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Tinnitus prevalence in New Zealand

Billy Wu, Grant Searchfield, Daniel Exeter, Arier Lee

ABSTRACT

AIM: There is a lack of consensus in the international literature pertaining to the prevalence of tinnitus for the overall population, as well as sex and age sub-groups, suggesting the need for country-specific prevalence estimates. We aim to find prevalence estimates of tinnitus that are representative of the New Zealand population.

METHOD: We obtained data from random-digit dialled telephone surveys of households, conducted by Roy Morgan Research Limited between August, 2007, and July, 2013, for people aged ≥ 14 years in New Zealand ($n=69,976$). As part of the survey, participants were asked whether they have had tinnitus in the last 12 months. The response options were “yes” or “no”. Estimates were standardised to the New Zealand population structure based on the 2013 national census. Sex, age and ethnic differences were explored.

RESULTS: The overall weighted prevalence for *any* tinnitus was 6.0% in the total New Zealand population age ≥ 14 years. Tinnitus was higher among males (6.5%) compared to females (5.5%). Males were 55% more likely to report tinnitus compared to females among young adults aged 14 to 24 years, while males were 32% more likely to report tinnitus compared to females among adults aged 50 to 64 years. Tinnitus prevalence increased with age, peaking at 13.5% for older adults aged ≥ 65 years. Adults aged ≥ 65 years are three times more likely to report tinnitus than people aged below 65 years. Tinnitus prevalence was highest among people identifying as European (7.05%) and lowest among people identifying as Asian (1.00%).

CONCLUSION: This is the first nationally representative study of tinnitus prevalence in New Zealand and largest study sample internationally for tinnitus prevalence to date. Tinnitus is a public health problem affecting approximately 207,000 people in the New Zealand population aged ≥ 14 years. This study has highlighted the importance of sex and age in defining a high-risk tinnitus population, but our knowledge falls short of profiling their ethnic and social-economic characteristics.

Tinnitus is the perception of sound in the head or ears in the absence of an external real sound. It is commonly associated with hearing loss, but appears to be the result of a cascade of neuroplastic events in auditory pathways and central networks.¹ Its effects can vary from slight annoyance to disruption of the individual's life.² Prevalence studies of tinnitus face methodological drawbacks due to the ambiguity surrounding the way tinnitus is defined and whether questions used in collecting epidemiological data are appropriately worded.³⁻⁵ Despite this difficulty, there have been numerous large-scale cross-sectional studies that have examined the prevalence of tinnitus in the overall population. All studies included for review used questions

about tinnitus that were adapted from Davis⁶ and Palmer, et al.⁷ While questions used by the studies differ in wording to varying degrees, they all sought to find out whether tinnitus was experienced by the participant, and allowed only for “yes” or “no” response options. As such, all studies included for review were able to provide a prevalence estimate for *any* tinnitus experienced by the overall study population.

In the UK, the National Study of Hearing⁸ deployed a postal questionnaire and found the overall weighted-prevalence ($n=48,313$) of self-reported prolonged spontaneous tinnitus (PST) was 10.1% among adults aged 18 to 80 years. Tinnitus was defined by the questions, “Nowadays do you get noises in your head or ears?” and “Do these noises

Table 1: Previous studies reporting the prevalence of any tinnitus in the general population (aged ≥14 years)

Authors	Year	Study	Sample	Tinnitus Definition	General Adults*
Davis & El Rafea ⁸	2000	National Study of Hearing (UK)	n=48,313 18–80 years	PST	10.1%
Hasson et al. ⁹	2010	Swedish Work Environment Survey (Sweden)	n=9,569 16–64 years	Tinnitus	26.2% unweighted
Shargorodsky et al. ¹⁰	2010	National Health and Nutrition Examination Survey (USA),	n=14,178 20 years and over	Tinnitus	25.3%
Oiticica & Bittar ¹¹	2014	Field survey questionnaires in São Paulo (Brazil)	n=1,960 18 years and over	Tinnitus	21.9% unweighted
Park et al. ¹²	2014	National Health and Nutrition Examination Survey (S. Korea)	n=21,893 12 years and over	Tinnitus	19.7%

