Hearing-impaired adults are at increased risk of experiencing emotional distress and social engagement restrictions five years later

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Abstract

Background: we aimed to assess both cross-sectional and temporal links between measured hearing impairment and self-perceived hearing handicap, and health outcomes.
Methods: in total, 811 Blue Mountains Hearing Study participants (Sydney, Australia) aged ≥55 years were examined twice (1997–99 and 2002–04). Hearing levels were measured with pure-tone audiometry. The shortened version of the hearing handicap inventory (HHIE-S) was administered, scores ≥8 defined hearing handicap.
Results: baseline hearing impairment was strongly associated with 7 of the 10 HHIE-S questions, 5 years later. Individuals with and without hearing impairment at baseline reported that they felt embarrassed and/or frustrated by their hearing problem, and that it hampered their personal/social life, multivariable-adjusted OR: 11.5 (CI: 3.5–38.1), OR: 6.3 (CI: 2.5–15.7) and OR: 6.0 (CI: 2.1–17.5), respectively, 5 years later. Hearing-impaired, compared with non-hearing-impaired adults had a significantly higher risk of developing moderate or severe hearing handicap, OR: 3.35 (CI: 1.91–5.90) and OR: 6.60 (CI: 1.45–30.00), respectively. Cross-sectionally (at wave 2), hearing handicap increased the odds of depressive symptoms and low self-rated health by 80 and 46%, respectively.
Conclusion: older, hearing-impaired adults were significantly more likely to experience emotional distress and social engagement restrictions (self-perceived hearing handicap) directly due to their hearing impairment.

Keywords: *age-related hearing loss, hearing handicap, incidence, Blue Mountains Hearing Study, Blue Mountains Eye Study*

Introduction

Age-related hearing loss is a highly prevalent yet relatively under-recognised health problem in elderly populations [1–3]. The deficit in physiological hearing function (measured hearing impairment or pure-tone hearing loss), however, does not necessarily reflect the self-perception of a social or emotional deficit in everyday life (self-reported hearing handicap) in older persons [4]. The self-perception of a hearing handicap among older adults is a key element in seeking audiological rehabilitation and in successful long-term use of hearing aids [4].

Clinically, behavioural audiograms are considered the 'gold standard' for evaluating hearing loss and are used to measure the degree of hearing impairment. Less often measured is hearing handicap which is usually evaluated by a self-reported questionnaire that assesses the emotional and social effects of hearing impairment [4]. Ventry and Weinstein [5] observed that audiometric measures accounted

for <50% of the variance in the perception of a hearing handicap among older adults, suggesting that hearing handicap is more appropriately measured via a self-report format rather than as an inference of audiometric data [4].

It has been suggested that primary care services could be used to identify hearing handicap using targeted questions, possibly alongside other screening interventions [6, 7]. However, epidemiological data on the temporal relationship between measured hearing impairment and self-perceived hearing handicap are required to provide a strong evidence base before such interventions and screening strategies can be justified. To address this gap, we used a large cohort of older adults aged ≥55 years and over, to establish the longitudinal relationships between measured hearing impairment and self-reported hearing handicap. We also explored cross-sectional associations between self-perceived hearing handicap and indicators of negative well-being, including poor quality of life, low self-rated health and depressive symptoms.

Methods

Study population

The Blue Mountains Hearing Study (BMHS) [2, 3] is a population-based survey of age-related hearing loss conducted during the years 1997–2004 among participants of the Blue Mountains Eye Study (BMES) cohort in Sydney, Australia [8]. During 1992–94, 3,654 participants ≥49 years or older were examined (82.4% participation; BMES-1). Surviving baseline participants were invited to attend examinations after 5 (1997–99, BMES-2) and 10 years (2002–04, BMES-3), at which 2,334 (75.1% of survivors) and 1,952 participants (75.6% of survivors) were re-examined, respectively. Audiometric threshold and hearing handicap data were collected at BMES-2 and then 5 years later at BMES-3. The study was approved by the Human Research Ethics Committee of the University of Sydney and was conducted adhering to the tenets of the Declaration of Helsinki. Signed informed consent was obtained from all participants at each examination.

