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Original Research

High prevalence of slight and mild hearing loss across mid-life: a cross-sectional national Australian study

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ABSTRACT

Objectives: Although presbycusis typically becomes symptomatic only in older age, slight and mild hearing loss may be detectable well before this. We studied current prevalence and characteristics of hearing loss in Australian mid-life adults.

Study design: This was a population-derived national cross-sectional study nested within the Longitudinal Study of Australian Children.

Methods: A total of 1485 parents/guardians (87.3% female) aged 30–59 years underwent air-conduction audiometry. Hearing loss was defined in three ways to maximize cross-study comparability: high Fletcher index (mean of 1, 2 and 4 kHz; primary outcome relevant to speech perception), lower frequency (mean of 1 and 2 kHz) and higher frequency (mean of 4 and 8 kHz). Multivariable logistic regression examined how losses vary by age, sex and neighbourhood disadvantage.

Results: On high Fletcher index, 27.3% had bilateral and 23.8% unilateral thresholds >15 dB hearing level (HL) (slight or worse), and 4.9% had bilateral and 6.3% unilateral thresholds >25 dB HL (mild or worse). Bilateral higher frequency losses were more common than lower frequency losses for thresholds >15 dB HL (30.9% vs. 26.4%) and >25 dB HL (11.0% vs. 4.6%). Age increased the risk of bilateral speech and higher frequency losses (all P for trend < 0.05), but not lower frequency losses >25 dB HL. Although sex was not associated with speech and lower frequency losses, men were more likely to have bilateral higher frequency losses (e.g. >15 dB HL: odds ratio [OR]: 2.2; 95% confidence interval [CI]: 1.5–3.2, $P < 0.001$).

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Conclusions: Both slight and mild hearing loss show high and rising prevalence across mid-life. This offers opportunities to prevent progression to reduce the profound later burden of age-related hearing loss.

Introduction

Age-related hearing loss or presbycusis is a serious issue in older adults. In a 2012 World Health Organisation (WHO) report, approximately one-third of persons had disabling hearing loss by the age of 65 years;[1] this rises to virtually all adults by the age of 80 years. Globally, hearing loss is the second leading cause of years lived with disability,[2] and in mid-life, it is associated with underemployment/unemployment, cognitive decline and low overall quality of life.[3,4] The economic cost of hearing loss to Australia in earnings, welfare, education and health services in 2005 was estimated to be $11.7 billion.[5]

Given that age-related hearing loss develops over decades—possibly beginning in childhood—a case has been made in Australia for screening to detect hearing loss at a sufficiently early stage for effective secondary prevention.[6] This could aim to identify high-risk population, reduce the experienced sensory deficit, prevent progression of loss and/or mitigate its flow-on impacts. However, there are very few local and international data on which to base this. We could locate only four national population-based research studies reporting prevalence estimates across the mid-life period, when hearing loss becomes noticeably more common:[7] the 2011–2012 US National Health and Nutrition Examination Survey (NHANES) (ages 20–69 years),[8] the 2014 Health Survey for England (16 + years),[9] the 2012–2013 Canadian Health Measures Survey (ages 20 to 79)[10] and the 2010–2012 Korea National Health and Nutrition Examination Survey (12 + years).[11] All studies except the Korean study reported hearing loss over 25 dB hearing level (dB HL) (mild or worse), by which time impairment may be entrenched and technologies (hearing aids, cochlear implants and assistive devices) improve thresholds but do not restore hearing to normal.[12] If secondary prevention is the goal, then losses over 15 dB HL (slight or worse/occurrence) earlier in life could also be of interest.

Finer grained contemporary prevalence data across mid-life are needed for several reasons. First, benefit-to-harm ratios of any screening program may be very sensitive to variation in prevalence by quite narrow age bands. Second, hearing loss epidemiology may be changing. On the one hand, the US NHANES revealed lower age-specific rates in US adults aged 20–69 years in 2011–2012 than in the 1999–2004 cycles,[8] and another study of American 45- to 94-year-olds reported a lower prevalence in the offspring than the parent generation.[13] On the other hand, hearing loss might be expected to rise alongside increasingly prevalent diseases of ageing that are, as hearing loss appears to be, driven by inflammation and metabolic stress.[14] Third, varying definitions make it difficult to draw comparisons between different hearing surveys. For instance, prevalence estimates of bilateral hearing loss >25 dB HL in NHANES ranged from 7.5% using a speech-frequency average (across 0.5, 1, 2 and 4 kHz) to 19.1% using a high-frequency average (across 3, 4, 6 kHz) among 20- to 69-year-olds in 2011–2012.[8] These cannot be readily compared with the Health Survey for England, which found 14% and 13% of adults older than 16 years had hearing loss at 1 kHz and 3 kHz, respectively, in 2014.[9] Fourth, it is important to document sociodemographic risk factors other than age to identify prevention opportunities. For example, the NHANES prevalence of bilateral speech-frequency hearing loss >25 dB HL was greater in men (9.9%) than in women (5.1%) and in people of lower (11.3%) than higher socio-economic status (4.0%).[8]

