

Self-reported hearing loss and manual audiometry: a rural versus urban comparison

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ABSTRACT:

Objective: To examine whether self-reported hearing difficulty is an accurate measure of hearing loss compared to standard hearing screening with pure tone audiometry in rural and urban communities.

Design: Convenience sampling.

Setting: Urban and rural areas of Western Australia.

Participants: 2090 participants (923 male; 1165 female; 2 unknown) aged 20 to 100 years presenting for community-based hearing screening in urban (982) and rural (1090) areas.

Main outcome measures: Self-reported hearing difficulty assessed with the Hearing Handicap in the Elderly-Screening (HHIE-S) questionnaire. Hearing loss defined as average hearing thresholds >25 dB in the better ear using screening audiometry conducted at 500, 1000, 2000 and 4000 Hz.

Results: The HHIE-S was sensitive (≥ 60 yrs = 76.69%; < 60 yrs = 71.67%) but not specific (≥ 60 yrs = 45.15%; < 60 yrs = 49.63%) for identifying hearing loss. The < 60 age group had a

hearing loss prevalence of 25.6%, and a false-positive rate of 67.12% compared to a prevalence of 69.12% and false-positive rate of 29.77% for the ≥ 60 age group. For all ages, rural participants were more likely to have a disabling hearing loss (OR 2.04 [95% CI 1.55, 2.67]; $X^2(1)=27.28$; $p<0.001$) but there were no significant differences in hearing aid uptake.

Conclusions: Patients in rural areas presenting for hearing screenings are more likely to suffer a hearing loss than adults in urban areas. We suggest rural health practitioners incorporate a self-reported hearing loss questionnaire into health check-ups for adults, particularly patients aged ≥ 60 years due to the high prevalence of hearing loss in this group.

What is already known on this subject?

- Access to treatment for hearing loss may be limited in rural and remote areas
- Intervention for hearing loss in the pre-retirement period is associated with better patient outcomes
- Early identification of hearing loss in primary care using the standard audiometric screening can be costly, requiring specialised equipment and training

What this study adds:

- There is a significant difference in the presence hearing loss in rural populations compared to urban populations in a self-referring participants
- The prevalence of self-reported hearing loss in adults aged over 60 years is extremely high in a self-referring population
- Self-report measures are a cost-effective method of screening for hearing loss in primary care and identifying patients but lack accuracy compared to audiometric screening

INTRODUCTION

Approximately 15% of the world's adult population have some degree of hearing loss, half of which is considered to be disabling.¹ This makes hearing loss one of the top twenty causes of disease burden globally.¹ Hearing loss affects interpersonal communication, psychosocial wellbeing, quality of life and economic independence.² The lack of access and availability of appropriate interventions for patients, particularly those in remote and rural areas, is of significant concern.³

Screening for hearing loss involves audiological tests that are costly and are often not available in rural healthcare settings.⁴ Other screening methods, such as telephone-based hearing screening and the whispered voice test, have been shown to be a valid method of screening for hearing loss. However, telephone-based screening requires initiation from the patient and the whispered voice test is often dependent on clinician experience.^{5,6} Self-report questionnaires for identifying hearing loss have therefore been proposed as a cost-effective

and time-efficient method of audiological screening that can be utilised by any health professional group.⁷⁻⁹

The uptake of hearing aids by patients with hearing loss is low.¹⁰ Identification and intervention for hearing loss in the pre-retirement period (approximately 50 to 65 years of age) is associated with a greater uptake of hearing aids¹¹ and improved rehabilitation outcomes.²⁻⁵ Self-report questionnaires may therefore be useful in early identification of hearing loss, prompting early intervention and improved outcomes in those who are motivated to receive treatment and rehabilitation for their hearing loss.

The Hearing Handicap Inventory for the Elderly – Screening (HHIE-S)¹² is a widely used measure of self-reported hearing difficulty and has been adapted for different age and cultural groups.¹³ It has been extensively psychometrically validated,¹² has comparable accuracy to similar validated questionnaires¹⁴ and higher accuracy than a single question for diagnosing hearing impairment.¹⁵

This study was designed to evaluate the accuracy of self-report measure for determining hearing loss amongst self-referring patients compared to audiometric screening and to examine the association between the uptake of hearing aids and location (rural or urban).

METHODS

Study Cohort

Data from hearing screenings conducted on self-referred volunteers performed by the Lions Hearing Foundation in Western Australia between March 2010 and July 2013 were collated in this study. Excluded were 182 potential participants who declined permission for their data to be used, 5 who did not complete the audiometric screening, 11 who did not provide a date of birth, and 49 who were under the age 20 years; leaving a cohort of 2090 participants. For the purposes of this study, participants were divided into two groups at 60 years of age, broadly representing a pre-retirement group.

