for various diseases will be consistent, enhancing comparisons and ensuring that the sum of the parts does not exceed the whole (total health expenditure in Australia).

The health expenditure costs reported for hearing loss include categories H90 and H91 from the International Classification of Disease Tenth Revision (ICD-10) and exclude procedures and treatments for otitis media, which is classified as a respiratory condition. Although otitis media can lead to hearing loss, to include it would overstate health system expenditure. The recurrent AIHW health system costs also do not encompass aids and devices such as cochlear implants or hearing aids, but would include implant surgery and associated in-patient hospital stays.

The AIHW include only 86% of total recurrent health expenditure in their estimates of expenditure by disease and injury, referred to as 'allocated' health expenditure. The 'unallocated' remainder includes capital expenditures, expenditure on community health (excluding mental health), public health programs (except cancer screening), health administration and health aids and appliances. However, in the case of hearing loss, it is evident that the cost of hearing aids and cochlear implants is much greater than the average cost of aids and appliances relative to recurrent spending across all diseases, so to factor up the recurrent spending by 100%/86% would understate the cost of such devices. *In this study, the factoring up is undertaken to cover the cost of the unallocated capital, community health, public health programs and health administration, while the aids and devices are separately estimated in Section 4.4.*

The AIHW recurrent allocated data for 2000-01 were used as the base for Access Economics' estimates for health expenditure on hearing loss in 2005. Two factors contributed to the extrapolation:

- health cost inflation (AIHW, 2005) measured 3.7% over 2000-01 to 2001-02, 4.1% over 2001-02 to 2002-03 and 3.8% over 2002-03 to 2003-04. For the 18 months from 2003-04 to the end of calendar year 2005, health cost inflation is assumed to have averaged 3.2%, which was the average rate over the period in 1997-98 to 2002-03. Thus overall inflation resulted in a 17.5% increase over the whole period from 2000-01 to end-2005; and
- estimated growth in prevalence of hearing loss 2000-01 to end 2005, derived from ABS demographic data and the Australian Hearing and Wilson prevalence rate data for each age-gender group.

The results are presented in the following sections.

4.2 TYPES OF HEALTH SYSTEM COSTS

Based on health expenditure data provided by the AIHW, the allocated health costs arising from hearing loss are estimated to be **$247.5 million in 2005** (Table 4-1).

- This equates to just under **$70 per person with hearing loss per annum**, nationally.

TABLE 4-1: HEARING LOSS, HEALTH SYSTEM EXPENDITURE, 2005 ($M)

	In-patients	Out-patients	Total hospital	Aged care homes	GPs	Path-ology & imaging	Spec-ialists	Total out-of hospital medical	Pharma-ceuticals	Other health profes-sionals	Re-search	Total
Males												
0-4	1.5	11.3	12.8	-	0.3	-	0.9	1.2	2.4	20.1	1.6	38.0
5–14	0.4	5.3	5.8	-	0.2	-	2.4	2.6	1.8	16.1	1.1	27.5
15–24	0.3	-	0.3	-	0.1	-	0.2	0.2	0.3	0.3	0.0	1.2
25–34	0.2	6.8	7.0	-	0.0	-	0.2	0.3	0.3	6.6	0.6	14.8
35–44	0.2	0.9	1.2	-	0.1	-	0.7	0.9	0.5	2.8	0.2	5.6
45–54	0.4	-	0.4	-	0.2	0.1	0.9	1.1	0.5	2.8	0.2	5.0
55–64	0.5	1.0	1.5	-	0.4	0.0	2.3	2.8	0.3	14.4	0.8	19.7
65–74	0.5	2.7	3.1	0.6	0.4	-	5.6	6.0	0.3	14.3	1.0	25.4
75-84	0.5	-	0.5	1.1	0.3	-	3.3	3.6	0.1	4.2	0.4	9.9
85+	0.0	-	0.0	1.0	0.1	-	1.1	1.2	0.0	1.8	0.2	4.2
Total	**4.4**	**28.1**	**32.5**	**2.7**	**2.1**	**0.1**	**17.6**	**19.8**	**6.5**	**83.5**	**6.3**	**151.3**
Females												
0-4	1.1	5.8	6.9	-	0.2	-	1.3	1.5	1.4	17.8	1.2	28.8
5–14	0.5	4.7	5.2	-	0.0	-	0.1	0.1	2.2	4.3	0.5	12.4
15–24	0.1	2.3	2.4	-	0.0	-	0.1	0.2	0.4	2.1	0.2	5.3
25–34	0.2	-	0.2	-	0.1	0.1	0.6	0.8	0.5	1.7	0.1	3.3
35–44	0.5	1.1	1.6	-	0.1	-	1.2	1.3	0.7	0.5	0.2	4.2
45–54	0.5	-	0.5	-	0.2	0.1	1.2	1.4	0.5	4.6	0.3	7.3
55–64	0.7	-	0.7	-	0.1	0.0	1.6	1.8	0.5	0.5	0.1	3.6
65–74	0.3	1.2	1.5	-	0.2	0.0	2.9	3.1	0.2	5.1	0.4	10.4
75-84	0.4	1.2	1.6	-	0.2	-	3.3	3.5	0.1	5.1	0.4	10.9
85+	0.0	1.1	1.1	-	0.2	-	3.0	3.2	0.1	5.1	0.4	10.0
Total	**4.3**	**17.6**	**21.9**	**-**	**1.4**	**0.2**	**15.3**	**16.9**	**6.7**	**46.6**	**4.0**	**96.1**
Persons												
0-4	2.6	17.2	19.7	-	0.5	-	2.2	2.7	3.8	37.9	2.8	66.9
5–14	0.9	10.1	11.0	-	0.2	-	2.5	2.7	4.0	20.5	1.6	39.8
15–24	0.4	2.3	2.7	-	0.1	-	0.3	0.4	0.8	2.4	0.3	6.5
25–34	0.4	6.8	7.2	-	0.1	0.1	0.8	1.1	0.8	8.2	0.7	18.1
35–44	0.8	2.0	2.8	-	0.2	-	2.0	2.2	1.2	3.3	0.4	9.8
45–54	0.9	-	0.9	-	0.3	0.2	2.0	2.5	1.0	7.4	0.5	12.4
55–64	1.2	1.0	2.2	-	0.5	0.1	3.9	4.5	0.8	14.8	1.0	23.3
65–74	0.7	3.9	4.6	0.6	0.6	0.0	8.5	9.1	0.5	19.4	1.5	35.8
75-84	0.9	1.2	2.1	1.1	0.5	-	6.6	7.1	0.2	9.4	0.9	20.7
85+	0.0	1.1	1.2	1.0	0.3	-	4.1	4.4	0.1	7.0	0.6	14.2
Total	**8.8**	**45.7**	**54.4**	**2.7**	**3.5**	**0.4**	**32.9**	**36.7**	**13.2**	**130.2**	**10.2**	**247.5**

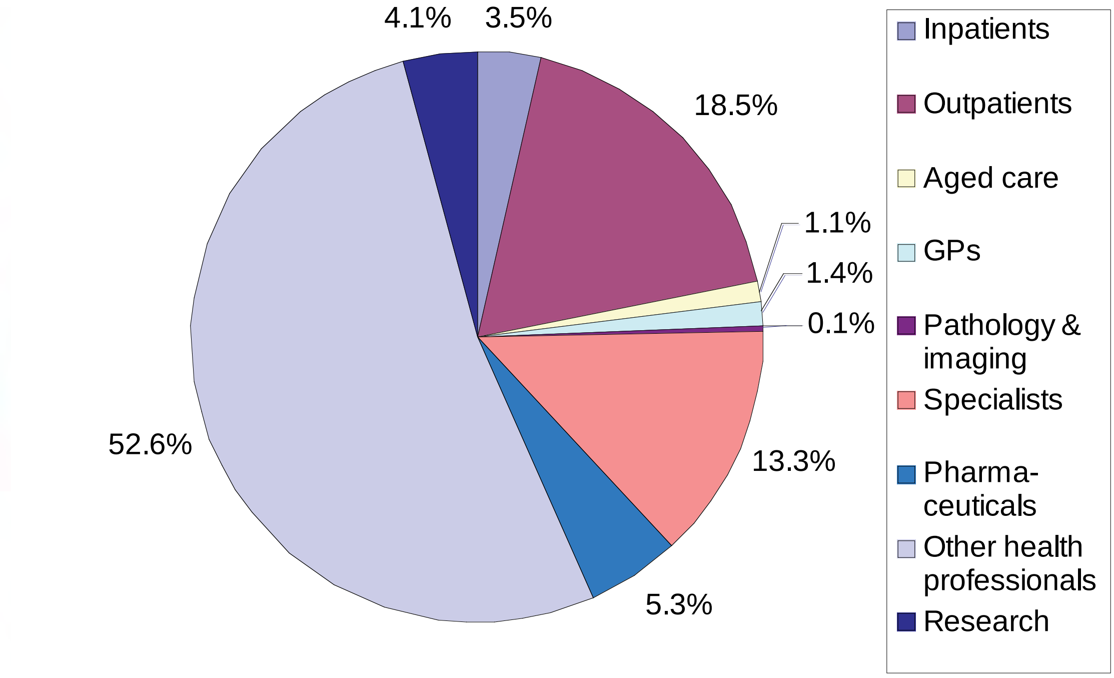
Source: AIHW specific data request.

Figure 4-1 shows health expenditure by type of health cost for people with hearing loss.

- The majority (53%) of health expenditure is directed to services provided by ‘other’ (ie, allied health or non-medical) health professionals – $130.2 million in 2005. This item would include audiology and speech therapy services.

- Outpatient expenditures were the second largest, comprising a further 19% or $45.7 million and would encompass ear examinations, advanced assessments of ear disease and procedures that can be performed in the out patient setting such as the removal of wax.
- Expenditure on medical specialists was the third most substantial cost element at $32.9 million (13% of the total).
- Expenditure was of similar order of magnitude (3.5% to 5.3% of the total) for inpatient costs ($8.8 million) – covering small numbers of surgeries to correct ossicular problems and perforations of the ear drum, implant surgeries (but not the devices)and other forms of ear surgery and treatment – as it was for health research ($10.2 million), and pharmaceuticals, the vast majority of which are over-the-counter medications ($13.2 million).
- Expenditure on GPs ($3.5 million) and aged care homes ($2.7 million) were relatively low – each just over 1% of the total.
- The remaining 0.1% of expenditure ($0.4 million) was for diagnostic imaging and pathology. There were no allocated hearing-related expenditures for optometry or dental services.

FIGURE 4-1: HEARING LOSS, HEALTH EXPENDITURE BY COST TYPE COST, 2005(%)

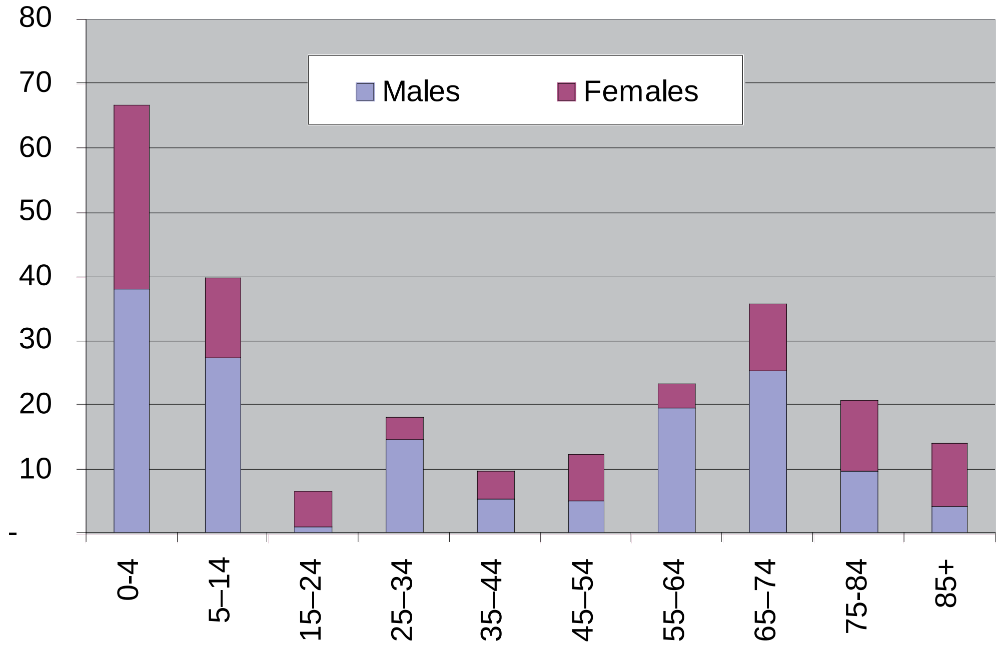


Source: AIHW special data request.

Figure 4-2 shows health expenditure by age and gender.