Audiological examination

An audiologist asked questions including history of any self-perceived hearing problem, including its severity, onset and duration, and if a hearing aid had been provided. The Hearing Handicap Inventory for the Elderly–Shortened version (HHIE-S), developed by Ventry and Weinstein [5], was also administered. The HHIE-S includes 10 questions and a response of 'yes' is given 4 points, 'sometimes' is given 2 points and 'no' is given 0 points. Scores ≥8 were taken to indicate the presence of a handicap [9]. Incident hearing handicap was defined as participants who did not have significant hearing handicap (≥8) at baseline (BMES-2) but developed hearing handicap 5 years later at the follow-up study (BMES-3).

Pure-tone audiometry at both visits was performed by audiologists in sound-treated booths, using standard TDH-39 earphones and Madsen OB822 audiometers (Madsen Electronics, Copenhagen, Denmark), calibrated regularly to Australian standards. A sound-proof room was set-up according to the International Standards Organization protocol 8253–2. Audiometric thresholds for air-conduction stimuli in both ears were established for frequencies at 250, 500, 1,000, 2,000, 4,000, 6,000 and 8000 Hz, with 3,000 Hz added if a 20-dB difference existed between the 2,000 and 4,000 Hz thresholds. We determined hearing impairment as the pure-tone average of audiometric hearing thresholds at 500, 1,000, 2,000 and 4,000 Hz ($PTA_{0.5-4\,KHz}$), defining any hearing loss as >25 dB HL, mild hearing loss as $PTA_{0.5-4\,KHz}$ >25–40 dB HL and moderate to severe hearing loss as $PTA_{0.5-4\,KHz}$ >40 in the better of the two ears (i.e. bilateral hearing loss).

Assessment of health covariates or outcomes

Participants were asked whether they receive a pension and if so, the type of pension they receive, e.g. age, invalid, veteran's or blind. The medical history covered cardiovascular disease, other systemic diseases and associated risk factors, medications used, exercise and smoking. History of cardiovascular disease was based on self-report of physician-diagnosed acute myocardial infarction or angina. The presence of physician-diagnosed stroke was also assessed. Diabetes was defined either by history or from fasting blood glucose ≥7.0 mmol/l.

Disability in walking was assessed as present if the participant was observed by a trained examiner to have walking difficulties or used walking aids or a wheelchair. Global self-rated health was assessed by asking the following question: 'For someone of your age, how would you rate your general health; would you say it is excellent, very good, fair or poor?' Participants reporting fair or poor self-rated health were considered to have low self-rated health. The 36-Item Short-Form Survey (SF-36) contains 36 items, which produces eight subscale scores representing dimensions of health and well-being. The subscales are summarised as a physical and mental component score, calculated by assigning relative weights to each subscale as described by the developers of this instrument [10]. The domain scores are rated so that higher values indicate better health (range 0–100) [11]. The Mental Health Index is a component of the SF-36. Scores were calculated as the sum of questions one to five multiplied by 25 and the result divided by 100, i.e. $\sum (MH1 - 5) \times 25/100$. A cut-off score of ≤59 out of 100 was used to define persons with depression and/or anxiety disorder [12]. Cognitive decline was assessed using the Mini-Mental State Examination (MMSE) questionnaire [13]. Participants with scores <24 were considered cognitively impaired.

Statistical analysis

SAS software (SAS Institute, Cary, NC, USA) version 9.1 was used for analysis including *t*-tests, χ^2 tests and logistic

regression. Measured age-related hearing impairment was the independent variable and incident self-perceived hearing handicap was the main dependent variable. Multivariable logistic regression analysis was used to calculate adjusted odds ratios (OR) and 95% confidence intervals (CI). Multivariable regression models were first adjusted for age and sex, and then further adjusted for potential confounders that were found to be significantly associated with the incidence of self-perceived hearing handicap (i.e., poor self-rated health, living status, depressive symptoms and receipt of pension payment). We also explored the cross-sectional association between self-perceived hearing handicap as the dependent variable and quality of life, self-rated health and depressive symptoms as independent variables. *P*-values <0.05 were considered statistically significant.

Results

Figure 1 shows the distribution of participation in hearing studies that were performed between 1997–99 and 2002–04 in the BMHS cohort. We compared study characteristics between those subjects with (*n* = 811) and without (*n* = 687) complete hearing handicap data. We found that those without versus those with hearing handicap data were more likely to be older, male and live alone. Among those with any, mild and moderate to severe measured hearing impairment at baseline, the 5-year incidence of any level of self-perceived hearing handicap was 66.7, 66.0 and 72.7%. We did not analyse the association between the use of hearing aids at baseline and 5-year incidence of hearing handicap, as the number of incident cases was too small (*n* = 8) among this group.