Here, in a population-derived national cross-sectional sample of 30- to 59-year-old parents whose children were participating in the Longitudinal Study of Australian Children (LSAC),[15] we aim to (1) describe the current prevalence of hearing loss using several definitions, against which to make prior and future comparisons, and (2) examine prevalence by age, sex and neighbourhood disadvantage.

Methods

Study design

The Child Health CheckPoint is a cross-sectional population-derived study, nested within the national LSAC. In 2004, the LSAC used a two-stage national random sampling framework clustered by state, urban/rural split and postcode to recruit two cohorts of young children with their parents who have since been followed up biennially. This article concerns the parents of the B cohort that initially comprized 5107 infants aged three–19 months at wave 1 (2004), representing 57.2% of all in-age children approached, of whom 75% were retained to wave 6 (2014).[16]

The Child Health CheckPoint, LSAC's physical health and biomarkers module, was a single cross-sectional data collection wave between LSAC's 6th (2014) and 7th (2016) biennial main waves; its primary focus was on cardiorespiratory and metabolic health. LSAC interviewers obtained consent at the wave 6 home-based interview to pass contact details to CheckPoint, which invited all retained B cohort children aged 11–12 years and their parents/guardians to participate. The Royal Children's Hospital Human Research Ethics Committee (HREC33225) and The Australian Institute of Family Studies Ethics Committee (AIFS14-26) approved the study. Parents provided written consent.[15]

Participants and procedures

From December 2014, CheckPoint contacted each family to ascertain interest and booked a single appointment for parent-child dyads as the CheckPoint assessment centre visited each Australian state sequentially between February 2015 and March 2016. Parents/guardians (this study's participants) underwent assessments of multiple body systems; here, we report on the 'Listen Up' station, which administered air-conduction pure-tone audiometry and tympanometry (not available to a small proportion visited at home).

Measures

Audiometry: Trained examiners performed air-conduction pure-tone audiometry using an Oscilla USB-330 (version 3.3.4) computer-based audiometer with Oscilla headphones, following a standardized modified Hughson–Westlake audiometric technique. Testing of the first frequency began at 30 dB HL; if within normal limits, testing for each frequency thereafter began at 20 dB HL. Participants were asked to remove hearing aids and/or cochlear implant speech processors if worn; testing of the first frequency then began at 60 dB HL and of successive frequencies at 20 dB HL above the adjacent frequency threshold. For the first 147 participants, only three frequencies were tested (1, 2 and 4 kHz) for each ear. As CheckPoint systems became faster and additional funding was sourced, testing at 8 kHz (n = 1338), tympanometry (n = 1088) and soundproof booths (n = 807) were successively added. If participants' hearing thresholds at two or more frequencies in at least one ear were >20 dB HL, their written feedback stated that hearing was outside the usual range and that they should consider a clinical audiology assessment.

Tympanometry was used to assess the impedance of the tympanic membrane (middle ear function). The Oscilla TSM500 automatically calculated ear canal volume, middle ear pressure and compliance during a pressure sweep. The result of the tympanometry is a curve called a tympanogram, which shows the movement of the middle ear system as pressure is varied. Tympanograms were classified as types A (normal compliance), B (no or negligible compliance) or C (normal compliance, negative middle ear pressure), with criteria and interpretation detailed in Table 1.[17] Hearing loss in combination with type A tympanogram was considered as sensorineural hearing loss.

Demographic characteristics: CheckPoint recorded participants' age, sex and postcode. Neighbourhood disadvantage was determined by the Social-Economic Indexes for Areas (SEIFA) disadvantage index,[18] divided into five national quintiles. This postcode-based composite is derived from the 2011 Australian Census; higher scores reflect less disadvantage.

