Are hearing losses among young Māori different to those found in the young NZ European population?

Janet E Digby, Suzanne C Purdy, Andrea S Kelly, David Welch, Peter R Thorne

Abstract

Aim This study was undertaken to determine if young Māori have more permanent bilateral hearing loss, or less severe and profound hearing loss than New Zealand (NZ) Europeans.

Methods Data include hearing-impaired children from birth to 19 years of age from the New Zealand Deafness Notification Database (DND) and covering the periods 1982–2005 and 2009–2013. These were retrospectively analysed, as was information on children and young people with cochlear implants.

Results Young Māori are more likely to be diagnosed with permanent hearing loss greater than 26 dB HL, averaged across speech frequencies, with 39–43% of hearing loss notifications listed as Māori. Māori have a lower prevalence of severe/profound losses (n=1571, chi squared=22.08, p=0.01) but significantly more bilateral losses than their NZ European peers (n=595, Chi-squared=9.05, p=0.01). The difference in severity profile is supported by cochlear implant data showing Māori are less likely to receive a cochlear implant.

Conclusions There are significant differences in the proportion of bilateral (compared to unilateral) losses and in the rates and severity profile of hearing loss among young Māori when compared with their NZ European peers. This has implications for screening and other hearing services in NZ.

Based on overseas data, permanent hearing loss in children and young people is thought to affect approximately 3 to 5 children and young people in every 1000 in high income countries, and up to 25 of every 1000 in low income countries.¹ ²

Permanent hearing losses include those which are sensorineural (related to disease or injury in the inner ear and auditory nerve), conductive (related to disease or injury in the outer or middle ear) or mixed (sensorineural/conductive) in origin. Transient losses such as those associated with otitis media are excluded from this definition.

While modern technology and educational support can now ameliorate some of the effects of hearing loss, late detection has a significant effect on children’s ability to learn language, their participation in education and their social inclusion.³

Moderate and mild hearing losses are diagnosed later, on average, than more severe hearing losses, even with the advent of newborn hearing screening.⁴ ⁵ There is some evidence that children with mild hearing loss perform more poorly socially and educationally.⁶

Understanding differences in prevalence with respect to population demographics is helpful for the development of appropriate screening, diagnostic and intervention policies and practices, which ensure early detection and allow more effective
intervention. However, no prevalence or epidemiological research has been undertaken to confirm whether there is indeed a difference in the prevalence and severity profile of Māori and New Zealand (NZ) Europeans or whether differences in service provision exist. As a result, public health officials and those working with hearing-impaired children are unsure whether the burden of disease is spread evenly in the population, or whether some ethnic groups may be more likely to present with hearing loss.  

A number of general research and monitoring sources, described below, point to a possible difference in prevalence of permanent hearing loss between Māori and other ethnic groups.  

These include four Household Disability Surveys between 1991 and 2006 which sampled a subset of individuals of all ages responding to the New Zealand Census and asked basic questions about hearing loss. (These surveys defined people ‘who have difficulty hearing or cannot hear what is said in a conversation with one other person and/or a conversation with at least three other people’ as being deaf or hearing impaired.)  

The surveys indicated that Māori have higher rates of hearing loss and higher rates of unmet need for technology and equipment when compared with non-Māori. Although the surveys provide some information about hearing loss in the New Zealand population, there are a number of limitations with this data as the surveys are quite general, not age specific and categorise hearing disability in different ways.  

The B4 School Check data also suggest the possibility of higher rates of hearing loss (of all types) among Māori. The B4 School Check aims to screen all children before they reach school, and to identify and provide intervention to those children identified with the targeted conditions, including hearing loss.  

The programme aims to screen the hearing of all children not already under the care of an otolaryngologist or audiologist following their fourth birthday. Those not screened before they reach school should be screened after they start school. This screening involves pure tone audiometry, usually conducted by a Vision Hearing Technician. If the child passes this test, no further referrals are required. Should the child be referred on the audiometry screening, tympanometry is also conducted.  

Searchfield, Bae and Crisp examined data from B4 School Checks completed in 2011 and found higher rates of referral from hearing screening for Māori children (9%) compared with non-Māori (5%). It is important to note that high referral rates for Māori may be the result of higher rates of middle ear disease as not all children who ‘refer’ on the B4 School Check hearing screen will be diagnosed with a permanent hearing loss.  

