Epidemiology of noise-induced hearing loss in New Zealand

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Abstract

Introduction Hearing loss is a major cause of disability in the world. Occupational noise exposure is likely to contribute to a very high proportion of the cases of hearing loss in adults. Concern has been raised by the Accident Compensation Corporation (ACC) in New Zealand about the fact that the number of new cases of noise-induced hearing loss (NIHL) is not declining, despite the health and safety legislation and establishment of hearing conservation programmes in industry. To inform strategies for prevention, a review of the burden of NIHL in New Zealand was undertaken, particularly focusing on the trends in compensation claims and costs, and the associated sociodemographic patterns.

Methods A review of the peer-reviewed published literature was conducted to identify national and international estimates of NIHL prevalence. The ACC claims dataset (July 1995 to June 2006) was analysed to describe annual trends in new NIHL claims, cost to ACC, and claimants’ age, gender and occupational group.

Results There is currently no reliable information regarding the overall incidence and prevalence of NIHL in New Zealand. ACC data reveals a substantial increase in the number of new NIHL claims annually, rising from 2823 in July 1995–June 1996, to 5580 in July 2005–June 2006. Together with ongoing claims the overall costs of NIHL claims increased by an average of 20% each year (a six-fold increase over the decade) resulting in a total cost to ACC of $193.82M over the review period. Collectively, agriculture and fisheries workers, trades workers, machine operators, and assemblers accounted for 53% of new claims. Most claims were lodged in middle age or later, with the vast majority of claimants (95%) being men. The relationship of age with the probability of making a claim changed significantly over the study period with rates in older age groups increasing faster than in younger.

Conclusions The substantial and increasing societal costs despite decades of NIHL control legislation suggests that current strategies addressing this problem are not effective, inadequately implemented, or both.

Noise-induced hearing loss (NIHL) is a form of hearing loss caused by sustained and repeated exposure to excessive sound levels. While commonly attributed to prolonged employment in high-noise industries, any form of sound exposure can lead to NIHL provided there is sufficient intensity and exposure time. The hearing loss occurs because of damage to the hearing organ (cochlea) of the inner ear. Exposure to sound above a level of approximately 85dBA initially manifests as a temporary hearing loss or ‘dullness’ of hearing (a temporary threshold shift) which recovers within 16–24 hours of the exposure. However, with repeated or sustained
exposure, the hair cells and associated nerve fibres degenerate and the threshold shift becomes permanent (permanent threshold shift).\textsuperscript{1}

Hearing loss is any change in hearing acuity in quiet or in the presence of background noise, but can be quantified in an audiogram as an auditory threshold of greater than 15dB at any frequency.\textsuperscript{4} In New Zealand, hearing loss is categorised as slight (15–25dB Hearing Level), mild (26–40dBHL), moderate (41–55dBHL), moderately severe (56–70dBHL) severe (71–90HL), or profound (91dBHL and above).\textsuperscript{4,5,7}

Generally a threshold of 25dBHL is regarded as the hearing level at which a person will experience significant problems.\textsuperscript{6} The hearing loss from noise exposure is typically binaural; it increases in severity with exposure level and duration and can result in a substantial hearing disability.\textsuperscript{7,8}

The loss of sensitivity and clarity of high pitched sounds and inability to discriminate speech sounds particularly in the presence of background noise result in major communication difficulties.\textsuperscript{9} People may also become intolerant of loud sounds and complain of tinnitus.\textsuperscript{8,10,11} These difficulties result in substantial physical and psychological distress for those affected by reducing their quality of life through limiting communication, entertainment, and employment opportunities, and place a substantial burden on their families and friends.\textsuperscript{12} Not surprisingly, uncorrected hearing loss can lead to social isolation and depression.\textsuperscript{13,14}

Internationally NIHL is recognised as a significant occupational health problem,\textsuperscript{15} with estimates of the prevalence ranging from about 7\% of the population in Western countries to 21\% in developing nations.\textsuperscript{16} In Australia, hearing loss is estimated to cost the country about $11.6 billion with NIHL accounting for about one-third of this cost.\textsuperscript{17}

The epidemiology of NIHL in New Zealand is poorly understood and more information is needed to identify effective strategies to prevent the hearing loss and the resultant individual and societal burden.

This paper describes the burden of NIHL in New Zealand as determined by data collated by national occupational and rehabilitation compensation systems over the past decade. The predominant source of information for this study is the number of claims to the Accident Compensation Corporation (ACC). These describe the number and rate of successful claims for rehabilitation from individuals with hearing loss from noise exposure. While these do not necessarily reflect the overall incidence of NIHL in the population, they serve as an index of the most readily available data on new cases that can be used to inform trends over time, across industries, ages, and ethnic groups.

Using these data, we examine related costs and high-risk sociodemographic groups to inform a population health strategy to address this problem.

