Audit of the Southern DHB B4 School hearing screening referral process: is there unmet need?

Thomas Oliver, Paul Joice, Patrick JD Dawes

ABSTRACT

AIM: The B4 School Check aims for early detection and appropriate management of hearing loss prior to school entry. In light of increasing awareness of inequitable health outcomes across a variety of measures in Aotearoa New Zealand, particularly for Māori and Pasifika, we performed an audit of B4 School screening hearing related referrals.

METHOD: For the census year 2018, we examined the hearing screening data for age, gender, ethnicity, region and locality. For those children whose screening triggered a referral, the district health board (DHB) record was examined to assess whether a referral was received by the public audiology or otolaryngology head and neck surgery (ORLHNS) departments and if any appointment was subsequently attended.

RESULTS: For Otago, but not Southland, there was a mismatch between census and screening programme estimates of the number of children eligible for screening. Māori and Pasifika children were significantly less likely to pass the screening tests (p<.00001) compared to other ethnicities. Referral rates were not significantly different among ethnic groups, but Pasifika children were significantly less likely be assessed by an audiologist or otolaryngologist (p<0.004). Despite an equal distribution of screening and referral, significantly more Māori and Pasifika children will start primary school with potential hearing impairment compared to other ethnicities.

CONCLUSION: While the Southern DHB B4 School hearing screening programme is equal in capturing children of different backgrounds, it demonstrates a greater prevalence of potential hearing impairment among Māori and Pasifika children when entering primary school. This raises the need to consider how to better provide ongoing care for these children.

Early detection and appropriate management of childhood ear disease and hearing loss ensures children have the best opportunities to achieve optimal language development, mitigates potential complications of unmanaged ear disease and assists learning and progress in education.

Paediatric hearing screening programmes have been developed in many countries around the world with the aim of identifying children with ear disease and enabling appropriate intervention as required. In Aotearoa New Zealand, formal hearing screening occurs at two age points—the newborn hearing screening programme at birth and the B4 School Check at 4 years of age.

The B4 School Check is a broad screening for multiple health, developmental and behavioural problems that may have a negative impact on a child’s ability to learn and take part at school. Children are identified from national databases, including the ENROL database, which includes every child enrolled to attend school in the country. All children in our region, aged 4, who are enrolled in preschool (including home-based) care are referred to the programme for hearing and vision screening, and this is cross-referenced against the national database. The ENROL database is then cross-referenced again so any children not identified at age 4 who are subsequently attending school are then captured in their first school year. All children identified are offered hearing screening unless they are reported to be under the care of an audiologist or otolaryngologist.

The hearing component of the screen consists of pure tone audiometry at 0.5, 1, 2 and 4 kHz, and tympanometry. Findings suggestive of a sensorineural hearing loss with thresholds of at least 40dBHL (decibels hearing level) prompt a referral to an audiologist, while children whose findings are suggestive of conductive loss (i.e., type B tympanometry), with thresholds of at least 40dBHL, are referred to their general practitioner (GP). If the child responds to tones at 40dBHL, but not at lower-intensity tones then they are rescreened three months later, and if they again do not pass they are referred to audiology or their GP as above. Any child who is unable to participate in the screen-
ing process, due to developmental, behavioural or other issues is referred to audiology directly.³

Health services (including the B4 School Check) across Aotearoa New Zealand were previously provided and funded by the 20 district health boards (DHBs), now defined as regions within Te Whatu Ora Health NZ. The Southern region covers the largest geographic area in the country but is relatively sparsely populated.