Data management

Table 1 details all derived variables with their constructs and rationale. Because of its relevance to the speech spectrum, our primary pure-tone average outcome was the high Fletcher

Table 1 – Summary of derived variables.

Construct/measures	Definitions	Rationale
Continuous		
High Fletcher index	The average of thresholds at 1, 2 and 4 kHz	Best reflects audibility at speech frequencies.
Lower frequency average	The average of thresholds at 1 and 2 kHz	Reflects audibility of lower frequency speech sounds (e.g., most vowels and letter combinations/ng//ch/,/sh/). Characteristic of conductive or sensorineural hearing loss.
Higher frequency average	The average of thresholds at 4 and 8 kHz	Reflects audibility of higher frequency speech sounds (e.g., most consonant and letter combinations/th/). Particularly disabling with background noise. Suggests noise-induced and/or sensorineural hearing loss.
Categorical		
Unilateral hearing loss	Definition 1: hearing threshold is >15 dB HL in worse hearing ear and hearing threshold is ≤15 dB HL in better hearing ear. Definition 2: hearing threshold is >25 dB HL in worse hearing ear and hearing threshold is ≤25 dB HL in better hearing ear.	Hearing loss in one ear.
Bilateral hearing loss	Definition 1: Hearing threshold is >15 dB HL in better hearing ear. Definition 2: Hearing threshold is >25 dB HL in better hearing ear.	Hearing loss in both ears.
Type A tympanogram	Ear canal volume: 0.6–1.5 cm^3; Middle ear pressure: −100 to +50 daPa; Compliance: 0.25 to 1.4 mmho.	Suggests normal middle ear function.
Type B tympanogram	Ear canal volume: 0.6–1.5 cm^3; Middle ear pressure: −100 to +50 daPa; Compliance: < 0.25 mmho.	Suggests middle ear effusion, tympanic membrane perforation, cerumen occlusion or a probe sealed against the canal wall.
Type C tympanogram	Ear canal volume: 0.6–1.5 cm^3; Middle ear pressure: < −100 daPa; Compliance: 0.25 to 1.4 mmho.	Suggests negative middle ear pressure.

HL, hearing level.

index (mean of 1, 2 and 4 kHz).[19] To support prior and future comparisons with as many studies as possible, we also calculated lower frequency average (1 and 2 kHz) and higher frequency average (4 and 8 kHz, believed to be more affected by noise exposure). We reported both better and worse ear thresholds. For all indices, we used two definitions: *case definition 1*—bilateral hearing loss defined as thresholds >15 dB HL in the better ear and unilateral hearing loss as thresholds >15 dB HL in the worse ear but ≤15 dB HL in the better ear; *case definition 2*—bilateral hearing loss defined as thresholds >25 dB HL in the better ear and unilateral hearing loss as thresholds >25 dB HL in the worse ear but ≤25 dB HL in the better ear. These thresholds were adopted from the American Speech-Language-Hearing Association guidelines to define slight or worse and mild or worse hearing loss.[20]

Statistical analyses

were performed using Stata 14.0. We applied cross-sectional survey weights to all analyses using Stata survey techniques. For aim 1, we calculated prevalence estimates of hearing loss with 95% confidence intervals (CIs). For aim 2, we used multivariable logistic regression models to calculate odds ratios (ORs) with 95% CIs for hearing loss according to sociodemographic characteristics. In sensitivity analyses, we repeated aim 1 including only the participants with type A tympanograms in both ears (n = 988) and for participants tested in soundproof booths (n = 807).

Results

Baseline characteristics

Fig. 1 presents the study flow from the initial sample of LSAC onwards. A total of 1485 parents/guardians (mean age 42.9 years; 87.3% female) were included in analyses. The weighted mean disadvantage index was 1009.6 (standard deviation [SD], 63.4), slightly above but with a lower spread than the national Australian mean of 1000 (SD, 100) (Table 2). We found no differences in age and sex between the first participants (n = 147) and later participants with audiometry at 8 kHz (n = 1338). However, the early participants were on average from slightly less disadvantaged neighbourhoods (postcodes) than the later participants (Supplementary Table e1), in keeping with known minor differences between the state of Victoria (visited first) and the remaining Australian states.

Audiometry

The mean hearing thresholds for individual frequencies and all three indices were similar when including all participants (total n = 1485) and the subgroups with type A tympanometry (n = 988) and audiometry at 8 kHz (n = 1338) (Supplementary Table e2).