- 61% of total health spending ($151.3 million) is on males and 39% ($96.1 million) is on females, reflecting prevalence proportions.
- While the greater prevalence of OHL in working age men and the greater longevity in women in later life explains most of the differences in expenditure patterns, it is not apparent why boys aged less than 14 years would require higher levels of hearing health expenditure than girls.

FIGURE 4-2: HEARING LOSS, HEALTH EXPENDITURE BY AGE AND GENDER, 2005 ($M)



Source: Australian Institute of Health & Welfare, special data request.

Most notably, 27% of health expenditure is associated with children up to the age of 14 years, although this cohort constitutes less than 1% of people with hearing loss. These figures equate to an annual expenditure of $6,511 per child.

At issue here is not that these children do not need such services (the evidence below in fact supports the opposite view) but rather that the remainder of people with hearing loss access relatively little rehabilitative treatment or care within the health system. Further, those services are generally not available more broadly within the community. People aged over 65 years constitute half of people with hearing loss but receive less than one third (29%) of the health system expenditure ($40 per person per annum).

There is a case for further research regarding this seeming inequity of allocation, as well as for other fields of research into hearing loss and its impacts. Dillon (2001:368-369) observes: "(T)here is a need for well-controlled research studies that enable us to better identify and quantify all the effects of hearing loss on general wellbeing". Research is required that can make the connections between hearing loss and its personal consequences (where they exist) and in turn, to link this information back into the prevention cycle. There are a variety of possible causal mechanisms that could be examined such as stigma and poor health outcomes (ie, the stress effects of hearing loss), lower socio-economic factors, pessimism, severity of perceived disability, social isolation, and negative emotion just to name a few. Hearing health requires an allocation of health research funding that can explore and prospectively examine these issues. Without a program of properly funded research and a suitably structured institute to focus and drive the research agenda, the costs and consequences of hearing loss are likely to remain hidden, with the connections between factors, consequences, costs and expenditure allocations simply not being made.

4.3 HEALTH SYSTEM EXPENDITURE COMPARISONS

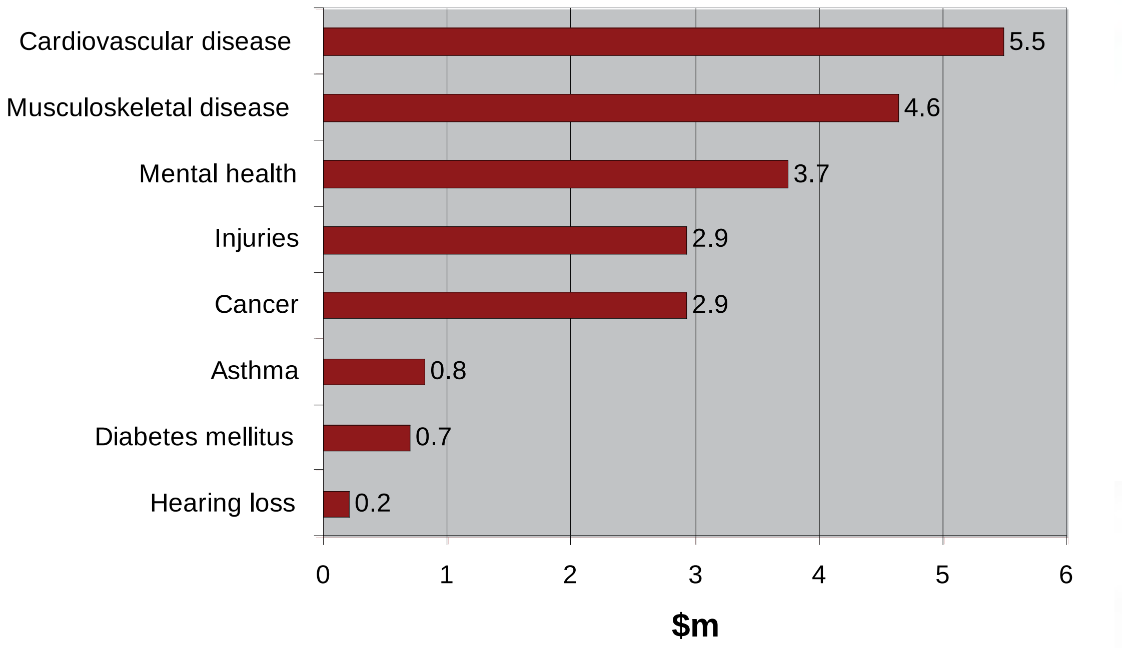
Figure 4-3 compares allocated health expenditure for hearing health with the national health priority areas. The year 2000-01 was used as the year of comparison as this provides the most recent data available for all disease areas.

Comparatively, health expenditure on hearing loss is less than 1% (0.9%) of the total expenditure on the national health priority areas, and only 0.35%[8] of total allocated recurrent health expenditure in Australia.

Using the prevalence of diseases reported in AIHW (2004:389) for 2001 and allocated recurrent health expenditures from AIHW (2005b) for 2000-01 it can be seen that, compared to the then expenditure of $62 per person with hearing loss per annum:

- an average of $10,904 is spent per person with cancer and an average of $2,064 is spent per person with a mental illness; and
- this implies that less than 5% of the average per capita expenditure on the national health priorities is spent on hearing loss.

FIGURE 4-3: HEARING LOSS, HEALTH EXPENDITURE COMPARED TO NATIONAL HEALTH PRIORITIES, 2001



Source: Derived from AIHW (2005b) Table 3: Allocated recurrent health expenditure on National Health Priority Areas, 2000-01 ($ million).

Adjusting the health expenditure data for expenditures not allocated by AIHW (recall Section 4.1) brings the **total cost of health expenditure on hearing to $287.8 million for 2005, or an estimated 0.034% of GDP**.

[8] $201m /$58,078m in 2000-01 as per AIHW (2005a: 93) Table A1: Total health expenditure, current price, Australia, by area of expenditure and source of funds, 2000-01.

4.4 HEARING AIDS AND COCHLEAR IMPLANTS

Hearing aids and cochlear implants are hearing prostheses used by people with hearing loss to aid communication. These costs are documented as additional health system expenditure. Their estimated cost is, in fact, the largest element of health system expenditure at **$376.7 million in 2005**, as calculated in the sections below.

4.4.1.1 HEARING AIDS AND RELATED INTERVENTIONS

Audiological interventions include hearing tests and the supply of ear moulds and hearing aids. These services are supplied to children and young people aged to 21 years by Australian Hearing via funding from the Office of Hearing Services. The Office of Hearing Services also provides a voucher-based hearing aid service to eligible adults in Australia. Eligibility is determined by possession of a pensioner concession or similar government card (e.g. Department of Veterans Affairs Gold Card, Health Card). These services are provided by accredited audiologists and hearing aid audiometrists from the private sector as well as Australian Hearing. For the year 2004-2005, the Office of Hearing Services provided a hearing service voucher to 192,149 people, the majority of whom were aged 65 years or over. Those aged less than 65 years who received a hearing aid under this program are assumed not to be double counted since they were excluded from the calculation of aids provided for the younger cohort below. The voucher entitles the individual to hearing tests and the provision of devices. Most people receiving a voucher proceed to take up hearing aids (161,849 people)[9] The annual cost for the provision of hearing services to eligible adults and related services in Australia under the **Office of Hearing Services Program is $243 million**[10] for 2004-2005 as per their annual report.

In contrast, services for adults of working age with hearing loss are predominantly provided by the free market. There is an absence of active hearing screening programs to identify hearing loss. Further, adults with hearing loss have been reported to be reluctant to accept hearing aids (Kochkin, 1999). Local studies (Wilson, 1997; Hogan et al, 2001) report that approximately 15% of older people with acknowledged hearing loss use hearing aids. Reviewing the prevalence data (better ear, ie bilateral loss) for adults aged 22–64 years, this suggests that at best, 151,693 people would have hearing aids. This figure is further revised downwards by 1,000 people[11] to 150,693 to allow for people in this age group receiving a free government aid as a result of being unemployed. Assuming too, that on the open market people only renew their hearing aids every five years, and that 50% have two aids (Harvey Dillon, NAL, personal communication), an estimated price of $2,500 per device (Harvey Dillon, NAL, personal communication), with batteries and device maintenance estimated to be $137 per person per year (as per costs provided by the Office of Hearing Services). The total **cost of hearing aids in the private market is then estimated as $133.7 million in 2005**.

[9] http://www.health.gov.au/internet/wcms/publishing.nsf/Content/health-hear-voucher-voucher4.htm

[10] Adjusted for 6 months health inflation.

[11] The estimate of 1,000 people is based on the finding from Table 5-13 that 969 people in employment services receive the Disability Support Pension (DSP), and there is a linkage between receipt of the DSP and eligibility for publicly provided hearing aids.

4.4.2 COCHLEAR IMPLANTS

Cochlear Ltd advises that approximately 400 Australians receive an implant each year, and that 33% of implantees are aged 18 years or less. As at October 2005, the cost of the Nucleus® Freedom™ cochlear implant system was $25,070. This equates to approximately **$10 million per annum on implantable devices for hearing loss**. Cochlear Ltd estimate that in Australia presently, less than 10% of people likely to benefit from the technology have accessed it.

FIGURE 4-4: THE AUSTRALIAN COCHLEAR IMPLANT SYSTEM

Apart from the devices themselves, all other costs associated with cochlear implantation (pre-operative, surgical and post-operative procedures) are covered under allocated recurrent health expenditures noted above.

4.4.3 ECONOMIC EFFICACY OF HEARING DEVICES

Although not a focus of this study, when evaluating the efficacy of interventions it is important that the health related quality of life and cost utility instruments used are sensitive to the condition of interest. Instruments such as the SF 36 (Ware and Sherbourne, 1992) do not have hearing specific questions in them, while the Health Utilities Index (Feeny et al, 1996) does. In situations where less sensitive instruments are used, utility results may be less than optimal. That said, the literature shows that devices such as hearing aids and cochlear implants yield significant benefits for relatively low investments, particularly for hearing aids. By way of comparison, the World Health Organization defines cost-effective and very cost-effective interventions as:

- **cost-effective**: one to three times GDP per capita to avert one lost DALY; for Australia in 2004, A$41,000 (US$30,000) to A$124,000 (US$90,000); and
- **very cost-effective**: less than GDP per capita to avert one lost DALY; for Australia in 2004, less than A$41,000 (US$30,000).

Table 4-2: Cost effectiveness of hearing aids and cochlear implants ($/QALY)

Study	Device	Measure	$ per QALY
Abrams et al (2002)	Hearing aids	SF 36	US$60
Palmer et al (1999)	Cochlear implant (Adults)	HUI	US$14,670
Cheng et al (2000)	Cochlear implant (Children)	HUI	US$5,197

5. OTHER FINANCIAL COSTS

Other financial costs are all those that are not direct health system costs (Chapter 4) nor intangible costs – the loss of health and wellbeing detailed in Chapter 6. It is also important to make the economic distinction between real and transfer costs.

- **Real costs** use up real resources, such as capital or labour, or reduce the economy's overall capacity to produce goods and services.
- **Transfer payments** involve payments from one economic agent to another that do not use up real resources, for example, a disability support pension, or taxation revenue.
  - Transfer costs are important when adopting a whole-of-government approach to policy formulation and budgeting.

5.1 PRODUCTIVITY LOSSES

People with hearing loss are 25% less likely to be earning higher incomes than people without hearing loss (OR 1.26 CI 95% 1.105 – 1.44) (South Australian Health Omnibus Data, 1994). Of the people in paid work, 72.1% of people with hearing loss reported incomes greater than $40,000 per annum compared with 77.9% of people without hearing problems, a net difference of 5.8%. In the Beaver Dam study, people with hearing loss were also reported to be twice as likely to earn less than $30,000 (Cruickshanks et al, 1998).

Table 5-1 examines the likelihood of people with hearing loss being in the high rather than the low income group compared with a sample of people with no hearing loss (age and gender adjusted). In all cases, people with hearing loss are less likely to earn a high income than people without hearing loss.

TABLE 5-1: SES BY GROUP: LIKELIHOOD OF PEOPLE WITH A HEARING LOSS BEING IN THE HIGH RATHER THAN THE LOWER INCOME GROUP COMPARED WITH A SAMPLE OF PEOPLE WITH NO HEARING LOSS (AGE AND GENDER ADJUSTED)

Group	N	Odds Ratio	P	95% CI
Mild loss	321	0.74	.120	.51-1.08
Moderate loss	90	0.42	.069	.16-1.07
Severe loss	26	0.60	.419	.17-2.09
Implantees	112	0.51	.026	.28-0.92

Source: Hogan et al (1999). Number in comparison group of respondents without a hearing disability: 2,112.

5.1.1 EMPLOYMENT IMPACTS

Hearing loss can have an impact on a person's capacity to work. If employment rates are lower for people with hearing loss, this loss in productivity represents a real cost to the economy.