There are inequitable health outcomes across a variety of measures in our country, particularly for Māori and Pasifika and also for rural communities, where socio-economic deprivation can be higher and access to health services more difficult. It has been reported that Māori are over-represented among those children with chronic otitis media and the more serious sequelae of this disease.⁴,⁵ More recently it has been shown that despite having higher rates of hospital admission for otitis media, Māori and Pasifika children have lower rates of ventilation tube insertion.⁶ Interestingly, a recent study did not show any association between deprivation and chronic otitis media in Aotearoa New Zealand; however, this study looked at an urban population and was unable to account for rural locality.⁷

For a child who does not pass the B4 School hearing screening in the Southern region, the pathway to assessment by an audiologist or an otolaryngology head and neck surgeon (ORLHNS) can be convoluted. In the context of conductive loss, it typically requires attendance at and referral from a GP, and potentially significant travel; all with associated costs, which may disproportionately disadvantage some children. This creates opportunities for children to not progress through the system and ultimately miss out on appropriate and timely management of their ear disease and hearing loss.

To investigate whether there was evidence for children being lost through the screening and referral process, and whether it leads to inequitable outcomes, we conducted an audit of children in the Southern DHB (SDHB) region undergoing hearing checks under the B4 School programme.

Method
Ethics approval

Ethics approval was received from the University of Otago Ethics Committee for a minimal risk health research audit and audit-related study. Approval recognised that “data will be entered into an audit database in deidentified form from which further analysis will be performed. A separate database will record study number and NHI should data checking be required. This material will be stored in a password protected DHB hard drive”.

Participants

We examined the SDHB records of children who underwent hearing screening at age 4 between 1 January 2018 and 31 December 2018.

The 2018 Census data

Census data from the same year were retrieved and analysed to determine the total number of eligible children in the district and their demographic breakdown.⁸ This provided an estimate of the number of children who may not have been captured by the screening programme, and therefore not screened at all. Using Chi-squared analysis, differences (significance threshold p=0.05) were assessed between the two databases to determine if there was evidence of potential inequity amongst children being identified for screening.

Inclusion and exclusion criteria

All children and whānau who were contacted for hearing testing were entered into the database.

Audit protocol

Each child’s demographic data including age, gender, ethnicity, region (Otago or Southland) and locality (urban or rural, defined as living within the Dunedin or Invercargill city boundaries, or not) were collated. For those children whose hearing screening triggered a referral for further assessment, the DHB record was examined to assess whether a referral was ultimately received by the public audiology or ORLHNS departments (either directly from the screening programme or via the child’s GP) and if any appointment was subsequently attended. The private clinic records of all otolaryngologists practicing in the two regions were also assessed to determine if any referrals and assessments had been received and carried out, bypassing the public system. The clinical records in both public and private clinics were otherwise not further examined.

Data collection and analysis

The data were entered into a deidentified database from which further analysis was performed. Sub-group Chi-squared analysis was conducted
for each demographic dataset to explore differences in terms of screening pass rates, referrals received by tertiary services and patients actually seen in clinic by these specialty groups (audiology and/or ORLHNS).

Results

On census night in March 2018, 3,753 4-year-old children were identified as being usually resident in the Southern DHB region. The screening programme identified 3,406 4-year-old children for hearing screening that year, shown in Table 1. The table shows the population of 4-year-old children normally resident in the Southern DHB at the time of the 2018 Census, with demographic breakdown, by total number (n) and percentage. This is compared with the numbers of those in the hearing check database, and percentage relative to the number in that sub-group identified by the census. Statistical comparisons using Chi-squared analysis within each demographic are also shown.

Significantly more children in Otago (p=0.003) were identified in the census but not screened when compared with those in Southland. There was no difference between rural and urban populations. When analysing data from Otago alone, significantly more rural children were identified by the census than the screening programme compared with urban children (p=0.026). Significantly more Māori (p=0.0005) and Pacific (p=0.0016) children were identified on the census than underwent screening when compared with children of other ethnicities.

Figure 1 shows how children passed through the screening programme. Of those identified for hearing checks, 135 were reported to be under the care of either an audiologist or ORLHNS, and nine declined screening; 3,262 children proceeded for hearing checks. A total of 326 (10%) did not pass the screen and were referred to either audiology or their GP. Of these, 223 (68%) had at least one type B tympanogram, suggesting otitis media with effusion (OME).