Finally, data from New Zealand’s Universal Newborn Hearing Screening and Early Intervention Programme (UNHSEIP) can be examined to see whether ethnic differences exist. Implementation of this programme began in 2007 and the last eight district health boards (DHBs) to be included within the roll-out began screening between July 2009 and July 2010. The large Auckland DHBs (Counties Manukau, Waitakere and Auckland) had all begun screening by April 2010.
Referral data reported from the UNHSEIP show 2.7% of Māori babies were referred as a result of a positive screen between April 2012 and December 2012, the most recent period for which data are available.\textsuperscript{12} This is double the 1.3% referral rate for those of NZ European ethnicity. This may be due to higher prevalence of middle ear problems among Māori children\textsuperscript{13,14} when compared with their NZ European counterparts, although it is possible that this difference reflects differences in rates of permanent hearing loss.

Only 57\% of diagnostic data were available to describe outcomes for children referred through the UNHSEIP during this period. These data show 13.8\% of Māori babies for whom audiological assessments were completed were diagnosed with permanent hearing losses, compared with 10.8\% of NZ European children (n=198). These data are difficult to interpret due to the low reporting rates, however they show that the higher rates of referral from the newborn hearing screen do flow through to diagnoses of permanent hearing losses.

The role of cytomegalovirus in the aetiology of deafness among New Zealand children and young people is also yet to be investigated, although overseas studies show this contributes to approximately 10–20\% of childhood deafness before the age of 5 years.\textsuperscript{15} The New Zealand data suggest differences in exposure to cytomegalovirus among different racial groups, with serologic data in 3 year olds showing highest exposure in Māori and Pacific Island groups.\textsuperscript{16}

To determine potential differences in hearing loss prevalence and severity between Māori and NZ Europeans, we analysed cases contained in the New Zealand Deafness Notification Database (DND) and children implanted by the Northern Cochlear Implant Programme which is the public provider for cochlear implants for all children and young people living in areas north of Taupo.

\section*{Method}

The DND was New Zealand’s annual reporting system from 1982 to 2005 and between 2010 and the present day for new cases of permanent sensorineural, conductive or mixed hearing loss among those under 18 years old.

The database was managed initially by the National Audiology Centre, then the Auckland District Health Board. It was not in operation from 2006–2009, due to a pause in Ministry of Health funding but it was restarted in 2010 by the New Zealand Audiological Society and has been funded by the Ministry of Health since 2012.

All notifications are provided by audiologists, originally through a paper form and more recently using an on-line process. Notifications since 2010 have used a refined set of inclusion criteria. Children born overseas and unilateral hearing losses are now included in the database, reflecting an improved understanding of the importance of unilateral hearing losses\textsuperscript{17} and acknowledging the potential impact of immigration on deafness statistics.\textsuperscript{18}

It is thought that the majority of new cases of hearing loss were notified to the database during the time periods under consideration, but the exact proportion cannot be calculated because of the lack of specific local prevalence rates, by age, for permanent hearing loss.

Throughout its operation the DND has been the only nationwide source of local information from which the prevalence of permanent hearing loss among young people may be estimated, and from which the characteristics of hearing loss among these young people can be understood.

Originally, the database categorised cases by ‘race’, and later this was shifted to ‘ethnicity’. The earlier notification form allowed only one code per case and these codes have been further grouped into the following categories: NZ European, Māori, Pacific Island, Asian, Other or Unknown.
Notifications to the current database are already coded in this way. Only data from those cases recorded as Māori and NZ European are reported here.

The original database (1982–2005) contained records which did not meet the criteria applied to the database at the time (e.g. some unilateral losses were included as were acquired losses and some born overseas) and as a result, some cases from this database were removed. This decision was made on the basis that, even if the criteria were not always applied, they would have been for some unknown proportion of cases. Hence it is better to exclude all cases not meeting the official inclusion criteria in place at that time. The reduced dataset does not differ materially from the original, larger dataset, including the proportion of notifications belonging to Māori and NZ European groups.

Key characteristics of the two datasets can be found in Table 1.

Table 1. The proportion of cases analysed in the two datasets compared with the population of the 1982-2005 datasets

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Age range</td>
<td>Between zero and 18 years of age at diagnosis</td>
<td>Between zero and 19 years of age at diagnosis</td>
</tr>
<tr>
<td>Unilateral</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Bilateral</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Acquired</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Severity</td>
<td>Mild (26–40 dB HL), moderate (41–65 dB HL), severe (66–95 dB HL) and profound (&gt;95 dB HL) hearing losses</td>
<td>Recoded where 4 thresholds available to match most recent codeframe used in 1982–2005 dataset</td>
</tr>
<tr>
<td>Method of notification</td>
<td>Mailed paper notification forms</td>
<td>Online notifications</td>
</tr>
<tr>
<td>Sample with complete ethnicity data</td>
<td>n=1692</td>
<td>n=763</td>
</tr>
<tr>
<td>Sample with ethnicity and severity data</td>
<td>n=1265</td>
<td>n=306</td>
</tr>
</tbody>
</table>

Over recent years, evidence for the detrimental developmental effects of mild and moderate hearing losses has increased⁹,¹⁰ and this may have led audiologists to become increasingly aware of the need to notify mild and moderate hearing losses during the database’s operation.

