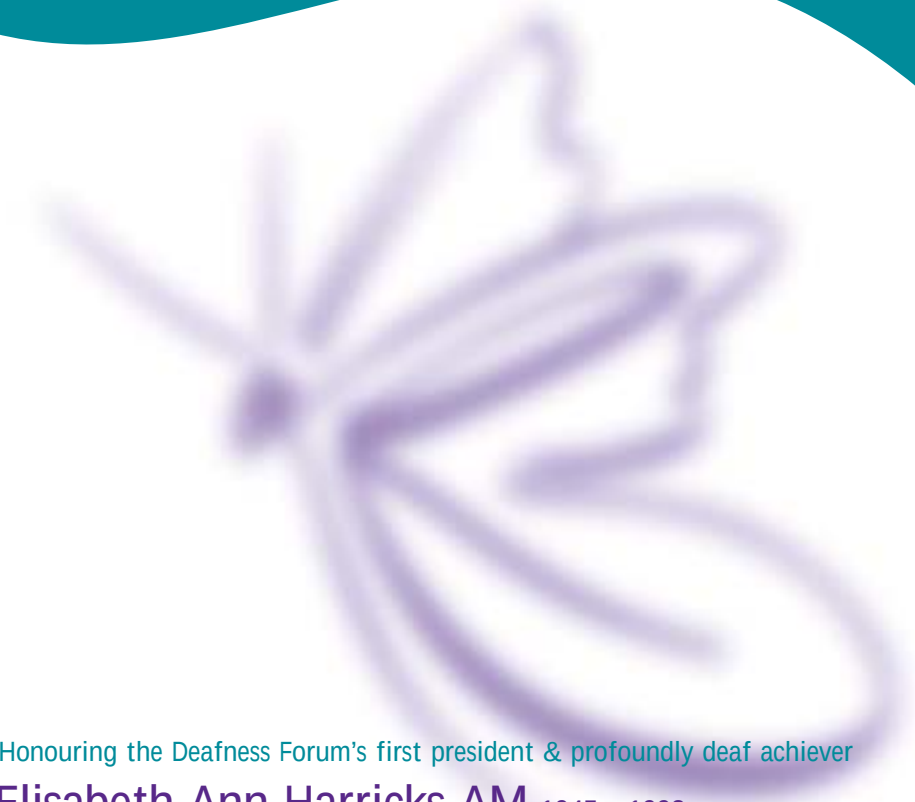
The 2002

Libby Harricks

Memorial Oration



Honouring the Deafness Forum's first president & profoundly deaf achiever

Elisabeth Ann Harricks AM 1945 – 1998

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About the Deafness Forum

Introduction

Deafness Forum is the peak body for deafness in Australia. Established in early 1993 at the instigation of the Federal government, the Deafness Forum now represents all interests and viewpoints of the Deaf and hearing impaired communities of Australia (including those people who have a chronic disorder of the ear and those who are DeafBlind).

Structure

The representational base of the Deafness Forum is divided into five Sections:

a) Hearing Impaired Section – persons with a hearing loss who communicate predominantly orally,

b) Deaf Section – i.e. the Deaf Community – those persons who consider themselves to be members of that community by virtue of its language (sign language known as Auslan) and culture,

c) Ear Disorders Section – persons with a chronic ear disorder (such as Tinnitus, Meniere's Disease or Acoustic Neuroma) and

d) Parents section – parents or legal guardians of persons who are Deaf or hearing impaired,

e) Service Providers section – service providers to the Deaf and/or hearing impaired communities.

Objectives

The Deafness Forum exists to improve the quality of life for Australians who are Deaf, have a hearing impairment or have a chronic disorder of the ear by:

- advocating for government policy change and development
- making input into policy and legislation
- generating public awareness
- providing a forum for information sharing and
- creating better understanding between all areas of deafness.

Community Involvement

The Deafness Forum is consumer-driven and represents the interests and concerns of the entire deafness sector, including:

- the Deaf community
- people who have a hearing impairment
- people who have a chronic ear disorder
- the DeafBlind community
- parents who have Deaf or hearing impaired children in their families

Introduction to the 4th Libby Harricks Memorial Oration

By Mr Stan Batson, Deafness Forum Chairperson

Professor Mitchell, Ms Jenny Hefford, invited guests, ladies and gentlemen. On behalf of the Board of Deafness Forum it gives me great pleasure to welcome you to the 4th Libby Harricks Memorial Oration.

The Deafness Forum is grateful for the continued support it receives from the Office of Hearing Services.

We very much appreciate the interest and support of the Office and, particularly, its new National Manager, Jenny Hefford, who is with us today.

Finally, I wish to acknowledge the generous donations of time and money contributed by a number of people, including members of the Harricks family, the Oration organising committee, some members of the Deafness Forum and the staff of our national secretariat office in Canberra.

The 4th Libby Harricks Memorial Oration is to be delivered by Professor Paul Mitchell.

Professor Mitchell has a longstanding interest in epidemiology. This interest was started by Professor Fred Hollows who carried out one of the first population studies of glaucoma in the world.

Professor Mitchell's clinical and research interests are in the areas of diabetic eye disease. Since 1986 he has been on the retinopathy subcommittee of the Australian Diabetes Society and is an advisor to the National Diabetes Strategy. He was also the principal author of the 1997 NH & MRC Clinical Practice Guidelines on Management of Diabetic Retinopathy.

Professor Mitchell has a busy clinical practice at Westmead Hospital in Sydney, and is a member of several national and international committees including the Association for Research in Vision and Ophthalmology, the Program Committee of the Royal Australian College of Ophthalmology and the Australian Drug Evaluation Committee.

Following appointment to the University of Sydney Department of Ophthalmology in 1990, Professor Mitchell designed and obtained NH & MRC funding for a large population based study of eye disease in older Australians called the Blue Mountains Eye Study. Funding for a 5-year follow up study with this same population and a concurrent study of their hearing was also approved in 1996. The third round of the study will commence shortly. To date, the studies have raised over $4 million in research grants and produced over 120 scientific papers which have been published in a wide variety of journals including the prestigious New England Journal of Medicine. His research and that of his colleagues has spanned a variety of health related issues including the epidemiology of fails and fractures, vascular events, nutrition, thyroid disease and of course age-related hearing loss, the topic of today's presentation.

Today, Professor Paul Mitchell will deliver the 4th Libby Harricks Memorial Oration. Please give Paul a warm welcome.

The Prevalence, Risk Factors and Impacts of Hearing Impairment in an Older Australian Community: the Blue Mountains Hearing Study

Delivered by Paul Mitchell, at the, on the 19 March 2002.