Access Economics measures the lost earnings and production due to health conditions using a 'human capital' approach. The lower end of such estimates includes only the 'friction' period until the worker can be replaced, which would be highly dependent on labour market conditions and un(der)employment levels. In an economy operating at near full capacity, as Australia is at present, a better estimate includes costs of temporary work absences plus the discounted stream of lifetime earnings lost due to early retirement from the workforce, reduced working hours (part-time rather than full-time) and premature mortality, if any. In this case, it is likely that, in the absence of impairment, people with hearing loss would participate in the labour force and obtain employment at the same rate as other Australians, and earn the same average weekly earnings. The implicit and probable economic assumption is that the numbers of such people would not be of sufficient magnitude to substantially influence the overall clearing of the labour market.

Table 5-2 reports on employment outcomes for people with hearing loss, with data drawn from the South Australia Health Omnibus Study (1994). Respondents within the Omnibus sample were identified for hearing loss by their response to the question '*Do you have trouble hearing conversation in a quiet room (even when wearing a hearing aid) when: i) people speak very loudly, ii) when they speak normally, iii) when they whisper iv) have no problems at all*. Respondents to items i), ii), iii) and iv) were coded as severe, moderate, borderline and no hearing problem respectively (Hogan et al, 1999).[12]

Of people with hearing problems aged 15–64 years, 55.6% ((130+53)/329 from Table 5-2 below) reported being in paid work compared with 62.4% of people without hearing problems, a net difference of 6.8% (OR 1.12 CI 95% 1.06–1. 19; South Australian Health Omnibus data, 1994). Notably 5.3% (133/2,502) of respondents reported their employment status as retired (early) but for people with hearing problems aged 15–64 years, 12.1% (40/329) reported being retired versus 4.3% (93/2173) of people without hearing problems.

TABLE 5-2: EMPLOYMENT OUTCOMES FOR PEOPLE WITH HEARING LOSS, 15-64 YEARS

Hearing status	Work full time	Part time	Home duties	Unemp-loyed	Retired	Student	Other	Total
When they speak loudly	3	0	4	2	4	0	2	15
If they speak normally	25	6	5	3	10	3	10	62
If they whisper	102	47	34	18	26	15	12	252
None of the above	983	373	365	118	93	206	35	2,173
Total	**1,113**	**435**	**408**	**141**	**133**	**224**	**57**	**2,502**

Source: South Australian Health Omnibus Data (1994). $\chi^2(1)=22.5$; p=.001 (linear by linear association).

Employment opportunities may be affected by gender, age and certainly by increasing levels of disability. To this end the employment data were re-examined controlling for gender as well as age in two groups, people aged 15-44 years and people aged 45-64 years.

Table 5-3 shows employment outcomes for the younger age group. There were no significant differences for employment outcome by hearing loss, although the result for females with hearing loss was borderline.

[12] This coding was validated in Wilson (1997).

TABLE 5-3: PEOPLE IN PAID WORK AGED 15-44 YEARS, BY HEARING PROBLEMS AND GENDER

		In paid work	Not in paid work	Total
Male	Hear problems	82 (79.6%)	21 (20.4%)	103 (100%)
	No hear problems	578 (74.9%)	194 (25%)	772 (100%)
Female	Hear problems	39 (50.6%)	38 (49.4%)	77 (100%)
	No hear problems	426 (54.7%)	353 (45.3%)	779 (100%)

Source: South Australian Health Omnibus Data Males $\chi^2(1)$= 1.645 p<0.2; Females $\chi^2(1)$ = 3.681 p<.055

Table 5-4 shows employment outcomes for the older age group. The age-standardised employment rate for males 45-64 years with hearing loss was 20.5 percentage points lower than that for people without hearing loss. Similarly, the age-standardised employment rate for females 45-64 years with hearing loss was 16.5 percentage points lower than that for people without hearing loss.

TABLE 5-4: PEOPLE IN PAID WORK AGED 45-64 YEARS, BY HEARING PROBLEMS AND GENDER

		In paid work	Not in paid work	Total
Male	Hear problems	46 (47.4%)	51 (52.6%)	97 (100%)
	No hear problems	197 (67.9%)	93 (32.1%)	290 (100%)
Female	Hear problems	16 (30.2%)	37 (69.8%)	53 (100%)
	No hear problems	155 (46.7%)	177 (53.3%)	332 (100%)

Source: South Australian Health Omnibus Data Males $\chi^2(1)$= 13.1 p<0.001; Females $\chi^2(1)$ = 5.04 p<.025

This implies that if people with hearing loss were employed at the same rate as average Australians of the same age, then an additional 158,876 people would be employed in 2005. With average (full-time and part time) weekly earnings for all Australians of $805.40[13], **the annual cost of lost earnings due to workplace separation and early retirement from hearing loss is $6.67 billion**. This equates to 0.79% of GDP.

5.1.2 ABSENTEEISM

Hearing loss does not appear to induce extra costs in terms of additional absenteeism. Indeed, the opposite may be the case as, in one study, people with

[13] http://www.abs.gov.au/websitedbs/d3310114.nsf/Home/key%20national%20indicators

hearing loss were less likely to have been absent from work in the previous two months (Mild OR 0.22 CI 95% 0.12-0.40; Moderate OR 0.14 CI 95% 0.05-0.33; Severe OR 0.32 CI 95% 0.14-0.71; Wilson, 1997:106). This phenomenon may be explained by the postulate that people with disabilities may experience greater job insecurity and hence be less prepared to take time off, even when unwell (Barnes, Thornton and Campbell, 1998).

5.1.3 TAXATION REVENUE IMPACTS

Taxation revenue foregone

Reduced earnings due to reduced workforce participation, absenteeism and premature death will also have an effect on taxation revenue collected by the Government. As well as foregone income (personal) taxation, there will also be a fall in indirect (consumption) tax, as those with lower incomes spend less on the consumption of goods and services.

Personal income tax foregone is a product of the average personal income tax rate and the foregone income. With hearing loss and lower income, there will be less consumption of goods and services, estimated up to the level of the disability pension. Without hearing loss, it is conservatively assumed that consumption would comprise 90% of income (the savings rate may well be lower than this). The indirect tax foregone is estimated as a product of the foregone consumption and the average indirect tax rate, derived from the Access Economics macroeconomic model.

Access Economics estimates that in 2005, **$2.00 billion of potential taxation revenue** will be lost due to the reduced participation of people with hearing loss in the paid workforce. Of this, **$1.33billion (67%) is lost income tax and $0.67 billion (33%) is lost consumption tax**.

As noted in the preamble to Chapter 5, lost taxation revenue is considered a transfer payment, rather than an economic cost. However, raising additional taxation revenue does impose real efficiency costs on the Australian economy, known as **deadweight losses**. Administration of the taxation system costs around 1.25% of revenue raised (derived from total amounts spent and revenue raised in 2000-01, relative to Commonwealth department running costs). Even larger deadweight losses also arise from the distortionary impact of taxes on workers' work and consumption choices. These distortionary impacts are estimated to be 27.5% of each extra tax dollar collected (Lattimore, 1997 and used in Productivity Commission, 2003, p6.15-6.16, with rationale).

Access Economics estimates that **$0.58 billion in additional deadweight loss is incurred** in 2005, due to the additional taxation required to replace that foregone due to the lost productivity of people with hearing loss (Table 5-5).

Welfare payments made to people with hearing loss who are no longer working must, in a budget-neutral setting, also be funded by additional taxation. The deadweight losses associated with welfare transfers are calculated in Section 5.5.2.

TABLE 5-5: LOST EARNINGS AND TAXATION REVENUE DUE TO HEARING LOSS, 2005

Potential earnings lost	$6.67 billion
Average personal income tax rate*	20.0%
Potential personal income tax lost	$ 1.33 billion
Average indirect tax rate*	15.3%
Potential indirect tax lost	$0.67 billion
Total potential tax revenue lost	$2.00 billion
Deadweight loss from additional taxation	**$0.58 billion**

* Source: Access Economics macroeconomic model (2005).

5.2 EDUCATION AND SUPPORT SERVICES

People with hearing loss have poorer educational and employment outcomes than the rest of the population (Hogan et al, 1999). Table 5-6 reports educational outcomes for adults with hearing loss by degree of loss. The number of people with more severe degrees of hearing loss reporting completing a trade course or higher is less than half that of the general population. Similarly, in the Beaver Dam study, compared with people with a college degree, people with hearing loss were 2.42 times less likely to have completed high school (Cruickshanks et al, 1998:881).

TABLE 5-6: EDUCATIONAL OUTCOME BY DEGREE OF DEAFNESS

Education	Implant	Very deaf	Mod deaf	Mild	Not deaf	Total
High school or less	86 (68.3%)	22 (78.6%)	50 (52.1%)	201 (56.5%)	1,455 (57.5%)	1,814 (57.9%)
Trade or higher	40 (31.7%)	6 (21.4%)	46 (47.9%)	155 (43.5%)	1,074 (42.5%)	1,321 (42.1%)
Total	**126 (4.0%)**	**28 (0.9%)**	**96 (3.1%)**	**356 (11.4%)**	**2,529 (80.7%)**	**3,135 (100%)**

Source: Hogan et al (1999). $\chi^2(4)=12.22$; p=.016. In his study Wilson validate these categories of hearing against clinical categories of mild, moderate and severe hearing loss.

5.2.1 EARLY INTERVENTION SERVICES

A range of audiological and educational services are available for the 1,457 children with hearing loss aged under five years. Interventions can include:

- neo-natal hearing screening services;
- early intervention programs for children aged less than 3 years, involving individual and/or group interventions and encompassing mode specific (sign/speech) interventions; and
- pre-school education programs either at a specialist centre or visiting services to existing pre-schools.

Data on early intervention and service costs for children with hearing loss aged less than 5 years was available from the Royal Institute for Deaf and Blind Children (RIDBC), Deaf Children Australia and Australian Hearing (Table 5-7).

Table 5-7: Additional costs of early intervention services

Service	Data Source	Cost/child	Estimated national cost
Early learning Program 0-3 years	RIDBC	$6,500	$4,241,132
Pre-school education ages 3-4 years	RIDBC	$20,632	$16,607,057
Total			$20,848,189

Figures adjusted for health inflation. Preschool costs per child are net of usual costs to provide child care for children of this age assuming $208 per child per week over 46 weeks of the year.

Universal neo-natal hearing screening has begun to be implemented across Australia. This service seeks to identify children born with hearing loss at the earliest possible time. Unfortunately, data on the costs of this service could not be obtained. **Thus the total estimated cost for early intervention services is $20.8 million in 2005.**

5.2.2 Primary and secondary education services

Presently there are no national data on the costs of school education for deaf and hearing impaired students. The Australian Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) has recently commissioned a scoping study to address this shortfall in data. However, it will be at least another year before a full study is commissioned and the data collected. Australian data are available on the costs of regular school education in Australia in the National Schools Report (MCEETYA, 2001).

International data: The Special Education Expenditure Project (SEEP), conducted by the Centre for Special Education Finance in the United States, provides extensive data on the costs of educating students with disabilities. The data are based on a nationally representative, “stratified random sample of 1,769 schools in 448 school districts and 30 affiliated intermediate education units” (SEEPa, 2003:4). SEEP used a resource cost model to document by individual student the nature and range of services utilised. As SEEP (2003a:14-15) reported:

> “These resources include the teachers, related service providers or paraprofessionals providing these services, the class size or numbers of students receiving these services at the same time, special equipment, supplies and materials. Services include classroom instruction, consultation of resource teachers with regular classroom teachers, pullout programs in resource rooms, integrated services provided in regular classrooms to students with special needs and overall administration and support....Detailed knowledge of the services provided, the ingredients used to provide these services , and the cost of each ingredient, along with the cost of school and district administration and support, allow for the calculation of the total expenditures required to educate each student”.

While the exact dollar values associated with special education in the USA may not be directly comparable to Australia, the nature and range of services appear similar. Moreover, the SEEP provides a ratio of costs of education for students with a range of disabilities as compared with students without disabilities:

- The average spending ratio for students with disabilities (excluding homebound students) to regular class students was 1.9:1.

- The average spending ratio for students with specific learning disabilities was 1.6:1.
- The average spending ratio for deaf and hearing impaired students was 2.4:1.
- The average spending ratio for students with multiple disabilities was 3.1:1.

School retention rates for deaf and hearing impaired children are poor. The British Association of the Teachers of the Deaf (2004) report that 86% of deaf and hearing impaired students leave school by age 16 years. Extrapolating these figures to Australia, the population of deaf and hearing impaired school students is estimated to be 20,918 students.[14]

Australian partial data: MCEETYA (2001:23) reports that the average per capita expenditure on government schools ($/full time equivalent (FTE) student) was $9,398 made up of $8,937 recurrent expenditure and $461 capital expenditure. SEEP (2003:8-11) demonstrate that the majority of costs in disability education are service costs. Recurrent expenditures were inflated to 2005 based on changes to average weekly earnings, while capital costs were inflated by the health component of the CPI. For 2005 then, the total expenditure on government schools per FTE student was estimated as $10,619 ($10,098+$521) per student.