Any measured hearing impairment at baseline was independently associated with a positive response to 7 of the 10 HHIE-S questions at the 5-year follow-up (Table 1). Hearing impaired compared with non-impaired individuals at baseline were at a higher risk of being embarrassed [OR: 11.5 (95% CI: 3.5–38.1)], frustrated [OR: 6.3 (95% CI: 2.5–15.7)] and/or experience social engagment restrictions [OR: 6.0 (95% CI: 2.1–17.5)] as well as difficulty when someone speaks in a whisper [OR: 5.7 (95% CI: 1.1–28.5)] at the 5-year follow-up.

Table 2 shows that having any measured hearing impairment significantly increased the risk of developing any, moderate or severe hearing handicap by 3.0-, 3.4- and 6.6-fold among older adults, respectively. Measured mild hearing impairment was significantly associated with increased risk of incident self-perceived hearing handicap, multivariable-adjusted OR: 3.47 (95% CI: 1.95–6.17)

After adjusting for age, sex, walking disability, depressive symptoms, history of arthritis, diabetes and/or cardiovascular disease, and admission to hospital in the past 12 months, self-reported hearing handicap was associated with increased likelihood of low self-rated health, OR: 1.46 (95% CI: 1.01–2.11). Similarly, after adjusting for age, sex, walking disability, receipt of pension payment, use of community support services, living alone, cognitive impairment, and history of arthritis and/or stroke, persons with hearing handicap had higher odds of having depressive symptoms, OR: 1.80 (95% CI: 1.17–2.79). We also assessed potential associations with quality of life. After adjusting for age, sex, receipt of pension payment, current smoking, living alone, walking disability, visual impairment, hospital admissions in the past 12 months, history of stroke and/or arthritis, persons with self-reported
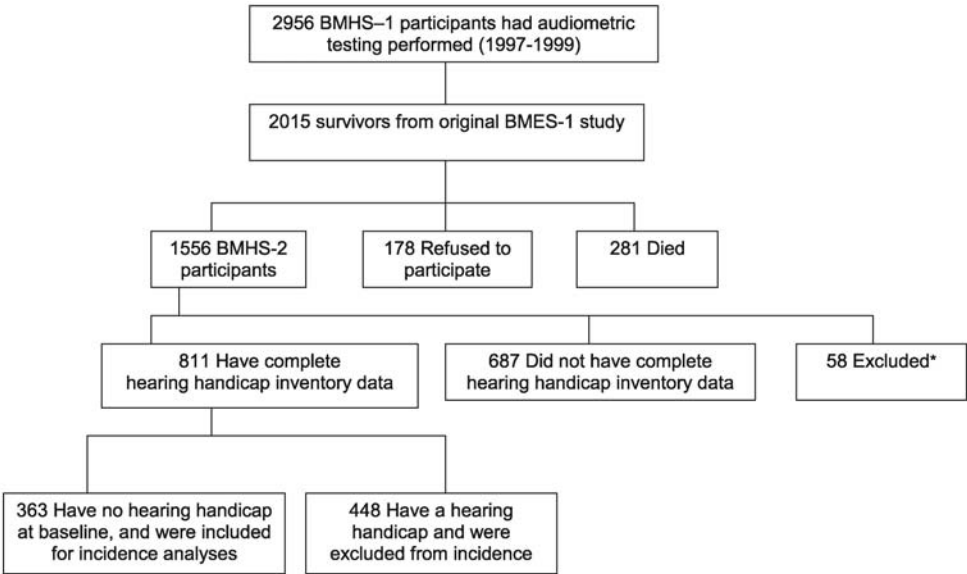
Figure 1. Participation in the Blue Mountains Hearing Study from 1997–99 to 2002–04. The asterisk indicates participants excluded on the basis that they had either conductive hearing loss and/or childhood hearing loss.