Abstract

There have been few recent large population-based studies to estimate the prevalence, risk factors and impacts of age-related hearing impairment. Our study aimed to provide these data for the cohort of older persons attending 5-year examinations of the Blue Mountains Study, in a defined area, west of Sydney, Australia. Of 2696 eligible residents, 2015 persons (75%) aged 55-99 (mean 70 years) were examined. A detailed questionnaire was administered and air and bone-conduction audiometric thresholds measured from 0.25 to 8KHz. Thresholds were higher in men than in women and in left compared with right ears. Hearing loss, defined as >25dBHL in the better ear averaged over 4 frequencies, was found in 39.3% of subjects. It was mild (>25 to ≤40 dBHL) in 25.9%, moderate (40 to ≤60 dBHL) in 11.2%, marked (60 to≤90 dBHL) in 2.3% and profound (>90 dBHL) in 0.4%. After adjusting for gender, the odds for hearing loss doubled with each increasing decade of age. Hearing loss was independently associated with both the duration and severity of reported work-related noise exposure (70% increased risk), the presence and duration of type 2 diabetes (50% increased risk), current smoking (40% increased risk), together with lower educational attainment and past history of stroke. Regular alcohol consumption was associated with a slightly reduced risk of hearing loss. Hearing impairment also impacted negatively on participants' perception of their general health and was independently associated with a higher use of community support services and a higher rate of nursing home placement Persons with hearing loss were more likely to also have visual impairment. This study has demonstrated important epidemiologic findings about age-related hearing loss that support and extend recent U.S. findings. Follow-up of this cohort is soon to commence and will assess the 5-year incidence and progression of hearing loss in this community.

Introduction

I met Libby Harricks, the first president of Deafness Forum, on only one occasion, when she attended a party with her husband David at my home to celebrate the award of the Blue Mountains Hearing Study grant. Philip Newall had discussed the project in detail with Libby and we included her as an investigator, because we felt that her knowledge of and links with the deaf community could be useful in presenting our material. She was very enthusiastic about the project and I was devastated when I heard later of her breast cancer and its spread.

I feel deeply honoured to have been invited to present this oration in her name. I believe that both Libby and I would have enjoyed the opportunity to discuss the study findings and their implications.

I would like to start with a confession. As a clinical ophthalmic sub-specialist in retinal diseases, I really know little about the pathophysiology of hearing impairment and its causes. However, wearing my other hat as an epidemiologist makes me feel at least somewhat comfortable in addressing this eminent international gathering.

Background

Despite the high frequency of age-related hearing loss, there have been few comprehensive studies of the epidemiology of hearing impairment in large, older populations that have comprehensively assessed its risk factors and the impacts of this sensory impairment on independent living. With well-known projected increases in life expectancy, the age-related loss of vision and hearing now represents one of our most important medical challenges. Generating accurate data on the prevalence, incidence, risk factors and impacts of age-related sensory loss is a critical step in responding to this challenge. Many surveys, such as the recent U.S. National Health Interview Survey[1], have documented self-reported sensory impairment and its impact on health-related quality of life. However, worldwide, there have actually been relatively few recent population-based estimates of the prevalence of measured hearing loss in large, older communities and even fewer longitudinal studies.

Existing data indicate that sensory impairment impacts severely on independent living. A recent publication on the burden of disease and injury in Australia by the Australian Institute of Health & Welfare includes hearing loss and age-related vision disorders among the top 12 causes of years of life lost due to disability in Australia[2]. Hearing loss was the second most frequent cause in men, after depression.

Useful, but limited Australian data on the prevalence of hearing loss was provided by a recent South Australian study that included 496 persons aged 50 years or older[3;4]. This study, however, had insufficient statistical power or potential risk factor data collected to provide a comprehensive evaluation of associations with hearing loss. To our knowledge, the Study has not undertaken a longitudinal evaluation of this cohort.

The recent Epidemiology of Hearing Loss Study (EHLS), conducted in Wisconsin, USA, examined the cohort of older persons who participated in a large population-based study of eye disease (the Beaver Dam Eye Study), by adding a detailed hearing component after the second 5-year eye examinations. To date, this landmark study of 3,753 persons aged 48-92 years has reported widely on the prevalence and risk factors for age-related hearing loss[5-15].

We recognised the pressing need for similar Australian data. Through our collaboration with the EHLS investigators, we decided to add a similar hearing component to our successful eye survey in the Blue Mountains region, west of Sydney. The Wisconsin and Blue Mountains Study populations have been shown in a series of papers to be very similar in a number of characteristics, so we took care to align many of the key methods used in our Hearing Study. This will permit a close comparison of the findings from these two complementary studies. One important difference between the two populations is that the Wisconsin Study is in a semi-rural farming area, so that noise-related hearing loss may be more important in that community than in ours, which represented a fairly typical urban Australian community.

Blue Mountains Eye & Hearing Study

The Blue Mountains Hearing Study (BMHS) is a population-based survey of age-related hearing loss in an older Australian community. It was conducted during 1997-1999 and included people who took part in the earlier Blue Mountains Eye Study (BMES) during 1992-1994, which was the first survey of its type in Australia. We designed the Eye Study to provide information about the frequency, causes, risk factors and impacts of visual impairment in a representative older Australian community.

To date, this project, including its hearing component, has raised nearly $3 million in research grants and produced close to 100 published papers, with another 50 manuscripts in press or submitted for publication. In addition to vision and hearing impairments, allied studies have examined the epidemiology of falls, fractures, vascular events, thyroid disease, as well as nutrition and the heritability of disease. Its findings have been published widely internationally in many key journals, including the *New England Journal of Medicine*. We have recently begun to pool our eye data with two other large population-based surveys using similar methods; the Beaver Dam Eye Study from Wisconsin (USA), which was also used for the EHLS, and the Rotterdam Study from the Netherlands. A recent NHMRC grant will use BMES data to exploring retinal vascular signs as risk markers for stroke or cerebrovascular death. Another will build on BMES findings to conduct a large randomised trial of improving vision to prevent falls and fractures.

We chose the Blue Mountains region, including the suburbs of Katoomba, Leura, Wentworth Falls and Medlow Bath, comprising two postcodes (2780, 2782) because this area has a relatively stable, older population, is fairly representative of the Australian population of this age, and could be targeted readily for publicity. In conducting a population-based study, the denominator (the number of age-eligible permanent residents of a defined area) needs to be accurately determined. A high proportion of this group must then be recruited into the survey and as much information as possible collected about non-responders.

The period of preparation for the Eye Study coincided with Census 91 in August, one of Australia's 5-yearly Census surveys, performed by the Australian Bureau of Statistics (ABS). In November 1991, we were able to recruit some ABS Census staff to conduct our own door-to-door census of all dwellings in the 38 census districts within the proposed study region. After enumerating, but excluding residents of nursing homes, our staff counted and collected details on 4,433 persons aged 50 or older, only six fewer than the number counted by the ABS in Census 91 from these postcodes. Over the next two years (1992 to 1994), we then progressively invited this group to attend a clinic at the local Blue Mountains District Hospital for a detailed eye examination. There were 3,654 people, aged 50-97 years, who participated in the examinations, a response of 82.4% among those counted, or 88% if we excluded persons who had left the area or had died during the survey period. During 1997, all of the surviving BMES participants were invited to attend 5-year follow-up eye exams, as well as a separate hearing assessment at a later date.

Of the original 3654 BMES participants, 575 (15.7%) had died before the 5-year follow-up eye exams commenced, while 383 subjects (10.5%) had moved from the area. This left 2696 eligible persons still living in the region. Of these, 2015 people aged 55-98 years (74.7%) agreed to take part in the hearing study (BMHS). At the time of participating, the mean age of BMHS participants was 69.8 years (slightly older than the EHLS population, which had a mean age of 65.8 years), and there were 1156 women and 859 men. The age and gender distribution was similar to the Australian population in this age range and is shown in Figure 1.
All participants provided written, informed consent.