In addition, the length of time it takes to identify mild and moderate hearing losses is likely to also be a key difference in the later dataset (2009–2013) which contains more children and young people whose hearing loss was diagnosed early when compared with the earlier 1982–2005 dataset, due in large part to the introduction of newborn hearing screening.

Ethnicity data for 294 children and young people from the Northern Cochlear Implant Programme (NCIP) were also analysed. These data include the vast majority of children and young people who have received a cochlear implant in the northern region of New Zealand (an area covering approximately half the New Zealand population) since the first implant was provided to a child, in 1989. Data from the Southern Programme were not included as these contain incomplete ethnicity information.

Results

Table 2 compares the proportion of notifications of NZ European and Māori ethnicities from the 1982–2005 and 2009–2013 datasets, with the proportion of these ethnicities contained in Census data from Statistics New Zealand (taken from 1996 and 2006 to provide an indication for the time period under consideration).
Table 2. Proportion of cases in the two datasets by ethnicity compared with the population

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>NZ European Māori</td>
<td>40% 39% n=1692</td>
<td>63% 24%</td>
<td>49% 43% n=763</td>
<td>62% 22%</td>
</tr>
</tbody>
</table>

A Chi-squared analysis was conducted on a merged dataset containing records from 1982–2005 and 2009–2013 to determine whether differences exist between NZ European (n=775) and Māori groups (n=796) in terms of their severity of hearing loss profile.

The analysis shows (Table 4) significant differences; Māori are less likely to be severely or profoundly hearing impaired and are more likely to have mild-moderate hearing loss when compared to their NZ European counterparts (n=1571, Chi-squared=22.08, p=0.01). Figure 1 shows the number of cases in each of the groups.

One way to better understand severity of hearing losses among children and young people in the population is to compare the proportion of Māori and NZ European groups who have been provided with cochlear implants.

Cochlear implants have typically been provided to children with profound hearing loss, although in recent years children with less severe losses have been implanted in cases where the child is not receiving adequate benefit from hearing aids, including in cases of Auditory Neuropathy Spectrum Disorder (ANSD).

A clinical team comprising the child’s surgeon, their audiologist, habilitationist and counsellor make candidacy decisions based on a set of considerations. The ratio of children recorded as Māori: NZ European within the current 2009–2013 DND was therefore compared to the ratio of children with cochlear implants.

Fewer Māori children and young people in the Northern region have cochlear implants (1:1.79 Māori:NZ European) than exist in the 2009–2013 DND (1:1.49 Māori:NZ European). The relatively low number of implants provided to Māori children and young people by the Northern Cochlear Implant Programme may reflect differences in the way Māori access these services, differences in intervention choices and/or the smaller numbers of more severe hearing losses among young Māori.
Māori children and young people are more likely than their NZ European contemporaries to have bilateral hearing loss. An analysis of the current DND (2009–2013) showed a higher proportion of bilateral compared to unilateral hearing losses in Māori than in NZ European (n=595, Chi-squared=9.05, p=0.01; Table 4). (Unilateral losses were not consistently reported in the earlier database as only bilateral hearing losses met the inclusion criteria for this database.)

Table 3. Percentage of bilateral and unilateral hearing losses in 2009–2013 DND, categorised by ethnicity

<table>
<thead>
<tr>
<th>Samples</th>
<th>Percentage bilateral</th>
<th>Percentage unilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZ European (n=211)</td>
<td>61%</td>
<td>39%</td>
</tr>
<tr>
<td>Māori (n=338)</td>
<td>81%</td>
<td>19%</td>
</tr>
<tr>
<td>Both ethnicities (n=46)</td>
<td>77%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Discussion

The majority of notifications to both databases were from children and young people recorded as NZ European or Māori. Proportionately greater numbers of notifications were recorded as Māori than in the demographics of the NZ population. The data were only analysed for Māori and NZ European as these comprised the majority of records in both databases.
The other coded ethnicities (Pacific Island and Asian) as well as those that had no known ethnicity data were too small in number to analyse in detail and therefore these are not included in this analysis.

The numbers of Pacific Island children in the database is considerably smaller than those of Māori and/or NZ European. Rates of hearing loss among this group are 9.8% for the 1982–2005 dataset and 11% for the 2009–2013 dataset. These figures are similar to the proportions (7.5% and 11%) of Pacific Island young people the NZ population under 20 years of age in similar periods. This finding is however difficult to interpret due to the small number of cases in this group.