*Prevalence estimates have been adjusted to reflect the national population structure of the study. Unweighted estimates, where specified, represent crude estimates.

last longer than five minutes?” Though not recent, the National Study of Hearing offered the largest study sample for tinnitus prevalence. In Sweden, findings from the Swedish Work Environment Survey showed an unadjusted prevalence of tinnitus was 26.2% among the general working population (n=9,569) aged 16 to 64 years, for any degree of frequency and severity.⁹ Participants were asked, “Have you during the most recent time experienced sound in any of the ears, without there being an external source (so-called tinnitus) lasting more than five minutes?”.

In the US, findings from the National Health and Nutrition Examination Survey¹⁰ showed an overall adjusted prevalence for any tinnitus (n=14,178) of 25.3% among adults 20 years and over. Participants were asked, “In the past 12 months, have you ever had ringing, roaring, or buzzing in your ears?” In São Paulo (n=1,960), field survey questionnaires showed an unadjusted tinnitus prevalence (n=430) of 22%. Participants 18 years and over were asked, “Do you have ringing in your ears?”¹¹ In South Korea, findings from the Korea National Health and Nutrition Examination Surveys¹² showed an overall adjusted tinnitus prevalence (n=21,893) of 19.7% among people 12 years and over. Participants were asked, “Within the past year, did you ever hear a sound (buzzing, hissing, ringing, humming, roaring, machinery noise) originating in your ear?”

There is little consistency among tinnitus prevalence studies regarding the rela-

tionship between tinnitus and sex. Studies from the US,¹⁰ South Korea,¹² and Brazil,¹¹ showed tinnitus was more prevalent among women than men. Conversely, studies from the UK,⁶ Sweden,⁹ and Australia,¹³ showed that tinnitus was more prevalence among men. Prevalence studies from Japan¹⁴ and Nigeria¹⁵ did not show statistically significant differences between sexes.

The increasing prevalence of tinnitus with increasing age has been well established.⁵ However, there does not appear to be clear consensus pertaining to age-specific tinnitus prevalence rates. For example, while the US National Health and Nutrition Examination Survey¹⁰ and the UK National Study of Hearing⁸ both found the highest prevalence of tinnitus among people aged 60–70 years, yet prevalence estimates were 31.4% in the US and 15.8% in the UK.

A number of studies examined the prevalence of tinnitus specifically among localised elderly populations.^{12–15} In Australia, findings from the Blue Mountains Hearing Study¹³ found an adjusted prolonged tinnitus prevalence of 30.3% for people aged 55–99 (n=2,015). Following an audiological assessment, participants were asked, “Have you experienced any prolonged ringing, buzzing or other sounds in your ears or head within the past year, lasting for 5 minutes or longer?” Elsewhere in Australia, prevalence data from the Australian Longitudinal Study of Ageing found that 17.8% of people aged 70 years and over (n=1,453) reported experiencing tinnitus.¹⁶ Participants were asked “Do you

Table 2: Previous studies reporting the prevalence of any tinnitus in the older adult population

Authors	Year	Study	Sample	Tinnitus Definition	Older Adults
Sanchez et al. ¹⁶	1999	Australian Longitudinal Study of Ageing (Australia)	n=1,453 70 years and over	Tinnitus	17.8%
Davis & El Rafaie ⁸	2000	National Study of Hearing (UK)	61–70 years	Tinnitus	15.8%
Sindhusake et al. ¹³	2003	Blue Mountains Hearing Study (Australia)	n=2,015 55–99 years	Prolonged tinnitus	30.3%
Michikawa et al. ¹⁴	2010	Community-based interviews (Japan)	n=1,320 65 and over	Tinnitus	18.6%
Lasisi et al. ¹⁵	2010	Nigeria Study of Aging (Nigeria)	n=1,302 65 years and over	Tinnitus	14.1%
Shargorodsky et al. ¹⁰	2010	National Health and Nutrition Examination Survey (USA)	60–69 years	Tinnitus	31.4%
Park et al. ¹²	2014	National Health and Nutrition Examination Surveys (Korea)	70 years and over	Tinnitus	32.1%

have ringing or other noises in your ears or head?” By contrast, the South Korean National Health and Nutrition Examination Surveys found a 32.1% prevalence for the same age group,¹² nearly doubling the rate found in the Australian Longitudinal Study of Ageing.