Methods

A review of the published literature was undertaken to identify articles in scientific journals estimating the prevalence of NIHL in New Zealand. Medline and PsychInfo online databases were searched using relevant MeSH terms and text words such as “noise-induced hearing loss” “noise”, “sound”, “hearing loss”, “deafness”, “occupational disease”, “hearing conservation” and “hearing protectors”. Key journals in the fields of audiology, hearing, noise and occupational medicine were hand-searched and their reference lists checked.
Unpublished articles, reports, monographs, and conference presentations in the ‘grey literature’ were identified through websites and contacts with key researchers in New Zealand and Australia. We also obtained and analysed de-identified data from ACC on new and active claims relating to NIHL together with information on the age, gender, ethnicity, and occupational group of claimants.

The data from each of these sources was summarised with a particular focus on information that provided population-based estimates of NIHL, and attention to the quality and reliability of these data, where this information was available.

Poisson regression was used to investigate whether the relationship of age with the probability of making an ACC claim had changed over time. The outcome was the number of claims, with the population as an offset and age, year and their interaction included as explanatory variables.

Results

There is very little published data on NIHL in New Zealand and there are few reports that specifically address its prevalence in the community.

Population surveys—In an overall occupational health survey of 381 farmers in Southland, it was reported that 11.6% (17.1% men; 1.5% women) had NIHL. This high prevalence rate is consistent with the noise levels experienced by agricultural workers and ACC data discussed below. Estimates of the prevalence of hearing loss, from any cause, in the New Zealand population have been derived by extrapolating data from overseas studies or from New Zealand Census data collected in 1991, 1996, and 2001.

Overall, 10–13% of the population are estimated to have significant hearing impairment with a higher prevalence in men. It is estimated that in New Zealand between 30% and 50% of the prevalence of hearing loss in adults can be attributed to noise exposure during a lifetime, which is comparable with the estimates in Australia of 38%.

Greville further suggests that the reduction in the number of people working in potentially noisy occupations (for example from 45% in 1981 to 36% in 1996) should result in a decrease in the incidence of NIHL due to occupational noise.

Notifiable occupational disease system (NODS)—Noise-induced hearing loss is a category within the NODS, a voluntary register maintained by the Department of Labour Occupational Health and Safety Service.

From 1992 to 1998, 2411 cases (95% male) of NIHL were reported to this register, with a further 709 notifications from 1998 to 2000. Collectively, NIHL accounted for approximately one-third of the occupational disease notifications during the period 1992–2000, a condition surpassed in frequency only by ‘occupational overuse syndrome/osteoarthritis’. However, as with most other voluntary reporting systems, this database is unlikely to provide a reliable indication of the prevalence of occupational NIHL at a population level.

Accident Compensation Corporation of New Zealand (ACC) Database: 1995–2006—The ACC maintains a database of successful claims for NIHL within New Zealand—a routinely collected administrative data source that has the potential to provide estimates of NIHL in the community. An analysis of ACC data indicates a steady rise in new claims from July 1995 to June 2006 (Figure 1). The numbers of new claims incurring a cost to ACC in 2005–6 (5580 cases) were approximately double the figure in 1995–1996 (2823). The ongoing claims include provision of
batteries as well as replacement or new hearing aids. The detail of the ongoing claims was not analysed further.

**Figure 1. The number and the cost of new and ongoing ACC claims annually between July 1995 and June 2006.**

The ACC compensation costs associated with the 44,106 new claims for NIHL over the study period was $89.94 million. With the ongoing NIHL rehabilitation costs, ACC has paid $193.82 million since 1995. The cost of new claims to ACC has increased by an average of 20% each year over the last decade. The 5580 claims in the 2005–2006 financial year accounted for just over $14 million representing an average first year cost of $2540 per claim (Figure 1). Over the same period, a further $38.8 million was spent on 17,871 ongoing claims for compensation and rehabilitation costs, leading to an overall cost directly related to NIHL in 2005–2006 of almost $53.06 million.

Agriculture and fisheries workers, plant and machine operators, labourers, and trade workers were the most common groups of the claimants based on the occupational category of individuals at the time of lodging the claim (Figure 2). Collectively, these groups accounted for over 50% of the claims (excluding the proportion where occupational group is not recorded). This finding is consistent with the recognised risk of exposure to high noise levels in these industries. While these groups, in general, featured in similar proportions across the analysis period, there appeared to be an increase in the proportion of professional groups among claimants, largely due to an increase in claims from engineering professionals. Of concern, however, the occupational group was unknown or not recorded for over 30% of the ACC claimants.
Figure 2. Distribution of new ACC claims by occupational categories for the period between July 1995 and June 2006. The occupational categories have been collapsed into a smaller number representing managerial, professional, clerical and trades for clarity

Approximately 95% of claims were made by men. The vast majority of new claims on the database related to people aged in their 50s and beyond, with increasing numbers among those nearing retirement age (Figure 3). Interestingly, the age distribution profile of new claims has shifted towards an older age group over the past decade (Figure 4). The difference in the probability of people in different age groups making a claim changed across time (p<0.0001) with rates in the older age groups increasing more over the 11 years than in the younger age groups.
Figure 3. The distribution of new and ongoing ACC claims across age for males and females for the period July 1995 to June 2006. The trendlines were calculated using a $6^{\text{th}}$-order polynomial.

