

Referral patterns to the Southern Cochlear Implant Programme for adult cochlear implant candidates: a retrospective review

Calum Pears, Robin Willink, Alice Stringer, Phillip Bird, Jill Mustard

ABSTRACT

AIM: The aim was to determine whether changes made to the Southern Cochlear Implant Programme (SCIP) following a previous audit in 2014¹ have affected referral patterns, and to identify ongoing areas of potential need that may inform future service provision and organisational policy. The primary objective was to assess whether changes in referral patterns (specifically distance to referral centre, ethnicity) occurred following interventions in SCIP service provision. The secondary objective was to evaluate the distribution of socio-economic deprivation for referrals to SCIP.

METHODS: A retrospective review of all adult patients referred for consideration of cochlear implantation to the SCIP was conducted between 1 December 2014 and 1 December 2022. Distances to nearest SCIP referral centre were calculated based on patients' regions of domicile. This was modelled with linear regression to assess the relationship between incidence of referrals and distance to nearest SCIP centre. Along with demographic data, this was compared to the 2014 audit and baseline New Zealand population demographics from the 2018 New Zealand Census.

RESULTS: In total, 793 individual patient referrals were identified and included. An improvement in referrals relative to distance to SCIP centre was demonstrated, along with a more even distribution of referrals across socio-economic groups. Assessment of ethnicity data was limited by the amount of unrecorded data.

CONCLUSION: Publicly funded cochlear implantation is currently a limited resource in New Zealand. Findings from this audit help assess both current and past service provisions, providing insights to guide future service developments. Interventions targeted at improving access to SCIP for those more geographically isolated from the service appear to be effective. These interventions, along with ongoing collection, audit and reporting of demographic data including ethnicity, should continue and help inform future service planning.

Cochlear implantation has been proven to be a successful option for adults with severe to profound hearing loss in whom hearing aid amplification is no longer beneficial.² The benefits include cost effectiveness, reduction of dementia progression and reduced rates of depression and anxiety.^{3,4,5} Internationally, there are well-recognised inequities in access to cochlear implantation and outcomes across different social groups. Documented factors that determine access include physical distance to a cochlear implant centre, socio-economic status, race and increasing age.^{6,7,8}

The Southern Cochlear Implant Programme (SCIP) was established in 2003 to facilitate cochlear implantation and hearing rehabilitation for the South Island and lower North Island of New Zealand. SCIP is an organisation that provides a multidisciplinary team service for assessment of cochlear implant eligibility, prioritisation of

publicly funded implantation, implantation surgery, rehabilitation or habitation and patient support. Referrals can be made by otolaryngologists, audiologists or "advisors on deaf children". The assessment process involves audiological and medical assessments for implantation candidacy, as well as assessing the social and functional impact the individual's hearing disability is causing them.

An audit conducted between 1 December 2014 and 1 December 2022¹ assessed referral patterns across this region. Key findings included a discrepancy in referrals based on the geographical location, with a higher proportion of referrals from providers closer to Christchurch, where the programme was physically based. Additionally, Māori and Pacific patients were under-represented in referrals compared to general population demographics, suggesting a potential unmet need in these population groups.

Since 2014, changes have been implemented

to attempt to address these geographical and ethnic discrepancies in referrals, aiming to improve access to the service. In 2015, SCIP opened an assessment and rehabilitation clinic in Wellington, the lower North Island (Figure 1), to reduce travel barriers for potential patients. Outreach clinics based in rural centres were also established, along with in-service education sessions and online seminars to improve awareness among audiologists (referrers) in the SCIP catchment areas. In addition to these changes, there has been wider political and media exposure of cochlear implantation and an increase in public funding. The aim of this second audit was to assess the effects of these changes on referral patterns to further inform future service provision.