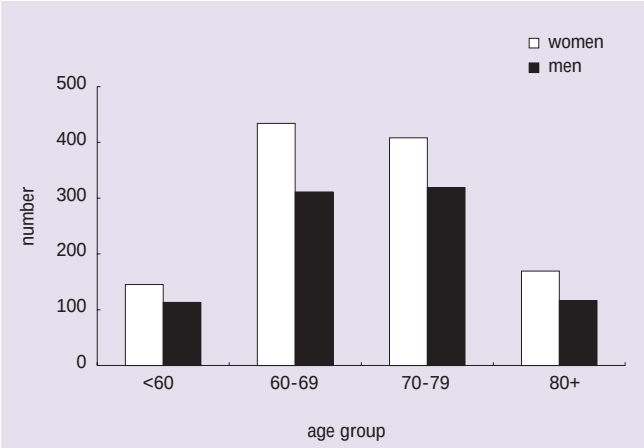

Figure 1. Age-gender distribution of participants in the Blue Mountains Hearing Study

In our questionnaire, we asked about any history of self-perceived hearing problem, including its severity, onset and duration, whether the participant's general practitioner or any hearing professional had been consulted and if a hearing aid had been recommended or provided. A detailed medical history was also taken including past history, treatment or risk factors for ear disease. Questions also asked about exposure to noise at work, during military service and leisure activities. We measured height, weight and blood pressure and asked participants to return for fasting blood tests that included glucose, lipids and many other tests. We also took EDTA whole blood samples, from which DNA has been extracted. Lastly, we removed some hair follicles to test for mitochondrial DNA mutations and haplogroups associated with hearing loss.

The hearing examination included pure-tone air-conduction audiometry conducted in sound-treated rooms on both ears by audiologists, using Madsen OB822 audiometers. Hearing thresholds at frequencies 0.25, 0.5, 1.0, 2.0, 3.0, 4.0, 6.0 and 8.0 kHz, and bone-conduction thresholds at 0.5, 1.0, 2.0 and 4.0 kHz were measured. The audiometers were calibrated regularly during the study period. Other tests included video-otoscopy on both ears, acoustic impedance tests, otoacoustic emission measures (including suppression) and a battery of speech discrimination tests.

In this study, we defined hearing impairment as the pure-tone average of hearing thresholds at 0.5, 1.0, 2.0 and 4.0 kHz >25dB hearing level (dBHL) in the better ear. This differed from the EHLS report[16], which defined hearing loss from thresholds in the worse ear. We classified the severity of hearing loss using the following criteria: mild (>25 to #40dBHL); moderate (>40 to #60dBHL); marked (>60 to #90dBHL); and profound (>90 dBHL). Conductive hearing loss was considered present when an air-bone gap ≥15dB was recorded at 0.5, 1.0 or 2.0 kHz.

Prevalence (Frequency) of Hearing Impairment

Measured hearing loss was found in 39% of BMHS participants and was more common in men (44%) than in women (36%). The prevalence (frequency) of hearing loss increased steeply with age. It was present in 11% of people aged in their fifties, 24% of those aged in their sixties, 51% of those aged in their seventies and was present in 78% of people aged 80 years or over. Hearing loss was classified as mild in 26%, moderate in 11%, marked in 1.9% and profound in 0.45%. Figure 2 shows that both the frequency and severity of hearing loss increased progressively with age. Marked or profound hearing loss was present in only around 1% of participants before age 75. However, from this age, its frequency doubled every 5 years, as shown in Figure 3.

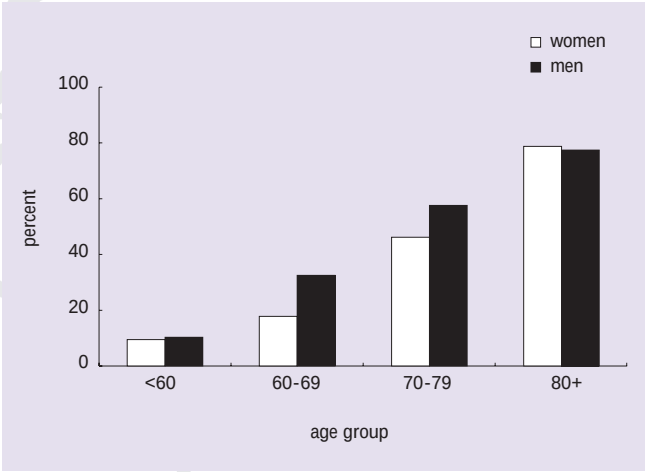

Figure 2. Frequency of hearing loss (%) in men and women by 10-year age group

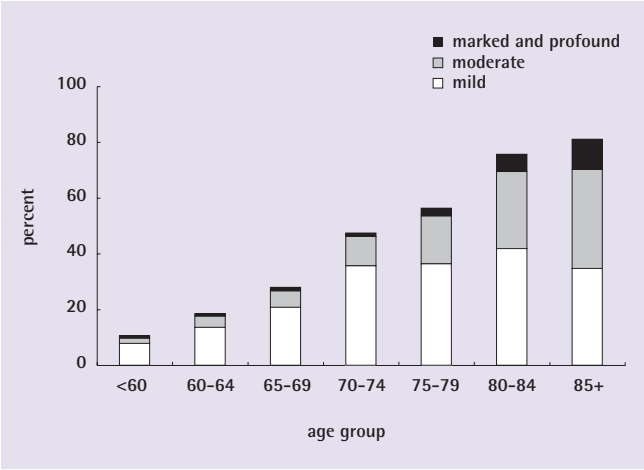

Figure 3. Frequency of hearing loss (%) by severity and 5-year age group

Bilateral profound deafness was present in 0.45% of the population. Unilateral profound deafness was present in 2.0% and was also age-related. A history of hearing loss from birth was given by 0.5% of the population, past ear surgery by 5.2% and conductive hearing loss was found in 2.2%. The male-female gender difference decreased in older age groups and actually disappeared if we averaged only the lower three frequencies (0.5, 1.0, 2.0 kHz) to define hearing loss.

How close are these prevalence estimates to those from the recent EHLS conducted in Wisconsin, U.S.A.[16]? This study estimated the prevalence of hearing impairment using data from the worse (either) ear, rather than the better ear, as in our Study? Applying a worse ear definition to our data, hearing loss was present in 53% of the population, including 61% of men and 48% of women. After age-standardising our prevalence rates to the EHLS report[16], Table 1 shows that there was no statistically significant difference in the overall frequency of hearing impairment between these two large studies. The overall hearing loss prevalence was 45.9% in the EHLS and 44.3% in the BMHS, age-standardised to the first population. The overlapping confidence intervals indicate that there is no statistical difference between these estimates.

Table 1. Comparison of hearing loss prevalence between Blue Mountains Hearing Study and U.S. Epidemiology of Hearing Loss Study16, using similar criterion >25dB HL (worse ear).