Figure 4. The rate of new ACC claims (rate per 100,000 population) across age for 6 years (1996, 1998, 2000, 2002, 2004, 2006)

The ethnic group was unknown or not recorded for 9% of claimants. Of the remainder the ethnicity of claimants—as coded in this database—was predominantly European/Pākehā (86%) with relatively few identified as Māori (5%) and Pacific peoples (1%) (Table 1).
For males 45 years and older (as most of the claimants were in this age bracket) approximately 7% of the population are Māori and 3% Pacific peoples.\textsuperscript{27}

Table 1. The percentage of new ACC claims broken down by ethnic group according to ACC classification

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>% Claims (1995–2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pākehā/European</td>
<td>78.02</td>
</tr>
<tr>
<td>New Zealand Māori</td>
<td>4.32</td>
</tr>
<tr>
<td>Pacific peoples*</td>
<td>0.97</td>
</tr>
<tr>
<td>Asian</td>
<td>0.30</td>
</tr>
<tr>
<td>Other</td>
<td>7.04</td>
</tr>
<tr>
<td>Unknown</td>
<td>9.35</td>
</tr>
</tbody>
</table>

*Mostly of Samoan, Tongan, Niuean, or Cook Islands origin.

Discussion

The most recent information from the ACC database indicates that about 15 New Zealanders successfully claim compensation for a new case of NIHL each day, and the costs associated with compensation and rehabilitation have increased considerably over the past decade. For several reasons—including the potential for inadequate screening and detection in the community—selection biases in administrative databases, and changes in reporting and coding practices, the apparent increase in the annual number of new claims of NIHL in the ACC database over the past decade may not accurately reflect trends in the population-based incidence of NIHL. The findings, however, point to an indisputably high cost to ACC, government, and society as a result of a theoretically preventable condition.

Despite the substantial burden, this review revealed a remarkable lack of robust data on the epidemiology of NIHL in New Zealand. Based on the census and linked disability surveys, the estimated prevalence of hearing loss (overall) resulting in disability (10%) in New Zealand\textsuperscript{13,24} is similar to the lower end of the range of prevalence estimates in other high-income countries. For example, the National Institute on Deafness and Communication Disorders\textsuperscript{28} has estimated that the population prevalence of hearing loss in the USA is about 10% with about 3–4% due to noise exposure. This is compared with a prevalence of hearing loss of about 14% (in the better hearing ear) in the United Kingdom\textsuperscript{29} and of 17% in Australia, with approximately 6% due to noise.\textsuperscript{17}

No equivalent population-based information was available for NIHL in New Zealand. Although the 2001/2 national disability survey sought information on the causes of hearing loss (where present), noise was not specified as a potential origin. The apparent inadequacies of available data are mirrored internationally, and reflect difficulties in defining the cause of hearing loss (if a single source was likely), differences in the criteria used to define hearing loss in surveys, and changes over time in the exposure to ambient noise, e.g. due to interventions within industry.

Nevertheless, the World Health Organization estimated that at a global level occupational noise exposure was the cause of the hearing impairment in one-sixth
(16%) of those people with a moderate or greater hearing loss. A US study assessed the contribution of occupational noise exposure to total deafness rates as approximately 7% in the most developed nations and 21% in developing regions.

Although the overall burden remains uncertain, the analysis of ACC data revealed that a relatively high proportion of claims were lodged by workers in the agricultural, building, and manufacturing sectors, as well as plant and machinery operators. Overall this is consistent with the estimated prevalence of hearing loss (from all causes) in different New Zealand occupations (based on the 2001/2 Disability Survey), which is relatively high in those employed in the construction (11.1%) and manufacturing (6.4%) industries.

In contrast, the prevalence of hearing loss (overall) among those employed in the agriculture, forestry and fisheries group was lower (3.8%), which may suggest a difference in motivation to claim for NIHL among the different occupational groups. It should be noted, however, that the latter survey did not seek information on the history of noise exposure or previous occupations that may have been relevant to the loss of hearing. Furthermore, the figures represented are likely to be influenced by the age distributions of the labour force involved.

In general, a third or more of new claims for NIHL were made by people older than the usual retirement age in New Zealand. Based on the data available, we could not determine if this primarily reflected the latent period between the onset of hearing loss and its appreciation by the claimant to a point where assistance is sought, an interaction between NIHL and age-related hearing loss, or both. The relative contributions of these factors and their relationship to the age profile of NIHL claims require further investigation.