Costs for deaf education were available from the Disability Programs within the New South Wales Department of Education and Training and from the Victorian Department of Education and Training (specific data request).

- In New South Wales there were approximately 1,400 students in mainstream settings receiving itinerant support and approximately 300 students in small support classes.
  - The latter are usually for severely to profoundly deaf students
- The cost of an itinerant teacher of the deaf (ITD) with salary and on costs per teacher was estimated to be $90,000 per annum, reflecting the high level of qualifications and experience of the teachers. In November 2005, there were 240.7 FTE ITDs. This equates to $21.7 million per annum or $15,474 per student. The costs of itinerant support are in addition to the usual costs of education.
- Support classes are serviced by a specialist teacher of the deaf, with support from at least a half time teacher's aid. The cost of the specialist teacher is as per the ITDs and the estimated cost of the teacher's aid is $35,000. There are 55 support classes in New South Wales. This equates to approximately $5.9 million (($90,000 + $17,500)*55) or $19,708 per child. However, since support classes replace the usual costs of education ($10,619), the additional cost of educating children in the support setting is approximately $9,090.
- Proportionately, the ratio of mainstream to support classes was (1400:300) 82%:18%. Extending this ratio nationally provides 8,921 students with itinerant support and 1,958 students in support classes.
- New South Wales estimates that there are additional costs that cannot be readily quantified such as capital costs, device maintenance costs and transport costs to support classes.

[14] Note that this uses 86% of the estimate of children aged 5-16, which includes 15 and 16 year olds estimated from the Wilson rather than Australian Hearing data, and thus including the higher prevalence rates at age 15.

The New South Wales support costs are comparable with figures provided by the Royal Institute for Deaf and Blind Children (RIDBC) who estimate a cost of $13,709 for itinerant support services. RIDBC also estimates the overall cost of educating a student in the signing setting to be $52,211, inclusive of the costs to educate the student if they were not deaf. For Victoria, costs were specified for students with "a bilateral sensori-neural hearing loss that is moderate/severe/profound and where the student requires intervention or assistance to communicate". The Department identifies 600 students in this category presently, receiving support totalling $21.02 million annually (or an average cost of $35,033 per student. Compared with the 1700 students in NSW receiving assistance, the funding in Victoria seems to be spread over a fewer number of students with more severe hearing loss.

In this analysis the NSW cost per student estimates are used as: (1) they are more likely to reflect the spectrum of severity of hearing loss; (2) segmentation by type of support is possible; and (3) the approach errs on the conservative side.

Costs were applied proportionately 82:18 to the 20,918 children with hearing loss aged 5-16 years. **The total 'extra' cost of education for children with hearing loss was thus estimated as $117.2 million in 2005.**

5.2.3 POST SCHOOL EDUCATION SERVICES

Australian and overseas studies note that hearing impaired students with high support needs consume considerable services in higher education (SEEP 2003a,b; Devlin, 2000:15). Interpreters and note takers are identified as comparatively high costs items by Devlin (2000) across a number of western countries including the United Kingdom and Canada (Jones, 1994). In the United Kingdom, Devlin reports that up to an equivalent of A$30,000 (year 2000 dollars) was paid to students requiring non-medical helpers such as interpreters. In a review of international studies, Devlin (2000) reports that in Ireland the average support costs for a hearing impaired student were A$6,705.

The North Melbourne Institute of TAFE (NMIT) advise that 60% of the Victorian TAFE budget to support students with disabilities is used for Deaf students alone.

Andrews and Smith (1992:175) estimated that on average, students with disabilities required support by degree of disability with costs increasing from low support ($91 per student), additional support ($391 per student) and high support ($1,147 per student) (all in 1992 dollars). They further assumed that costs of the lowest category would be absorbed by the College, therein leaving an average cost of $1,540 (rounded) per student with a disability (see also Devlin, 2000:21). Devlin (2003:23) suggested that the average cost of providing for all enrolled students with a disability was $327 per student and $832 for students with support needs. Notably, students with very high support needs such as signers were identified with costs on average of $5,000 per annum

Numbers of tertiary students requiring services: In 2004, some 10,300 deaf and hearing impaired people were enrolled in vocational educational programs in Australia (National Centre for Vocational Educational Research (NCVER), specific data request). For deaf and hearing impaired students who access post-school education, support is available to them on the basis of need.

The estimate of students using support in vocational and educational training services was derived as follows, based on data provided by NMIT, NCVER and New South Wales Department of Education and Training:

- vocational and educational training enrolments of deaf and hearing impaired students by state, roughly reflect national ABS population distributions with New South Wales and Victoria being the two largest states.
- in 2004 in Victoria, 3.5% (105/3,010) of deaf and hearing impaired students accessed support services as per NIMT's report. Victoria's enrolment represents 30% of the national in vocational and educational training enrolment of deaf and hearing impaired students.
- the New South Wales Department of Education and Training reports that there were 518 deaf and hearing impaired students accessing support services in 2005 and that this is a representative number for their usual enrolment. This represents 16.9% (500/3,070) of deaf and hearing impaired students accessing support services. New South Wales' enrolment represents 37% of the national in vocational and educational training enrolment of deaf and hearing impaired students. It is generally acknowledged that the New South Wales' system is more readily accessed than the other states and that Victoria's rate probably reflects a more realistic level of support provision.
- so, rather than taking a crude average between these two states, it is more appropriate to cost services for New South Wales at their reported rate and the rest of the country using Victoria's rate. On this basis New South Wales has 518 students accessing services and the remainder of the country is estimated to be 223. Thus it is estimated that at least 741 students are accessing support services such as sign language interpreting in vocational and educational training.

Current and real costs data were provided by New South Wales as $3,508 per student. Although not as high as the Devlin estimate for students with higher support needs, the New South Wales costs are used as the estimate because of its currency and the number of students under-pinning the estimate. The **costs of supporting deaf and hearing impaired tertiary students in 2005 was thus estimated as $2.6 million**.

5.2.4 OTHER SERVICES FOR PEOPLE WITH HEARING LOSSES

People with hearing loss require additional services relative to other people in the community, such as audiological and interpreter services and support to the Deaf Community.

5.2.4.1 INTERPRETER SERVICES

A national sign language service for Medicare rebate-able medical interpreting services is provided through Wesley Mission Brisbane, under a tender arrangement from the Commonwealth Department of Family and Community Services. The actual costs of this interpreting service could not be obtained, so they have been derived on the basis of the Department's request for tender. In the request for tender the Department advised that it had allocated interpreter funding of $18.4 million over 4 years to establish a national service to book and pay for accredited Auslan interpreters (John Paton, Victorian Deaf Society, personal communication). These costs were averaged over four years with **$4.6 million allocated for this year for interpreter services**.

5.2.4.2 CAPTIONING

Table 5-8 details the annual costs of captioning television and movies in Australia.

TABLE 5-8: COST OF CAPTIONING SERVICES

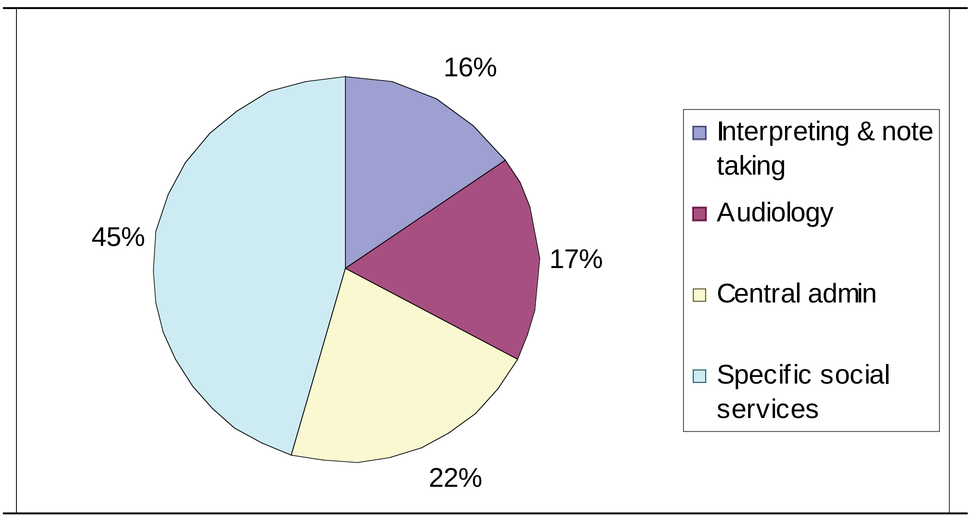
Service	Cost (Millions)
Captions for free to air TV	$14.0
Captions for pay TV	$1.0
Captions for video/DVD	$1.5
Captions for Television commercials	$1.0
Captions for cinema	$0.5
Estimated captioning costs	**$18.0**

Varley, A. Australian Caption Centre (pers. com) 26/10/05

5.2.4.3 SERVICES TO THE DEAF COMMUNITY

A range of community services are provided to the Deaf Community in Australia by various Deaf Societies. The nature of services provided varied by State/Territory but encompassed services across the life span including community-based family support services, community support, community education, interpreting[15] and aged care. Costs associated with fund raising are not reported here. The costs of services were provided by the New South Wales, Victorian, South and West Australian Deaf Societies. Costs for Tasmania and the Territories were established on a proportional population basis against the data provided by the other societies using population data. Excluding the costs of audiology services (which are more likely to be provided to people with acquired hearing loss), the cost of delivering these services to the Deaf Community in the last financial year were estimated to be **$13.6 million**.

FIGURE 5-1: COSTS OF DEAF COMMUNITY WELFARE SERVICES



[15] Communications with the national provider of interpreter services shows that these costs are not double counted but represent additional services provided.

5.3 COMMUNICATION AIDS AND DEVICES

The costs detailed in this section sum to **$13.8 million** – comprising $2.1 million for non-health communication devices (since hearing aids and cochlear implants are included in Chapter 3), $1.2 million for specific Telstra telephones and $10.5 million for ACA TTY machines.

5.3.1 COMMUNICATION DEVICES

Table 5-9 reports data from the Survey of Disability Ageing and Carers on the use of communication devices by people who reported their hearing loss as their main condition.

TABLE 5-9: HEARING DEVICES UTILISED

Communication Aid Used	Number
Hearing aid	130,800
Cochlear implant	Np
Other hearing aid(s)	20,100
Low technology reading or writing aids	3,600
Low technology speaking aids	100
High technology reading or writing aids	3,100
High technology speaking aids	Np
Mobile or cordless telephone	10,700
Fax machine	3,900
Reading, writing or speaking aid not specified	4,700
Does not use a communication aid	81,500
Total	**218,200**

Source: ABS (2003) Survey of Disability Ageing and Carers – special data request.

Earlier it was noted that the SDAC is likely to under report hearing loss by a factor of 1:3. The estimates in the above table need to be adjusted for this factor, leaving aside the costs of hearing aids and cochlear implants, which were covered in Section 4.4. Similarly, telecommunications technologies (e.g. high technology writing aids) are addressed in Section 5.3.2. The remaining (additional) communication aids and the adjusted number of users are then:

- low technology reading or writing aids (probably pen and paper): 10,800
- low technology speaking aids (e.g. communication device such as the Franklin Speaking Language Master @ $588[16]): 1,500
- fax machine (e.g. Samsung SS341p $159.95 [17]): 58,500
- reading, writing or speaking aid not specified (as these cannot be directly priced they are imputed using the average sale price of $129.53 from Deafness Resources Australia, who in 2004-05 had sales of $388,603 to 3,000 customers: 70,500.

[16] http://www.novitatech.org.au/product.asp?p=247&id=1601

[17] Harvey Norman Woden November 10, 2005 pers.com

Using these estimated volumes and unit prices, the total cost of these communication aids is estimated as $2.1 million (see Table 5-10).