Materials and procedures

All participants completed the HHIE-S, a conventional audiometric hearing screening and an additional questionnaire including items on hearing aid use and outcomes designed by the investigators. HHIE-S scores of >8 indicated a hearing impairment. Ears were examined by

otoscopy to ensure there was no obstruction of the ear canal prior to screening audiometry, which was conducted with a GSI 17 audiometer (Grasson Stadler, Eden Prairie, MN, USA) and Peltor 211 headphones (3M, St. Paul, MN, USA), calibrated annually. Screening was conducted by trained, non-specialist volunteers in a sound-treated booth on a bus modified for mobile hearing screenings. Hearing screening commenced at 25 dBHL. Participants “passed” if they responded to low intensity sounds at 500, 1000, 2000 and 4000 Hz in both ears. If they did not respond, intensity was increased in 5 dBHL steps until the participant responded. Order of testing left or right ears first was not prescribed, and the order of testing frequencies was 500, 1000, 2000 and 4000 Hz.

Data analysis

Hearing screening and HHIE-S data, together with age, gender, location and hearing aid use were analysed in SPSS v21 (New York: IBM Corp). Hearing loss was defined as mild (best ear four-frequency average >25dB) or disabling (best ear four-frequency average >40dB) across the frequencies of 500, 1000, 2000 and 4000 Hz, according to the WHO criteria.¹ Accessibility/Remoteness Index of Australia (ARIA) classification codes¹⁶ were used to identify an urban (ARIA code: 0) or rural/regional address (ARIA codes: 1, 2, 3, 4) according to postcode.

RESULTS

Participant profile

Of the 2090 participants in the study, 982 (46.99%) resided in the metropolitan area of Perth and 1090 (52.15%) in the regional, rural or remote areas of Western Australia according to ARIA classifications; 18 (0.86%) people did not provide a valid postcode for ARIA classification. More females (n=1165) than males (n=923) were included; the sex of two people was not reported. The mean age of participants was 60.0 years (SD 13.93, range 20.3 to 100.32 years), with no statistically significant difference between the gender balances or age of urban versus rural participants (independent sample t-tests; $p>0.05$). Figure 1 shows the distribution of participants according to age, gender and hearing loss.

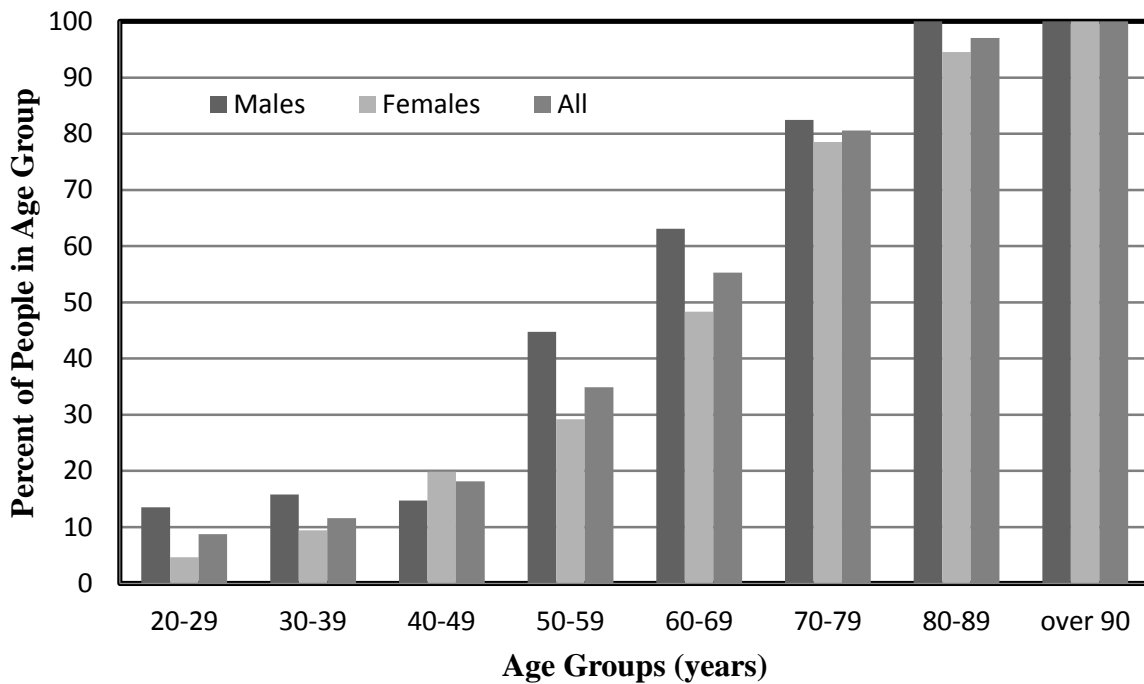


Figure 1: Prevalence of hearing loss (>25dBHL) according to age and sex in participants attending the Lions Hearing Bus.