	Blue Mountains Hearing Study		Epidemiology of Hearing Loss Study	
age group (years)	number	% with hearing loss	number	% with hearing loss
48-59 *	258	20.5	1246	20.6
60-69	743	38.5	1056	43.8
70-79	724	66.6	892	66
80-92	270	88.5	362	90
all	1995	53.1	3556	45.9
		44.3 (CI 42.7-46.0)ǂ	45.9 (CI 44.3-47.6)	

* age group 55-59 years in Blue Mountains Hearing Study

ǂ age-standardized to EHLS population

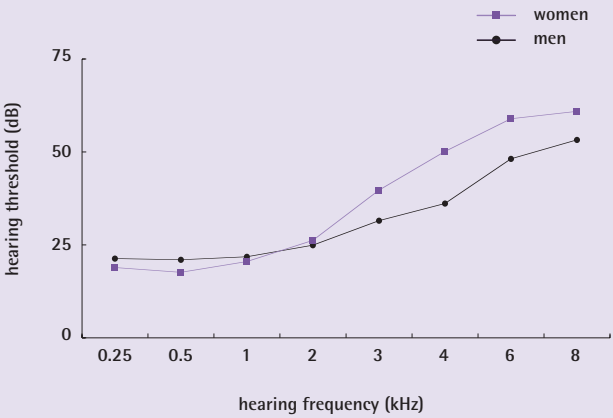

Figure 4. Hearing thresholds in men and women by audiometric frequency

Hearing thresholds were higher (i.e. hearing was poorer) in men than in women, but this difference was only consistently seen for thresholds over 2 kHz, as shown in Figure 4. The hearing thresholds were also significantly worse in right than in left ears.

Risk Factors for Hearing Impairment

A well-established approach used in assessing risk factors for age-related diseases is to construct a multivariate model of those factors that remain statistically significantly associated with the condition (e.g. hearing loss) and independent of each other. This approach has its drawbacks, particularly in regard to adequate statistical power for the examination of some less frequent associations and difficulty with strongly cross-correlated factors. The development of such models is also, to some extent, always a work in progress, as new relationships emerge over time.

The following is a summary of our current work in developing a picture of independent risk factors for age-related hearing loss. Any such assessment of risk factors for hearing loss needs firstly to take into account (to "adjust for") the effects of age and gender, as many potential factors are themselves age-related or, as in the case of occupational noise, have greater exposure to men than women. As systemic factors are likely to affect hearing in both ears symmetrically, hearing loss should be defined as being present bilaterally.

Table 2 shows the principal factors that we found associated with hearing loss defined using >25dB HL in the better ear (that is, bilateral hearing loss). The proportion (%) of participants with each factor is shown. The odds ratio for this association, together with its 95% confidence interval, indicates the magnitude of the relationship found and its statistical significance.

All of the factors shown (increasing age, male gender, family history, work-related noise exposure, low education, diabetes and history of stroke) were found to be independently related to hearing loss, as their confidence intervals are outside or include 1.0. The relationship with smoking was statistically significant in the model until history of stroke (also strongly associated with smoking) was added. It then became marginally non-significant.

To indicate what these numbers mean, the odds ratio of 1.7 for family history indicates that participants who reported that their brother, sister or parent suffered from hearing loss had around 70% increased odds for measured hearing loss affecting both ears, using our definition, than participants without a family history. It needs to be stated that for a condition as frequent as hearing loss, odds ratios will tend to overstate the increased relative 'risk' of individual factors.

The attributable risk or proportion (%) is a measure of each potentially modifiable factor's overall proportional contribution to hearing loss in the study population. Table 2 shows that both familial (heritable) influences and a history of work-related noise exposure appear to contribute most to hearing loss in this community. These two factors had the highest attributable proportions in the model. Table 3 demonstrates an increasing magnitude of many of these associations in the model, for moderate to severe hearing loss (>40dB HL in the better ear, excluding cases with mild hearing loss).

Table 2. Multivariate model of risk factors for moderate to severe hearing loss in the BMHS (>40dB HL in better ear)

Factor risk (%)	**% with factor**	**odds ratio** (95% confidence intervals)	**attributable**
age (year)		1.20 (1.17-1.23)	
male gender	42.6	1.7 (1.1-2.5)	
family history of hearing loss	42.8	2.9 (2.0-4.1)	44.8
history of work in noisy industry	37.8	2.0 (1.4-3.1)	27.4
low education (no post-school qualifications)	39.2	1.5 (1.0-2.1)	16.4
diabetes	10.5	1.8 (1.1-3.1)	7.7
history of stroke	6.2	2.0 (1.1-3.9)	5.8

We excluded 92 people from risk factor analyses because information about some factors was missing (n=24), they gave a history of hearing loss from birth (n=10), or of otosclerosis (n=15) or had audiometric evidence of conductive hearing loss (n=43).

Table 3. Multivariate model of risk factors for any hearing loss in the BMHS (>25dB HL in better ear)

Factor risk (%)	% with factor	odds ratio (95% confidence intervals)	attributable
age (per year)		1.14 (1.13-1.17)	
male gender	42.6	1.4 (1.1-1.8)	
family history of hearing loss	42.8	1.7 (1.4-2.1)	23.1
history of work in noisy industry	37.8	1.7 (1.3-2.1)	20.9
low education (no post-school qualifications)	39.2	1.3 (1.0-1.6)	10.5
diabetes	10.5	1.5 (1.1-2.1)	5.0
history of stroke	6.2	1.7 (1.1-2.6)	4.2
(current smoker)	9.3	1.4 (0.9-2.1)	3.6

These risk factors will now be examined in more detail separately.

1. Increasing age

The frequency of any hearing impairment almost doubled for each decade after the fifties, as shown in Figure 3. This age-related increase was greater for more severe (moderate, marked and profound categories) than for mild hearing loss. The odds for hearing loss were found to increase by around 14% for each year of age.

2. Male gender

Hearing impairment (either any hearing loss or moderate to severe hearing loss) was consistently more frequent in men than women. This gender difference was independent of other risk factors, including history of work-related noise exposure. However, we found a statistically significant gender difference in hearing sensitivity only for higher frequencies (2kHz or higher), as shown in Figure 4.

3. Family history

As with most age-related diseases, familial aggregation of hearing loss has frequently been reported. Participants who responded that any of their siblings or either parent had hearing impairment were more likely to have measured hearing loss (42.0% overall) than those without a family history (37.7%). This relationship was similar, for a positive family history affecting brothers, sisters, fathers or mothers. The relationship between family history and hearing loss was found for all age groups. However, it was stronger for moderate or more severe levels of hearing loss (>40dB HL, better ear) than for any (>25dB HL) hearing loss, as shown in Figure 5.

It is possible that mutations in some of the genes linked to youth-onset hearing loss (e.g. Connexin 26 gene) may be implicated in age-related hearing loss[17]. We are currently collaborating with key groups in the U.S. to explore this possibility, and plan to use the DNA that was extracted from blood collected on BMHS participants. We have also recently applied to NHMRC for funding of a study that will characterise mitochondrial DNA mutations and specific haplogroups, and their relationship to age-related hearing loss. This study will examine mitochondrial DNA extracted from the hair follicles that were collected from all participants.