Studies from Japan¹⁴ and Nigeria¹⁵ tested the same age group, had very similar sample sizes, and deployed a tinnitus question using similar wording. In the township of Kurabuchi, Japan, home-based interviews (n=1,320) with residents 65 years and over found a prevalence of 18.6% for both mild and severe tinnitus combined.¹⁴ Participants were all asked, “In the past year have you experienced any ringing, buzzing, or other sounds in your ears?” In Nigeria, face-to-face interviews with participants 65 years and older found 14.1% experienced some degree of tinnitus. Participants were asked whether they had a perception of ringing, swishing, humming, or other type of noise in the ear or head without an external source of sound.¹⁵

There has been a lack of population data for tinnitus in New Zealand. It is often presumed that tinnitus prevalence in New Zealand is the same as North America or the UK. However, New Zealand has a different population structure compared to other countries and a diverse ethnic mix, comprising of large Māori, Pacific, Asian and non-European groups. Providing a snapshot of tinnitus in New Zealand, the Dunedin Multidisciplinary Study¹⁷ found that

38.2% of people aged 32 years experienced tinnitus “rarely”, while 6.8% experiencing tinnitus “half the time or more”, and found no difference between sexes. Consistent with other international studies, the tinnitus question used in the Dunedin Multidisciplinary Study was adapted from Davis,⁶ which asked participants “In the last 12 months, when you are awake and it is quiet, have you experienced tinnitus (ringing, whistling, or buzzing) in the head or ears?” Participants were offered five response options: never, rarely, about half the time, most of the time, and all the time.

The literature provides little consensus pertaining to the prevalence of tinnitus for the general population. There is also no clear consensus over the prevalence of tinnitus by age or sex. The variations seen in the results from prevalence studies discussed above highlight the need for country-specific prevalence estimates of tinnitus, and the closer examination of prevalence by age and sex. In this paper, we use data that have been adjusted for sampling-weights from the Roy Morgan database (a nationally representative survey) to estimate the prevalence of “any” tinnitus in the New Zealand population, which is inclusive of all forms of tinnitus severity, frequency, and disablement.

Method

Data Source: Roy Morgan Research Limited is an independent, Australian-based marketing firm who also conducts tele-

Table 3: Population structure of study population (August 2007–July 2013), by sex, age, and ethnicity

Characteristic	No. of People Surveyed (n=)	Proportion of Total Sample (Crude)	Proportion of Total Sample (Weighted)	Proportion of Total Sample (Census 2013)
Total Population	69,976	100%	100%	100%
Sex				
Male	27,100	38.7%	48.5%	48.1%
Female	42,876	61.3%	51.5%	51.9%
Age				
14–24	8,421	12.0%	19.9%	19.3%
25–34	9,727	13.9%	16.0%	14.9%
35–49	19,286	27.6%	26.6%	25.3%
50–64	18,539	26.5%	22.0%	23.0%
65 and Over	14,003	20.0%	15.5%	17.6%
Ethnicity*				
European	53,645	75.6%	72.6%	68.1%
Māori	6,435	9.1%	10.3%	12.4%
Pacific Islanders	1,639	2.3%	3.4%	5.3%
Asian	2,843	4.0%	6.0%	11.5%
Other	6,385	9.0%	9.5%	2.7%