Prevalence of hearing loss (aim 1)

Table 3 shows the prevalence estimates of bilateral and unilateral hearing loss. Regarding our primary outcome (high Fletcher index), 27.3% and 23.8% had bilateral and unilateral thresholds >15 dB HL (slight or worse), respectively, and 4.9% and 6.3% had bilateral and unilateral thresholds >25 dB HL (mild or worse), respectively. Bilateral higher frequency losses were more common than lower frequency losses for thresholds >15 dB HL (30.9% vs. 26.4%) and thresholds >25 dB HL (11.0% vs. 4.6%).

In sensitivity analyses, prevalence estimates were similar when including participants with type A tympanogram (n = 988) (Supplementary Table e3) but slightly lower when tested in soundproof booths (n = 807) than the overall prevalence estimates (Supplementary Table e4).

Sociodemographic risk factors (aim 2)

In multivariable regression analysis, older age, male sex and disadvantaged index were consistently associated with bilateral losses >15 dB HL and >25 dB HL (Fig. 2; adjusted ORs detailed in Table 4). On the high Fletcher index, bilateral losses >15 dB HL rose from 22.1% among 35- to 39-year-olds to 45.4% among 55- to 59-year-olds (P for trend <0.001). Similar associations were noted in high Fletcher index >25 dB HL and higher frequency losses (all P for trend <0.05) (Fig. 2a). Men and women had similar rates of high Fletcher and lower frequency losses, but men were substantially more likely to have higher frequency hearing loss >15 dB HL (OR: 2.2, 95% CI: 1.5–3.2, $P < 0.001$) and >25 dB HL (OR: 2.6, 95% CI: 1.5–4.4, $P < 0.001$) (Fig. 2b). The linear trend towards rising prevalence across quintiles of increasing disadvantage was not strongly evident, but those in the most disadvantaged quintile experienced the highest rates on the high Fletcher index (OR: 1.8, 95% CI: 1.1–3.0, $P = 0.02$) and lower frequency average (OR: 1.7, 95% CI: 1.1–3.0, $P = 0.04$) (Fig. 2c).

Discussion

Main findings of this study

We estimate that around one in four Australian adults aged 30–59 years has bilateral hearing loss >15 dB HL on an index closely related to speech perception, increasing with age from 22.1% at 35–39 years to 45.4% at 55–59 years. Around one in 20 has hearing loss >25 dB HL. Bilateral higher frequency losses were more common than lower frequency losses, especially in men. Neighbourhood disadvantage did not convincingly predict hearing loss.

Interpretation in light of other studies

Because prevalence is highly dependent on how hearing loss is defined, it is difficult to draw comparisons between studies. Most previous studies have reported speech frequency hearing losses >25 dB HL (because amplification might be offered to reduce already-evident negative impacts on health and quality of life[3]) in broad age brackets. When stratified by age, our speech frequency prevalence >25 dB HL in 30- to 39-year-olds was 3.8% (95% CI: 1.8–7.5%), higher than the 0.9% (0.4–2.1%) in the NHANES[8] and 2.8% (1.2–4.4%) in the United Kingdom (31- to 40-year-olds).[21] This most likely reflects the fact that our sampling frame generated more 35- to 39-year-olds (n = 224) than 30- to 34-year-olds (n = 53). Our rates in individuals older than 40 years resembled prior studies.