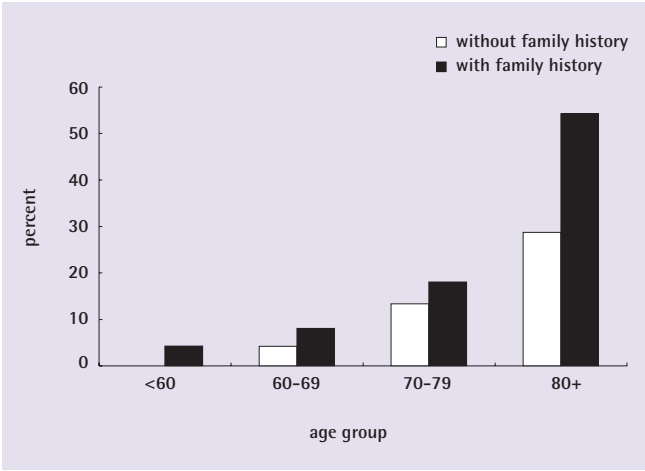

Figure 5. Frequency of moderate hearing loss (>40 dB in the better ear) by age in participants with and without a family history

4. History of work in noisy industry

We asked participants whether they had ever worked in a noisy industry or farm environment. Overall, 34.6% of the population stated that they had at some time in the past, including 20.8% who stated that they had worked in this environment for over 10 years. We further asked participants to estimate the severity of the noise they were exposed to on an average day, as 'mostly quiet', 'tolerable but able to hear speech' or so noisy that they were 'unable to hear anyone speaking', which we classified as severe. Of subjects who said that they had worked in a noisy environment for at least one year (29.6%), overall there were 175 (9.2%) who described the noise as 'tolerable' and 63 (3.3%) who described it as 'severe'. Participants were also asked whether hearing protection was worn and whether they had observed a change in their hearing after their period of work. Other questions asked about military and leisure activity noise exposures, including the use of firearms[15] and in hobbies or sports.

We found that both the duration and the severity of reported work-related noise exposure were independently associated with measured hearing impairment. Figure 6 shows that the higher audiometric frequencies were most affected, and that hearing sensitivity was worst in those who stated they had were exposed to

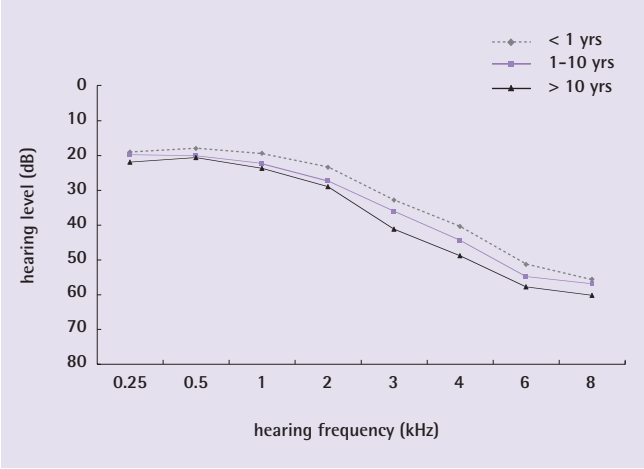

Figure 6. Age-sex adjusted mean hearing thresholds by the duration of reported noise exposure

noise at work for over 10 years. Figure 7 demonstrates our finding that a history of 'severe' noise exposure at work appeared to be more important as a risk factor for hearing impairment among younger than older participants.

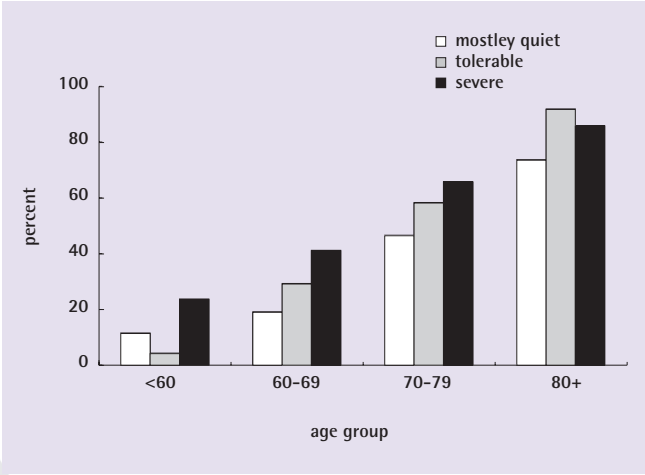

Figure 7. Prevalence of hearing loss (%) by age and the reported level of noise exposure at work

5. Diabetes

Type 2 (also termed 'non insulin-dependent') diabetes was present in 10.5% of this population. This number included 7.5% of the population whose diabetes was already diagnosed and 3.0% who had undiagnosed diabetes that we detected from our fasting blood glucose tests. Figure 8 shows that diabetes was independently associated with hearing impairment at all ages. Hearing loss was found overall in 48.5% of persons with diabetes and in 38.1% of those without diabetes. This resulted in around 50% higher odds for hearing loss among persons with diabetes, similar to that found in the EHLS[10]. Figure 9 shows that hearing sensitivity was worse for all eight frequencies tested and that diabetes equally affected

lower and higher frequencies. A strong diabetes-duration relationship was also demonstrated, as shown in Figure 9, with consistently worse hearing sensitivity found in participants whose diabetes had been present for 10 or more years.

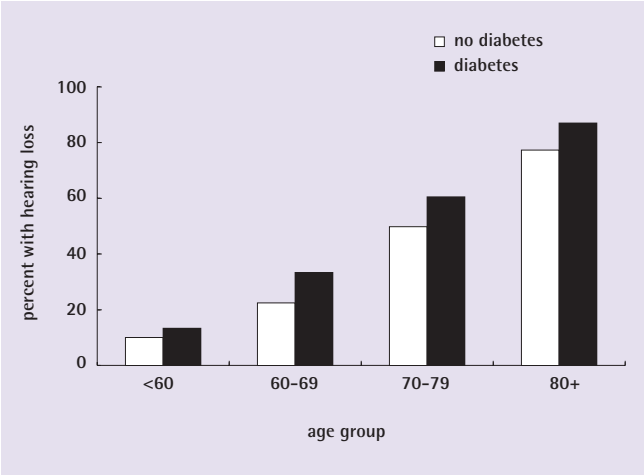

Figure 8. Hearing loss (%) by the presence of diabetes (both diagnosed and undiagnosed) and age group

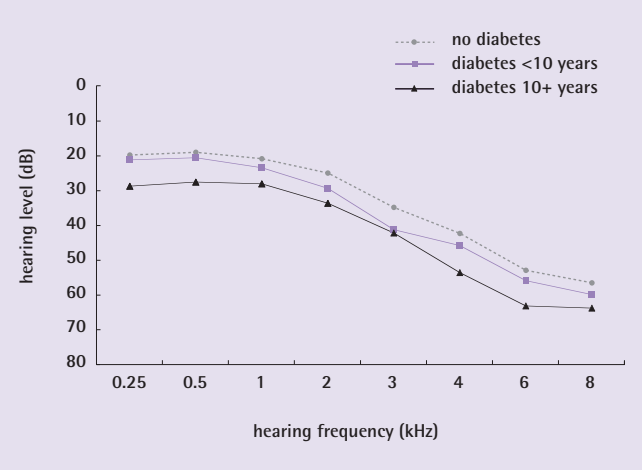

Figure 9. Hearing sensitivity (age-sex adjusted mean thresholds) by diabetes and its duration and audiometric frequency

6. Smoking

Figure 10 shows that people who stated that they currently smoked (9.3% of those examined) were more likely than non-smokers to have hearing loss, by around 50% higher odds, present at most ages. This association was statistically significant in the multivariate model, until we included history of stroke. The relationship then became marginally non-significant. However, the association between smoking and hearing loss was stronger and remained statistically significant (with 80% higher odds), after we excluded persons who gave a history of exposure to noise at work. This relationship has recently been reported by the EHLS[18].