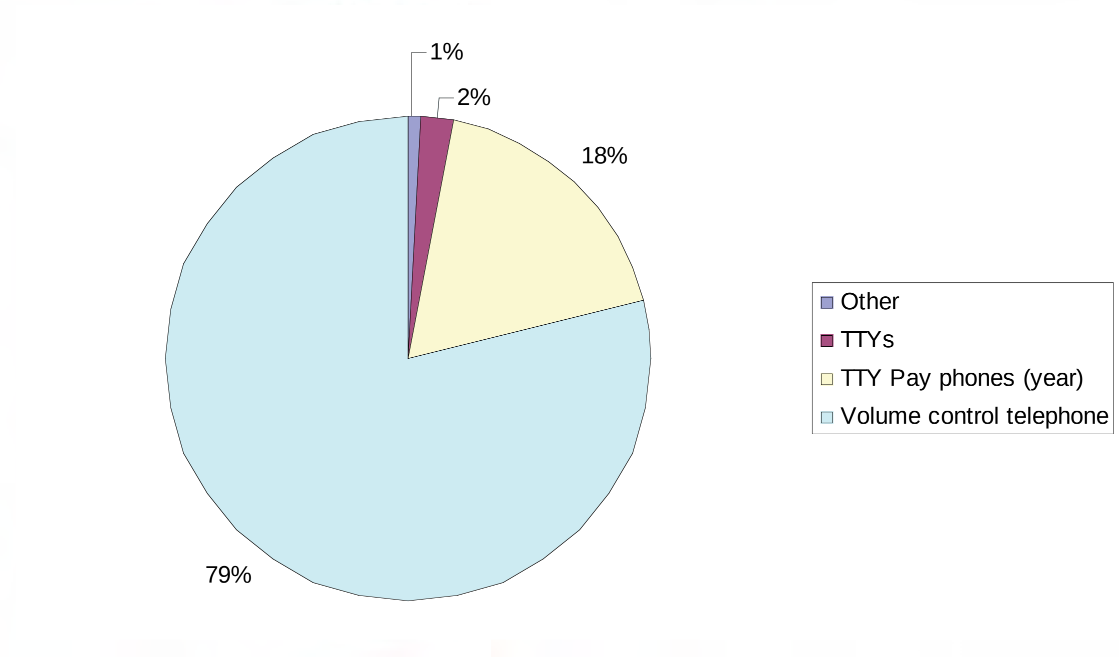
TABLE 5-10: ESTIMATED COSTS OF ADDITIONAL COMMUNICATION DEVICES

Device	Average cost pa	Number of people	Total cost pa
Pens and pencils	$5 (estimate)	54,000	$270,000
Communication aids	$196	300	$58,800
Fax machines	$53.32 + $50 consumables	11,700	$1,208,844
Other devices	$43.18	14,100	$608,838
Total			**$2,146,482**

Estimates assume technology purchases last three years and were expensed for this period.

Telstra provides telecommunications equipment for deaf and hearing impaired people through its disability equipment program. The number of units provided and costs associated with these services for the year 2004-05 are available through the Telecommunications Performance Report (ACMA, 2005) and Telstra's terms of business for its wholesale customers. Actual costs to the market would be higher than the figures reported although, as the overall estimate is small, a retail margin has not been included. The estimated cost of these devices is **$1.2 million in 2005**. The major cost driver was volume control telephones. Volume controls have just become standard on all telephones, so the cost of this item will reduce considerably next year.

FIGURE 5-2: TELEPHONE DEVICES PROVIDED BY TELSTRA AND ASSOCIATED PROVIDERS



Source: ACMA (2005)

5.3.2 TELECOMMUNICATIONS

A National telephone relay service is provided by the Australian Communication Exchange (ACE) funded by the Australian Communications Authority (ACA). This service provides a telecommunications interface so that Deaf people and hearing people can communicate via telephone. The Deaf person uses a telephone typewriter to communicate with ACE who in turn communicate with the hearing person being called and relay the communication back to the Deaf person. The TTY can be likened to an interactive facsimile machine. The service is funded via levies to the telecommunications industry.

For the year 2003-04, ACA reports that the total cost of the relay service was $15.7 million. ACA reports that two thirds of incoming calls were from TTY machines. Assuming that this represents Deaf people using the service, the cost of the relay service directly to Deaf people would be **$10.5 million** for the year.

Deaf people also use texting or SMS to communicate. As this cost is likely to be similar to other market segments e.g. young people communicating via SMS, no additional cost is allocated in this study.

5.4 CARERS

Informal care, in a hearing loss context, can encompass repeating what has just been said for a person, buying a train ticket for them, making telephone calls, taking notes in a meeting at work or in a classroom, or assisting with communication at a medical appointment. Such care is usually provided by a family member or close friend. By example, the reader may recall the scene in *Four Weddings and a Funeral* where the lead actor Charles (Hugh Grant) was required to interpret in sign language for his brother at a job interview.

Informal community care is provided by family and friends of the person with hearing loss at no monetary cost. However, informal care still has an economic cost, as the caregiver cannot spend that time doing other activities, including paid work or other leisure activities.

Presently, there are no data available on the costs of caring for people with hearing loss in Australia from the ABS Survey of Disability and Ageing due to the very small number of responses and consequent very high standard errors. The absence of primary carers for people with hearing loss is interesting, particularly given Wilson's finding that people with hearing loss were more than twice as likely to require help with managing communication difficulties as other Australians (Wilson 1997; OR 2.15 CI (95%) 1.35-3.42). Similarly, it would be very unlikely that large numbers of young children and older people with hearing loss would be accessing the health services reported in Section 4 alone. It is feasible that the nature of caring in hearing loss is not well recognised, and/or that most carers are not primary carers but do provide non-primary care services.

While accepting that people with hearing loss have a need for communicative assistance, the level of need will vary with the extent of impairment. Since some people with mild hearing loss may be unaware of their hearing loss, it would not be realistic to attribute caring needs to these people. However, it would be reasonable to attribute caring needs to people with moderate or worse hearing loss in their better ear. Five hours per week is the imputed rate of care being taken as the lowest levels of imputed care from the study on carers in Australia (Access Economics, 2005b: 14) provided by non-primary carers. Adjusting the imputed rate by the odds ratio ((5 * 2.15) -5) the imputed rate is 5.75 hours. This provides for 126.6 million care hours per year based on 422,765 people for 5.75 hours per week and 52.1 weeks per year.

From a methods perspective, it is noted that this analysis is partial (rather than a general equilibrium approach) and that, as with the approach to production losses, an implicit principle is that the economy is operating at full capacity (and therefore household tasks are a net resource cost). In this context, there are several possible methods for valuing the time foregone by caregivers including:

- **Opportunity cost**: the value of lost wages foregone by the carer;
- **Replacement valuation**: the cost of buying a similar amount of services from the formal care sector; and
- **Self-valuation**: what carers themselves feel they should be paid.

Access Economics has adopted the replacement valuation approach in this report, due to the lack of information about the demographic characteristics of carers of Australians with hearing loss, noting that replacement valuation will generally give higher results than the other two methods, for which data are not available.

The estimate of the replacement value of informal community care is sensitive to changes in the estimate of the wage parameter for alternate formal sector care. In this analysis, the unit cost used has been based on the wage of moderately skilled formal sector carers (supervised employees). In May 2004, full-time carers and aides employed in the formal sector received an average wage of $17.20 per hour, or $650.30 for a 37.8 hour week (ABS 2005c). This average includes payment of overtime for after hours work. However, the hourly rate received by employees does not account for on-costs such as superannuation incurred by employers, the wages of supervisors, managers or administrative support staff or other capital overheads. Loadings are added for each of these additional costs, and for average wage growth between May 2004 (when the survey was last undertaken) and February 2005 (the most recent period for which estimates of average weekly earnings across all employees are available).

TABLE 5-11: REPLACEMENT VALUATION OF INFORMAL CARE, UNIT COST COMPONENTS

	% Loading	Hourly rate
Base rate per hour – May 2004		$17.20
Loading for growth in AWE May 2004 to Feb 2005	4.9%	$0.85
Loading for on-costs	15.6%	$2.82
Loading for capital	3.6%	$0.75
Loading for supervision and administration	16.3%	$3.40
Total hourly rate inc. overheads		**$25.01**

The 15.6% loading of on-costs comprises superannuation, workers compensation, payroll and Fringe Benefits Taxation allowances (ABS 2004a). Loadings for capital (3.6%) and administrative (16.3%) overheads are based on the relative shares of capital expenditure and administration costs to other areas of recurrent spending in Australia's formal health sector (AIHW 2004a, 2005). When all these loadings are added, the hourly cost of employing a carer in the formal sector to replace an informal carer is $25.01 in 2005 (Table 5-11).

Based on this rate, **the total value of family and other informal carer provided to Australians with hearing loss is $3.17 billion in 2005**. It is acknowledged that this may well be an under-estimation of the true cost of caring for a child or spouse with significant hearing loss.

5.5 TRANSFER COSTS

5.5.1 WELFARE AND INCOME SUPPORT

Two data sources were available to ascertain the number of people with hearing loss of working age on employment support benefits, the Disability Services Census (2003) and direct data sources available through Centrelink. According to the Disability Census, in 2003, 2,414 people with hearing loss used an open employment service in Australia (Table 5-12). This survey focused on users of Commonwealth funded disability service programs delivered by the States; 84% of these services were employment services.

TABLE 5-12: EMPLOYMENT SUPPORT SERVICES USED BY PEOPLE WITH HEARING LOSS

	Number using service	Hearing loss as % of clients supported
Open employment service	2,131	4.7
Supported employment	197	1
Dual open/supported employment	86	2.3
Total	**2,414**	

Source: Commonwealth Department of Family and Community Services (2003):7-8.

For people who reported having a hearing loss and who were receiving a Centrelink work related benefit, the Disability Support Pension was the main source of income (74%) (Table 5-13).

TABLE 5-13: INCOME SUPPORT RECEIVED BY PEOPLE IN EMPLOYMENT SUPPORT PROGRAMS WITH HEARING LOSS

	Number	Number on a benefit	% on benefit
Disability support pension	969	969	74%
Newstart youth allowance	236	236	18%
Other pension benefit	103	103	8%
Compensation	3		
Paid work	794		
Other income	48		
Nil income	69		
Not known	192		
Total	**2,414**	**1,308**	**100**

Source: Commonwealth Department of Family and Community Services (2003:77-82).

From Section 5.1.1, an estimated 158,876 people are not working due to hearing loss in 2005. Table 5-13 suggests that, of those who were not in paid work (1,620 of the 2,414), 1308 (81%) received welfare payments (DSP, Newstart and 'other pension/benefit) and 312 did not. Thus, 81% of 158,876 suggests an estimated 128,278 people who received welfare payments due to hearing loss in 2005. Average benefits are calculated using a weighted average of those in Table 5-14 below ($397.49 per fortnight), which reflect the main welfare payments to people with hearing loss.

TABLE 5-14: CENTRELINK BENEFITS AND THEIR VALUE, 2005

	Mean value of benefit
Disability support pension (pension)	391.21
Youth allowance	317.84
Newstart	412.63
Mature Age (NSS) allowance	412.68
Total	**$397.49**

For these various benefits, a range of payments are available by age and circumstance. The mean value from Centrelink published rates was taken as the value reported here.

Using this unit cost, the **value of welfare payments due to hearing loss are estimated as $1,328.3 million**.

5.5.2 SUMMARY OF DEADWEIGHT LOSSES

The welfare payments calculated immediately above are, like taxation revenue losses, not themselves economic costs, but rather a financial transfer from taxpayers to the income support recipients. The real resource cost of these transfer payments is only the deadweight loss caused by the taxation needed to finance the welfare payments. As previously, the deadweight loss is assumed to be 28.75 cents for each dollar of taxation required. In this case, a deadweight loss of $381.9 million per annum will be incurred to finance additional income support payments to people with hearing loss.

Finally, the revenue required to finance the Commonwealth share (46.7%) of the total health expenditure including hearing aids and cochlear implants ($674 million) will also incur a DWL, totalling $90.5 million.

Adding the health, welfare and taxation DWLs, **the total of deadweight losses for people with hearing loss sum to $1.048 billion**.

5.6 SUMMARY OF FINANCIAL COSTS

The total real financial costs of hearing loss are thus estimated as $11.75 billion in 2005, summarised in Table 5-15 and Figure 5-3.