*Census ethnicity structure based on prioritised output

phone-based household surveys in New Zealand. Only one person aged ≥ 14 years is interviewed per household. Eligible respondents were recruited through both landline numbers and Random Digit Dialling (RDD) of mobile numbers.¹⁸ In New Zealand, household telephone access ranged between 86% and 92% (Census 2006 and 2013, respectively), while mobile phone access ranged between 74% and 84% (Census 2006 and 2013, respectively).¹⁹ Given this wide coverage, landlines and RDD of mobile numbers was considered the most nationally representative and robust collection method. The household surveys consisted of data including demographics, social-economic indicators, lifestyle behaviour and attitudes, consumer behaviour, and health conditions.¹⁸ Quality control (recontacting a proportion of respondents) occurred after each round of interviewing. In New Zealand, surveys conducted by Roy Morgan Research Limited equated to approximately 12,000 eligible

samples per year, and allowances for design effect were pre-calculated by Roy Morgan.¹⁸

Study Population: Between August, 2007, and July, 2013, 69,976 people aged 14 years and older were interviewed and added to the database. Participants who had already taken part in the survey were excluded from subsequent surveys. Table 3 shows the number of people who were surveyed (n) for each sub-group and their distribution as a proportion of the total sample (%). The sample was adjusted using sampling weights by Roy Morgan Research Limited, accounting for age, sex and region, to represent the New Zealand population. The total weight-adjusted New Zealand population was 3,460,726 people aged ≥ 14 years.

Sampling weight adjustments were necessary since persons living in small households had a higher-than-average chance of selection. A two-tier weighting system was applied. Firstly, an initial design weight (*a priori* weight) was assigned to each respondent. The sum of these design weights

Table 4: Estimates of prevalence for *any* tinnitus in the New Zealand adult population (aged ≥14 years)

Characteristic	No. of people with tinnitus	No of people surveyed (n)	Crude Estimate (%)	Weighted Prevalence (%)	Confidence Interval (95% CI)
Total Population	4,771	69,976	6.8	5.98	5.95–6.00
Sex					
Male	2,128	27,100	7.9	6.45	6.42–6.49
Female	2,643	42,876	6.2	5.53	5.50–5.57
Age					
14–24	112	8,421	1.3	1.60	1.57–1.63
25–34	259	9,727	2.7	2.64	2.60–2.68
35–49	912	19,286	4.7	4.62	4.58–4.67
50–64	1,608	18,539	8.7	8.72	8.66–8.78
65 and Over	1,880	14,003	13.4	13.50	13.41–13.59
Ethnicity					
European	4,134	53,645	7.7	7.05	7.02–7.08
Māori	232	6,435	3.6	2.89	2.84–2.95
Pacific Peoples	24	1,639	1.5	1.08	1.02–1.14
Asian	35	2,843	1.2	1.00	0.95–1.04
Other	373	6,385	5.8	5.31	5.23–5.38

were compared with the population profile to determine the final weights to be applied.

A combination of cell and rim weighting were applied to achieve the population targets that reflect the population structure of the 2013 New Zealand Census (Table 3). For example, the original sample consisted of 38.7% male and 61.3% female. After adjustment, the sample consisted of 48.5% male and 51.5% female, reflecting the sex distribution of the 2013 New Zealand Census. The largest group by age was the 35 to 49 years group (26.6%), while the largest group by ethnicity was European (72.6%).

Measure: As part of the Roy Morgan household surveys, participants were asked, “Which of the following illnesses or conditions have you had in the last 12 months?” Among other health conditions, ear and hearing conditions, including tinnitus, were asked. For “Tinnitus”, the response options were “Yes” and “No”. The tinnitus question was loosely modelled on Davis⁶ in terms of the “last 12 months”. An explanation of tinnitus, such as ringing or buzzing in the ears, was not provided to the participants. There was no integration or follow-up questioning regarding the frequency and/or

severity of tinnitus. As such, the measure of tinnitus in this study is that of *any* tinnitus.