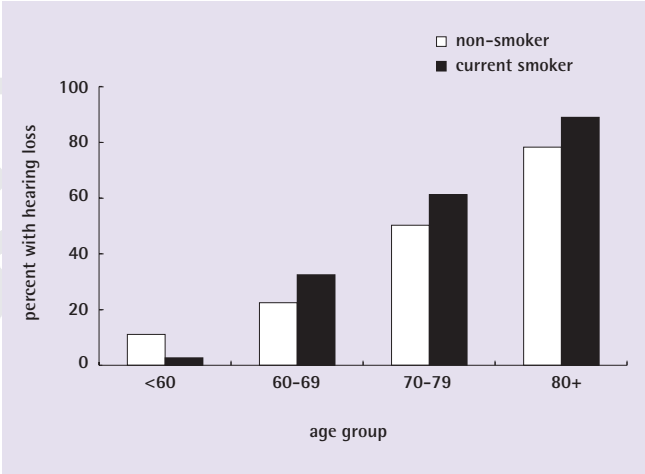

Figure 10. Prevalence of hearing loss (%) by age and smoking status

7. History of stroke

A past history of stroke was given by 6.2% of participants. People who gave this history were more likely to have impaired hearing (58.2%) compared to those without a stoke history (38.1%). Figure 11 shows that the relationship between past stroke and hearing loss was present at all ages, but was strongest among persons aged 65 to 74 years.

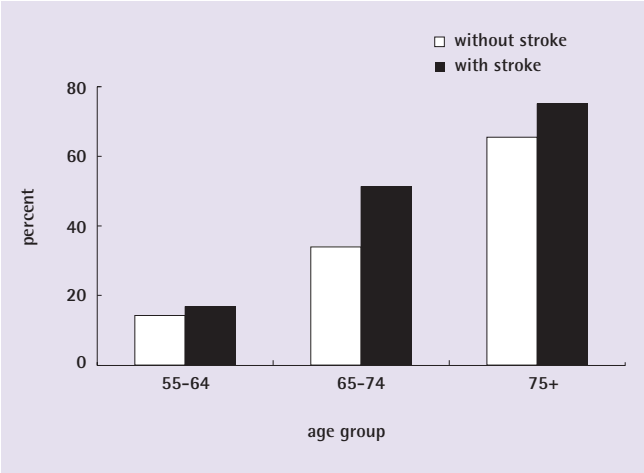

Figure 11. Prevalence of hearing loss (%) by age and history of stroke

8. Alcohol

Now, for some good news! Regular alcohol consumption was associated with a significantly decreased likelihood of moderate or greater levels of hearing loss (>40 dB HL), after adjusting for potential confounders. The magnitude of this protective association ranged from odds of 0.6 (CI 0.4-0.9) to 0.5 (CI 0.3-0.9) over the range of regular alcohol consumption. As with smoking, the protective effect was strongest in people reporting no substantial occupational noise exposure. This finding provides some indirect support for cardiovascular mechanisms in the pathogenesis of age-related hearing loss.

9. Relationship between vision and hearing impairments

Participants who had measured hearing loss were more likely, after adjusting for other factors associated with hearing loss, to also have visual impairment after refraction, with around 40% higher odds (odds ratio 1.4, 95% confidence interval 1.0-1.9). The odds for hearing impairment increased by around 18% for each line of reduced corrected visual acuity. This finding could reflect some sharing of risk factors among older persons with sensory impairment. Data from the EHLS has already demonstrated links between hearing loss and two common age-related eye diseases, cataract[19] and age-related maculopathy[20]. Recent analyses using

our data have confirmed the latter relationship. A number of studies have shown that the impact from combined sensory impairment is magnified and may contribute to cognitive decline[21].

Impacts of Hearing Loss on Independent Living

Many previous reports have examined the impact of hearing impairment on various factors that reduce or impair the ability of older people to live independently. Some of these include impacts on:

- Quality of life[22;23] Psychological factors[22], including impacts on depression[21;24;25] social functioning[26;27] and intimate relationships[28] Social isolation[21;23;29]
- Education and employment[30]
- Cognitive function and dementia[21;31-33]
- Mortality[2]

Blue Mountains Hearing Study findings

We have begun to explore a number of previously unreported impacts of hearing impairment in this older population. Although incomplete, some early findings are presented below:

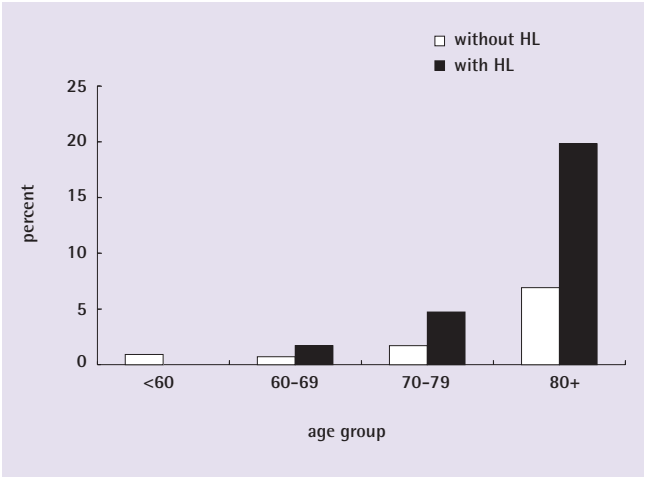

Figure 12. Use of community support services (%) and hearing loss

1. Use of community support services

Use of community support services, including 'Meals-on-Wheels', 'Home Care' and home nursing visits, was reported by 80 participants (6.7% of those examined). Figure 12 shows that after age 60, the presence of measured hearing loss was associated with more than a doubling of reported community service use. This relationship was independent of other factors found associated with use of these services. The relationship was more consistent across age groups when we included as dependent those who needed regular help from non-family members and friends.

2. Perceived general health

The ranking that people provide when asked to rate their general health (excellent, good, fair or poor) has been shown to be a good measure of the impact of disease[34] and has also been found to correlate well with the future risk of dying[35]. The question, "How would you rate your general health?" is now standard in many health surveys. In our population, we regarded those who rated their health as only "fair" or "poor" as having a reduced perception of their general health. Measured hearing loss in our population impacted significantly on this ranking, as shown in Figure 13.