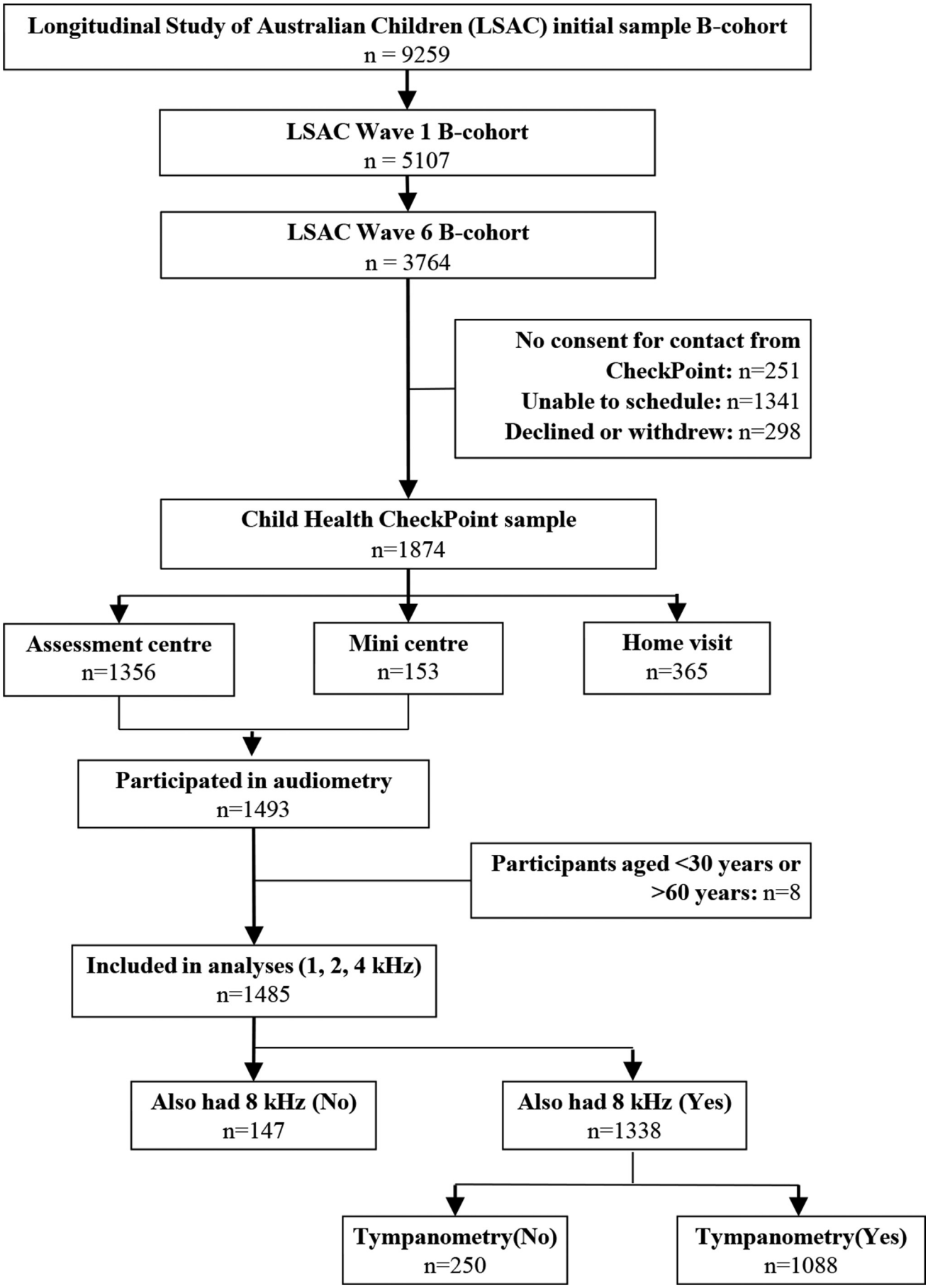

Fig. 1 – Audiometric recruitment and participation.

Table 2 – Baseline characteristics (n = 1485).

Characteristic	Mean (SD or weighted %)
Age in years	42.9 (5.2)
30–39	25.4
40–49	64.8
50–59	9.8
Female sex	87.3
Disadvantage index	1009.6 (63.4)
1st quintile (least disadvantaged)[a]	26.5
2nd quintile	23.2
3rd quintile	19.9
4th quintile	17.7
5th quintile (most disadvantaged)	12.7
Conducted in soundproof booth	52.4

SD, standard deviation.
[a] Based on national quintiles.

Table 3 – Prevalence of bilateral and unilateral hearing loss.

Variable	% overall prevalence (95% CI)[a]	
	>15 dB HL slight or worse	>25 dB HL mild or worse
High Fletcher index (1, 2 and 4 kHz)[b]		
Bilateral	27.3 (24.7–30.1)	4.9 (3.7–6.3)
Unilateral	23.8 (21.3–26.4)	6.3 (5.0–8.0)
Lower frequency average (1 and 2 kHz)[b]		
Bilateral	26.4 (23.6–29.3)	4.6 (3.4–6.1)
Unilateral	24.9 (22.3–27.7)	5.6 (4.5–6.9)
Higher frequency average (4 and 8 kHz)[c]		
Bilateral	30.9 (28.0–33.9)	11.0 (9.1–13.3)
Unilateral	23.3 (20.5–26.3)	10.9 (8.9–13.3)

CI, confidence interval; dB HL, decibels hearing level; kHz, kilohertz.
[a] Survey weighted prevalence.
[b] Whole sample (n = 1485).
[c] Subsample 1 only: participants with audiometry at 8 kHz (n = 1338).