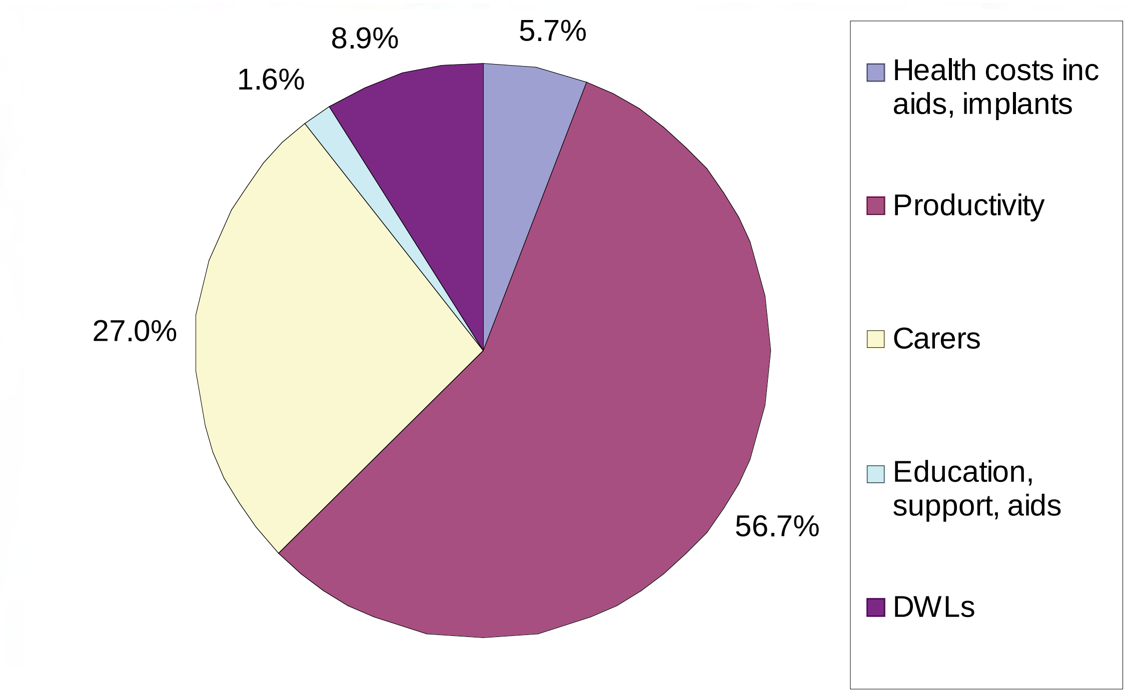
- Lost earnings to individuals with hearing loss is the greatest cost, accounting for well over half (56.7%) of all financial costs ($6.7 billion).
- The cost of carers is second at 27.0% of the total ($3.2 billion).
- The deadweight costs from losing taxation revenue and having to find alternative sources of taxation to fund increased welfare and health services, cost $1.0 billion in 2005 (8.9% of total costs).
- Direct health costs, including hearing aids and cochlear implants) account for only 5.7% of costs ($674 million).

- Education and support services and various non-health communication aids comprise the remaining 1.6% ($191 million).
- **Annual costs per person with hearing loss are $3,314, $578 for every Australian and 1.4% of GDP in total**.

TABLE 5-15: HEARING LOSS, FINANCIAL COST SUMMARY, 2005, $M

Cost element	Real cost	Transfer payment
Total health costs plus hearing aids & implants	**$674**	$315
Indirect financial costs		
Lost earnings (people with hearing loss)	$6,667	
Tax foregone (people with hearing loss)		$1,333
Value of carers	$3,168	
Welfare payments		$1,328
Education, support and aids	$191	
Deadweight losses	$1,048	
Total indirect financial	**$11,073**	
Subtotal, financial costs	**$11,748**	**$2,662**
Per person with hearing loss	$3,314	
Per capita (population)	$578	
% of GDP	**1.39%**	

FIGURE 5-3: HEARING LOSS, FINANCIAL COST SUMMARY, 2005 (% TOTAL)



Source: Table 5-15

6. BURDEN OF DISEASE

To those experiencing hearing loss, less tangible costs such as loss of quality of life, loss of leisure, physical pain and disability are often as or more important than the health system costs or other financial losses. This chapter measures the burden of suffering and premature death from hearing loss.

6.1 VALUING LIFE AND HEALTH

Since Schelling's (1968) discussion of the economics of life saving, the economic literature has properly focused on **willingness to pay** (willingness to accept) measures of mortality and morbidity risk. Using evidence of market trade-offs between risk and money, including numerous labour market and other studies (such as installing smoke detectors, wearing seatbelts or bike helmets etc), economists have developed estimates of the **value of a 'statistical' life (VSL).**

> The willingness to pay approach estimates the value of life in terms of the amounts that individuals are prepared to pay to reduce risks to their lives. It uses stated or revealed preferences to ascertain the value people place on reducing risk to life and reflects the value of intangible elements such as quality of life, health and leisure. While it overcomes the theoretical difficulties of the human capital approach, it involves more empirical difficulties in measurement (BTE, 2000, pp20-21).

Viscusi and Aldy (2002) summarise the extensive literature in this field, most of which has used econometric analysis to value mortality risk and the 'hedonic wage' by estimating compensating differentials for on-the-job risk exposure in labour markets, in other words, determining what dollar amount would be accepted by an individual to induce him/her to increase the possibility of death or morbidity by x%. They find the VSL ranges between US$4 million and US$9 million with a median of US$7 million (in year 2000 US dollars), similar but marginally higher than the VSL derived from US product and housing markets, and also marginally higher than non-US studies, although all in the same order of magnitude. They also review a parallel literature on the implicit value of the risk of non-fatal injuries.

> A particular life may be regarded as priceless, yet relatively low implicit values may be assigned to life because of the distinction between identified and anonymous (or 'statistical') lives. When a 'value of life' estimate is derived, it is not any particular person's life that is valued, but that of an unknown or statistical individual (Bureau of Transport and Regional Economics, 2002, p19).

Weaknesses in this approach, as with human capital, are that there can be substantial variation between individuals. Extraneous influences in labour markets such as imperfect information, income/wealth or power asymmetries can cause difficulty in correctly perceiving the risk or in negotiating an acceptably higher wage.

Viscusi and Aldy (2002) include some Australian studies in their meta-analysis, notably Kniesner and Leeth (1991) of the Australian Bureau of Statistics (ABS) with VSL of US2000 $4.2 million and Miller et al (1997) of the National Occupational Health and

Safety Commission (NOHSC) with quite a high VSL of US2000$11.3m-19.1 million (Viscusi and Aldy, 2002, Table 4, pp92-93). Since there are relatively few Australian studies, there is also the issue of converting foreign (US) data to Australian dollars using either exchange rates or purchasing power parity and choosing a period.

Access Economics (2003b) presents outcomes of studies from Yale University (Nordhaus, 1999) – where VSL is estimated as $US2.66m; University of Chicago (Murphy and Topel, 1999) – US$5m; Cutler and Richardson (1998) – who model a common range from US$3m to US$7m, noting a literature range of $US0.6m to $US13.5m per fatality prevented (1998 US dollars). These eminent researchers apply discount rates of 0% and 3% (favouring 3%) to the common range to derive an equivalent of $US 75,000 to $US 150,000 for a year of life gained.

6.1.1 DALYs and QALYs

In an attempt to overcome some of the issues in relation to placing a dollar value on a human life, in the last decade an alternative approach to valuing human life has been derived. The approach is non-financial, where pain, suffering and premature mortality are measured in terms of Disability Adjusted Life Years (DALYs), with 0 representing a year of perfect health and 1 representing death (the converse of a QALY or "quality-adjusted life year" where 1 represents perfect health). This approach was developed by the World Health Organization, the World Bank and Harvard University and provides a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990, projected to 2020 (Murray and Lopez, 1996). Methods and data sources are detailed further in Murray et al (2001).

The DALY approach has been adopted and applied in Australia by the Australian Institute for Health and Welfare (AIHW) with a separate comprehensive application in Victoria. Mathers et al (1999) from the AIHW estimate the burden of disease and injury in 1996, including separate identification of premature mortality (YLL) and morbidity (YLD) components. In any year, the disability weight of a disease (for example, 0.18 for a broken wrist) reflects a relative health state. In this example, 0.18 would represent losing 18% of a year of healthy life because of the inflicted injury.

The DALY approach has been successful in avoiding the subjectivity of individual valuation and is capable of overcoming the problem of comparability between individuals and between nations, although nations have subsequently adopted variations in weighting systems. For example, in some countries DALYs are age-weighted for older people although in Australia the minority approach is adopted – valuing a DALY equally for people of all ages.

The main problem with the DALY approach is that it is not financial and is thus not directly comparable with most other cost measures. In public policy making, therefore, there is always the temptation to re-apply a financial measure conversion to ascertain the cost of an injury or fatality or the value of a preventive health intervention. Such financial conversions tend to utilise "willingness to pay" or risk-based labour market studies described above.

The Department of Health and Ageing (based on work by Applied Economics) adopted a very conservative approach to this issue, placing the value of a human life year at around A$60,000 per annum, which is lower than most international lower bounds on the estimate.

"In order to convert DALYs into economic benefits, a dollar value per DALY is required. In this study, we follow the standard approach in the economics literature and derive the value of a healthy year from the value of life. For example, if the estimated value of life is A$2 million, the average loss of healthy life is 40 years, and the discount rate is 5 per cent per annum, the value of a healthy year would be $118,000.[18] Tolley, Kenkel and Fabian (1994) review the literature on valuing life and life years and conclude that a range of US$70,000 to US$175,000 per life year is reasonable. In a major study of the value of health of the US population, Cutler and Richardson (1997) adopt an average value of US$100,000 in 1990 dollars for a healthy year.

Although there is an extensive international literature on the value of life (Viscusi, 1993), there is little Australian research on this subject. As the Bureau of Transport Economics (BTE) (in BTE, 2000) notes, international research using willingness to pay values usually places the value of life at somewhere between A$1.8 and A$4.3 million. On the other hand, values of life that reflect the present value of output lost (the human capital approach) are usually under $1 million.

The BTE (2000) adopts estimates of $1 million to $1.4 million per fatality, reflecting a 7 per cent and 4 per cent discount rate respectively. The higher figure of $1.4 million is made up of loss of workforce productivity of $540,000, loss of household productivity of $500,000 and loss of quality of life of $319,000. This is an unusual approach that combines human capital and willingness to pay concepts and adds household output to workforce output.

For this study, a value of $1 million and an equivalent value of $60,000 for a healthy year are assumed.[19] In other words, the cost of a DALY is $60,000. This represents a conservative valuation of the estimated willingness to pay values for human life that are used most often in similar studies.[20]" (DHA, 2003, pp11-12)."

As the citation concludes, the estimate of $60,000 per DALY is very low. The Viscusi (1993) meta-analysis referred to reviewed 24 studies with values of a human life ranging between $US 0.5 million and $US 16m, all in pre-1993 US dollars. Even the lowest of these converted to 2003 Australian dollars at current exchange rates, exceeds the estimate adopted ($1m) by nearly 25%. The BTE study tends to disregard the literature at the higher end and also adopts a range (A$1-$1.4m) below the lower bound of the international range that it identifies (A$1.8-$4.3m).

[18] *In round numbers, $2,000,000 = $118,000/1.05 + $118,000/(1.05)^2 + … + $118,000/(1.05).^{40}* [Access Economics comment: The actual value should be $116,556, not $118,000 even in round numbers.]

[19] The equivalent value of $60,000 assumes, in broad terms, 40 years of lost life and a discount rate of 5 per cent. [Access Economics comment: More accurately the figure should be $58,278.]

[20] In addition to the cited references in the text, see for example Murphy and Topel's study (1999) on the economic value of medical research. [Access Economics comment. Identical reference to our Murphy and Topel (1999).]

The rationale for adopting these very low estimates is not provided explicitly. Certainly it is in the interests of fiscal restraint to present as low an estimate as possible.

In contrast, the majority of the literature as detailed above appears to support a higher estimate for VSL, as presented in Table 6-1, which Access Economics believes is important to consider in disease costing applications and decisions. The US dollar values of the lower bound, midrange and upper bound are shown at left. The 'average' estimate is the average of the range excluding the high NOHSC outlier. Equal weightings are used for each study as the:

- Viscusi and Aldy meta-analysis summarises 60 recent studies;
- ABS study is Australian; and
- Yale and Harvard studies are based on the conclusions of eminent researchers in the field after conducting literature analysis.

Where there is no low or high US dollar estimate for a study, the midrange estimate is used to calculate the average. The midrange estimates are converted to Australian dollars at purchasing power parity (as this is less volatile than exchange rates) of USD=0.7281AUD for 2003 as estimated by the OECD.

Access Economics concludes the VSL range in Australia lies between $3.7m and $9.6m[21], with a mid-range estimate of $6.5m. These estimates have conservatively not been inflated to 2004 prices, given the uncertainty levels.

TABLE 6-1: INTERNATIONAL ESTIMATES OF VSL, VARIOUS YEARS

		US$m		A$m
	Lower	**Midrange**	**Upper**	**0.7281**
Viscusi and Aldy meta-analysis 2002	4	7	9	**9.6**
Australian: ABS 1991		4.2		5.8
NOHSC 1997	11.3		19.1	
Yale (Nordhaus) 1999		2.66		**3.7**
Harvard (Cutler and Richardson) 1998	0.6	5	13.7	6.9
Average*	2.9	**4.7**	7.4	**6.5**

* Average of range excluding high NOHSC outlier, using midrange if no data; conservatively not inflated. A$m conversions are at the OECD 2003 PPP rate.

6.1.2 DISCOUNT RATES

Choosing an appropriate discount rate for present valuations in cost analysis is a subject of some debate, and can vary depending on which future income or cost stream is being considered. There is a substantial body of literature, which often provides conflicting advice, on the appropriate mechanism by which costs should be discounted over time, properly taking into account risks, inflation, positive time preference and expected productivity gains.

[21] Calculated from the non-indexed studies themselves. Converting the Access Economics average estimates from USD to AUD at PPP would provide slightly higher estimates - $3.9 million and $10.2m, with the same midrange estimate.