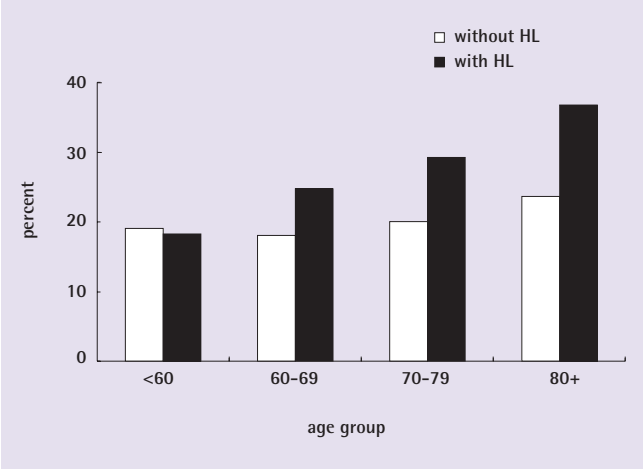

Figure 13. Reduced self-rated health (%) and hearing loss

It is interesting that overall, increasing age had little effect on a person's perception of their health. However, with increasing age, presence of hearing loss had an increasing impact on perceived health in this community. Hearing impairment was found to be an independent predictor of reduced perceived health (40% increased odds), after taking into account the many other factors associated with this ranking (odds ratio 1.4, 95% confidence interval 1.1-1.9).

3. Other impacts

For other relevant impacts such as nursing home admission or mortality, we do not yet have longitudinal data on hearing loss. However, questions at the baseline examination regarding hearing can be used. Using this information, self-reported hearing impairment was found to be one of the factors predicting future nursing home admission (40% increased odds, borderline statistical significance). However, we could not demonstrate a relationship between self-reported hearing impairment and higher mortality. Although the EHLS[9] and our study[36] have reported a reasonably close correlation between self-reported and measured hearing impairment, the failure to find stronger associations may reflect measurement error.

Projections from our findings

Projecting Blue Mountains Hearing Study data, age-standardised to the 2001 Australian population, we estimate that there are 1.5 million Australians aged 55 or older with hearing loss affecting both ears, using the criterion of >25dB. Among this group, 436,000 have moderate, 73,000 have marked and 19,000 have profound hearing impairment.

Our data indicate that hearing aids are currently worn by 13% of Australians of this age with hearing impairment, including 17% of those with mild, 59% of those with moderate and 90% of persons with marked or profound loss. These data indicate the large unmet need for effective management of this common disorder.

Because of their greater longevity, women account for 53% of Australians with any hearing impairment. However, of the 92,000 Australians of this age with marked or profound hearing impairment, 54,000 (59%) are men.

Future directions?

We will soon contact all persons who participated in the original (and 5-year) Eye and Hearing Studies to return for a 10-year eye assessment and a 5-year hearing assessment. Specifically, this will determine the cumulative 5-year incidence and progression of age-related hearing loss in this cohort, in relation to the range of potential risk factor data collected at the baseline examination. We will also determine a range of impacts from hearing impairment on dependency, specific morbidities, quality of life and perceived health and on depression, cognitive decline and mortality.

Because of our close relationship with investigators from the Epidemiology of Hearing Loss Study in Wisconsin, including the close alignment of methods, we will explore the possibility of pooling data in order to increase the study power to examine less frequent associations.

Further studies in this population will determine better assessments of the genetic risk (heritability) of hearing loss, using our DNA bank. We will also explore gene-environment interactions with hearing, for example, in relation to history of noise exposure. This area is likely to be critical in developing preventive strategies.

I would now like to raise with you one final issue and seek your support. The projections I have outlined confirm the pressing need, both in Australia and elsewhere, to increase the research effort into the relatively under-studied area of hearing impairment. Such research could identify modifiable factors that, if targeted, might lead to a reduction in the incidence, severity or progression of age-related hearing impairment, or could delay its onset. In the area of visual impairment, population-based studies such as ours have already identified some practical intervention strategies that could reduce its future burden and impact.

In the United States, sensory impairment research, in its broadest sense, draws around 10% of the National Institutes of Health budget. The Australian proportion is substantially lower and needs to be increased. This is an area where sensory researchers should join their efforts. One approach may be worth considering. At present, the Australian government has identified seven National Health Priorities:

- Cardiovascular health
- Cancer control
- Injury prevention and control
- Mental health
- Diabetes
- Asthma
- Arthritis

I believe that the time is now right for a coordinated application to the federal government for sensory impairment to be considered the 8th Australian National Health Priority, and I seek your support in this endeavour.

Acknowledgments

We wish to acknowledge and thank all of the participants in this study for the sacrifice of their time and for their enthusiasm. Particular thanks go to Prof Bill Gibson, Prof John MacCallum, Ms Donna Smith and Mr Greg Birtles for their work and support. Many others, too numerous to mention by name, have also assisted in the conduct of this project and are thanked.

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References

1. Campbell VA, Crews JE, Moriarty DG, et al. Surveillance for sensory impairment, activity limitation, and health-related quality of life among older adults—United States, 1993-1997. Mor Mortal Wkly Rep CDC Surveill Summ 1999;48:131-56.
2. Mathers C, Vos T, Stevenson C. The burden of disease and injury in Australia. PHE 17, 1-245. 999. Canberra, AIHW.
3. Wilson D, Walsh PG, Sanchez L, Read P. Hearing impairment in an Australian population. 1-54. 1998. Centre for Population Studies in Epidemiology, South Australian Department of Human Services.
4. Wilson DH, Walsh PG, Sanchez L, et al. The epidemiology of hearing impairment in an Australian adult population. Int J Epidemiol 1999;28:247-52.
5. Wiley TL, Cruickshanks KJ, Nondahl DM, et al. Tympanometric measures in older adults. Journal of the American Academy of Audiology 1996;7:260-8.
6. Nondahl DM, Cruickshanks KJ, Wiley TL, et al. Interexaminer reliability of otoscopic signs and tympanometric measures for older adults. Journal of the American Academy of Audiology 1996;7:251-9.
7. Wiley TL, Cruickshanks KJ, Nondahl DM, et al. Aging and high-frequency hearing sensitivity. J Speech Lang Hear Res 1998;41:1061-72.
8. Popelka MM, Cruickshanks KJ, Wiley TL, et al. Low prevalence of hearing aid use among older adults with hearing loss: the Epidemiology of Hearing Loss Study [see comments]. J Am Geriatr Soc 1998;46:1075-8.
9. Nondahl DM, Cruickshanks KJ, Wiley TL, et al. Accuracy of self-reported hearing loss. Audiology 1998;37:295-301.
10. Dalton DS, Cruickshanks KJ, Klein R, et al. Association of NIDDM and hearing loss. Diabetes Care 1998;21:1540-4.
11. Cruickshanks KJ, Klein R, Klein BE, et al. Cigarette smoking and hearing loss: the epidemiology of hearing loss study. JAMA 1998;279:1715-9.
12. Wiley TL, Cruickshanks KJ, Nondahl DM, Tweed TS. Aging and middle ear resonance. J Am Acad Audiol 1999;10:173-9.
13. Wiley TL, Cruickshanks KJ, Nondahl DM, Tweed TS. Self-reported hearing handicap and audiometric measures in older adults. J Am Acad Audiol 2000;11:67-75.
14. Wiley TL, Torre P, III, Cruickshanks KJ, et al. Hearing sensitivity in adults screened for selected risk factors. J Am Acad Audiol 2001;12:337-47.
15. Nondahl DM, Cruickshanks KJ, Wiley TL, et al. Recreational firearm use and hearing loss. Arch Fam Med 2000;9:352-7.
16. Cruickshanks KJ, Wiley TL, Tweed TS, et al. Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin. The Epidemiology of Hearing Loss Study. Am J Epidemiol 1998;148:879-86.
17. Morell RJ, Kim HJ, Hood LJ, et al. Mutations in the connexin 26 gene (GJB2) among Ashkenazi Jews with nonsyndromic recessive deafness. N Engl J Med 1998;339:1500-5.