Statistical Analysis: The data used in our analysis have been accessible since November, 2013, from the Roy Morgan database, using Asteroid version 5.14 (Roy Morgan Research Ltd, Melbourne). Sampling weight adjusted data (available from the Roy Morgan database) enabled us to provide population estimates in our results. Fisher’s exact tests were carried out to determine the differences in prevalence estimates (expressed as a prevalence rate ratio [PRR]) between males and females, and older-adult and younger-adult sub-groups. Calculations were conducted in R Statistics version 3.2.0 (<http://www.r-project.org>).

Results

Overall Prevalence: The overall weighted prevalence for *any* tinnitus was 5.98% (95% CI = 5.95–6.00) in the total New Zealand population aged ≥14 years (Table 4). Among 69,976 participants, 4,771 reported experiencing tinnitus in the last 12 months, equating to approximately 207,000 people in the New Zealand population

Table 5: Weighted frequencies of people affected by tinnitus in New Zealand

Weighted frequencies	Total	Male	Female
Total Population	206,915	108,329	98,587
Age			
14–24	11,032	6,789	4,243
25–34	14,579	7,659	6,921
35–49	42,611	21,804	20,807
50–64	66,345	37,125	29,220
65 and Over	72,348	34,952	37,396
Ethnicity			
European	177,074	93,347	83,727
Māori	10,279	5,188	5,091
Pacific Peoples	1,251	509	742
Asian	2,074	1,358	716
Other	17,510	8,709	8,801

(Table 5). Overall, the prevalence of tinnitus was higher among males (6.45%, 95%CI = 6.42–6.49) compared to females (5.53%, 95% CI = 5.50–5.57). Tinnitus prevalence increased with increasing age, starting at 1.6% (95% CI = 1.57–1.63) for young people aged 14 to 24 years, and peaking at 13.5% (95% CI = 13.41–13.59) for people aged 65 years and over. Tinnitus prevalence was highest among people identifying as European (7.05%, 95% CI = 7.02–7.08) and lowest among people identifying as Asian (1.00%; 95% CI = 0.95–1.04). Notably, tinnitus prevalence was relatively high among people who identified with *Other* ethnicity (5.31%; 95% CI = 5.23–5.38)

Prevalence by Sex: In the total population, males were slightly more likely to report *any* tinnitus compared to females (PRR= 1.17; 95% CI = 1.16–1.18, $p < .01$). This higher prevalence seen among males accounts for nearly 10,000 more cases of tinnitus in the total male population (Table 5). Across sub-groups (with the exception of Pacific Peoples), males were more likely to report *any* tinnitus compared to females (Table 6).

By age group, tinnitus prevalence was highest among older males 65 years and over (14.28%). However, the largest difference by sex was seen among younger adults aged 14 to 24 years, with males 55% more likely to report tinnitus compared

to females (PRR= 1.55, 95% CI = 1.49–1.61, $p < .01$). A notable difference by sex was also seen among adults aged 50 to 64 years, with males 32% more likely to report tinnitus compared to females (PRR= 1.32, 95% CI = 1.30–1.34).

In addition to differences by sex, there were also ethnic variations in tinnitus prevalence. The largest difference by sex was seen among both Māori (PRR = 1.32, 95% CI = 1.27–1.38, $p < .01$) and Asian (PRR = 1.32, 95%CI = 1.20–1.45), where males were 32% more likely to report tinnitus compared to females. Pacific Peoples was the only subgroup where females were more likely to experience *any* tinnitus compared to males (PRR = 0.85, CI 95%, 0.76–0.96, $p < 0.01$).

Prevalence by Age: Across all groups, tinnitus prevalence was much higher among elderly adults (Table 7). By sex, estimates were highest among older adults who were male (14.28%), while by ethnicity, estimates were highest among older people who were either European (13.69%) or *Other* ethnicity (13.47%). By contrast, the prevalence estimate for Asian (5.80%) is relatively low when compared to other ethnic groups in the older adult age group.