Public audiology services and/or public and private ORLHNS services in the region received referrals for 207 of these children (63.5% of those who did not pass). Appointments were not

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Census</th>
<th>B4 School hearing screen</th>
<th>Potentially missed</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% (of total)</td>
<td>n</td>
<td>% (of census population)</td>
</tr>
<tr>
<td>Other</td>
<td>2,823</td>
<td>75</td>
<td>2,707</td>
<td>96</td>
</tr>
<tr>
<td>Māori</td>
<td>750</td>
<td>20</td>
<td>581</td>
<td>77</td>
</tr>
<tr>
<td>Pasifika</td>
<td>180</td>
<td>5</td>
<td>118</td>
<td>66</td>
</tr>
</tbody>
</table>

* p denotes statistical significance at threshold <0.05.

Table 1: Comparison of census data and hearing screening data across demographics in the Southern DHB region.
### Table 2: Differences in screening “did not pass” (DNP) and subsequent assessment rates within different demographic subgroups (% of total screened).

<table>
<thead>
<tr>
<th>Demographic</th>
<th>‘DNP’ rate</th>
<th>P-value</th>
<th>Assessed after ‘DNP’ screen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Other (79.6%)</td>
<td>218</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>Māori (16.9%)</td>
<td>85</td>
<td>15.4</td>
<td>*p&lt;0.00001</td>
</tr>
<tr>
<td>Pasifika (3.5%)</td>
<td>23</td>
<td>20.4</td>
<td>*p&lt;0.00001</td>
</tr>
<tr>
<td>Southland (38.6%)</td>
<td>142</td>
<td>11.3</td>
<td>p=0.054</td>
</tr>
<tr>
<td>Otago (61.4%)</td>
<td>184</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>Urban (52.9%)</td>
<td>189</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>Rural (47.1%)</td>
<td>137</td>
<td>8.9</td>
<td>p=0.051</td>
</tr>
<tr>
<td>Male (51.0%)</td>
<td>187</td>
<td>11.2</td>
<td>*p=0.016</td>
</tr>
<tr>
<td>Female (49.0%)</td>
<td>139</td>
<td>8.7</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Prevalence of type B tympanometry at screening, in total and by ethnicity.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Type B tympanogram</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Other</td>
<td>144</td>
</tr>
<tr>
<td>Māori</td>
<td>62</td>
</tr>
<tr>
<td>Pasifika</td>
<td>17</td>
</tr>
</tbody>
</table>

* denotes statistical significance at threshold <0.05.

### Table 4: Potentially unmanaged hearing loss at school following the hearing screening and referral process, in total and by ethnicity.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Unmanaged hearing loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Other</td>
<td>92</td>
</tr>
<tr>
<td>Māori</td>
<td>39</td>
</tr>
<tr>
<td>Pasifika</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>147</td>
</tr>
</tbody>
</table>

* denotes statistical significance at threshold <0.05.
**Figure 1:** Progress through the screening process. The diagram shows the numbers of children not progressing through each stage in the hearing screening and referral process and the numbers for each end point (not screened, passed, seen by tertiary services or not seen by tertiary services). Note that the number not screened is an estimate using census data as a correlate only, and also includes 135 children who were reported to be under audiology/ORLHNS care and so were not screened.

- **3753** Total Census Population
- **3406** Identified for hearing screening
- **3262** Screened
- **326** Did not pass
- **207** Referred to ORL/Audio
- **188** Seen by ORL/Audio
- **~350** Potentially not identified for screening
- **144** Declined or 'under care'
- **~490** Not screened
- **2936** Passed
- **119** Referral not received
- **19** Did not Attend
- **138** Not seen by ORL/Audio
attended by 19 children, so 188 children were seen by audiology or ORLHNS.