18. Cruickshanks KJ, Klein R, Klein BE, et al. Cigarette smoking and hearing loss: the epidemiology of hearing loss study [see comments]. JAMA 1998;279:1715-9.
19. Klein BE, Cruickshanks KJ, Nondahl DM, et al. Cataract and hearing loss in a population-based study: the Beaver Dam studies. Am J Ophthalmol 2001;132:537-43.
20. Klein R, Cruickshanks KJ, Klein BE, et al. Is age-related maculopathy related to hearing loss? Arch Ophthalmol 1998;116:360-5.
21. Nusbaum NJ. Aging and sensory senescence. South Med J 1999;92:267–75.
22. Brooks DN, Hallam RS. Attitudes to hearing difficulty and hearing aids and the outcome of audiological rehabilitation. Br J Audiol 1998;32:217-26.
23. Kramer SE, Kapteyn TS, Kuik DJ, Deeg DJ. The association of hearing impairment and chronic diseases with psychosocial health status in older age. J Aging Health 2002;14:122-37.
24. Herbst KG, Humphrey C. Hearing impairment and mental state in the elderly living at home. Br Med J 1980;281:903-5.
25. Ormel J, Kempen GI, Penninx BW, et al. Chronic medical conditions and mental health in older people: disability and psychosocial resources mediate specific mental health effects. Psychol Med 1997;27:1065-77.
26. Mulrow CD, Aguilar C, Endicott JE, et al. Quality-of-life changes and hearing impairment. A randomized trial. Ann Intern Med 1990;113:188–94.
27. Bess FH, Lichtenstein MJ, Logan SA, et al. Hearing impairment as a determinant of function in the elderly. J Am Geriatr Soc 1989;37:123-8.
28. Hetu R, Jones L, Getty L. The impact of acquired hearing impairment on intimate relationships: implications for rehabilitation. Audiology 1993;32:363-81.
29. Weinstein BE, Ventry IM. Hearing impairment and social isolation in the elderly. J Speech Hear Res 1982;25:593-9.
30. Vernon M, LaFalce-Landers E. A longitudinal study of intellectually gifted deaf and hard of hearing people. Educational, psychological, and career outcomes. Am Ann Deaf 1993;138:427-34.
31. Uhlmann RF, Teri L, Rees TS, et al. Impact of mild to moderate hearing loss on mental status testing. Comparability of standard and written Mini–Mental State Examinations. J Am Geriatr Soc 1989;37:223-8.
32. Uhlmann RF, Larson EB, Rees TS, et al. Relationship of hearing impairment to dementia and cognitive dysfunction in older adults. JAMA 1989;261:1916-9.
33. Maggi S, Minicuci N, Martini A, et al. Prevalence rates of hearing impairment and comorbid conditions in older people: the Veneto Study. J Am Geriatr Soc 1998;46:1069-74.
34. Jylha M, Leskinen E, Alanen E, et al. Self-rated health and associated factors among men of different ages. J Gerontol 1986;41:710-7.
35. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. J Health Soc Behav 1997;38:21-37.
36. Sindhusake D, Mitchell P, Smith W, et al. Validation of self-reported hearing loss. The Blue Mountains Hearing Study. Int J Epidemiol 2001;30:1371-8.

Libby's Story

Libby's story is one of courage and triumph over adversity by utilising the knowledge of her own severe hearing loss to help others.

Libby started to lose her hearing following a bad dose of flu in the English winter soon after her marriage in 1969. Having returned to Australia in 1970 she began to find difficulty in understanding conversation and instructions, particularly on the telephone which was very important in her profession of pharmacy.

In spite of advice to the contrary, Libby tried hearing aids and found they helped. Had she heeded the negative advice, Libby believed she might never have embarked on the road to self-help, which so enriched her own life and that of many others.

She thought her two boys quickly learnt to sleep through the night and her friends remarked they had loud voices, which was the boys' mechanism for coping with a deaf mother!

The more the doctors said nothing could be done to help, the more Libby looked towards self help and so she learnt to lip read, a tool she relied on heavily in her quest to help others.

Libby's will to win led her, with the help of others, to get involved with the setting up of a support group, which became SHHH – Self Help for Hard of Hearing people. The American founder, Rocky Stone, was invited to Australia in 1982 and did a lecture tour entitled "The Hurt That Does Not Show" which cemented the bonds between the US and Australian groups and helped the local SHHH develop.

Libby, with others, then began SHHH News, a quarterly publication, and with Bill Taylor set up the first Hearing Information and Resource Centre at "Hillview", Turramurra with support from Hornsby/Kuringai Hospital. This centre provided reliable information on, and demonstrated, assistive listening devices for hearing impaired people. Through this interest, Libby became an enthusiastic user of technology and with her handbag full of electronic aids was enabled to join in a full social life with family and public.

Libby became President of SHHH in 1986 and began to develop her role as an advocate for hearing impaired people generally. She became involved in ACCESS 2000, under the Australian Deafness Council, and a member of the Disability Council of NSW. Her horizons broadened further as Vice President of the Australian Deafness Council and then as the first, and two terms, President of the newly formed national peak body in deafness, the Deafness Forum of Australia. In this latter role Libby made a huge contribution to bring together all the different organisations into a central body, and actively lobbied on behalf of Deaf and hearing impaired at the highest level – the archetype of a successful achiever despite her profound hearing loss.

For her work on behalf of hearing impaired people Libby was made a Member of the Order of Australia in 1990. Later she was appointed by the Government to the Board of Australian Hearing Services and was asked to represent the needs of hearing impaired on the Olympic Access Committee.

Unfortunately, Libby faced another hurdle when she was diagnosed with breast cancer in 1995. Following surgery, she continued her family and volunteer work with undiminished vigour. She would wickedly show off her wig at public functions after her chemotherapy, and talked openly of her "mean disease". She died peacefully on 1 August 1998 and was honoured by hundreds who attended her Thanksgiving Service on 6 August.

In her own words, Libby related her outlook:

"I look back over these years since I became hearing impaired and realise that any efforts that I have made have been returned to me threefold. I have found talents I never knew I had, I have gained so much from the many people I have met and worked with to improve life for people with disabilities and through self help I have turned the potential negative of a profound hearing loss into a positive sense of purpose and direction in my life".

The Libby Harricks Memorial Oration program is supported by the Libby Harricks Memorial Fund of the Deafness Forum of Australia. Donations to this fund are tax deductible. Please see enclosed donation form for full details.

Donations should be made payable to Deafness Forum. Additional donation forms and general information regarding deafness can be obtained from:

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