Hearing loss >15 dB HL was much more prevalent. This is expected because hearing acuity is distributed along a continuum and progresses with 75.6% of adults older than 70 years who suffered hearing loss >15 dB HL in the NHANES 2005–2006.[22] While such a deficit may have few obvious impacts on speech and communication, it may still result in less satisfaction with own independence, reduced emotional well-being and greater perceived limitation.[23] Higher frequency prevalence discrepancies for both >15 and > 25 dB HL by sex is in line with previously reported sex differences in hearing loss >25 dB HL.[10,21] This male excess is usually assumed to reflect greater lifetime work and/or leisure noise exposure[24] but might also reflect sex differences in the associations with putative risk factors of hearing loss, such as risk factors of non-communicable diseases.[25]

Strengths and limitations

This study fills a gap in the known epidemiology of emerging hearing loss, using standardised air-conduction audiometry, at different stages of mid-life in Australia. To enhance comparability and harmonisation with current and future studies, we reported age-specific prevalence by three different indices at two different thresholds. Even so, we expect that others will make different choices of classification and take different sampling opportunities.

Limitations include the lack of testing at additional frequencies (e.g., 0.5, 3, 6 kHz) reported by previous studies.[8,10,21] We note that intraoctave frequency (3 and 6 kHz) thresholds are typically intermediate to those of the two bounding octave frequencies[26] and that 0.5 kHz is both the least relevant to spoken speech and the most affected by residual background noise, as present in CheckPoint. Second, bone-conduction audiometry would have more accurately classified sensorineural and conductive losses but was infeasible and would have reduced comparability with other population studies.[27,28] However, our sensitivity analysis indicated little influence of middle ear status on overall estimates (Supplementary Table e3). Third, 47.9% of participants could not be assessed in soundproof booths, with sensitivity analyses indicating a resulting likely slight overestimate of overall prevalence. This is partly offset by our sex imbalance of 87.3% mothers to 12.7% fathers. If extrapolated to a roughly 50:50 female:male adult population of an equivalent age structure, the overall prevalence of bilateral hearing loss >15 dB HL would have been 29.6% (mean of 26.6% and 32.5%) for high Fletcher index, 27.0% (mean of 26.1% and 27.9%) for lower frequencies and 38.8% (mean of 28.2% and 49.4%) for higher frequencies (Fig. 2b). This would have underestimated true prevalences slightly for lower frequencies and high Fletcher index (e.g., >15 dB HL, by around 0.5% and 2%, respectively) and more substantially for higher frequencies (e.g., >15 dB HL, by around 8%). Finally, these audiometric results might be less applicable to Australian adults who are not parents, although we have no reason to suppose this to be the case.

Implications

With no obvious easy sampling frame for Australian population studies of hearing in mid-life adults, this study provides the only objective national data on losses starting from 15 dB HL and is one of the few studies to report this internationally. The high prevalence is concerning because non-communicable diseases are usually progressive with first perturbations often starting early in life.[29,30] Population longitudinal audiometric studies are needed in children, young and mid-life adults to investigate hearing trajectories,[12] rates of deterioration with age and indeed whether deterioration is inevitable. Second, investigating risk factors for slight and mild hearing loss could lead to discovery of treatments that reduce progression (or even prevent onset) of presbycusis. It is important to know whether mechanisms of more severe presbycusis also underlie its onset; these include genetic (e.g., mitochondrial DNA mutations)[31] and environmental (e.g., noise exposure, smoking and diabetes)[25,32,33] risk factors. Third, quantitative and qualitative studies are needed to clarify the impact of slight and mild hearing loss on health and quality of life. Our high prevalence of slight and mild hearing loss may show policymakers why to act, but without this range of additional information, it will be difficult to know how to act—for example, whether and when to