Table 1. Longitudinal association between measured hearing loss (>25 dB HL) at baseline and a positive response to each individual HHIE-S question 5 years later, presented as odds ratios (OR) and 95% confidence intervals (CI)*

	No hearing loss (≤25 dB HL)		Any hearing loss (>25 dB HL)	
	n (%)	OR (95% CI)	n (%)	OR (95% CI)
1. Does a hearing problem cause you to feel embarrassed when meeting new people?	4 (1)	1.0 (reference)	25 (11)	11.5 (3.5–38.1)
2. Does a hearing problem cause you to feel frustrated when talking to members of your family?	9 (3)	1.0 (reference)	22 (12)	6.3 (2.5–15.7)
3. Do you have difficulty hearing when someone speaks in a whisper?	46 (30)	1.0 (reference)	26 (55)	5.7 (1.1–28.5)
4. Do you feel handicapped by a hearing problem?	14 (4)	1.0 (reference)	33 (14)	3.6 (1.6–7.7)
5. Does a hearing problem cause you difficulty when visiting friends, relatives or neighbours?	7 (2)	1.0 (reference)	18 (9)	3.0 (1.1–8.0)
6. Does a hearing problem cause you to attend meetings and religious services less often?	2 (1)	1.0 (reference)	8 (3)	3.5 (0.6–18.8)
7. Does a hearing problem cause you to have arguments with your family members?	6 (2)	1.0 (reference)	9 (3)	1.8 (0.5–5.6)
8. Does a hearing problem cause you difficulty when listening to TV or radio?	10 (4)	1.0 (reference)	25 (20)	4.7 (1.9–11.3)
9. Do you feel that any difficulty with your hearing limits or hampers your personal or social life?	6 (2)	1.0 (reference)	22 (9)	6.0 (2.1–17.5)
10. Does a hearing problem cause you difficulty when in a club or a restaurant with relatives or friends?	7 (4)	1.0 (reference)	15 (12)	3.6 (1.00–12.7)

*Adjusted for age, sex, living status, self-rated health, depressive symptoms and receipt of pension payment.

Table 2. Five-year incidence of varying severity of hearing handicap and the presence of hearing loss at baseline, presented as odds ratios (OR) and 95% confidence intervals (CI)

	Any handicap (HHIE ≥8) n = 161		Moderate handicap (HHIE >8–24) n = 147		Severe handicap (HHIE ≥26) n = 14	
	Age-sex adjusted OR (95% CI)	Multivariable-adjusted* OR (95% CI)	Age-sex adjusted OR (95% CI)	Multivariable-adjusted* OR (95% CI)	Age-sex adjusted OR (95% CI)	Multivariable-adjusted* OR (95% CI)
Presence of hearing loss, dB HL						
No hearing loss (≤25), n = 258	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Any hearing loss (>25), n = 105	2.90 (1.75–4.82)	3.04 (1.75–5.28)	3.06 (1.82–5.17)	3.35 (1.91–5.90)	7.12 (1.98–25.56)	6.60 (1.45–30.00)

*Adjusted for age, sex, living status, self-rated health, depressive symptoms and receipt of pension payment.

hearing handicap compared with those without any handicap had a significantly lower mean (SD) physical composite score, 40.6 (10.9) and 43.6 (11.3), respectively, $P = 0.004$. Also, the mean (SD) mental composite score was significantly lower among those with rather than without self-perceived hearing handicap, 50.4 (10.7) and 52.4 (9.2), respectively, $P = 0.002$.

Discussion

Around two out of three individuals with any level of impaired hearing at baseline went on to develop significant hearing handicap within 5 years. Seven out of the 10 HHIE-S questions showed a significant and positive association with baseline measured hearing impairment, particularly, questions pertaining to self-perception of frustration, embarrassment and/or of disruptions to one's social and personal life. Older adults with self-perceived hearing handicap compared with those without were more likely to have depressive symptoms, low self-rated health and poor quality of life.

Previously, Lutman *et al.* [14] observed that with increasing level of measured hearing impairment the likelihood of

communication difficulties also increases. This concurs with data from the Epidemiology of Hearing Loss Study (EHLS) which found that the prevalence of hearing handicap increased with the severity of loss [15]. However, in our cohort we did not observe a significant increase in risk of incident hearing handicap with increasing severity of hearing loss, after adjusting for all variables. It was previously shown that hearing thresholds do not necessarily correlate with the degree of disability experienced by persons with hearing impairment [4, 5]. Alternatively, those with severe hearing impairment and, as such, significant hearing handicap are more likely to use a hearing aid over a 5-year period as previously shown in the BMHS [16] and this could have masked the temporal association between measured hearing loss and hearing handicap. Finally, the small number of incident cases of hearing handicap among persons with moderate to severe hearing impairment at baseline could have reduced our study power and our ability to detect a significant association. Clearly, our findings require confirmation and further longitudinal data from other cohort studies in this area are warranted.