Māori may be underrepresented in the DND due to the higher proportion of milder hearing losses which are more likely to go undiagnosed, or be diagnosed late. If this is the case, then Māori may have even higher rates of hearing loss than suggested by this analysis. It may also be that disparities in access to, and through, the health system could have concealed cases from the database.

Systemic disparities in health outcomes, differences in exposure to the determinants of health, and poorer health system responsiveness in Māori and Pasifika groups compared with the NZ European population may also be factors influencing deafness statistics.

Furthermore, factors such as maternal health have already been found to contribute to significant differences in the prevalence of other conditions between Māori and NZ Europeans, suggesting that other health disparities may also contribute to differences in hearing loss statistics. Differences in hearing loss prevalence between various ethnicities have been reported in overseas studies.

The DND is a national database that receives notifications from audiologists throughout the country, but because there are no epidemiological data available it is not possible to determine how accurately the database reflects the number of children with hearing losses throughout New Zealand.

There is no mandated reporting and so it is up to individual audiologists to provide the information and to do so accurately. Audiologists around the country are reminded regularly to complete the forms and there is an iterative process to query data which is incomplete or contradictory. There is an ongoing focus to try to increase the proportion of new diagnoses meeting the database criteria that are notified to the database. This is difficult as there are no data available to allow calculations of the number of notifications which may be missing in a given year.

Notifications within the 1982–2005 dataset were classified by birth hospital and/or area making regional differences difficult to detect. The 2009–2013 dataset shows that those DHB areas with higher numbers of notifications than their population would suggest are those DHBs with a higher proportion of Māori and/or Pacific populations (e.g. Counties Manukau, Northland, Bay of Plenty, Tairawhiti), however some DHBs are not contributing notifications to the database at the expected rate, and so no conclusions can yet be drawn from these differences.

Both DND datasets contain severity data which are consistent with international evidence that, for high income countries, permanent mild and moderate hearing losses are much more prevalent than severe and profound hearing losses. The significant
difference in the severity profiles evident in the DND database may be due to a genetic preponderance of more mild degrees of hearing loss among Māori, or because middle ear problems which are more likely among Māori are thought to result in milder degrees of sensorineural hearing loss over time.

It is also possible that some of the older children have permanent conductive hearing loss resulting from repeated bouts of otitis media and this could be more prevalent in Māori, who have higher rates of middle ear disease than NZ Europeans. The cause of hearing losses contained in the 1982–2005 dataset cannot be determined and this information is not independently verified in the 2009–2013 dataset.

One way to validate the hearing loss severity profile evident in the NZ DND is to compare the NZ European data to another similar population. Severity data coded using similar criteria were available for another largely European population containing bilateral hearing losses from Colorado, as in Table 4. The Colorado sample received intervention services at some point between birth and the age of three years. The Colorado data shows a similar severity profile to the current NZ European group.

Table 4. Hearing loss severity profiles in New Zealand compared with Colorado, United States (Personal communication, Allison Sedey, 13 February 2014.)

<table>
<thead>
<tr>
<th>Samples used</th>
<th>1982–2005 bilateral deafness notifications, born in NZ, under the age of 18</th>
<th>Hearing impaired children in Colorado who received early intervention services between birth and 3 years</th>
<th>Born 2006 to 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NZ Māori</td>
<td>European</td>
<td></td>
</tr>
<tr>
<td>Mild (26–40dB HL)</td>
<td>331</td>
<td>270</td>
<td>99</td>
</tr>
<tr>
<td>Moderate (41–65 dB HL NZ, 41–70 dB HL Colorado)</td>
<td>214</td>
<td>240</td>
<td>102</td>
</tr>
<tr>
<td>Severe and profound (&gt;66 dB NZ and &gt;70 dB HL Colorado)</td>
<td>79</td>
<td>131</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td>624</td>
<td>641</td>
<td>268</td>
</tr>
</tbody>
</table>

Evidence that Māori children have a higher prevalence of mild-moderate hearing loss is important for both the New Zealand Universal Newborn Hearing Screening and Early Intervention Programme and for the B4 School Check.

Future reviews of the newborn hearing screening protocols should consider this evidence, looking for ways to minimise disadvantage for Māori, particularly as current screening technologies are not currently able to consistently identify mild hearing losses. The B4 School Check should also consider this evidence when reviewing the hearing level below which a child passes their hearing screen.