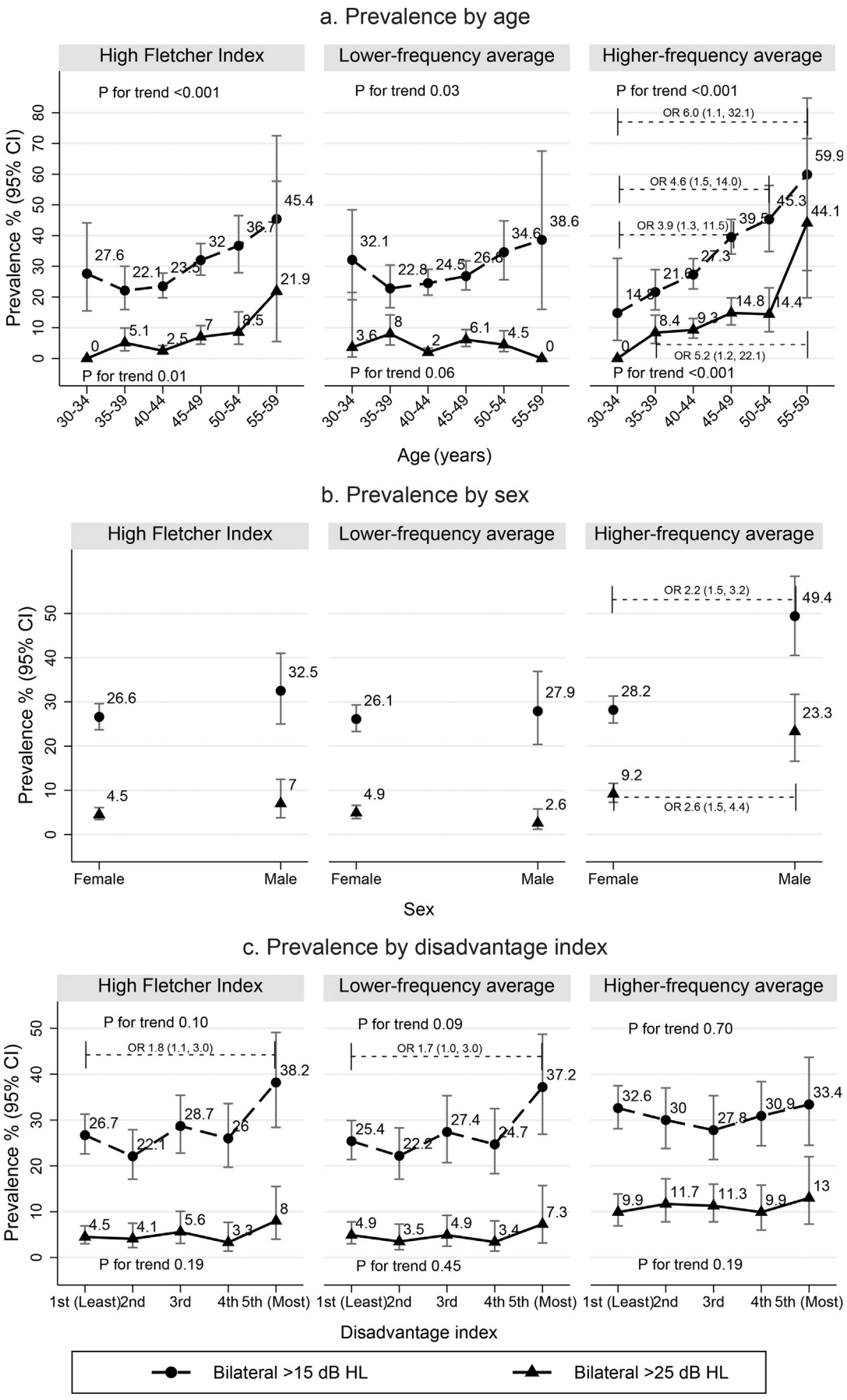

Fig. 2 – Prevalence of bilateral hearing loss by age, sex and neighbourhood disadvantage. CI, confidence interval; dB HL, decibels hearing level; OR, odds ratio.

Table 4 – Potential demographic risk factors for bilateral hearing loss.