The absolute minimum option that one can adopt in discounting future income and costs is to set future values in current day dollar terms on the basis of a risk free assessment about the future (that is, assume the future flows are similar to the certain flows attaching to a long term Government bond).

Wages should be assumed to grow in dollar terms according to best estimates for inflation and productivity growth. In selecting discount rates for this project, we have thus settled upon the following as the preferred approach.

- **Positive time preference**: We use the long term nominal bond rate of 5.8% pa (from recent history) as the parameter for this aspect of the discount rate. (If there were no positive time preference, people would be indifferent between having something now or a long way off in the future, so this applies to all flows of goods and services.)
- **Inflation:** The Reserve Bank has a clear mandate to pursue a monetary policy that delivers 2 to 3% inflation over the course of the economic cycle. This is a realistic longer run goal and we therefore endorse the assumption of 2.5% pa for this variable. (It is important to allow for inflation in order to derive a real (rather than nominal) rate.)
- **Productivity growth**: The Commonwealth Government's Intergenerational report assumed productivity growth of 1.7% in the decade to 2010 and 1.75% thereafter. We suggest 1.75% for the purposes of this analysis.

There are then two different discount rates that should be applied:

- to discount income streams of future earnings, the discount rate is:

  5.8 - 2.5 - 1.75 = 1.55%.
- to discount other future streams (healthy life, health services, legal costs, accommodation services and so on) the discount rate is:

  5.8 – 2.5 = 3.3%

While there may be sensible debate about whether health services (or other costs with a high labour component in their costs) should also deduct productivity growth from their discount rate, we argue that these costs grow in real terms over time significantly as a result of other factors such as new technologies and improved quality, and we could reasonably expect this to continue in the future.

Discounting the VSL of $3.7m from Table 6-1 by the discount rate of 3.3% over an average 40 years expected life span (the average from the meta-analysis of wage-risk studies) provides an estimate of the value of a life year of $162,561.

6.2 ESTIMATING THE BURDEN OF DISEASE FROM HEARING LOSS

Burden of disease estimates are conservatively based on hearing loss in the better ear, as noted in Section 2.5.

The disability weights used in this study are based originally on those calculated by the AIHW (Mathers et al, 1999), which are adjusted for co-morbidities in older people (and hence there is a range of weights depending on age). These weights (not adjusted for hearing aids) are:

- 0.018 to .020 for mild hearing loss;
- 0.104 to 0.120 for moderate hearing loss; and
- 0.324 to 0.370 for severe hearing loss.

However, the burden of disease calculation differs from that of the AIHW in the manner in which it takes account of the use of hearing aids or similar devices to correct hearing loss. The AIHW based its adjustment to prevalence on hearing aid usage reported in Wilson et al (1999) that critically did not report that the hearing aid usage rates of 38% were only for those who already had a hearing aid, which was 15.6% as per the South Australia Health Omnibus Study (1994). This latter figure is consistent with an Australian self report population study of device use (Hogan et al, 2001). Self reports of device use are less controversial than perceptions of impairment as the former have to be dispensed by a practitioner. For this study, re-examination of the data, communications with the South Australian Health Commission and consultation with the AIHW have together resulted in a re-estimation of the burden of disease. In keeping with AIHW, in the DALY calculation, where people used a hearing aid, they were moved down one category of severity in analysis.

In addition, the AIHW argue that prevalence rates in young adults, as per Wilson et al (1990) are overstated. The plausibility of this argument can be seen in moving from the Australian Hearing data with prevalence rates of less than 1% at age 14 to the Wilson rate of 5.7% at 15-50 years. Comparing the Wilson data to Davis' (1989) UK data shows two things.

- There is little difference in the prevalence of impairment in the worse ear – 5.7% and 5.6% respectively at 25 dB.
- However, the rates are different for the better ear with Davis reporting, for example, 1.8% at 25 dB for people aged 17-30 years whereas Wilson reports only a grouped report for the cohort 15-50 years.
- In calculating DALYs, AIHW used data from the 1993 Survey of Disability, Ageing and Carers to adjust the prevalence rates. Reservations regarding SDAC in relation to reporting prevalence of hearing loss were noted in Section 3.1.
- Instead, this costing has *conservatively omitted* all those aged between 15-34 years from the prevalence estimates in the calculations.
- A final downward adjustment is made to the prevalence estimate for the burden of disease calculation as the Deaf Community do not report hearing loss as

'burdensome' in terms of quality of life impact, so the DALY calculation is made with 10,000 people excluded from the severe category.

There is no estimate for YLL for hearing loss, based on the assumption that no-one dies prematurely from hearing loss.

6.2.1 YEARS OF LIFE LOST DUE TO DISABILITY

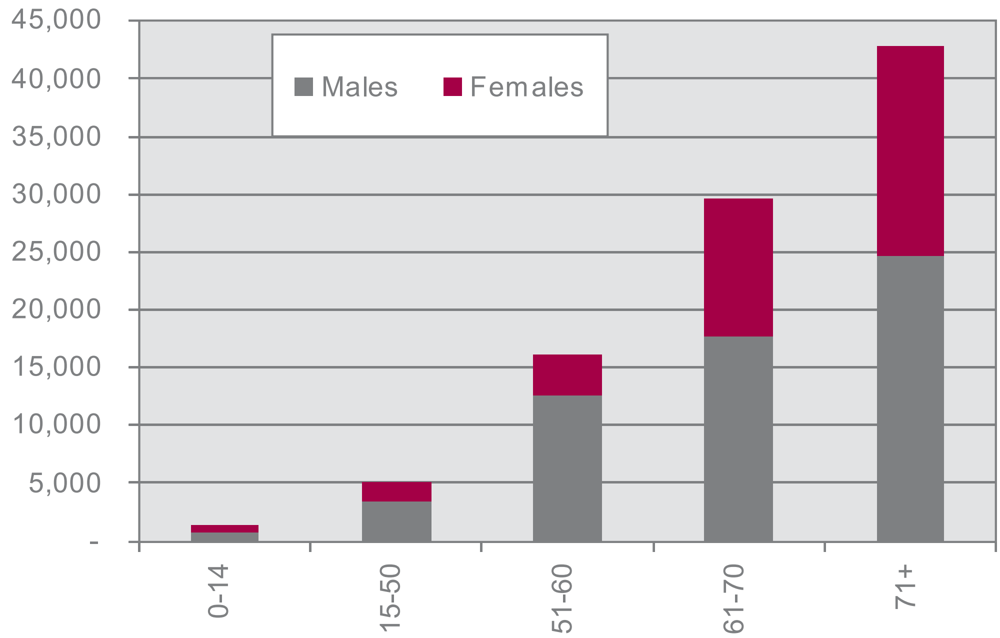
Based on the methods outlined above, the total number of people experiencing disability from hearing loss (adjusted for hearing aid use) is estimated by severity as shown in Table 6-2, together with the total estimated YLD and its gross value (calculated by multiplying YLD by $162,561).

TABLE 6-2: HEARING LOSS, ESTIMATED YLD BY SEVERITY AND GROSS VALUE

	Number of people	YLD	$bn
Mild	2,073,543	36,585	5.9
Moderate	309,542	33,281	5.4
Severe	75,600	25,139	4.1
Total	**2,458,685**	**95,005**	**15.4**

Figure 6-1 illustrates YLD due to hearing loss, which total 95,005 DALYs. Notably the greatest impact commences during the late working age years of 51-60 years, with men in these age groups proportionately having 3.5 times the YLD of women.

FIGURE 6-1: YEARS LIFE LOST DUE TO DISABILITY (DALYS)



Source: Based on Mathers et al (1999) disability weights, modified, and AE prevalence estimates.

These results reflect the epidemiology underpinning the model and particularly the cumulative impact of excessive noise exposure on men. **The estimated gross cost of these DALYS is $15.4 billion**.

6.2.2 NET VALUE OF HEALTHY LIFE LOST

Bearing in mind that the wage-risk studies underlying the calculation of the VSL take into account all known personal impacts – suffering and premature death, lost wages/income, out-of-pocket personal health costs and so on – the estimate of $16.4 billion should be treated as a 'gross' figure. However, costs specific to hearing loss that are unlikely to have entered into the thinking of people in the source wage/risk studies should *not* be netted out (eg, publicly financed health spending, care provided voluntarily). The results after netting out are presented in Table 6-3.

TABLE 6-3: NET COST OF DISABILITY AND PREMATURE DEATH, HEARING LOSS, $M, 2005

	Individual
Gross cost of suffering	**15,444**
Minus production losses net of tax	5,333
Plus welfare receipts	1,328
Minus health costs borne out-of-pocket	145
Net cost of suffering	**11,290**

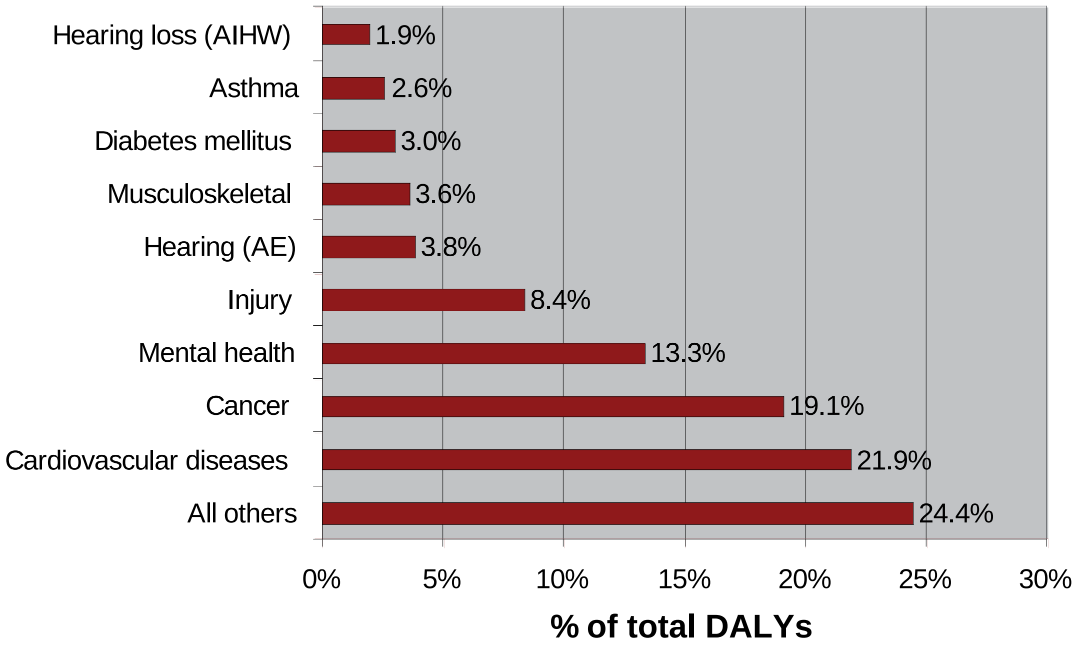
The net cost of suffering is thus $11.3 billion in 2005.

6.2.3 COMPARISONS WITH OTHER CONDITIONS

Figure 6-2 compares DALYs lost due to hearing loss relative to other national health priorities and disease groups. Within the original assessment of burden of disease by Mathers et al (1999) adult acquired hearing loss (which is the majority of hearing loss) accounted for about 2% of all DALYs. This proportion of DALYs is similar to that reported in the Global Burden of Disease Study, that the Australian project closely followed.[22] However, as was demonstrated in the preamble to Section 6.2, there was a significant assumption in that modelling, which appears not to be supported by the data. In Figure 6-2 it can be seen that, with the corrected disability weights, the burden of disease from hearing impairment is 3.8%, which is greater than that of three of the National Health Priority Areas – asthma, diabetes and musculoskeletal conditions.