Accuracy of HHIE-S self-report questionnaire

The sensitivity of the HHIE-S questionnaire was 76.69% (95%CI 73.33, 79.75), with specificity of 45.15% (95%CI 40.29, 50.01) for identifying mild hearing loss in adults aged ≥ 60 years. For adults aged < 60 years, the sensitivity of the HHIE-S was 71.67% (95%CI 65.35, 77.27) and specificity was 49.63% (95%CI 45.80, 53.46). The < 60 group had a false-positive rate of 67.12% [95%CI 62.82, 71.16] compared to 29.77% [95%CI % 26.57, 33.19] for the ≥ 60 group; the false-negative rate for the < 60 year old group was 16.42% [95%CI 13.01, 20.48] and for the ≥ 60 years group was 54.85% [95%CI 49.91, 59.71], (Table 1).

Table 1: Two-by-two tables showing accuracy of the HHIE-S for identifying hearing loss in adults.

Hearing loss criteria	<60 years of age		≥ 60 years of age	
	HHIE <8 (%)	HHIE-S ≥ 8 (%)	HHIE <8 (%)	HHIE-S ≥ 8 (%)
Normal hearing	336 (36.9)	341 (37.5)	186 (16.8)	162 (14.6)
Hearing loss (>25 dB)	66 (7.2)	167 (18.3)	226 (20.4)	533 (48.1)
Totals	402 (44.2)	508 (55.8)	412 (37.2)	695 (62.8)

HHIE-S, Hearing Handicap Inventory for the Elderly – Screening.

The prevalence of audiometric hearing loss in participants aged ≥ 60 years was 69.12% (95%CI 66.32, 71.79). Participants aged < 60 years had a lower prevalence (25.60% [95%CI 22.82, 28.59]) (Figure 1). There was an increased risk of having a HHIE-S score > 8 associated with participants from rural areas compared to urban areas (OR 1.32 [95%CI 1.11, 1.59]; $X^2(1)=9.51$; $p=0.002$). Participants in rural populations also had an increased risk of mild hearing loss (OR 1.73 [95%CI 1.45, 2.06]; $X^2(1)=38.13$; $p<0.001$) and disabling hearing loss (OR 2.04 [95%CI 1.55, 2.67]; $X^2(1)=27.28$; $p<0.001$). There were no differences in hearing aid uptake (mild hearing loss: OR 0.93 [95%CI 0.66, 1.46]; $X^2(1)=0.008$; $p=0.927$) (disabling hearing loss: OR 0.54 [95%CI 0.84, 2.20]; $X^2(1)=1.614$; $p=0.204$) (Tables 2 & 3).

Table 2: A comparison of prevalence and degree of hearing loss (HL) and use of hearing aid(s) (HA) in urban and rural areas (all ages).

Hearing loss criteria	Urban (n = 982)		Rural (n = 1090)	
	HL (%)	HL + HA (%)	HL (%)	HL + HA (%)
Mild HL	409 (41.6)	49 (5.0)	602 (55.2)	53 (4.9)
Disabling HL	88 (9.0)	29 (2.9)	182 (16.7)	43 (3.9)
Totals	675 (50.6)	105 (15.6)	788 (83.3)	72 (9.1)

Table 3: Analysis of participants with hearing loss (HL) and participants with hearing loss using hearing aids (HL + HA) in urban and rural areas (all ages).

Hearing loss criteria	Rural compared to urban locality			
	$X^2(1)$	<i>p</i>	OR	95%CI
Mild HL	38.13	<0.001	1.73	1.45, 2.06
Disabling HL	27.28	<0.001	2.04	1.55, 2.67
Mild HL + HA	0.008	0.927	0.93	0.66, 1.46
Disabling HL + HA	1.614	0.204	0.54	0.84, 2.20

CI, confidence interval; OR, odds ratio.

DISCUSSION

This study examined the prevalence of hearing loss in a cohort of self-referring adults from rural and urban areas of Western Australia. Participants in rural areas showed a significantly higher prevalence of hearing loss but their rates of hearing aid uptake were not significantly different. There was a high prevalence of hearing loss in those attending community-based

hearing screenings and the HHIE-S questionnaire was a sensitive, but not specific, measure for detecting a hearing loss for adults aged ≥ 60 years in this study. Approximately 70% of participants aged ≥ 60 years had an audiometric hearing loss. However, these prevalence figures cannot be generalised to the wider population due to the sampling method.