Families may have less understanding of the impact of mild and moderate hearing losses, as affected children may appear to hear some of the time in advantageous listening conditions, particularly at home. This may influence whether families will treat the condition seriously and, for example, support the use of hearing aids which improve speech and language outcomes for children with mild hearing loss when fitted early and appropriately.
Thus, detection of mild hearing losses via screening should be supported by good education programmes and appropriate habilitation options for families.

The analysis of the more recent DND dataset, which includes both unilateral and bilateral notifications, showed significantly higher rates of bilateral hearing losses among Māori (and lower rates of unilateral hearing losses) compared with their NZ European counterparts.

The 3.34:1 ratio found in the current study is higher than previous reports from overseas, which show varying ratios of bilateral:unilateral hearing loss from 2.6:1\textsuperscript{29} to 0.78:1.\textsuperscript{30} Sample differences and different definitions of unilateral hearing loss are likely to contribute to this variation in the literature, making it difficult to draw conclusions about population differences.

This paper describes broad differences in hearing losses between NZ European and Māori children and young people, across a range of aetiologies. Different patterns are likely to emerge when examining smaller groups, such as those children with microtia or atresia, for example.

Understanding of the genetic causes of deafness has developed significantly in recent years. Mutations in the connexin 26 gene are known to be responsible for a significant proportion of cases of prelingual non-syndromic deafness.\textsuperscript{32}

Previous studies have shown variations in the carriage rate of these mutations in different populations and there may be differences between people of Māori and NZ European descent which could be investigated.\textsuperscript{33}

As knowledge of genetic causes of hearing loss grows further, genetic testing following a diagnosis of hearing loss is becoming more commonplace but is still not universally undertaken and there may be differences across populations in acceptance of this testing. There are also many cases of hearing loss which are not explained by current genetic models.

There are systemic disparities in health outcomes, differences in exposure to the determinants of health, and poorer health system responsiveness for Māori when compared with the NZ European population.\textsuperscript{24}

Understanding differences in prevalence among ethnic groups is important to aid in the early detection of and effective intervention for children and young people with hearing loss. The improved understanding of ethnic differences may assist in improving policies and practice associated with the detection of and intervention for children and young people with hearing loss.

This analysis confirms the value of the DND in helping to improve understanding of the rates and severity of hearing loss among various groups. The DND is important as it enables understanding of the type and characteristics of hearing losses diagnosed in New Zealand children and young people. These data assist public health professionals, clinician managers and medicos to identify and plan services for children and young people identified with hearing loss.

All degrees of hearing loss, from mild to profound, can have a significant impact on learning, behaviour and the psychosocial wellbeing of children and young people and hence it is important that parents and health professionals should be encouraged to
refer children of any age with suspected hearing loss to audiological services for a complete diagnostic assessment.

**Competing interests:** Janet Digby currently manages the Deafness Notification Database for Accessable which manages this in turn for the Ministry of Health.

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**References:**


Appendix 1. Exclusions from the dataset

The table below contains the number of cases in each of the categories which were excluded from the original and hence from this analysis. Some records were excluded for more than one reason and hence the number of excluded cases in each category does not sum to the total number of cases excluded.

Cases were included where either the audiometric data met the 26 dB HL average over four frequencies, or where the severity level had been coded separately and was listed as mild or greater based on the codeframe used between 1996 and 2005 (mild losses within this codeframe start at a 26 dB HL average).

Reasons for excluding cases from the 1982–2005 dataset

<table>
<thead>
<tr>
<th>Types of records excluded from the 1982–2005 dataset</th>
<th>Number excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial number of records</td>
<td>5025</td>
</tr>
<tr>
<td>Duplicates</td>
<td>163</td>
</tr>
<tr>
<td>Outside years of operation of database (1982–2005)</td>
<td>576</td>
</tr>
<tr>
<td>Number excluded as they did not contain a year of confirmation</td>
<td>146</td>
</tr>
<tr>
<td>Born overseas</td>
<td>426</td>
</tr>
<tr>
<td>Ethnicity listed as other than Māori or NZ European</td>
<td>745</td>
</tr>
<tr>
<td>Missing ethnicity information or unknown ethnicity</td>
<td>982</td>
</tr>
<tr>
<td>Acquired hearing losses</td>
<td>216</td>
</tr>
<tr>
<td>Unilateral hearing losses</td>
<td>2557</td>
</tr>
<tr>
<td>Outside the severity range for the database (mild to profound) and missing or incomplete severity information (n=1215)</td>
<td>2413</td>
</tr>
<tr>
<td>Outside the database’s age range of 0–18 years</td>
<td>12</td>
</tr>
<tr>
<td>Total cases included in main analysis</td>
<td>1265</td>
</tr>
</tbody>
</table>