Overall, older adults aged 65 years and over were nearly three times more likely to report tinnitus than younger adults

Table 6: Tinnitus weighted prevalence by sex in the New Zealand adult population (aged ≥14 years)

Characteristic	Male Weighted Prevalence (%)	Female Weighted Prevalence (%)	Prevalence Rate Ratio	95% CI (p < .01)
Total Population	6.45	5.53	1.17	1.16–1.18
Age				
14–24	1.94	1.25	1.55	1.49–1.61
25–34	2.86	2.42	1.18	1.14–1.22
35–49	4.92	4.34	1.13	1.11–1.16
50–64	9.95	7.54	1.32	1.30–1.34
65 and Over	14.28	12.85	1.11	1.09–1.13
Ethnicity				
European	7.65	6.48	1.18	1.17–1.19
Māori	3.36	2.54	1.32	1.27–1.38
Pacific Peoples	0.98	1.15	0.85	0.76–0.96
Asian	1.11	0.84	1.32	1.20–1.45
Other	5.48	5.15	1.07	1.03–1.10

Table 7: Tinnitus weighted prevalence by age (65 years and over) and younger adults (under 65 years)

Characteristic	Older Adults (≥ 65 years) Weighted prevalence (%)	Younger Adults (< 65 years) Weighted prevalence (%)	Prevalence Rate Ratio	95% CI (p < .01)
Total Population	13.50	4.60	2.93	2.91–2.96
Sex				
Male	14.28	5.12	2.79	2.75–2.83
Female	12.85	4.10	3.13	3.09–3.17
Ethnicity				
European	13.69	5.48	2.50	2.47–2.52
Māori	11.23	2.41	4.67	4.44–4.90
Pacific Peoples	10.39	0.89	11.64	10.00–13.52
Asian	5.80	0.92	6.33	5.42–7.37
Other	13.47	4.39	3.07	2.96–3.18

aged under 65 years (PRR = 2.93; 95% CI = 2.91–2.96, $p < .01$). By ethnicity, the likelihood of older adults reporting tinnitus, compared to younger adults, was two and a half times for European (PRR = 2.50; 95% CI = 2.47–2.52, $p < .01$) and over 11 times for Pacific Peoples (PRR = 11.64; 95% CI = 10.00–13.52, $p < .01$), suggesting greater age-inequality among Pacific Peoples compared to other ethnic groups.

Discussion

This is the first nationally representative study of *any* tinnitus in New Zealand. To our knowledge, this is also the largest study sample for tinnitus prevalence to date, both nationally and internationally. The overall weighted prevalence of *any* tinnitus in New Zealand was 6.0%, corresponding to approximately 207,000 New Zealanders

aged ≥ 14 years. This prevalence estimate is substantially lower than prevalence estimates reported in existing cross-sectional studies internationally, which ranged between 10.1% and 26.2%.⁸⁻¹² Our results correspond closest to the adjusted-prevalence from the UK National Study of Hearing, where 10.1% of adults aged 18 to 80 years reported *prolonged spontaneous tinnitus*.⁸ It is important to note that some tinnitus prevalence estimates cited in this paper have not been standardised to a single population and as such, care should be taken when comparing total prevalence rates from different studies.

Our results indicate that males had a marginally higher, statistically significant ($p < .01$), adjusted prevalence of *any* tinnitus compared to females in New Zealand. Our finding for the general population was consistent with the results from the UK,⁶ Sweden,⁹ the US,¹⁰ and Australia,¹³ which showed a higher male tinnitus prevalence compared to female. Our results showed that the difference between sexes was most pronounced in three sub-groups: people aged 50 to 64 years, people who identified as Māori; and people who identified as Asian. While another study based in New Zealand found no difference between sexes for tinnitus overall, those researchers only interviewed people aged 32 years from the Dunedin Multidisciplinary Study¹⁷ birth cohort. When we stratified our results by age, we also found no difference between sexes for the participants aged 30 to 34 years (PRR = 0.98; 95% CI = 0.94–1.03, $p = 0.43$), suggesting that the difference between sexes for tinnitus cannot be adequately captured when sampling is limited to this age group.