[22] http://www.who.int/healthinfo/bodestimates/en/index.html

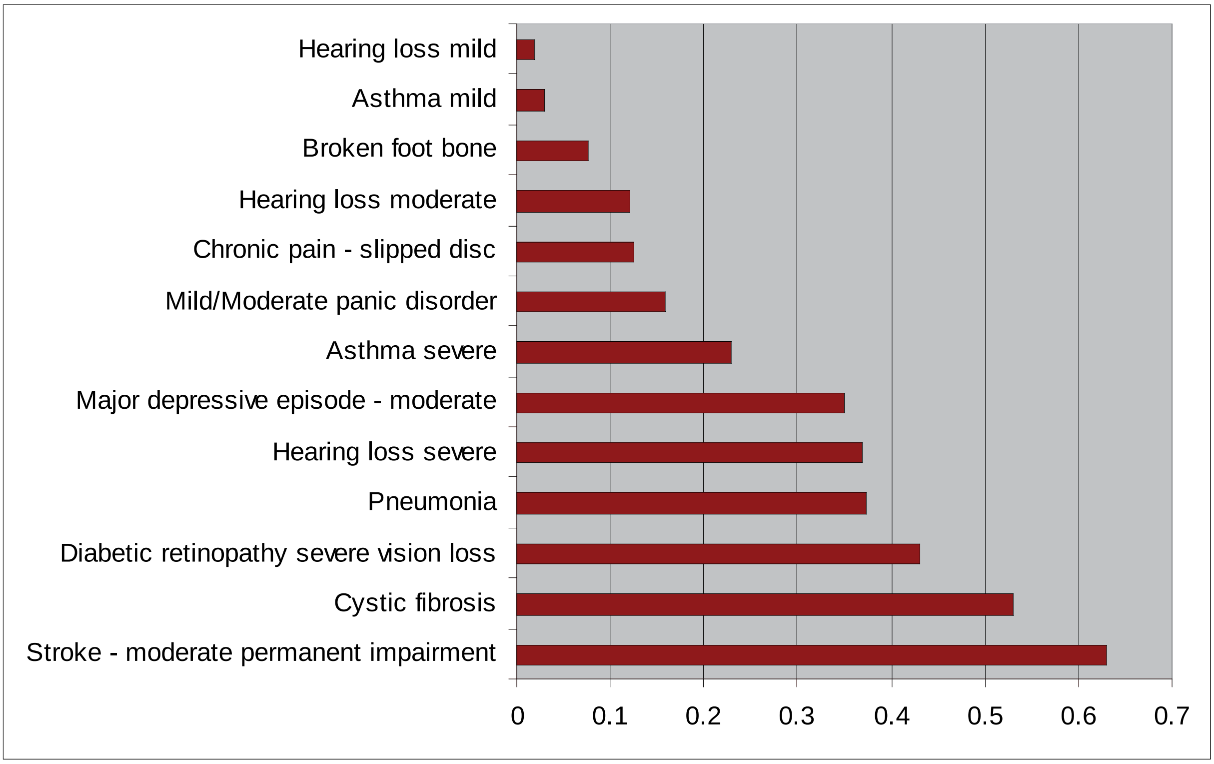
FIGURE 6-2: COMPARISON OF DALYS WITH NATIONAL HEALTH PRIORITIES



Source: Mathers et al (1999:236), Table H and Access Economics estimates.

Another informative comparison of the burden of disability associated with hearing loss can be gleaned from a comparison of disability weights, which reflects the severity given to differing conditions. This comparison is depicted in Figure 6-3, directly drawing from the AIHW data (without adjustments).

FIGURE 6-3: DISABILITY WEIGHTS, HEARING LOSS AND SELECTED COMPARATORS



Source: Mathers et al (1999) Table B.

In Figure 6-3 hearing loss can be evaluated by degrees of severity against other conditions. Mild hearing loss is comparable, for example with mild asthma – a national priority condition. Moderate hearing loss is comparable, for example, with chronic pain arising from a slipped disc as well as a moderate depressive episode – again a condition addressed as a national health priority. Finally severe hearing loss is comparable with pneumonia as well as more advanced diabetes, one resulting in complications. Again, diabetes is a national health priority area. Across the spectrum of hearing impairment then, the impact of this disability, be it mild, moderate or severe, is directly comparable with conditions rated as national health priorities.

7. FURTHER RESEARCH

This study has identified a number of gaps in research pertaining to early intervention and management of hearing loss. Further research into these areas may serve to reduce the impact of hearing loss on the community. Research is needed in the following areas:

- epidemiology of hearing loss
- prevention of hearing loss
- enhancing access to, and continued use of, hearing aids
- health effects of hearing loss
- caring
- productivity of people with hearing loss
- biomolecular and genetic approaches to hearing loss; and
- aboriginal hearing loss.

7.1 EPIDEMIOLOGY OF HEARING LOSS

The epidemiology of hearing loss conducted by the Centre for Population Studies in Epidemiology, within the South Australian Department of Human Services (see Wilson et al. 1992 and 1998) has been the only epidemiological study of hearing loss in Australia. This project built on the foundational work of Davis (1989) in the United Kingdom. In order to monitor progress in the management and prevention of hearing loss there is a need to maintain an accurate and current epidemiology.

7.2 PREVENTION OF HEARING LOSS

7.2.1 NOISE EXPOSURES

Exposure to excess occupational or recreational noise is a known cause of hearing loss. The mechanism of exposure and injury has been established as a dose-response relationship. Strategies for reducing noise emissions and noise exposures have also been developed and laws are in place that limits noise exposures in the workplace and in the environment. Nonetheless, noise continues to account for 37% of all hearing loss. Research is required to identify barriers to the adoption of noise controls in the design of equipment. Where such controls cannot be achieved, research is required to identify barriers to the adoption of personal protective equipment such as ear muffs. Broadly based community awareness programs are also required.

Long term population studies are required to establish the effect of recreational noise exposures resulting from personal stereo systems.

The full effects of acoustic shriek on hearing remain unclear and continued research is required in this area.

7.2.2 OTHER CAUSES OF HEARING LOSS

Two thirds of hearing loss is not caused by common exposures to noise. This factor is particularly evident in the rapid increase of hearing loss among middle to older age women, whose rate of hearing loss eventually catches that of men by older age. This result is commonly attributed to the ageing process. Effective research into hair cell regrowth may serve as a remedy to the ageing process.

Ototoxic substances have also been identified as a cause of hearing loss. These are substances taken for example in medicines or inhaled through fumes, which damage the hair cells. Most obviously drugs such as aminoglycoside antibiotics and platinum-based chemotherapeutic agents result in hearing loss (Ryback and Whitworth, 2005). However, exposures to chemicals may directly impact on hearing loss and possibly exacerbate the damaging effects of noise when the two exposures occur either together or in sequence. Toluene is a case in point (Johnson, 1993). More common still, simple and commonly used medications such as aspirin also appear to damage the hearing mechanism (McFadden and Champlin, 1990). It is feasible that ototoxicity is the under-recognised major and preventable cause of hearing loss. Effective research into the biomolecular processes of presbyacusic hearing loss, coupled with studies of hair cell regrowth, may identify avenues for delaying or mitigating hearing loss associated with the ageing process.

7.3 ACCESSING AND USING HEARING AIDS

In Section 6.2, the extent of hearing aid use in the community was discussed, based on Australian epidemiological data. There it was noted that the number of people owning a hearing aid was low (15%) and that of those who owned an aid, only some 38% regularly used their aids. Data available on the website of the Commonwealth Department of Health for the Office of Hearing Services suggests that rates of hearing aid use in Australia have risen to over 20% among older people since the last studies were published. Nonetheless, this remains a low take-up rate. The research reported in this paper also reported that people delayed seeking assistance for hearing loss, on average for six years. Barriers exist to:

- accepting hearing loss
- seeking help
- getting a hearing aid
- continuing to use a hearing aid

Research is required for the development of strategies that can enable people to access services earlier. Research is also required to address cosmetic and technical problems that inhibit people from using hearing aids. In particular, research needs to address making hearing aids more effective in background noise, as this is the most common technical limitation reported by users.

7.4 HEALTH EFFECTS OF HEARING LOSS

In Section 2.5.1 health effects associated with hearing loss were noted. Recalling this material it was observed that "(T)here is a need for well-controlled research studies that enable us to better identify and quantify all the effects of hearing loss on general wellbeing" (Dillon, 2001:368-369). Specifically, research is required that can examine possible connections between hearing loss and its health and personal consequences (where they exist) and in turn, to link this information back into the prevention cycle.

There are a variety of possible causal mechanisms that were identified from the literature such as stigma and poor health outcomes (ie, the stress effects of hearing loss), lower socio-economic factors, pessimism, severity of perceived disability, social isolation, and negative emotion just to name a few. A significant barrier to progress in this area has been the absence of prospective studies that can examine causal relationships.

Specific research questions pertaining to longer term health outcomes and hearing loss were also identified:

- Does a cascade of benefits result from effective hearing interventions, so people not receiving assistance fare worse?
- Do differences in attitudes and behaviours associated with health service utilisation including willingness to seek treatment for medical conditions result in differing health outcomes? and
- Do health professionals or patients trade off the need to treat hearing loss in the context of managing seemingly more serious conditions? If so, what are the consequences of such trade offs for people with hearing loss.

In addition, research is required to examine the extent to which current interventions such as hearing aids remediate any health and social effects arising from hearing loss.

7.5 BIOMOLECULAR AND GENETIC APPROACHES TO HEARING LOSS

Given recent advances in the identification of specific genes and their biomolecular activities, the possibility now arises both to create diagnostics to identify those individuals with particular susceptibility to presbyacusic hearing loss, and potentially to create pharmacological approaches to reverse or mitigate the biomolecular processes that result in hearing loss. In addition, advances in this field may in the future identify pharmacological approaches to preventing or mitigating the damage to hearing sensory cells resulting from noise.

7.6 CARING

Current public data sources do not document the nature or extent of informal caring provided by parents, partners and friends of people with hearing loss. Consideration should be given to questions that capture the nature and extent of such caring in surveys such as the Survey of Disability, Ageing and Carers (ABS).

7.7 PRODUCTIVITY OF PEOPLE WITH HEARING LOSS

Australia has a well developed public hearing services infra-structure for children and retired people. However, no such infra-structure exists for people of working age. Interestingly, this group is associated with the largest socio-economic impact of hearing loss - lost productivity. Notably the productivity impact in terms of unemployment is on adults aged over 45 years – younger people with hearing loss had employment rates comparative to the rest of the community. Under-employment appeared to be more of an issue to younger people with hearing loss. By contrast, people with hearing loss are largely silent in official welfare and employment statistics. The numbers of people identified in official statistics with hearing loss were disproportionately low given the epidemiological data that also captured unemployment rates. Preliminary research in this area suggests that people with hearing loss are on the margins of the workplace and struggle to maintain their employment. Key problems include equally participating in meetings, coping with background noise and discrimination, keeping up to date with informal conversations, negotiating reasonable communication accommodations and being able to participate in spontaneous but critical workplace conversations (Hogan, Stewart and Giles, 2002). Research is required that more systematically articulates the impact of hearing loss on employment opportunities, particularly in the middle working years and in turn identifies strategies that address this impact.

7.8 HEARING LOSS IN THE ABORIGINAL POPULATION

An epidemiology of hearing loss and associated risk factors in Australian Aboriginal communities is required. Included within this study is a need to identify the nature and extend of intermittent as well as permanent conductive hearing loss and its effects on learning. This is particularly required given that many Aboriginal children experience chronic suppurative otitis media.

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ABOUT THE STUDY SPONSORS

Cooperative Research Centre for Cochlear Implant and Hearing Aid Innovation

In Australia alone, over 3 million adults and children suffer from hearing disabilities. With rising noise levels in everyday life, and the ageing of the population, the number of people with hearing loss will continue to rise.

To address these problems, The Cooperative Research Centre for Cochlear Implant and Hearing Aid Innovation (CRC HEAR) was first established in 1992, and renewed in 1999, with the aims to improve communication for hearing-impaired adults and children.

To achieve this goal, CRC HEAR works with industry partners to conduct specialist research leading to innovative new hearing technology products including multichannel cochlear implants with increased capabilities, totally implantable neuroelectric and acoustic hearing prostheses, as well as intelligent hearing aids for those with mild and moderate hearing losses. Research is also concentrated on developing innovative clinical procedures and products to enhance benefits for users of hearing devices and reduce health care service delivery costs. Developments may also have application in telecommunications or aligned fields.

The CRC provides a unique interdisciplinary team and the collaboration of its Core Parties – Australian Hearing, Cochlear Limited, the University of Melbourne, Siemens Hearing Instruments Australia and the Bionic Ear Institute – together with the involvement of other commercial, university, hospital and hearing healthcare agency partners will help ensure that speech processing and technology outcomes are commercially relevant and feasible.

The research objectives of the CRC are:

- to conduct research leading to innovations enabling new hearing technology products;
- to conduct research leading to innovative clinical procedures that enhance benefits to users of hearing devices;
- to provide innovative postgraduate training with enhanced employment prospects, and to develop new approaches expanding professional training in the field; and
- to provide innovative technology transfer activities to ensure that Centre research and education outcomes result in improved communication benefits for hearing impaired adults and children.

Victorian Deaf Society

The Victorian Deaf Society (Vicdeaf), founded in 1884, provides a range of services to the estimated 1 million Victorians who are deaf or hard of hearing. Vicdeaf is a membership charity employing around 175 staff. During the last financial year, Vicdeaf spent $10 million in its endeavours to substantially improve quality of life for deaf and hard of hearing people.

Key activities comprise providing information and raising awareness, delivering training courses and consultancy on deafness and disability, and campaigning and advocacy work. Vicdeaf is the largest single Auslan communication support agency in Victoria and its services include sign language interpreters, lip speakers and note takers. It has:

- a comprehensive employment program to help deaf and vision impaired people into work;
- an extensive audiology and rehabilitation service;
- a comprehensive case management and support service; and
- a range of services for deaf and hard of hearing people with additional needs.