Characteristics	Bilateral hearing loss (>15 dB HL)			Bilateral hearing loss (>25 dB HL)		
	High Fletcher index[a]	Lower frequency average[a]	Higher frequency average[b]	High Fletcher index[a]	Lower frequency average[a]	Higher frequency average[b]
	OR (95% CI)[c]	OR (95% CI)[c]	OR (95% CI)[c]	OR (95% CI)[c]	OR (95% CI)[c]	OR (95% CI)[c]
Age group in years						
30–34	reference	reference	reference	0.0	reference	0.0
35–39	0.8 (0.4–1.9)	0.7 (0.3–1.5)	1.7 (0.5–5.2)	reference	2.6 (0.3–19.4)	reference
40–44	0.9 (0.4–2.0)	0.8 (0.4–1.6)	2.3 (0.8–6.8)	0.5 (0.2–1.3)	0.6 (0.1–4.4)	1.2 (0.6–2.4)
45–49	1.4 (0.7–3.1)	0.9 (0.4–1.8)	3.9 (1.3–11.5)**	1.5 (0.6–3.6)	1.9 (0.3–14.4)	1.9 (1.0–3.8)
50–54	1.7 (0.7–3.8)	1.2 (0.6–2.7)	4.6 (1.5–14.0)**	1.7 (0.6–4.7)	1.4 (0.2–11.1)	1.7 (0.7–3.8)
55–59	2.3 (0.5–9.7)	1.5 (0.4–6.3)	6.0 (1.1–32.1)*	5.0 (0.8–31.0)	–	5.2 (1.2–22.1)*
	P for trend< 0.001	*P for trend 0.03*	*P for trend< 0.001*	*P for trend 0.01*	*P for trend 0.06*	*P for trend< 0.001*
Sex						
Female	reference	reference	reference	reference	reference	reference
Male	1.2 (0.8–1.8)	1.0 (0.6–1.6)	2.2 (1.5–3.2)***	1.1 (0.5–2.3)	0.5 (0.2–1.3)	2.6 (1.5–4.4)**
Disadvantage quintilerowhead						
1st (Least)	reference	reference	reference	reference	reference	reference
2nd	0.8 (0.6–1.3)	0.9 (0.6–1.3)	1.0 (0.7–1.6)	1.0 (0.5–2.2)	0.7 (0.3–1.7)	1.4 (0.8–2.7)
3rd	1.2 (0.8–1.8)	1.1 (0.7–1.8)	0.9 (0.6–1.5)	1.4 (0.7–3.1)	1.0 (0.4–2.4)	1.4 (0.7–2.6)
4th	1.1 (0.7–1.7)	1.0 (0.6–1.6)	1.1 (0.8–1.7)	0.9 (0.3–2.5)	0.7 (0.2–2.0)	1.2 (0.6–2.4)
5th (Most)	1.8 (1.1–3.0)*	1.7 (1.0–3.0)*	1.2 (0.7–2.1)	2.2 (0.9–5.2)	1.5 (0.6–4.1)	1.7 (0.8–3.5)
	P for trend 0.10	*P for trend 0.09*	*P for trend 0.70*	*P for trend 0.19*	*P for trend 0.45*	*P for trend 0.19*

CI, confidence interval; dB HL, decibels hearing level.
*P < 0.05; **P < 0.01; ***P < 0.001.
[a] Whole sample (n = 1485).
[b] Subsample 1 only: participants with audiometry at 8 kHz (n = 1338).
[c] Survey weighted.

implement adult hearing screening. Finally, research is hampered for any prevalent condition (including hearing loss) when differing definitions and measurement preclude data pooling or comparisons. One way forward would be to establish an international repository of deidentified person-level audiometric data, retaining flexibility in definition while supporting larger scale research into the epidemiology, causes and potential for prevention and treatment.

Conclusions

This study provides the first objective national Australian data on slight and mild hearing loss at different stages of mid-life and adds to sparse international data. Both slight and mild hearing loss show high and rising prevalence across mid-life. This offers opportunities to prevent progression to reduce the profound later burden of age-related hearing loss.

Author statements

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Ethical approval

The Royal Children's Hospital Human Research Ethics Committee (HREC33225) and The Australian Institute of Family Studies Ethics Committee (AIFS14-26) approved the study. Parents provided written consent.

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Competing interests

The authors declare no potential conflicts of interest, including no specific financial interests relevant to the subject of this manuscript.

Authors' contribution

M.W. conceived and led the CheckPoint study with the CheckPoint team and was LSAC's Health Design Leader. M.W. was the primary student supervisor, along with R.A.B. and V.S., and oversaw all aspects of the study and manuscript preparation. R.S.L. contributed to hearing data collection and, under the guidance of P.C., designed the hearing protocols. J.W. and C.M.P.L.C. conducted data extraction, cleaning and handling. J.W. performed data analysis and wrote the main article. M.W., P.C., F.K.M. and L.G. advised on statistical issues and interpretation. All authors critically reviewed the manuscripts and had final approval of the submitted and published version of this article.

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Appendix A. Supplementary data

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