The low representation of claimants of Māori and Pacific ethnicity raise particular concerns with regard to the potential biases of these data. Notwithstanding the relatively younger age distribution of these populations relative to New Zealand Europeans (and therefore the lower risks of NIHL from an age perspective), both Māori and Pacific peoples are over-represented in many industries where noise exposure is higher. Furthermore, Māori have a higher prevalence of hearing loss (overall) across age groups.

Explanations for the lower than expected claims from these ethnic groups could include the quality of ethnicity coding in the ACC database (which does not currently employ the recommended New Zealand Ethnicity Protocol), limited screening and diagnosis of NIHL of these groups in the community, and barriers to accessing healthcare and ACC services. The 2001/2 national disability survey noted that despite their higher prevalence of hearing loss resulting in disability, Māori adults were only half as likely as non-Māori to use hearing aids or other assistive listening devices.

Without reliable information regarding changes in exposure to ambient noise over time in major industries and given uncertainties regarding the population-based incidence and prevalence estimates, it is difficult to interpret the apparent increase in numbers of new compensation claims in New Zealand. It is not possible to reliably determine if this reflects greater exposure to hazardous levels of ambient noise at work and elsewhere over recent decades, artefacts of surveillance (e.g. increasing awareness and screening for hearing loss, diagnostic and reporting trends, and
changes in ACC compensation criteria), or other explanations such as the improvement in hearing technologies and uptake of hearing aids.

In the absence of better knowledge regarding the underlying determinants, it is also difficult to reliably project future trends in the burden of NIHL. As noted by Greville,\textsuperscript{24} it could be argued that as the number of people working in traditionally noisy industries in New Zealand declines, the number of individuals developing hearing loss from noise exposure should, at least theoretically, diminish. This possibility requires more detailed examination, particularly as noise levels may be increasing in “non-traditional” industries (e.g. hospitality and education environments) and the decline in worker numbers may not be occurring equally across industries with high NIHL incidence rates.

Furthermore, the apparent increase in the rate of new claims in older age groups over the 1996–2006 period is not associated with a decline in rate of new claimants in younger age groups. This is not consistent with a decline in NIHL claims in the near future. In a context where increasing numbers (and proportions) of claimants are of older age, distinguishing real shifts in the age of onset of NIHL due to changes in exposure to noise from age-related hearing loss is problematic. This is compounded by other temporal changes in factors relating to claimants and providers such as increasing public awareness of NIHL, increasing availability of audiology services and access to more effective hearing aids. These issues require exploration using focused studies that are not limited to claims data.

Given the many uncertainties but major public health significance of NIHL, there is a critical need for dedicated surveys of workers in different industries including audiometric assessments of hearing. These data would provide more robust information to estimate the current burden and future trends of occupationally-mediated NIHL. The impact of non-occupational noise exposure (e.g. shooting and loud music) should also be considered, acknowledging the value of blurring the distinction between on and off-work injuries\textsuperscript{32,33} when considering the determinants of NIHL and opportunities for prevention.

New Zealand and many other high-income countries have implemented strategies of varying intensity to reduce the incidence of NIHL. These efforts have been lauded as successful in some countries such as the UK and Finland where the numbers of cases of NIHL and claims for compensation have declined steadily.\textsuperscript{34} In contrast, this burden is estimated to be increasing in other European countries such as The Netherlands.\textsuperscript{34} Also the European Agency for Safety and Health at Work reports an increase in the proportion of workers who report hearing problems because of noise in the workplace.

The European Agency for Safety and Health at Work reports an increase in the proportion of workers who report hearing problems because of noise in the workplace.\textsuperscript{34} The data underlying these contradictory assertions must be examined with caution given differences in the data collected, definitions of NIHL and criteria for compensation across countries and over time. Regardless of these caveats, noise exposure is an occupational hazard and interventions are required in industry to reduce its effects on hearing.
To address the significant burden of NIHL in New Zealand, a more rigorous population health approach to identify and monitor outcomes and investigate and address antecedent causes is essential. In a recent review of the best-practice approaches for NIHL prevention we identified a shift internationally towards hearing loss prevention and noise management approaches rather than the more passive hearing conservation approach. Furthermore, it was clear that these interventions can only be effective if there is strong management support and commitment, consistent high quality noise and audiology monitoring and strict adherence to the use of hearing protectors. Sole reliance on the use of hearing protectors as the main means of protection against NIHL is unlikely to deliver the expected outcome.

It is encouraging that in New Zealand, ACC, and the Department of Labour along with the Health Research Council of New Zealand have identified NIHL as a priority occupational condition and are working with industry, researchers and the community to understand the epidemiology of the problem in this country and develop better interventions.

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