Hypothesis

The study hypothesises that the change made to the SCIP service delivery and provision would impact the referral patterns between the two audits, showing an improved incidence of referrals relative to distance to referral centre. Secondly, the demographic distribution of referrals in the more recent audit is hypothesised to

be more reflective of the overall demographics in New Zealand, in particular ethnicity and relative socio-economic deprivation.

Methods

A retrospective review of consecutive patients 18 years and older and referred to SCIP between 1 December 2014 and 1 December 2022 was conducted. Deidentified patient data were collected from the SCIP patient database to identify all referrals over the audit period and create a dataset. This dataset was placed alongside 2018 New Zealand Census data and compared with the dataset from the 2014 audit, which included patients referred between 1 March 2003 and 30 November 2014. The census data were used to give a baseline reference for the New Zealand population distribution of age, gender, ethnicity and domicile.

Primary objective:

- To evaluate 2014–2022 referral demographics, specifically distance to SCIP centre and ethnicity, and to compare these to 2003–2014 referral demographics.

Figure 1: Locations of SCIP clinics in Wellington and Christchurch, as well as region of service highlighted in green. Outreach clinics are intermittently based in provincial towns throughout the region of service.



Secondary objective:

- To evaluate the distribution of socio-economic deprivation for referrals to SCIP between 2014 to 2022.

The dataset of SCIP referrals included date of birth (age at referral calculated based on this), gender, ethnicity and domicile location. The distance to the nearest SCIP clinic was taken to be the distance from the domicile council region calculated using the Google Maps™ mapping tool in a standardised fashion. The distance to the Christchurch SCIP clinic alone was also calculated to allow comparison to the previous audit. Distance to outreach clinic was not calculated, as these clinics were variable in their frequency and location during the audit period. The 2014 audit was conducted prior to the opening of the Wellington SCIP clinic. Patients were geographically grouped by their domicile council district for the other statistical analysis. New Zealand Index of Deprivation (NZDep) 2018 score⁹ was extrapolated from patients' addresses. The NZDep2018 score is an established index of relative deprivation within the New Zealand population. It geographically divides areas based on address into even deciles across New Zealand, with a score of 10 indicating the most deprived.

Statistical analysis

The incidence of referral (number of referrals per person per year) was estimated for each of the geographic districts using the baseline adult population of their district as the denominator. The incidence was calculated by dividing the number of referrals per person by the total number of years of audit duration. The relationship between incidence and distance to the nearest SCIP centre (Christchurch or Wellington) was modelled using linear regression. Although data analysis had been completed in the previous audit and the classification into council districts had changed since then, conducting our analysis on the relevant figures from the previous audit as well as on our dataset allowed direct comparison between the two datasets. 95% confidence intervals were placed on two regression slopes to draw a conclusion about whether there had been an improvement between the two time periods.

The proportions of patients in the audit sample for different ethnic groups and different NZDep2018 scores were calculated. These were compared with proportions in the New Zealand

population to assess relative representation in the audit dataset. Regional-specific demographic data were not available for sub-analysis comparison.

Ethical considerations

The study proposal was submitted through the Health and Disability Ethics Committees (HDEC) and noted to be outside of scope and did not require HDEC approval.

Results

There were 793 individual patient referrals between 2014 and 2022. (The 2014 audit covering the period 2003–2014 had included 709 patients.) The demographic distribution of these referrals is described in Table 1. Ethnicity data were unspecified in 27.6% of referrals for the current audit and 19.7% of the 2014 audit. Calculation of percentages for ethnicity and NZDep2018 score was performed with and without excluding the referrals with missing data. Sub-analysis of referral patterns for each individual year of the audit period was not specifically analysed as it was thought that case numbers would not be enough on a yearly basis to allow for significant statistical analysis.

Geographic analysis

Comparing the incidence of referrals vs distance to nearest SCIP clinic, a change is noted between the 2003–2014 period and the current audit period (Figure 2).