The prevalence for elderly people over the age of 65 years was 13.5%; highest of all age groups. Our findings were consistent with two other studies that examined tinnitus prevalence for the same age group; the community-based study in Japan,¹⁴ which showed an 18.6% prevalence of *any* tinnitus, and the Nigeria Study of Aging,¹⁵ which showed a 14.1% prevalence of *any* tinnitus. The studies from Japan and Nigeria were similar in sampling and measurement, and despite their obvious ethnic heterogeneity, there was only a 4.5% difference in their results. As age-specific

rates, these prevalence estimates can offer some useful comparison between countries. However, care should still be taken for a country, like Japan, where the population is rapidly aging.²⁰

However, geographic, age, and ethnic homogeneity may not always provide consistent results. For instance, despite similarities in sampling age and study context, the two Australian studies differ greatly in prevalence estimates; with the Australian Longitudinal Study of Aging¹⁶ finding 17.8% for people 70 years and over, compared to 30.3% for people 55 to 99 years found in the Blue Mountains Hearing Study.¹³ We believe these differences in the estimated tinnitus prevalence in these studies may result from the differences in the questions used to identify tinnitus. Where the Australian Longitudinal Study of Aging very broadly asked participants whether they had “ringing or other noises” in their ears or heads, the Blue Mountains Hearing Study asked participants about “prolonged” tinnitus “lasting for 5 minutes or longer”.

In the New Zealand context, our results for adults in the 30–34 year age group for “*any*” tinnitus (3.68%, 95% CI = 3.60–3.76) did not correspond with the findings from Welch and Dawes,¹⁷ where 6.8% of people age 32 years from the Dunedin Multidisciplinary Study experienced tinnitus half the time. The key difference between our study and that of Welch and Dawes again lies in the structure of questions concerning tinnitus and the response types offered to the participants. The Dunedin Multidisciplinary Study included the words “when you are awake and it is quiet” in the question, and offered “half the time or more” in the response options. We believe that the inclusion of the proportion of time experienced by the individual, while very useful, may have encouraged participants to select responses other than “never”, thus capturing people with very minor “non-clinical” tinnitus. We also believe that providing a description of tinnitus alongside the Roy Morgan survey question would have increased the response rate for tinnitus in our study, since many people may not know what tinnitus is. As such, our results may represent those with clinically significant tinnitus while the Dunedin

Multidisciplinary Study and others may have captured more people who experienced tinnitus, but were not bothered by it.

In general, ethnic variations in tinnitus prevalence remain largely under-explored in the literature. Our results indicate that the New Zealand European group were more likely to report *any* tinnitus compared to other ethnic groups. This finding is consistent with US National Health and Nutritional Examination Survey,¹⁰ which found a higher overall tinnitus prevalence among the “White” ethnic group compared to the non-Hispanic group. When examining ethnic sub-groups, two key issues exist that may have played a part in skewing our results.

Firstly, ethnic heterogeneity is more common in English-speaking countries—such as New Zealand, Australia, the UK, and the US—compared to countries such as Japan, South Korea, or Nigeria. Indeed, our results show strong ethnic variations in tinnitus prevalence within each sex or age specific group. For instance, the Pacific group had the largest inequality in prevalence between older adults and younger adults (PRR = 11.64, 95% CI = 10.00–13.52, $p < .01$), which was marked by a high prevalence of tinnitus among the people over 65 years, and a low prevalence among people under 65 years. Similarly, the Asian group shares the same inequality. However, the prevalence of tinnitus among Asian people are relatively low compared to other ethnic groups, for both older adult and younger adult age groups. These ethnic variations, particularly for Pacific and Asian people, may be due to under-reporting as a result of not fully understanding the survey question.