Therefore, 42% of children who did not pass the hearing screen were not further assessed by either of these two specialty groups in the public system (or ORLHNS in private).

Table 2 shows subgroup analyses performed for ethnicity, gender, region (Otago or Southland) and locality (urban or rural). Māori and Pasifika children were significantly less likely to pass the screening tests (p<0.00001 in both groups) compared to other ethnicities; and as shown in Table 3, were also more likely to have signs of OME as suggested by type B tympanometry (p<0.001 in both groups). The table shows the total number (n) that did not pass the hearing screen and percentage relative to the total number screened for that demographic, and the number and percentage (relative to the total number that did not pass) that were ultimately assessed by either otolaryn-gology or audiology as a result. Statistical comparisons using Chi-squared analysis within each demographic are also shown.

Referral rates through to ORLHNS and audiology services among children who had not passed were not significantly different among ethnic groups. When attendance rates at subsequent appointments are examined, Pasifika children were significantly less likely be assessed by an audiologist or otolaryngologist (p<0.004).

There were no significant differences in “did not pass” rates, referrals or specialist review between Otago and Southland, or between urban and rural populations. Males were less likely to pass the screening, however, had no difference in referral or clinic review rates when compared with females.

Table 3 shows the total number (n) that had type B tympanometry at screening and did not pass, and percentage relative to the total number screened for that demographic. This provides an estimate of the prevalence of otitis media with effusion causing hearing loss amongst the screened population. Statistical comparisons using Chi-squared analysis within each demographic are also shown.

Table 4 shows the numbers of children that either did not pass the hearing screening and were not subsequently assessed by either ORLHNS or audiology, or declined screening altogether, and the percentage relative to the total number identified for screening, by ethnicity. This represents the total number, and proportion, of children starting school with a potential hearing loss that has not been managed. Statistical comparisons using Chi-squared analysis within each demographic are also shown.

In total, 147 children identified for screening by the programme did not pass and subsequently were not seen by either audiology or ORLHNS, or declined screening altogether, which represents 4.3% of all children identified in the database; these children then start school with potentially unmanaged hearing loss. These rates are significantly higher in Māori (7%, p=0.0002) and Pasifika children (14%, p<0.0001) when compared with other ethnicities (Table 4).

Discussion

We have reviewed the performance of the hearing screening programme as part of the B4 School Checks across the Southern DHB. It is of note that the databases used appear to underestimate the number of eligible children residing in Otago when compared to census data from the same year. This was an unexpected finding and warrants further examination. It was not within the remit of this audit to undertake this; however, it is likely that some of these children are captured in the subsequent year (once they start school) via the ENROL database.

Figure 1 shows the times at which a child may not participate in the screening programme; the majority being those who are not screened either because they were not captured in the database, declined screening or were reported to have other care arrangements. These children are effectively left out of a process which aims to ensure that when children start school their hearing needs have been addressed. Subsequently, referrals for a further 138 children recommended for further management of their ear condition (4.2% of all those screened, or 42% of those who did not pass the screening test) were either not received by public audiology or regional ORLHNS or did not attend a specialist assessment; this is addressed further below.

Support for the efficiency of the screening programme lies in the similar proportions screened both in urban and rural settings. The male predominance of those not passing the screening is consistent with findings of the Dunedin Study which identified 57% male preponderance of persistent or transient otitis media with effusion. It should be noted that the ethnic composition of the Dunedin Study participants was different from that of our group and comparison cannot be made in this respect.
In accordance with previous reports\textsuperscript{5,10–11} the prevalence of probable middle ear disease is higher among Māori and Pasifika children. For the Southern region, the proportion of Māori receiving specialist attention following a failed screen is similar to “other ethnicities”. This is encouraging in that, for Māori, there appears to be equal outcomes from the “screening process”. However, the number of “at risk” children is carried forward into the numbers of these children at risk of hearing impairment when entering school. That is, Māori and Pasifika children have a greater risk of entering school with hearing impairments that will potentially hinder their early schooling experience. In making this assessment we have assumed that similar proportions of those who were not screened will not pass the screen.