With the data from the 2014 audit, we obtain a point estimate of slope of -0.0037 per kilometre, with the *upper* limit of a 95% confidence interval being -0.0024 per kilometre. In the current audit, the point estimate of slope is -0.0008 per kilometre and the *lower* limit of a 95% confidence interval is -0.0029 . The two confidence intervals for the slopes do not overlap, so there is strong informal evidence that there is a more even distribution of referrals in the current audit period in terms of distance relative to patient domicile. Distribution of scatter plot varies more widely in the current audit. This included a larger number of distance variables due to measuring distance relative to council district rather than using district health board as the prior audit had. Thus, the variation in scatter distribution is thought to be most likely a reflection of this change.

Ethnicity analysis

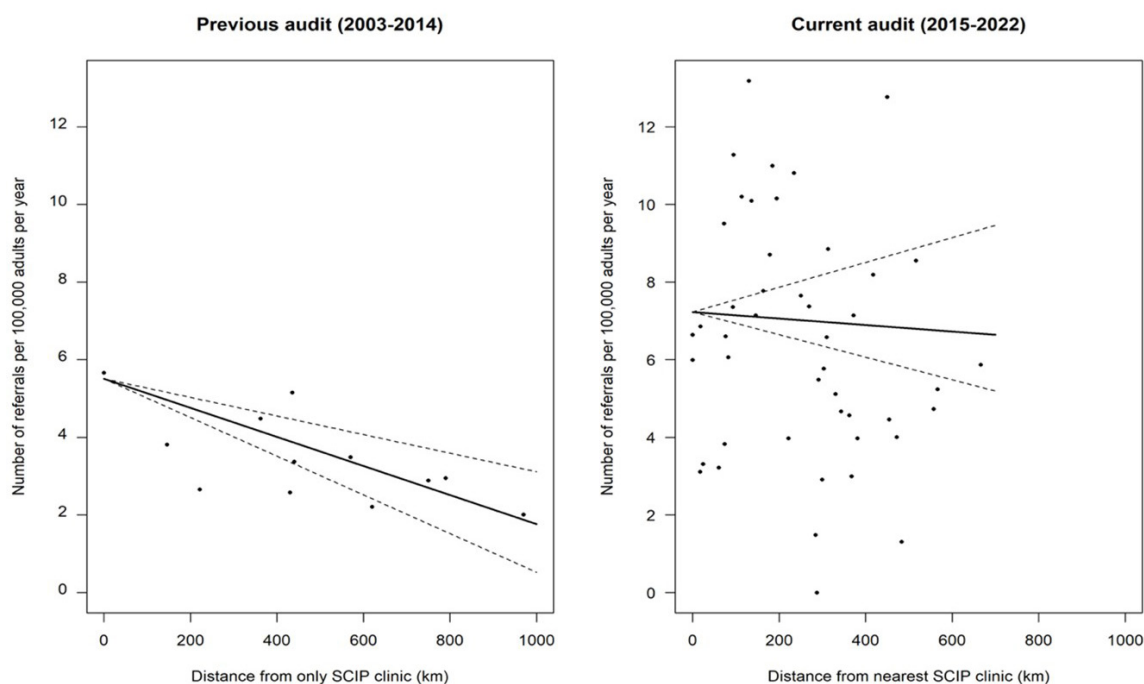
In the current audit, the proportion of Māori

Table 1: Demographic distribution of referrals.

Demographics	Referrals 2003–2014 (709)	Referrals 2014–2022 (793)	Percentage (%) 2003–2014*	Percentage (%) 2014–2022*	NZ population percentage (%) 2018 Census
Gender					
Male	357	475	50.3	59.9	49.4
Female	352	312	49.7	39.2	50.6
Unspecified	0	6	0	0.01	
Ethnicity					
NZ European	517	517	72.9 (90.9)	65.2 (90.2)	70.2
Māori	31	52	4.4 (5.4)	6.6 (9.1)	16.5
Pacific peoples	9	3	1.3 (1.6)	0.3 (0.5)	8.1
Asian	12	2	1.7 (2.1)	0.2 (0.4)	
Unspecified	140	219	19.7	27.6	
NZDep2018 Score					
1	84	84	11.8	10.6 (11.2)	
2	65	69	9.1	8.7 (9.2)	
3	46	84	6.5	10.6 (11.2)	
4	81	71	11.4	9.0 (9.5)	
5	68	71	9.6	9.0 (9.5)	
6	85	72	11.9	9.1 (9.7)	
7	98	82	13.8	10.3 (11.0)	
8	77	77	10.8	9.7 (10.3)	
9	71	82	10.0	10.3 (11.0)	
10	34	54	4.8	6.8 (7.2)	
Unspecified	0	47	0	5.9	