Secondly, while the effects of ethnicity on socio-economic indicators are well established in New Zealand,^{21,22} the effects of socio-economic indicators and access to health services on tinnitus outcome remains unclear. For instance, findings from the Dunedin Multidisciplinary Study found that people from lower socioeconomic backgrounds were more likely to report tinnitus, and that tinnitus sufferers were more likely to be socially withdrawn, reactive to stress, and alienated.¹⁷ While this finding seems plausible given its generalisability to chronic conditions overall, we found that Pacific Peoples had the lowest prevalence of

tinnitus (1.08%, 95% CI = 1.02–1.14). Since the Pacific ethnic group is often marked by both poorer health outcomes²¹ and lower socio-economic status,²³ it is unclear whether the low tinnitus estimate is a result of underreporting or service under-utilisation. Similarly, it is unclear whether the very low prevalence of tinnitus found among the Asian group (1.00%, 95% CI = 0.95–1.04) was a result of service underutilisation²⁴ or the healthy migrant effect.²⁵

Another limitation in this study relates to the sampling method deployed by Roy Morgan. Since low-income earners tend to have no access to a landline or mobile phone, we may not have adequately sampled low-income earners, resulting in bias. Furthermore, our survey did not include follow-up questions to determine the frequency or severity of tinnitus experienced by survey participants. As such, we were restricted to prevalence estimates for *any* tinnitus and were unable to estimate tinnitus by level of severity (eg, “mild” vs. severe) or frequency (eg, sometimes vs. always). The restriction of response items to “yes” and “no”, and the lack of follow-up questioning, may have reduced the response rate in our study. However, even with its inclusion, follow-up questions are useful only in understanding the variations of tinnitus frequency and severity in a study population. Nevertheless, the inclusion of follow-up questions would do little to remove the uncertainty in results that arise from subjective tinnitus self-assessments, or the lack of objective measure for the symptoms of tinnitus.²⁶ These limitations highlight the need for longitudinal studies that integrate audiological methods for determining tinnitus severity. Another limitation was the lack of ethnicity weighting applied to the survey population.

This paper provides a preliminary investigation into the sex, age, and ethnic profile of people who experience some form of tinnitus in New Zealand. This also provides an opportunity to further explore the predictors or comorbidities of tinnitus sufferers in the New Zealand context. Furthermore, given New Zealand’s ethnic heterogeneity, community-based sampling for tinnitus research may be explored. Follow-up questions may be included in future research to understand

the frequency of tinnitus experienced by the study participant, while audiological assessments such as the Tinnitus Functional Index (TFI),²⁷ Tinnitus Handicap Inventory (THI),²⁸ or Tinnitus Handicap Questionnaire (THQ)²⁹ may be carried out to understand the severity of tinnitus.

Conclusion

Tinnitus is a chronic public health problem affecting over 207,000 people in the New Zealand population aged ≥ 14 years.

Better understanding the prevalence of tinnitus contributes toward meeting health service needs and identifying high-risk groups in New Zealand. This study has highlighted the importance of sex and age in defining a high-risk tinnitus population, but our knowledge falls short of profiling their ethnic and social-economic characteristics. While our study has revealed some insight into ethnic variations in tinnitus prevalence in New Zealand, the effect of ethnicity on tinnitus remains largely unexplored.

Competing interests:

Grant Searchfield reports grants from Auckland Medical Research Foundation, Tinnitus Research Initiative, Deafness Research Foundation (NZ), Links Research and Grants, grants and personal fees from GN ReSound during the conduct of the study; other from Tinnitus Tunes, outside the submitted work; In addition, Grant Searchfield has a patent Tinnitus treatment system and method US 20120283593 A1 issued to Pending, and a patent Interactive gaming system US 20140171195 A1 issued to Pending.

Author information:

Billy P Wu, School of Population Health, The University of Auckland; Grant Searchfield; Audiology, The University of Auckland; Daniel John Exeter; Epidemiology & Biostatistics; University of Auckland; Arier Lee, Epidemiology & Biostatistics, University of Auckland.

Corresponding author:

Grant Searchfield; Audiology, The University of Auckland.
g.searchfield@auckland.ac.nz

URL:

www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2015/vol-128-no-1423-16-october-2015/6683

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