When considering how this audit helps optimise outcomes for children there are points to address. These are: optimising capture by the screening programme, maximising participation at the initial assessment and improving the transfer of care between screening and specialist assessment. The first we cannot address readily, however, the second and third may be addressed through modest changes to the screening programme protocol. Simple changes could be to, by default, undertake a screen unless the child’s guardian specifically declines this service regardless of whether they are already “under care”, and for onward referral from the screening programme to be directed to the local audiology service (or to specified private care) directly, regardless of the modality of their hearing loss. It is important to highlight that the problem does not appear to necessarily be related to onwards referral from the screening programme itself (which follows a robust protocol) but rather the pathway through which children must progress after this stage to then ultimately be referred and seen by specialist services. These changes could be easily made and documented, so enabling future audit.

What is less easily addressed, and not part of this audit, is the optimal specialist management strategy for Māori and Pasifika children. It is recognised that there are barriers to accessing such care\textsuperscript{6,12,13} and also to optimising specialty access in rural settings. Across Otago and Southland, private audiologists provide services in rural communities and funding for B4 School-referred children, while already in place, could be expanded with the potential to improve attendance to a more localised service. Engagement with appropriate stakeholders is essential for improving access and outcomes. In conjunction with local Iwi, the ORLHNS Department in the Bay of Plenty runs a successful rural clinic in Kawerau. The population is predominantly Māori and with a high deprivation index; between 2016 and 2019 clinic attendances were 94% compared to 83% at Tauranga Hospital.\textsuperscript{13}

Within Central Otago there is availability for people to be seen locally by a private ORLHNS through a Central Otago Health Board funding stream, although our data suggest that this is little used for those who do not pass their hearing screen and the pathway would require changes to the funding model.

**Strengths and limitations**

The structure of the hearing component of the B4 School screening programme provides an excellent starting point for addressing the detection of hearing impairment among children about to enter primary school. There is sound data from which comparisons can be drawn, and this has allowed an assessment of the “bigger picture” within the Southern region. We deliberately selected a data collection period that coincided with the 2018 Census; this helped identify the probable number due for hearing screening. However, the census only records the numbers of people normally resident in Otago and Southland on one night and this introduces inaccuracy when determining how many children should have been identified for screening. Despite this, it is notable that the census proved accurate for Southland, but not for Otago. Additionally, a reasonable number of these children may be subsequently identified during their first year of school, although these children will have potentially had treatment delayed by a year as a result.

We are fortunate that the private ORLHNS working across SDHB are all based in Dunedin and agreed to inform us of any children they had seen following a screening referral. For practical reasons we could not extend this to GP and private audiology services across our DHB and this has likely led to an overestimate of the number of children who had unmanaged hearing loss. Children may have attended their GPs and been managed appropriately, and similarly in rural locations pathways for referrals to private audiologists directly from the screening program are in place in certain circumstances, and the findings and outcomes of these referrals have not been accounted for. While this may have caused overestimates in the total numbers being lost through...
the referral pathways, it may be reasonable to assume that the relative disparities between subgroups would persist.

The audit protocol is fairly straightforward and could be used by other DHBs to assess the effectiveness of hearing screening and identification of children at risk, with a view to optimising subsequent management.

**Conclusion**

The Southern region hearing screening programme is effective at engaging with children and whānau identified within the databases they use, and follow robust protocols. The management of children identified at risk of hearing loss follows recommended guidelines but these do not necessarily specifically direct children to either audiology or ORLHNS for ongoing management. This may increase the likelihood of ongoing unmanaged hearing loss due to a potentially convoluted referral pathway; Māori and Pasifika children are at higher risk. There is scope to consider modest changes to the referral process that may optimise the management of children that do not pass their hearing screening.
COMPETING INTERESTS
Nil.

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REFERENCES