*Percentage excluding unspecified data is presented in brackets.

Figure 2: Incidence of referrals (number of referrals per 100,000 adult population per year) versus distance to the SCIP clinic (in kilometre) for different geographical districts. The solid lines give estimates of linear relationships obtained by standard regression methods. The slopes of the dashed lines indicate 95% confidence limits on the slopes of the underlying relationships (the intercepts of the dashed lines do not have statistical meaning).



among referrals with known ethnicity was 9.1% (52/574) with a 95% confidence interval of 7–12%. In the 2014 audit, 5.4% (31/569) of the referrals with known ethnicity were Māori. These proportions lie below the proportion of Māori in the population, which is 16.5%. This may suggest that Māori are continuing to be referred at a reduced rate from non-Māori. However, due to the large proportion of unspecified ethnicity data (27.6% in the current audit and 19.7% in 2014) this cannot be confirmed. Additionally, due to under-reporting of ethnicity data, meaningful statistical analysis of ethnic differences in referral patterns could not be undertaken. Delayed, late and reduced referral rates for Māori for ear health issues have also been reported in the literature previously.^{10,11} Pacific peoples made up 0.5% of referrals, with Asians making up 0.4% of referrals where data were recorded. While not statistically significant (due to the large proportion of unspecified ethnicity data), both of these ethnicities are likely under-represented compared to baseline New Zealand population.

Socio-economic analysis

The socio-economic data based on NZDep2018

scores calculated from home address show a relatively even distribution across the decile range, except for the most deprived areas with an NZDep2018 score of 10 making up 7.2% of referrals, after excluding referrals without a known address. Five-point-nine percent of referrals had no physical address recorded and thus NZDep2018 scores for these referrals remain unspecified. On the basis that NZDep2018 divides the national population into even deciles and the geographical area admitting a referral to SCIP is representative of the nation, the expected percentage of baseline NZDep2018 scores would be close to 10% for each decile.

Gender analysis

Assessment of gender was not a specific primary or secondary objective during the study design process. There was, however, an unexpected gender imbalance in referrals during the audit period. The proportion of men among referrals with known gender was 475/787 (60.4%) with a 95% confidence interval of 57–64%. Thus, even though this analysis is formally *post hoc*, there is evidence that men are being referred at a higher rate than women.

Discussion

The benefits of having access to sound and functional hearing are well evidenced. Hearing loss remains one of the most modifiable mid-life risk factors for dementia,¹² and adequate management of hearing loss can improve depression and anxiety.^{3,4,5} Cochlear implantation is more cost effective when compared with other high-cost implantable medical devices, such as pacemakers and defibrillators.¹³ Additionally, they are cost beneficial from an overall societal perspective.⁵

There is evidence in the literature that geographical location of services is a barrier to provision of healthcare.¹⁴ This study demonstrates that changes to the SCIP have been successful in improving access to cochlear implant assessment for those who are geographically distant to its primary office. Since the opening of a second referral centre and the provision of rural outreach clinics and education sessions, there has been an improvement in the rate of referrals relative to geographical distance to referral centre. True causation between the above interventions and the changes in referrals, however, cannot be proven with this study design.