Population-based estimates of self-reported hearing loss are 46.2% for a regional population at 60-65 years of age.⁹ Whilst lower than our sample, this illustrates the high prevalence of self-reported hearing loss in the general population. Whilst this study did not examine the causes of hearing loss, both workers and families living in rural areas are at a higher risk of occupational noise exposure through agricultural and production industries.⁴

Our findings show an increased prevalence of hearing loss in regional and rural areas, and support previous calls⁹ for the better identification of hearing loss in primary care. Identifying and treating hearing loss in the pre-retirement period is associated with an increased uptake of hearing aids and improved rehabilitation outcomes.^{3,11} Considering the results of this study, the routine use of questionnaires for adults aged ≥ 60 years in a primary care may enable the early identification of hearing loss, due to the high prevalence of the condition in this age group. However, self-report hearing measures do not have comparable accuracy to audiometry, and better access to these services in rural and remote areas is therefore still needed.

For both age groups the HHIE-S was sensitive (≥ 60 yrs = 76.69%; < 60 yrs = 71.67%), but not specific (≥ 60 yrs = 45.15%; < 60 yrs = 49.63%). Low specificity could result in excessive referrals for patients who self-report a hearing difficulty in the absence of an audiometric hearing loss. This study produced similar sensitivity estimates to previous studies of the HHIE-S (Sindhusake et al. 2001; 80%)¹⁷, but with lower specificity (Sindhusake et al. 2001; 76%).

The HHIE-S false-positive rate for patients aged < 60 years was substantially higher (67.12%) compared to those aged ≥ 60 years (29.77%). False-positives incorrectly diagnose a patient as having a condition (i.e. self-reported hearing loss), in the absence of the condition according to the gold standard (i.e. hearing loss confirmed by audiometry). The impact of false-positives in the < 60 years group is likely to put greater strain on specialist services – resulting in an increase in referrals for hearing assessment in the absence of a hearing loss. However, it may be argued that a client who self-reports difficulty may still benefit from consultation.

The <60 year-old group had a lower false-negative rate than the ≥ 60 year old group, at 16.42% and 54.85%, respectively. This is expected, considering the high prevalence of hearing loss in the ≥ 60 years age group. These false-negatives represent patients with a hearing loss according to audiometric testing, who did not self-report a hearing loss using the HHIE-S. Whilst these patients may not feel they are experiencing sufficient limitations on their quality of life to warrant intervention, counselling on the impact of hearing loss and the benefits of early intervention may be beneficial.¹⁸

The cost-effectiveness of audiometric screening in community settings has been debated and there is some evidence that hearing screening increases the uptake of hearing aids.¹⁹

However, both screened and not-screened groups in the Yueh et al. (2010)¹⁹ study showed a low-uptake of hearing aids when followed-up one year after screening.

Pronk and colleagues²⁰ have argued for better methods of hearing screening in adults and a wider range of alternative rehabilitative options in addition to hearing aids, such as informational counselling and communication strategies. In our study the HHIE-S showed poor specificity for identifying a clinically significant, audiometric hearing loss. This suggests that self-report measures may identify patients with listening difficulties, in the absence of audiometric hearing loss, who could benefit from these alternative rehabilitation options. This finding also highlights the need for better access to specialist hearing services in rural areas to distinguish between patients who would benefit from hearing aids, medical or surgical intervention or communication tactics.

Whilst screening questionnaires can be effective in detecting hearing loss early, these methods are not sufficient for a definitive diagnosis, which requires a diagnostic audiometry assessment. These services are rarely available in rural and remote areas²¹ and result in increased time and cost to travel to the nearest specialist, or require a specialist visit the region. The advent of automated audiometers^{22,23} that can be operated via telehealth or local primary care staff and interpreted remotely by audiologists may serve as a means of improving access to these specialist services. This technology, in conjunction with self-report measures, has the potential to streamline the clinical pathway of patients from identification to appropriate diagnosis and intervention.

LIMITATIONS

As participants voluntarily presented for hearing screening it can be assumed that many already had concerns about their hearing and were therefore not representative of the general population. Poor specificity of the HHIE-S in this study is in contrast to other studies where specificity has ranged from 70-95%.^{17,24} However, numerous population-based studies support the recommendation of regular, primary-care assessments for self-reported hearing loss, whether via a single-question or validated questionnaire.⁷⁻⁹

CONCLUSION

The results highlight the increased risk of hearing loss in rural areas. This study demonstrates the potential value of self-report measures for detecting hearing impairment for adults, particularly those aged ≥ 60 years in setting where audiometric screening equipment is not available. However, greater provision of audiometry services would allow more accurate identification of hearing loss.

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