Measured bilateral hearing impairment was strongly and positively associated with most of the hearing handicap questions. Participants with measured bilateral hearing

impairment (>25 dB HL) compared with those without at baseline were at a higher risk of developing emotional distress as a result of their hearing impairment and were also more likely to experience social engagement restrictions 5 years later. These data suggest that deterioration of communication abilities can place constraints on social life. The strong, positive temporal link between measured hearing loss and hearing handicap in the current study reinforces previously published data that have shown significant links between hearing impairment and depression [17], reduced independence [18] and a greater risk of mortality [19].

Moreover, we observed independent associations between self-perceived hearing handicap and several indicators of negative well-being including poor quality of life, low self-rated health and the presence of depressive symptoms. Hence, our study demonstrates that the social and emotional conditions of hearing impairment could have an important bearing on the mental and physical health [20] of older adults. These findings are not surprising because those who feel handicapped by their hearing impairment may also tend to perceive themselves as being not in good health. Given that HHIE-S is a measure of the emotional distress of hearing-impaired persons as well as the social and communication troubles experienced with their families and friends [4], it is also not surprising that self-perceived hearing handicap was associated with depressive symptoms and poor quality of life. Findings from the BMHS concur with those of the EHLS [21], which demonstrated that HHIE-S scores rather than audiometric results correlated more closely with poorer quality of life. Additionally, a Japanese cohort study of adults aged ≥65 years showed that hearing handicap was a significant predictor of depressive symptoms 3 years later [20]. Thus, screening for self-reported hearing handicap would not only identify people with a greater need for further hearing evaluation and/or rehabilitation [5], but also those who could be at a greater risk of deteriorating overall health.

Our findings could have important public health implications as they suggest that interventions targeting self-perceived hearing handicap could be a potentially useful strategy for preventing a decline in the mental and physical well-being of older adults. Such potential strategies could include educational programmes on hearing impairment and communication which have previously been shown to improve HHIE measures among older people [22, 23]. Hence, effective audiological rehabilitation incorporating education about the nature of the hearing impairment, and proper hearing aid or assistive listening device usage, provided not only to the hearing-impaired individual but also to their family and friends [20], could prevent the induction of adverse health outcomes caused by self-perceived hearing handicap.

The current study has several strengths including its representative prospective, large cohort, high participation rate and use of standardised, audiometric testing to measure

hearing sensitivity. However, some limitations deserve discussion. First, measures of handicap were obtained by self-report, which could have led to an overestimation or underestimation depending on contextual factors [24]. However, we used a standardised instrument that is well documented in the literature. Second, we cannot rule out the possibility of residual confounding as there could have been several unmeasured parameters such as societal or lifestyle factors that could have influenced the association between hearing loss and incident hearing handicap. Third, we need to highlight the relatively small number of incident cases of hearing handicap at the 5-year follow-up which could have reduced the statistical power needed to detect modest associations. Fourth, we cannot rule out the possibility of selection bias, as 687 study participants did not have complete hearing handicap data, and significant differences in study characteristics between participants with and without HHIE-S data were observed, which could have influenced our results. Finally, well over half of hearing-impaired persons (65.0%) already had hearing handicap at baseline. Therefore, observed associations between hearing loss and hearing handicap from the current study could be an underestimation.

In summary, around two out of three older adults with measured hearing impairment at baseline went on to develop self-perceived hearing handicap within 5 years. Given that measured hearing impairment was an independent predictor of self-perceived hearing handicap and this in turn was linked with adverse health outcomes including poorer quality of life, depressive symptoms and low self-rated health, preventive strategies should target this common age-related condition in order to preserve an older person's mental and physical functioning.

Key points

- Around two out of three older adults with measured hearing impairment at baseline went on to develop self-perceived hearing handicap within 5 years.
- Hearing-impaired persons had a 3-fold higher risk of developing social and emotional deficits in everyday life.
- Targeting hearing handicap could be a useful strategy to preserve the optimal mental and physical functioning of older adults.

Conflicts of interest

None declared.

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