A limitation exists in the consistency of the data for the analysis relating to Figure 2 (labelled above, comparing incidence of referrals versus distance to SCIP during both audit periods). The 2014 dataset used district health board domiciles while the more recent dataset utilised regions of domicile due to the disestablishment of district health boards. However, the mean point difference of 55 kilometres may suggest that some of the improvements noted for geography of referrals between the audits may not be due to addition of the new referral centre alone. The changes made over this period coincided with increased political awareness of the effects of hearing loss and increased public funding of cochlear implantation.

Unfortunately, there was limited recording of ethnicity in this study. Reporting of ethnicity data is not required to be included in referrals to SCIP; it is recorded at the time of patient assessment if the referral criteria is met. More than one-quarter of the ethnicity data were unrecorded in the referrals assessed in this study, many of which were related to referrals without ethnicity data that did not subsequently get assessed for cochlear implantation. As such, it is difficult to assess any trend with regards to ethnicity of patients being referred to SCIP. The 2014 audit noted that Māori and Pacific peoples were under-represented in

referrals to the SCIP clinic. It remains likely that this is an ongoing issue, which needs to be a continued focus for service development and data collection.

There are limitations in using the 2018 New Zealand Census data as a comparison for demographic data in New Zealand. Stats NZ reports 73% of people in the 2018 Census dataset with Māori descent filled out an individual form during the 2018 Census compared with an 83.3% overall response rate.¹⁵ This increases the chance of statistical error and makes drawing accurate conclusions from this study more challenging.

The Deafness Notification Database¹⁶ has repeatedly demonstrated that lower socio-economic status is associated with hearing loss (not remediable by grommets) in children in New Zealand. Internationally, lower socio-economic status is linked to poorer hearing health outcomes.¹⁷⁻¹⁹ To the authors' knowledge, no studies have been able to sufficiently explain this phenomenon or to determine whether this association persists into adulthood or affects eligibility for cochlear implantation in the New Zealand setting. This study has demonstrated a relatively even distribution of referrals for assessment according to socio-economic status. However, it is possible that this does not reflect the distribution of hearing loss in our population, because people who are more deprived may be over-represented in the hearing-impaired population. Further research is required but should not delay efforts to make hearing assistance more accessible to those more deprived.

The tentative finding of higher referrals for males noted in the more recent audit may be due to a variety of factors, including a potentially higher proportion of males with workplace noise exposure history.^{20,21}

Conclusion

With targeted efforts to improve access to the SCIP service, some of the geographic barriers have improved. There is likely persisting inequity in referrals to SCIP for non-NZ European ethnicities. Given cochlear implants are an expensive and limited resource in the public health system, we need to ensure that efforts are made to identify those who will benefit most. Ongoing development and expansion of the service should consider targeting these potential areas of discrepancy in service provision, the goal being to ensure equitable access to the service across the southern region of New Zealand served by SCIP.

COMPETING INTERESTS

AS provides surgical services for the Southern Cochlear Implant Programme.

PB is a Trustee of the Southern Charitable Hearing Trust, which governs the Southern Cochlear Implant Programme.

AUTHOR INFORMATION

Dr Calum Pears: Otolaryngology Registrar, Health New Zealand – Te Whatu Ora Southern, Dunedin, New Zealand.

Dr Robin Willink: Senior Research Fellow/ Biostatistician, Biostatistical Group, University of Otago, Wellington, New Zealand.

Dr Alice Stringer: Otolaryngologist, Health New Zealand – Te Whatu Ora Capital, Coast and Hutt Valley, Wellington, New Zealand.

Dr Phillip Bird: Otolaryngologist, Health New Zealand – Te Whatu Waitaha Canterbury, Christchurch, New Zealand.

Jill Mustard: Clinical Manager, Southern Cochlear Implant Programme, Christchurch, New Zealand.

CORRESPONDING AUTHOR

Dr Calum Pears: c/o ENT department, Dunedin Hospital, Great King Street, Dunedin 9016, New Zealand.
E: Calum.Pears@southerndhb.govt.nz

URL

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